THE RELATIONSHIP BETWEEN QUALITY MANAGEMENT AND SUPPLY CHAIN MANAGEMENT: AN ANALYSIS OF THE AUTOMOTIVE INDUSTRY IN THAILAND

by

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December 2009

ACKNOWLEDGEMENT

First, I wish to express my deepest gratitude and sincere appreciation to my advisor, Dr.Barbara Igel, for her dedication, helpful guidance, invaluable suggestions and constant encouragement which has made this dissertation possible.

I am indebted to Professor John C.S. Tang, Professor Voratas Kachitvichyanukul and Dr. Tritos Laosirihongthong for their constructive comments and valued suggestions while serving as members of the examination committee.

Sincere appreciation is also conveyed to the experts, Mr. Parinya Siriattakul, Dr. Duangpun Kritchanchai, Dr. Tuanjai Somboonwiwat, Dr. Walailuk Atthirawong, Dr. Ninlawan Choomrit, Dr. Adisak Theeranuphattana, Dr. Nilubon Sivabrovornvatana, Mr. Suwat Janyapoon, Mr. Somkiat Engpornsin, Mr. Ponlatep Pantanakul, Mr. Jaruk Sripa, Mr. Piboon Tiyasuttipun, for giving constructive advice in research instrument development and analysis in this study.

Special thanks are due to Prof. Keah-Choon Tan for graciously consenting to act as the external examiner and taking the efforts to provide suggestions to enrich my dissertation.

Genuine thanks are extended to Mrs. Chanoksuda and Dr. Tawit Sudsakorn for their valuable time in editing the dissertation and morale support during the study.

Grateful thanks also to all the organizations and respondents to my questionnaires for their time and participation in this research.

In addition, I wish to thank all staff of the School of Management, Asian Institute of Technology, for their assistance throughout my study.

I am thankful to all my friends and classmates for their help and for making life at this school more enjoyable and meaningful.

Words fail to enable me to express my wholehearted gratitude to my dearest parents and family members for their love, understanding, patience, and morale support, which have inspired me during my study. This humble accomplishment is only a small reflection of their tireless and uncompromising efforts.

ABSTRACT

This study investigates the impact of Quality Management Practices (QMP) on Supply Chain Management Practices (SCMP) and Firm's Supply Performance (FSP) in the automotive industry in Thailand. To achieve this objective, the measurement instruments of SCMP, QMP and FSP were developed based on an extensive literature review and were verified by experts and a pilot test. For the large-scale survey data collection, multiple responses from each company were sought to improve the reliability of the information obtained. In total, 211 companies responded to the paper-based surveys or e-questionnaires. Non-respondent bias and multiple respondent bias tests were conducted to ensure similarity between respondents and non-respondents and between the single and multiple responding firms. Then, the reliability of the measures was examined with item-total correlations, Cronbach's alpha, composite reliability and average variance extracted. The first-order, the second-order confirmatory factor analysis, convergent, discriminant and nomological validity were applied to confirm validity. The results show that the set of SCMP, QMP and FSP measures and their underling theories are reliable and valid for Thailand's automotive industry. A hypothesized model was tested using path analysis of the structural equation modeling, revealing that QMP does not only have a direct positive impact on SCMP and FSP, but it also has an indirect positive impact on FSP via SCMP. This result was valid for the whole sample and the Thai owned companies. Furthermore, descriptive statistic validated that the automotive companies in Thailand applied QMP more extensively than SCMP. MANOVA was employed to investigate the differences across organizational characteristics (company ownership, company size, tier in the supply chain and quality management maturity) on SCMP, QMP and FSP. Overall, there were significant differences across organizational characteristics on SCMP, QMP and FSP. Japanese companies, large companies, first-tier suppliers and the companies with ISO/TS 16949 had more intensively applied SCMP and QMP and achieved a higher level of FSP. Through multiple regression analysis, it was found that, overall, QMP significantly supported every SCMP sub-construct. There was synergistic effect of simultaneously implemented SCMP and QMP on FSP. Moreover, SCMP had partial mediation effect on the relationship between QMP and FSP. In addition, in-depth case studies of two companies helped provide more information in a qualitative manner. Generally, the case study findings confirmed that QMP had a positive impact on SCMP and FSP and the management recommended that industry-specific quality management systems such as ISO/TS 16949 should be introduced before implementing supply chain management. However, the case companies still experienced some negative effects especially when employees were adhering too strictly to quality management standards or did not clearly understand and did not align their functional objectives to the corporate goals.

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LIST OF ABBREVIATION

CFA	Confirmatory Factor Analysis
CWQC	Company Wide Quality Control
ECR	Efficient Consumer Response
EQA	European Quality Award
FSP	Firm's Supply Performance
FTI	Federation of Thai Industry
GMP	Good Manufacturing Practice
GSCF	Global Supply Chain Forum
HACCP	Hazard Analysis and Critical Control Point
IATF	International Automotive Task Force
IEAT	Industrial Estate Authority of Thailand
JIT	Just In Time
MANOVA	Multivariate Analysis of Variance
MBNQA	Malcolm Baldrige National Quality Award
MLE	Maximum Likelihood Estimation
QA	Quality Assurance
QC	Quality Control
QDC	Quality-Delivery-Cost
QM	Quality Management
QMP	Quality Management Practice
QR	Quick Response
SCC	Supply-Chain Council
SCM	Supply Chain Management
SCMP	Supply Chain Management Practice
SCOR	Supply Chain Operations Reference
SCQM	Supply Chain Quality Management
SEM	Structural Equation Modeling
SSC	Seamless Supply Chain
TAI	Thailand Automotive Institute
TAPMA	Thailand Automotive Part Manufacturer Association
TCA	Transaction Cost Analysis
Thai-VCML	Thai Value Chain Management and Logistics
TPI	Thailand Productivity Institute
TPS	Toyota Production System
TQC	Total Quality Control
TQM	Total Quality Management

CHAPTER 1
INTRODUCTION

1.1 Introduction

Supply Chain Management (SCM) and Quality Management (QM) are playing an increasing role in strengthening organizational performance (Sila *et al.,* 2006). In a dynamic international market, quality is not enough. Supply at the right time, place and cost is critical for competitive advantage (Chin *et al.*, 2004; Robinson and Malhotra, 2005). Moreover, the global business competition is not only between the firms but between supply chains of the firms (Li *et al.,* 2006; Kuei *et al.,* 2001). Therefore, most leading companies have adopted SCM and QM. Some have even restructured their organizations to facilitate the adoption by establishing a separate department for SCM and QM. However, an integrative implementation of both systems is difficult. It takes time and great effort, and consumes considerable investment due to the extended scope that covers not only internal functions but also the operations of external business partners. If the implementation can, however, be accomplished, costs can be recovered and the organization should reap a great deal of benefits. If the implementation fails, there would be a serious impact on the business performance of an organization.

Although, both SCM and QM are critical for organizational competitiveness, the subjects have been, most of the time, studied separately (Gunasekaran and McGaughey, 2003; Robinson and Malhotra, 2005; Casadesus and Castro, 2005). On the contrary, this research aims to study and analyze the relationship among SCM practices (SCMP), QM practices (QMP) and Firm's Supply Performance (FSP). Since, supply chain performance covers supply performance of the whole supply chain; while, firm's supply performance includes only supply performance of the supply chain members. It must be noted that FSP in this study covered firm's supply performance of the automotive part suppliers not the supply chain performance of the whole automotive supply chain. The automotive industry in Thailand has been employed as a case study because the automotive supply chain is very complex and very active in both SCM and QM. Also, the automotive industry is one of the globally competitive industries in Thailand. Particular SCMP, QMP and FSP which are commonly applied in the automotive industry in Thailand will be identified and classified in this study. The differences across organizational characteristics on SCMP, QMP and FSP in the implementing organizations will also be examined. Although there are many levels of QM such as Quality Control (QC), Quality Assurance (QA) and Total Quality Management (TQM), the TQM framework is used as a reference framework for QM in this study because, TQM is generally and widely accepted as the superior QM system.

1.2 Rationale for the Study

1.2.1 Contribution of the Automotive Industry to the Thai Economy

The automotive industry is one of Thailand's competitive industries in the global market. For this reason, the Thai government has a strategic national policy to heavily and continuously promote the automotive industry. A dedicated national institute known as Thailand Automotive Institute (TAI) has been established to promote the Thai automotive industry. Between 1998 and 2007, the volume of cars manufactured in Thailand grew dramatically by 808.3% (89.8 % per year) from 143,250 units to 1,301,149 units as shown in Table 1.1 (Thailand Automotive Institute, 2008). Currently, the world leading automotive manufacturers, namely Toyota, General Motors, Ford, Honda, Isuzu, etc. all have their own manufacturing bases in Thailand.

Table 1.1: Growth of the automotive industry in Thailand during 1998 - 2007

Year	Manufactured Car (units)
1998	143,250
1999	321,411
2000	405,761
2001	454,797
2002	564,392
2003	750,512
2004	960,371
2005	1,125,316
2006	1,193,885
2007	1,301,149
Average Annual Growth	89.8 %

Source: Thailand Automotive Institute (2008)

1.2.2 Impact of Quality Management on the Supply Chain Management and Firm's Supply Performance

Ideally, QM deployed at the firm level is considered a critical success factor for SCM (and vice versa) to deliver quality products to the customer(s) at the right time and right cost**.** Without providing empirical evidence, Gunasekaran and McGaughey (2003) suggested that TQM may significantly affect SCM. Similarly, Bandyopadhyay and Sprague (2003) stated that *"TQM approach can be effectively implemented in a supply chain for achieving quality excellence and competitiveness in a world market place"*. Accordingly, TQM approach can be applied to complex supply networks such as the automotive supply chain. Although an average automobile consists of over 15,000 components, only a few are manufactured by the final assemblers (Perez and Sanchez, 2001). Most component parts are manufactured

and supplied by a network of specialized vendors. Therefore, price, quality and delivery of an automobile depend significantly on those of its components, which in turn are influenced by quality and efficiency of all partners along the supply chain. As a result, the automotive industry is one of the most active industries in the development of supply networks and clusters of suppliers. Most companies in this industry have implemented Just-In-Time (JIT) purchasing and operations. JIT is one of the crucial aspects of SCM which helps companies maintain an on-time delivery and minimize unnecessary inventory cost of component parts and especially that of finished automobiles. To achieve JIT delivery, quality of the whole internal operations as well as that of the external partners (such as upstream suppliers and downstream customers) should assure zero defect, zero breakdown, zero delay and zero inventory. However, few empirical research has been conducted to confirm this.

1.2.3 Research on Supply Chain Management and Quality Management

QM has been widely researched by numerous studies. There are many research studies on the impact of QM on business performance, for example, Rahman (2001), Sun (2000), George and Sherry (1998), Danny and Mile (1999), Khan (2003), Hendricks and Singhal (1997), Prabhu *et al.* (2000). Some researchers have studied the impact of QM on specific performance dimensions. For example, Hoang *et al.* (2006) as well as Prajogo and Sohal (2003) have studied the impact of TQM on innovation. Eriksson and Hansson (2003) have researched the impact of TQM on financial performance. Li *et al.* (2002a) have studied the impact of QM on customer relationship management. For SCM, several studies have discussed the contribution of SCM in improving business performances in general. These studies include those of Scannell (2000), Tan *et al.* (1999), Kuei *et al.* (2001), Li (2006), Tracey *et al.* (2005).

While there is some evidence that QM and SCM share several similarities, they have been mostly studied separately. Only few empirical research have explored the relationship between QM and SCM in different aspects (Gunasekaran and McGaughey, 2003; Robinson and Malhotra, 2005; Casadesus and Castro, 2005; Kuei *et al.,* 2001). For instance, Casadesus and Castro (2005) have explored the impact of ISO 9000 on SCM, but could not confirm that ISO 9000 fully supports SCM. Romano and Vinelli (2001), in one case in the textile and apparel industry compare the firm's QM practices in two types of supply chain relationship. These are traditional and coordinated supply chains. This found that the coordinated supply chain has better ability to achieve customers' quality expectations. Choi and Rungtusanatham (1999) have compared QM at three supply chain levels, i.e., final assemblers, top-tier suppliers and tertiary-tier suppliers, in the automotive, electronics and other industry groups. However, they could not find any statistically different quality levels across the supply chains in their samples.

Claims and counterclaims about the impact of QM on SCM are rarely supported with rigorous empirical evidences. Therefore, such interrelationships should be judged against rigorous statistical and empirical evidence generated through a systematic research methodology.

1.3 Research Questions and Objectives of the Study

SCM and QM are widely applied and contributed significantly to the automotive industry in Thailand. Their frameworks are, however, still unclear and not commonly accepted. Thus, the first research question of this study is:

1) Which SCMP, QMP and FSP are commonly applied in the automotive industry in Thailand?

SCM and QM share many similarities and differences in aspects such as goals and integration. However, they are usually separately studied, implemented and almost never integrated together. The integration of both approaches may release some synergies. Therefore, the second research question of this study is:

2) Does QM have any impact on SCM?

However, both SCM and QM have there own practices. The second research question can be detailed further to the following specific questions:

2.1) Do QMP have any impact on SCMP?
2.2) Do QMP have any impact on FSP?
2.3) Do SCMP have any effect on the relationship between QMP and FSP?

Moreover, there might be differences across organizational characteristics such as ownership, company size, tier in the supply chain and QM maturity on SCMP, QMP and FSP of the implementing organizations. Therefore, the third research question is:

3) Are there differences across organizational characteristics on SCMP, QMP and FSP?

It is interesting to study the impacts of QM on SCM in order to examine whether or not QM significantly and positively affects SCM of the automotive industry in Thailand (Gunasekaran and McGaughey, 2003; Ayers, 2001). This study aims to contribute to the academics and practitioners in the area of SCM and QM, especially those in the automotive industry in Thailand. The objectives of this study are

1) To identify and classify SCMP, QMP and FSP measures which are commonly applied in the automotive industry in Thailand.
2) To study the relationships among SCMP, QMP and FSP of the automotive industry in Thailand. Such relationships include
    2.1) The effects of QMP on SCMP
    2.2) The effects of QMP on FSP
    2.3) The effects of SCMP on the relationship between QMP and FSP
3) To identify and examine the differences across organizational characteristics on SCMP, QMP and FSP in the implementing organizations.

1.4 Scope of the Study

The scope and application of SCM and QM are very vast and still extending. They are varied by many factors such as industry, management style and organizational characteristic. Accordingly, the scope of the study can be summarized as follows:

- The population of the study was automotive part manufacturers in Thailand. The automotive manufacturers, the automotive dealers as well as the companies in supportive industries such as mold and die manufacturers were excluded.
- Organizational characteristics of the samples such as major shareholder, company size, tier in the supply chain, quality management maturity were not constrained.
- SCMP, QMP and FSP in the study included both strategic level and operational level.
- FSP in this researched included firm's supply performance of the automotive part suppliers not the supply chain performance of the whole automotive supply chain.

1.5 Benefits of the Study

The study significantly and directly contributes to academics and practitioners especially those in the automotive industry in Thailand.

- SCMP, QMP and FSP which are commonly used in the automotive industry in Thailand will be identified, classified and discussed in this study.
- The relationship among SCMP, QMP and FSP of the automotive industry in Thailand will be examined.
- The differences across organizational characteristics on SCMP, QMP and FSP in the implementing organizations will be investigated.
- Finally, strategic decision making on return on investments on both SCM and QM implementation can be determined more precisely, systematically, effectively and efficiently in this study. Failure in the implementations of both which can severely affect the entire firm's business performance could be avoided or at least minimized.

In addition to the mentioned direct benefit to the automotive industry in Thailand, this study and its concept can also be used as a reference for the automotive industry in other countries. It can be applied to other industries, especially those industries that need a lot of component parts and have a complicated supply network such as electrical and electronic appliance industry. Furthermore, the concepts of this study are applicable to other related research areas, for example, the impact of QM on good governance or on e-commerce and vice versa.

1.6 Supply Chains in the Automotive Industry

Supply chains in different industries have different characteristics that may require different SCM tools, techniques and applications. In accordance with the classification by Cigolini *et al.* (2004), the automotive supply chain falls into the category of lean supply chain. Lean supply chain is appropriate for the products that do not focus mainly on novelty or price, but compete concurrently on quality, novelty, price, and customer service. Most of them are internally complex products such as automobiles, computers and white goods.

Due to complexity of the manufacturing process, the automotive supply chain needs collaboration among the part suppliers, especially the first-tier suppliers and the automobile assemblers, in order to reduce internal complexity of the automobile assemblers operations. This can be done by designing products and processes in a modular way and by operating with JIT concepts and principles.

1.6.1 First-Tier Suppliers

Normally, automotive assemblers have a large number of parts suppliers due to complexity of the automobiles and tremendous size of the industry. However, too many suppliers lead to complexity in the supply chain, management difficulty and unnecessary cost. Therefore, automotive assemblers have attempted to reduce the number of suppliers. At present, they are only focusing and working closely with a small group of first-tier suppliers, who provide sub-assemblies to them. Outsourcing non-core activities to first-tier suppliers can help automobile assemblers leverage and improve their internal and external competitiveness through technology, product quality, delivery, cost and flexibility. Therefore, outsourcing and relying on partnership and consistent performance of the first-tier suppliers are a growing trend in the automotive industry worldwide including in Thailand.

Although, some value-added activities are assigned to first-tier suppliers via outsourcing strategy, the automotive assemblers still dominate the supply chain as focal firms. They still control the core technology, research and development capabilities and the marketing system. The automotive assemblers expect that the first-tier suppliers will strategically and efficiently manage their own suppliers in next tiers of the supply chain in the same manner.

1.6.2 Modular Supply

A structure of a car is composed of a set of modules such as airbags, brake systems, wiring harness, heating and air-conditioning systems, instrument cluster, and steering column. In the modular supply concept, first-tier suppliers have to supply complete modules as a single unit to the automobile assemblers rather than the individual component which constitutes a module. This allows the design and manufacturing of the subassemblies to be transferred to first-tier suppliers. Complexity of the internal operations of the automobile assemblers is thus reduced. Moreover, the automotive assemblers are able to focus more on their core

competencies which are core technology, research and development capabilities and marketing systems. The modular suppliers also gain more responsibilities and involvement in new products and process development with a higher value creation.

However, only being a first-tier supplier is not enough to compete in the modular supply chain. The modular suppliers have to develop competencies that are critical to the modular environment so as to increase leverage towards the automotive assemblers. They need to have intrinsic technologies; which, the automotive assemblers cannot deliver by themselves. Moreover, they must also have critical characteristics of the mature suppliers such as key resources, supplier relationship capabilities, excellent SCM and QM, and value transfer potential.

1.6.3 Just-in-Time (JIT)

Inventory cost is a considerable cost in the automotive industry. It can be in the form of component parts, work in process and finished vehicles. To resolve this problem, JIT has been initiated and successfully implemented by Toyota Motor Corporation (Chase *et al.,* 2001; Nicholas, 1998). At present, JIT purchasing and operations have an increasing role in managing and minimizing inventories in many industries, especially, in the automotive industries. JIT aims to deliver right products with right quantity to right customers at the right place and the right time by eliminating all kinds of waste (e.g., inventory, over production, and transportation) along the supply chain (Tan *et al*, 2004; Kannan and Tan, 2005).

JIT in the lean supply chain environment means suppliers produce component parts only when the customers order them. They will promptly deliver a small batch of parts to the automotive assemblers. Small quantity of components may be mixed together and loaded onto a single truck. Ideally, the delivery is headed directly to assembly lines without incoming inspection. Therefore, the first-tier suppliers are normally located close to the automotive assemblers to have better communication and lower transportation cost. Moreover, localization of components is needed to allow higher frequency of deliveries and lower inventory in small lot environment. JIT purchasing needs strong buyer-supplier relationship and supplier development program based on mutual benefit to ensure quality and supply commitment. It also needs extensive communication among the automobile assembler and its suppliers through advanced production scheduling. Other important JIT practices include set-up time reduction, the use of Kanban, process design and standardization, preventative maintenance and quality control, for example (Tan *et al*, 2004; Kannan and Tan, 2005).

1.7 Organization of the Report

This dissertation is organized into six chapters as follows:

Chapter 1 Introduction: This chapter presents the overview of the study, the rationale for the study, research questions and objectives of the study, the scope of the study, the benefit of the study, the supply chain in the automotive industry, and the organization of the report and summary.

Chapter 2 Literature Review: This chapter reviews SCM and QM literature extensively. It included literature regarding similarities and differences between SCM and QM and their relationships, possible positive and negative relationships among SCMP, QMP and FSP, relevant research in those relationships, various frameworks of SCMP, QMP and FSP and summary.

Chapter 3 Conceptual Framework, Hypothesis and Research Methodology: This chapter identifies the conceptual framework and hypotheses based on the extensive literature review, research questions, objectives and the scope of the study. Moreover, research instrument development and data collection process are explained in this chapter. Collected data are primarily classified and analyzed by organizational characteristics. Statistical techniques for data analysis to be applied in this study are introduced.

Chapter 4 Data Analysis and Discussion: This chapter applies the comprehensive statistical techniques to the research in response to the research questions, objectives of the study and research hypotheses. The analytical results are also extensively discussed.

Chapter 5 Case Study: This chapter presents and examines case studies of two selected first-tier supply companies which apply SCM and QM to better explain their relationship in a qualitative manner.

Chapter 6 Conclusions and Recommendation: In this chapter, the findings and implications of the study are explained. Finally, the contribution and limitation of the study as well as the recommendation for future research are discussed.

1.8 Summary

Mostly, SCM and QM have been studied separately although they are claimed to be critical for organizational performance and competitiveness. Few studies have empirically explored the relationship between SCM and QM. This research aims to analyze the relationships among SCMP, QMP and FSP in the automotive industry in Thailand. Hence, SCMP, QMP and FSP measures which are commonly applied in the automotive industry in Thailand and the differences across organizational characteristics on SCMP, QMP and FSP in the implementing organizations are examined in this study. The automotive industry in Thailand is used as a case study, because the automotive supply chain is very complex and very active in both SCM and QM. Moreover, automotive industry is considered as one of Thailand's competitive industries in the global market, and has contributed significantly to the Thai economy.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

This chapter reviews SCM and QM literatures extensively for further development of the conceptual framework and hypotheses. Similarities and differences between SCM and QM are identified and discussed in order to frame the possible relationships among SCMP, QMP and FSP. Moreover, existing literature regarding such relationships are reviewed. Then, various frameworks of SCMP, QMP and FSP are examined to shape the constructs.

2.2 Philosophical Perspective of QM and SCM

TQM is acclaimed as a superior quality management system/concept. TQM has been defined in many ways (Sun, 2000), particularly as a management philosophy (Perry and Sohal, 2001; Khan, 2003; Chan *et al.*, 1999; Terziovski and Samson, 1999) *"that encourages cost reduction, the creation of high quality goods and services, customer satisfaction, employee empowerment, and the measurement of results"* (Gunasekaran and McGaughey, 2003).

Similarly, SCM can also be understood as a management philosophy (Tan *et al.,* 2002; Chan and Qi, 2003). For instance, Lummus and Vokurka (1999) reviewed Ellram and Cooper (1993)'s definition, which states that "*SCM is an integrating philosophy to manage the total flow of a distribution channel from supplier to ultimate customer"*.

As a result, Vanichchinchai and Igel (2009) concluded that as management philosophy tends to be intangible and aims to describe an ideal, TQM and SCM could be further developed to include innovative management practices, tools, techniques, applications and anything else that would be in line with both conceptual approaches. However, the fact that there is still no consensus on conceptual definitions for TQM and SCM poses obstacles to their practical implementation. Therefore, there is a need for a new framework, especially for SCM, since it is particularly difficult to clearly define and, therefore, to implement.

Table 2.1: Similarities and differences between TQM and SCM

Concepts	TQM	SCM
Perspective (Example)	Management philosophy and large-scale management system	Management philosophy and large-scale management system
Original Function	Quality inspection	Logistics
Evolutional Stage	Inspection → QC → QA → TQM	Logistics → SCM → SSC (Seamless supply chain)
Maturity Stage (Example)	1) Unaware, 2) Uncommitted, 3) Initiator, 4) Improver, and 5) Achiever (Chin *et al.*, 2002)	1) Baseline, 2) Functional Integration, 3) Internal Integration and 4) External Integration (Stevens, 1989)
Ultimate Goal	Customer satisfaction	Customer satisfaction
Primary Goal	Specification-based performance or quality (Q)	Time-based performance or delivery (D)
Ultimate Integration	Both internal and external integration	Both internal and external integration
Primary Integration	Internal participation (executives and employees)	External partnership (suppliers and customers)

Source: Vanichchinchai and Igel (2009)

2.3 Goal of Quality Management and Supply Chain Management

2.3.1 Ultimate Goals

Both TQM and SCM aim to achieve customer satisfaction (Gunasekaran and McGaughey, 2003; Gunasekaran *et al.,* 2001; Mills *et al.*, 2004 in Lamey, 1996). However, customer satisfaction is a buzzword which is easy to say but difficult to do and even more so to accomplish. There are many strategies and approaches to satisfy customers. Basically, customers require better quality, faster delivery and cheaper cost or QDC (quality-delivery-cost). The organizations must meet these requirements to achieve customer satisfaction.

2.3.2 Primary Goals

Quality could be viewed from many perspectives depending on the context within (Khanna *et al.*, 2003). Crosby (1984) defined quality as defect avoidance (Khanna *et al.*, 2003) and Crosby (1979) advocated zero defect management (Calingo, 1996). BSI EN ISO 9001: 2000 (British Standards Institute, 2000) defines quality as the *"degree to which a set of inherent characteristics (distinguishing features) fulfils requirements"* (Manning *et al.*, 2006). Similarly, Schroder and McEachern (2002) indicated that quality is *"the degree to which a set of inherent characteristics fulfill requirements"*. That is why conventional QC focuses on specification-based performance or *"small-q"*. It emphasizes inspection to prevent defectives delivered to customers. Accordingly, ISO 9000 has its operational definition of quality as conformity to documented requirements (Kartha, 2004). Sun *et al.,* (2004), Prajogo and Sohal (2004) as well as Prajogo and Sohal (2001) agreed that TQM focuses more on quality by conformance. It aims to deliver error-free products and services. Modern QM tools and techniques (e.g. TS-technical specification, six-sigma) still imply this primary purpose in their terminologies. At present, bigger scope of quality or *"big-Q"* could be extended to cover whatever customers require including safety, environmental friendly features, flexibility and agility.

Unlike TQM, SCM basically satisfies customers with delivery or time-based performance. Efficient delivery always leads to cost effectiveness in the supply chain. Jayaram *et al.* (2000) had reviewed SCM literature extensively and concluded that the issue of timing receives special attention in SCM research. SCM aims to respond to customers rapidly at the right time, place and cost to customers (Chin *et al.*, 2004; Kuei *et al.,* 2001). Samaranayake, (2005) indicated that SCM aims to accomplish speed-to-market, agility and flexibility in order to respond quickly to customer requirement with minimum cost. Lummus and Vokurka (1999) also reviewed SCM literature extensively and summarized the supply chain as *"all the activities involved in delivering a product from raw material through to the customer…"*. Similarly, Lummus *et al.,* (2003) advised that SCM *"requires coordination among various entities involved in delivery of a product to the ultimate consumer"*. Lee and Ng (1997) defined SCM as *"a network of entities that starts with the suppliers' supplier and ends with the customers' custom the production and delivery of goods and services"* (Croom *et al.*, 2000).

According to the delivery, several SCM experts agree that SCM emphasizes flow of material and information throughout the whole supply chain and present this concept in their SCM definition. For instance, Casadesus and Castro (2005) concluded that *"the true object of study in SCM is the flow of materials from the supplier to the customer, via all the agents involved"*. Ellram (1991) advised that supply chain is *"a network of firms interacting to deliver product or service to the end customer, linking flows from raw material supply to final delivery"* (Croom *et al.*, 2000). Moreover, Logan and Harold (2001) indicated that *"SCM involves seamlessly moving raw material through production and into the hands of the end user"* (Varma *et al.,* 2006). Russell (2001) complemented that *"SCM is the practice of co-coordinating the flow of goods, services, information, and finances as they move from raw material to parts supplier to manufacturer to wholesaler to retailer to consumer"* (Varma *et al.,* 2006). Mentzer *et al.* (2001) defined supply chain as "*three or more organizations directly linked by one or more of the flows of products, services, finances, and information from a source to a customer*" Golicic *et al.* (2002). Similarly, Kopczak (1997) advised that supply chain is *"the set of entities, including suppliers, logistics services providers, manufacturers, distributors and resellers, through which materials, products and information flow"* (Croom *et al.*, 2000). This may be because traditional SCM focused on logistics, physical distribution and transportation (Gilmour, 1999; Croom *et al.*, 2000).

SCM has been described in various terms: supplier integration; partnerships; supply base management; supplier alliances; supply chain synchronization (Tan *et al.,* 2002); network sourcing; supply pipeline management; value chain management and value stream management (Croom *et al.,* 2000; Romano and Vinelli, 2001) and as a demand chain (Kotzab and Otto, 2004 in Vahrenkamp, 1999; Blackwell and Blackwell, 1999). In regards to the primary goal of SCM, Vanichchinchai and Igel (2009) commented that the primary goals of QM and SCM target quality and delivery respectively. If the term QA is used to represent operational quality (e.g. ISO 9000, ISO/TS 16949), either Supply Assurance (SA) or Delivery Assurance (DA) may be employed to represent operational SCM (e.g. QR, ECR, JIT). If the term TQM is referred to as the superior QM, Total Supply Management (TSM) or Total Delivery Management (TDM) may be used to describe the superior SCM.

Moreover, Vanichchichai and Igel (2009) advised that although TQM and SCM share the same ultimate goal, which is customer satisfaction, their primary goals are different, as implied by the emphasis on "quality and supply" (see Table 2.1). Better quality and a faster delivery always lead to lower costs. Finally, better QDC enhances customer satisfaction and the competitiveness of the whole supply chain. In some cases, there may be a trade-off if conflict arises between quality and delivery performance, and this is when the difference in primary goals can present potential problems in implementing an integrated TQM and SCM approach. On the other hand, there is synergy in the ultimate goal, since both TQM and SCM aim to achieve customer satisfaction. Therefore, more research needs to be done to further explore the potential areas of conflict and synergy.

2.4 Development and Maturity of QM and SCM

2.4.1 From Quality Inspection to TQM

The evolution of QM started from quality inspection to QC, QA and TQM. This evolution also reflects the maturity of QM. In general, the traditional QM consists of reactive result-oriented approaches. In comparison, the modern QM places more emphasis on quality at source or process control by every related party (e.g. suppliers, R&D, purchasing, production, maintenance, customers) so as to prevent errors which cause defects. It is a proactive process-oriented approach (Mehra and Agrawal, 2003).

Quality inspection focuses on counting, grading and sorting to prevent defective or non-compliant products from being delivered to the customers in order to minimize external failure costs (Lau *et al.*, 2004). QC applies various statistical quality control techniques such as control charts and sampling plans to monitor and control processes (Lau *et al.*, 2004). In the concept of QA, the aim is to for everything to be right the first time and every time (Pheng and Hwa, 1994). QA emphasizes more on the process control to conform and to satisfy customer requirements (Prajogo and Sohal, 2004). Early (1995) defined QA as *"a strategic management function concerned with the establishment of policies, standards and systems for the maintenance of quality" (*Manning *et al.,* 2006). ISO 9000 is a good example of QA (Kartha, 2004). It examines quality as a process from the beginning to the end of the process (Goldman, 2005; Talha, 2004) and aims to control process rather than product quality (Magd and Curry, 2003; International Organization for Standardization, 2007). With the awareness of QA, several dedicated QA such as ISO/TS 16949 in the automotive industry, HACCP (Hazard Analysis and Critical Control Point) in the food industry, GMP (Good Manufacturing Practice) in the food industry are introduced to specific industries in order to prevent quality problems and control quality at their source. Currently, all of these have become internationally accepted QA.

TQM is considered as a superior QM. Even ISO 9000 could be determined only as a subset of TQM (Kartha, 2004; Anderson *et al.*, 2004). The concept of TQM was firstly presented in 1957 when Dr. Feigenbaum presented his paper entitled "Total quality control". He defined TQC as *"an effective system for integrating the quality development, quality maintenance, and quality-improvement efforts of the various groups in an organization so as to enable production and service at the most economical levels which allow for full customer satisfaction"* (Martinez-Lorente *et al*., 1998). Ishikawa (1990) introduced Company Wide Quality Control (CWQC) in Japan in 1968 as *"quality control consists of developing, designing, producing, marketing, and servicing products and services with optimum cost-effectiveness and usefulness, which customers will purchase with satisfaction. To achieve these aims, all the separate parts of a company much work together"* (Martinez-Lorente *et al*., 1998). From these definitions, there are no significant differences between TQC and CWQC in their concept (Martinez-Lorente *et al*., 1998). Later, the term *"control"* is substituted by *"management"*; because quality is a matter of management and not just control (Martinez-Lorente *et al*., 1998). At present, TQC and CWQC (Martinez-Lorente *et al*., 1998) can be used interchangeably with TQM (Duffin, 1995; Ako, 1991). As a further development, many countries developed their own TQM frameworks as criteria to reward national quality award in order to encourage quality

awareness and improvement of business sectors in their countries, such as the Malcolm Baldrige National Quality Award (MBNQA) of the US (National Institute of Standards and Technology, 2007).

For development of QM in organizations, some QM experts attempted to define the levels of QM development or maturity. A higher level represents more maturity. For instance, Chin *et al*. (2002) identified five stages of QM maturity: 1) Unaware, 2) Uncommitted, 3) Initiator, 4) Improver and 5) Achiever (Lau *et al.*, 2004). Prabhu *et al*. (2000) classified QM into six levels. They were 1) Could do better; 2) Room for Improvement; 3) Promising; 4) Vulnerable; 5) Potential Winners and 6) World Class. Similarly, six levels of QM maturity, namely, 1) Uncommitted, 2) Drifters, 3) Tool Pushers, 4) Improvers, 5) Award Winners and 6) World Class were applied in Claver and Tari (2003) and Li and Yang (2003) in Dale and Lascelles (1997).

2.4.2 From Logistics to Seamless Supply Chain Management

SCM firstly appeared in 1982 (Lee and Kincade, 2003). Initially, it focused on operational logistics activities (Gilmour, 1999). After that, the evolution of SCM was still more along the lines of physical distribution and transportation (Croom *et al.*, 2000; Tan *et al.*, 2002). Thus, several SCM experts recognized SCM as integrated logistics management (Romano and Vinelli, 2001). Dotson *et al.* (2003) also advised that SCM is referred to as a logistics network. Currently, the term SCM and logistics are always used interchangeably (Varma *et al.,* 2006).

However, Johnson and Wood (1996) and Cooper *et al*. (1997a) advised that most SCM experts agree that the present scope of SCM exceeds that of logistics (Mills *et al.*, 2004). It has evolved to cover not only activites at the operational level, but also at the strategic level in both internal functions and external business partners. Logistics has been defined as *"the process of strategically managing the procurement, movement and storage of materials, parts and finished inventory (and the related information flows) through the organization and its marketing channels in such a way that current and future profitability are maximized through the cost-effective fulfillment of orders"* (Christopher, 1992). The Global Supply Chain Forum (GSCF) defines SCM as *"the integration of key business processes from end user through original suppliers that provide products, services and information that add value to customers and other stakeholders"* (Tracey *et al.*, 2005; Lambert *et al.* 2005; Chan and Qi, 2003). This extension is to gain synergies from a cross-functional collaboration among all business partners. Such interrelated partners include customers, suppliers, marketing, purchasing, production, logistics, customer service, research and development and finance.

In specific industries, dedicated SCM such as JIT, Quick Response (QR) and Efficient Consumer Response (ECR) are initiated to improve efficiency and effectiveness of operational supply in the automotive, textile and grocery industries respectively. At present, the scope of SCM is still developing to cover more functions such as marketing; product development and commercialization; product return (or reverse logistics) and recycling as well (Lockamy III and McCormack, 2004b; Mills *et al.*, 2004).

Similar to QM, some SCM experts attempt to define the level of SCM development in organizations, or SCM maturity. Higher levels represent more mature SCM. For example, Harland (1996) provided a framework consisting of four levels of SCM maturity (Mills *et al.*, 2004; Harland *et al.*, 1999). They are 1) Internal Chain, 2) Dyadic Relationship, 3) External Chain and 4) Network. Lockamy III and McCormack (2004a) introduced a SCM maturity model with five stages: 1) Ad Hoc, 2) Defined, 3) Linked, 4) Integrated and 5) Extended. Stevens (1989) introduced SCM framework that have four levels of supply chain maturity, namely, 1) Baseline, 2) Functional Integration, 3) Internal Integration and 4) External Integration. In addition, the Performance management group (PMG) and Pittiglio, Rabin, Todd and McGrath (PRTM) jointly identified four stages of SCM maturity (Cohen and Roussel, 2004) composed of 1) Functional Focus, 2) Internal Integration, 3) External Integration and 4) Cross-Enterprise Collaboration.

Although different series of SCM maturity have different evolutional stages, they share the same evolutional trend. It starts from weak coordination among internal functions and extends to strong integration among external business partners. Ideally, the entire supply chain should be viewed as sole system, or called "Seamless Supply Chain" (SSC) (Lummus and Vokurka, 1999; Towill *et al.*, 2002). Towill (1997) defined SSC as *"the state of total integration in which all players think and act as one"* (Towill *et al.*, 2002).

As a result, Vanichchinchai and Igel (2009) concluded that TQM and SCM have similar evolutional trend although they have different origins (see Table 2.1). Their evolutions are heavily relevant to the degree of integration. They were initiated at a tactical level from sole operational functions (inspection and logistics) which are primary activities in the organizations' value chain. After that, they have been extended to integrate all interrelated parties in order to gain synergy. These parties include all internal primary and supportive functions as well as external business partners. They shift to focus more on strategic rather than traditional operational or tactical issues. Superior TQM and SCM could be viewed from various perspectives such as large-scale management system or management philosophy. At present, their scopes and applications are still being developed. This is particularly true for TQM which is being extended to cover all best practices or world class management. That is why MBNQA criteria, which are acclaimed as the most accepted TQM framework (Black and Porter, 1996), are referred to as criteria for performance excellence (National Institute of Standards and Technology, 2007). Martinez-Lorente *et al.* (1998) also determined SCM as an element of TQM.

2.5 Integrative Focus

Integration is a key and outstanding characteristic of TQM and SCM. Both require participation from all internal functions (or intra-organizational) and partnership from all external partners (or inter-organizational) (Gimenez, 2004; Sohal and Anderson, 1999 in Dean and Bowen, 1994) in order to minimize conflicts of interest and gain synergies along the whole supply chain. Vanichchinchai and Igel (2009) reviewed SCM and QM literature extensively and found that while TQM emphasizes more on internal partnership, SCM focuses more on external partnership

(see Table 2.1). However, customer satisfaction could be achieved only when quality is built in the whole supply chain (Robinson and Malhotra, 2005). Different integrative focus between TQM and SCM might facilitate or hinder each other.

2.5.1 Internal Participation

Oakland (1989) advised that *"total"* in TQM includes every department and every person at every level (Lakhe and Mohanty, 1994). Although TQM requires involvement from customers and suppliers, it places more emphasis on participation from employees in the organization (Khan, 2003). For instance, the focus should be both on internal primary and supportive functions in the value chain of the organizations. In TQM environment, all employees including executive management, are treated as internal customers. If the internal customers are not satisfied, external customer satisfaction is difficult. Accordingly, Oakland (1989) defined that *"TQM is essentially a way of organizing and involving the whole organization; every department, every activity, every single person at every level"* (Lakhe and Mohanty, 1994). *"…TQM centres on ensuring employee commitment and participation…"* (Dawson, 1994). *"TQM emphasizes the commitment and involvement of all employees"* (Andersson *et al.,* 2006). Ross (1998) indicated that *"TQM focused on the improvement of quality within individual organizations"* (Sila *et al.*, 2006). Similarly, Robinson and Malhotra (2005) concluded that traditional QM an intra-organizational focus. Consequently, several terms are often used in TQM literature to represent and encourage participation, especially employee participation, such as employee involvement, total employee involvement, employee participation, employee empowerment, top management commitment, teamwork, group activity, ownership, internal customer, next process is our customer, total and cross-function. Most literature and frameworks of TQM such as MBNQA criteria (National Institute of Standards and Technology, 2007), EQA (European quality award) criteria (The European Foundation for Quality Management, 2007) include human resource issues. Accordingly, Hoang *et al.* (2006) had reviewed TQM literature extensively and concluded that human resource management related issues received the highest coverage in TQM frameworks.

Focusing too much on internal participation might lead to difficulties in the actual implementation of TQM. Yeung and Amstrong (2003) reported that a main barrier of TQM implementation is lack of external focus, and quality improvement efforts are only given to internal matters. However, customer satisfaction could be achieved only when quality is built into the whole supply chain (Robinson and Malhotra, 2005). Therefore, the focus of modern QM has shifted from a firm-centered setting to the whole supply chain (Kuei *et al.,* 2001; Robinson and Malhotra, 2005).

2.5.2 External Partnership

SCM requires business process integration across the whole supply chain (Gimenez, 2004; Towill *et al.*, 2002), including both internal and external integrations. Internal integration covers all functions in the organization; in contrast, external integration includes all business partners e.g. customers and suppliers (Stock *et al.* 1998). Effectiveness and efficiency of SCM depend significantly on the degree

of integration (Chin *et al.*, 2004; Bagchi and Skjoett-Larsen, 2005). Therefore, SCM aims to improve not only the performance of individual organizations, but also that of the whole supply chain (Li *et al.,* 2006). However, SCM focuses more on external partnerships. Croom *et al.* (2000) reviewed SCM literature extensively and confirmed Saunders (1995)'s conclusion that most SCM definitions share at least one characteristic *"…they focus on the external environment of an organization…"*. Similarly, Mills *et al.* (2004) agreed that *"SCM was then purely concerned with the external logistical integration of customers and suppliers*". Therefore, external business partners as well as their relationship are often emphasized in SCM definitions. For example, Lee and Ng (1997) defined SCM as *"a network of entities that starts with the suppliers' supplier and ends with the customers' custom the production and delivery of goods and services"* (Croom *et al.*, 2000). Similarly, Kopczak (1997) advised that SCM is *"the set of entities, including suppliers, logistics services providers, manufacturers, distributors and resellers, through which materials, products and information flow"* (Croom *et al.*, 2000). Ellram (1991) suggested that supply chain is *"a network of firms interacting to deliver product or service to the end customer, linking flows from raw material supply to final delivery"* (Croom *et al.*, 2000).

In SCM concept, the external focus may be attributed to the fact that there is not only one organization. Mentzer *et al.* (2001) defined supply chain as "*three or more organizations directly linked by one or more of the flows of products, services, finances, and information from a source to a customer*" Golicic *et al.* (2002). Holmberg (2000) advised that *"a supply chain is viewed as a number of organizations – at least three – working cooperatively with at least some shared objectives"*. Despite internal SCM, it focuses on primary functions rather than supportive functions in the organizations' value chain. Most literature and frameworks of SCM emphasize relationships with business partners and almost neglect internal human resource issue, for example, SCM frameworks of GSCF (Lambert *et al.*, 2005), Li *et al.* (2006). Accordingly, Gowen III and Tallon (2003) reviewed SCM extensively and concluded that few researchers have studied human resource management in SCM. Various terms such as supplier and customer relationship, buyer-seller relationship, strategic alliance, long term relationship, network, partnership, customer service, business process integration, supply chain connectivity, co-operation, co-ordination, collaboration, trust, chain, streamline, pipeline are often used in SCM literature to promote partnerships, especially supplier-customer partnerships.

Although SCM focuses on external integration, the real implementation must start from internal integration among functions and then extend to external integration among all business partners. Coordination within the organizations was a prerequisite of SCM (Lambert and Cooper, 2000). Moreover, practical SCM focuses only on a few strategic suppliers and customers. This is because most supply chains are too complex to achieve full integration of all business partners (Tan *et al*., 1998). This difference in emphasis can be a potential problem when implementing a synthesis of TQM and SCM, and more research is needed to explore these implications (Vanichchinchai and Igel, 2009).

2.6 Supply Chain Quality Management

TQM and SCM have evolved along similar paths, even though they emerged from different starting points. They diverged in terms of the degree of integration. They both emerged in response to the need to develop tactical strategies for operational functions (inspection and logistics). They then were broadened in scope to gain synergy by integrating the concerns of all interrelated parties. These parties included all internal primary and supportive functions as well as the external business partners. Then, there was a shift in focus from operational concerns towards strategic issues. Consequently, Supply Chain Quality Management (SCQM) emerged as a new management concept that combined aspects of TQM with SCM (Sila *et al.,* 2006 in Ross, 1998; Robinson and Malhotra, 2005). Ross (1998) defined SCQM as *"the participation of all members of a supply channel network in the continuous and synchronized improvement of all processes, products, services, and work cultures focused on generating sources of productivity and competitive differentiation through the active promotion of market winning product(s) and service solutions that provide total customer value and satisfaction"* (Sila *et al.,* 2006). Accordingly, Robinson and Malhotra (2005) defined SCQM as *"the formal coordination and integration of business processes involving all partner organizations in the supply channel to measure, analyze and continually improve products, services, and processes in order to create value and achieve satisfaction of intermediate and final customers in the marketplace"*.

Vanichchinchai and Igel (2009) observed that when TQM and SCM are integrated, the business processes and the organizational structure will become more complex. For example, some focal organizations in the supply chain may need to establish a supplier development department to work with suppliers in quality improvement projects. The SCM department may need to include a quality assurance unit or vice versa. The quality policy of individual supply chain members may need to be aligned together for consistency to ensure a common quality policy of the entire supply chain. There is a need, therefore, for more research into the implications of integrating business processes into the organizational structure. Gunasekaran and McGaughey (2003) have suggested focusing on the issues such as training, information system and cultural issues in TQM and SCM organization. Since the concept of SCM was introduced so much later, there is an even greater need for further research into how TQM can influence SCM. Internationally recognized SCM standards or certificates should be initiated to encourage the development of SCM as a counterpart to the ISO 9000.

2.7 Supply Chain Management Practice Framework

Although several authors have suggested implementing business processes in the context of SCM, there is no an industry standard on what these processes should be (Casadesus and Castro, 2005; Lambert *et al.*, 2005; Croom *et al.*, 2000). SCM framework is still not yet well understood (Romano and Vinelli, 2001). Scannell *et al.* (2000) found that SCM is a loosely defined concept that lacks a universal definition, both in terms of depth and breadth of its strategies and processes. Ayers (2001) argued that supply chain and the associated tasks that go with SCM depend very much on the eyes of the implementing organizations. Different companies and even managers in

the same company may have different viewpoints when it comes to SCM. Moreover, these paradigms are evolving rapidly. Ayers had an opinion that there is no right or wrong supply chain viewpoint. This is because companies' situations are different, and what is good for one may not be good for another. Croom *et al.*, (2000) reviewed various definitions of SCM in the literature without being able to come up with a universal definition of SCM.

As previously mentioned, SCM is referred to using various terms such as supplier integration, supplier partnerships, supply base management, supplier alliances, supply chain synchronization network sourcing, supply pipeline management, value chain management and value stream management (Tan *et al.,* 2002; Romano and Vinelli, 2001; Tan, 2001). However, the term Supply Chain Management (SCM) is most widely used to describe these management concepts (Tan *et al.*, 2002; Tan, 2001). Moreover, industry-specific SCM tool/techniques are recognized by different names depending on the industry in which it is applied (Gimenez, 2004). For instance, SCM technique in the automotive industry utilizes many principles commonly found in JIT concept (Gimenez, 2004; Tan, 2001; Narasimhan *et al.,* 2008) which was created by Toyota Motor Corporation (Chase *et al.,* 2001; Nicholas, 1998). JIT aims to eliminate wastes in the production processes (Kannan and Tan, 2005; Tan *et al.*, 2004). In JIT, production can be planned. Raw materials are not inventoried, but are scheduled to be received only when needed and with short advance notice (Fiorito *et al.*, 1995; McMichael *et al.,* 2000). At present, JIT is also recognized by other names, such as Lean Manufacturing and Toyota Production System (TPS) (Emiliani, 2006; Nicholas, 1998; Bhuiyan and Baghel, 2005).

The SCM technique in the textile and apparel industries which emphasizes the timely flow of information and merchandise among business partners has been referred to as Quick Response (QR) (Lee and Kincade, 2003; Harris *et al.*, 1999; Perry and Sohal, 2001). QR was developed from the US apparel supply chain analytical project conducted by Kurt Salmon Associates (Lummus and Vokurka, 1999; Fernie and Azuma, 2004; Lummus *et al.,* 2001). Its concept was further developed from JIT (Gimenez, 2004; McMichael *et al.,* 2000; Brockman and Morgan, 1999). Fiorito *et al.* (1995) reported that QR results in quicker deliveries, faster inventory turns, fewer stock-out and lower inventory investment.

In the grocery industry, the SCM technique is known as Efficient Consumer Response (ECR). ECR is a further development of QR. It attempts to streamline the supply chain and to eliminate inefficiencies which cause unnecessary costs along the supply chain (Fiorito *et al.,* 1995; McMichael *et al.,* 2000; Brockman and Morgan, 1999). ECR was initiated in 1992 in the US by a group of grocery industry leaders (Harris *et al.*, 1999: Gimenez, 2004; Lummus and Vokurka, 1999) in order to add value by reducing excessive inventory and cost as well as responding to customer requirements quickly (Hoffman and Mehra, 2000; Lummus *et al.,* 2001). ECR Europe defined ECR as *"a joint initiative by members of the supply chain to work to improve and optimize aspects of the supply chain and demand management to create benefits for the consumer e.g. lower prices, more choice variety, better product availability"* (ECR Europe, 2006).

There are many series of SCM Practices developed and proposed by SCM experts and professional organizations. In 1994, a group of executives from multi-national companies, later became known as the GSCF, developed a framework for SCM (Lambert *et al.,* 2005). The framework composed of eight key business processes which require collaboration of all internal functions and that of external partners:1) Customer Relationship Management, 2) Customer Service Management, 3) Demand Management, 4) Order Fulfillment, 5) Manufacturing Flow Management, 6) Supplier Relationship Management, 7) Product Development and Commercialization and 8) Returns Management. These processes were applicable to any industry.

Tan *et al.* (2002) surveyed senior managers in various industries to study SCM in their companies. Using factor analysis, they were able to obtain six SCM factors, namely, 1) Supply Chain Characteristics, 2) JIT Capability, 3) Supply Chain Integration, 4) Geographical Proximity, 5) Information Sharing, 6) Customer Service Management.

Lee and Kincade (2003) reviewed SCM literature extensively and identified six management components of SCMP consisting of 1) Management Commitment, 2) Partnership, 3) Partnership, 4) Demand Characteristic, 5) Operation Flexibility and 6) Performance Measurement. They further conducted a SCM research in the US apparel industry and used factor analysis to verify these six management components. In addition, Gunasekaran and McGaughey (2003) applied Lee and Kincade (2003)'s SCM practices in his/her article.

Li (2002) studied SCMP, performance and competitiveness and identified six SCMP, namely, 1) Strategic Supplier Partnership, 2) Customer Relationship, 3) Information Sharing, 4) Information Quality, 5) Lean System and 6) Postponement.

Mills *et al.* (2004) referred to Cooper *et al.* (1997)'s SCM framework in their research to conclude that the scope of SCM included part of marketing activity. The framework comprised 1) Customer Relationship Management, 2) Customer Service Management, 3) Demand Management, 4) Order Fulfillment, 5) Manufacturing Flow Management, 6) Procurement and 7) Product Development and Commercialization.

Min and Mentzer (2004) developed a framework for SCM which composed of 1) Agreed Vision & Goals, 2) Information Sharing, 3) Risk & Reward Sharing, 4) Cooperation, 5) Process Integration, 6) Long-term Relationship and 7) Agreed Supply Chain Leadership.

Chin *et al*. (2004) had examined several SCMP and identified five strategic factors. They were 1) Building Customer-Supply Relationships, 2) Implementing Information and Communication Technology, 3) Re-engineering Material Flows, 4) Creating Corporate Culture and 5) Identifying Performance Measurements.

Sahay and Mohan (2003) studied SCMP in the Indian industry. There were four major dimensions of supply chain, namely, 1) Supply Chain Strategy, Supply Integration, 3) Inventory Management and 4) Information Technology.

Kim (2006) reviewed literature extensively and interviewed 30 supply chain executives and experts. Finally, he/she identified seven SCM components: 1) Advanced Management and Manufacturing Technology, 2) National-wide Information Network, 3) Formalization of Supply Chain Organization, 4) Executive Program for Supply Chain Management, 5) Human Resource Management, 6) Logistics Infrastructure and 7) Close Location to Suppliers and Customers

Wong *et al.* (2005) developed a framework of SCM in a toy supply chain. The framework consisted of 1) Supply Chain Performance, 2) Product Differentiation, 3) Lead-time Management, 4) Postponement and Customization, 5) Inventory and Cost Management, 6) Bullwhip Effects, 7) Information Sharing and Coordination, 9) Buyer-Seller Relationships, 10) Distribution and Logistics, 11) Retail Strategy and 12) SCM Initiatives

From operational perspective of SCMP, Supply-Chain Council (SCC), a non-profit organization, developed the Supply Chain Operations Reference (SCOR) (Lambert *et al.,* 2005; Foggin *et al.*, 2004). SCOR contains common process oriented practices for communicating operational issues among supply chain partners (Lockamy III and McCormack, 2004b). In version 6.0, SCOR contained five major practices, namely, 1) Plan, 2) Source, 3) Make, 4) Delivery and 5) Return (Supply-Chain Council, 2003). SCOR focuses only on activities that are directly relevant to physical movement of the products (Supply-Chain Council, 2003). It does not include every supportive function such as research and development, sales and marketing, human resource management and quality assurance, accounting, finance (Supply-Chain Council, 2003; Reichardt and Nichols, 2003). Huang *et al.* (2005) concluded that *"SCOR provides a common supply chain framework, standard terminology, common metrics with associated benchmarks, and best practices; and can be used as a common model for evaluating, positioning, and implementing supply chain application software"*. Therefore, it might be acclaimed as the first industrial standard supply chain framework developed specifically for an integrated SCM (Simatupang and Sridharan, 2004; Stewart, 1997, Tan *et al.*, 2002). At present, SCOR is one of the most accepted framework for integrated SCM (Stewart, 1997). In 2007, SCC has nearly 1,000 corporate members and has many international chapters around the world (Supply-Chain Council, 2007) while ISO 9000 (including ISO 14000) are implemented in around 887,770 organizations in 161 countries world-wide (International Organization for Standardization, 2007)

However, it must be noted that SCMP framework is still not complete because of its ever extending scope. There are other SCMP frameworks by different applications, industries and other factors. The industry-specific SCMP framework for the automotive industry in Thailand is needed. From the literature review, most SCMP frameworks share similar practices which can be grouped into Information Management, Lean System, Partnership Management and Supply Chain Organization as shown in Table 3.1. Then, SCMP framework in this study comprised these four practices. The frameworks and measurement items of Li *et al.* (2005), Li *et al.* (2006), Li (2002), Min and Mentzer (2004), Tan *et al.* (2002), Lee and Kincade (2003), Sahay and Mohan (2003), Wong *et al.* (2005), Chin *et al*. (2004), GSCF in Lambert *et al.* (2005), Cooper *et al.* (1997) in Mills *et al.* (2004), and Kim (2006) were utilized to develop SCMP framework in this study (see Table 3.1 and Appendix 3.1)

2.8 Quality Management Practice Framework

Scope and framework of Quality Management Practices (QMP) may range from basic quality inspection to TQM depending on the applications and scope and framework of QMP are still expanding to cover all best practices. Some QMP are very specific and appropriate for only some industry sectors. For instance, the Food and Drug Administration (FDA) of the US introduced HACCP as an operational quality assurance in the food industry. It aims to analyze and control biological, chemical and physical hazards in food manufacturing process from procurement, manufacturing to distribution (Taylor and Taylor, 2004; U.S. Food and Drug Administration, 2006). Initially, HACCP was developed as a microbiological safety system for the first US manned space project (Taylor and Taylor, 2004 in Buchanan, 1990). After that, it has been applied to specific food industries such as juice, seafood and canned food. At present, it has also been further developed to be applicable to other areas of the food industry (U.S. Food and Drug Administration, 2006).

In the automotive industry, ISO/TS 16949 was developed by the International automotive task force (IATF) which is composed of an international group of vehicle manufacturers and national trading associations to be used as an ISO technical specification to serve common quality requirements for the global automotive industry. It was developed from American (QS 9000), German (VDA 6.1), French (EAQF) and Italian (AVSQ) automotive quality standards to become an international standard and can be used as a substitute for those individual certification. ISO/TS 16949 aims to manage and improve quality of all automotive-related products through design, development, production, installation and service processes (Kartha, 2004).

Conversely, some QMP are generic in nature and applicable to any organization without limitation of size, product or sector, for instance, ISO 9000. ISO9000 was originated by the International Organization for Standardization in 1987 as an international technical standard to facilitate international trade of goods and services in all industries with a common set of quality standards (International Organization for Standardization, 2007; Martinez-Lorente and Martinez-Costa, 2004). ISO 9000 emphasizes compliance with customer requirements with a consistent level of product quality (Kartha, 2004). ISO 9001: 2000 is based on eight principles: 1) Customer Focus, 2) Leadership, 3) Involvement of People, 4) Process Approach, 5) System Approach to Management, 6) Continual Improvement, 7) Factual Approach to Decision Making and 8) Mutual Beneficial Supplier Relationships (International Organization for Standardization, 2007). Given its focus on process rather than product quality, ISO 9000 is an international quality standard that can be applied to every business sector worldwide (Goldman, 2005; Talha, 2004).

Malcolm Baldrige National Quality Award (MBNQA) criteria are generic practices for achieving performance excellence through quality awareness for all businesses (National Institute of Standards and Technology, 2005). Its criteria categories are composed of 1) Leadership, 2) Strategic Planning, 3) Customer and Market Focus, 4) Measurement, Analysis and Knowledge Management, 5) Human Resource Focus, 6) Process Management and 7) Business Results (National Institute of Standards and Technology, 2005). MBNQA is the world's most famous and accepted TQM framework (Black and Porter, 1996). This is because it incorporates all

major elements of TQM and is often referred to as a de facto definition of TQM (Kartha, 2004). In comparison to ISO 9000, overall, ISO 9000 registration covers less than 10 percent of MBNQA criteria (National Institute of Standards and Technology, 2005). As a further development, some countries also developed their own TQM frameworks as criteria to reward national quality award in order to encourage quality awareness and improvement of business sectors in their countries.

Some researchers have further developed dedicated TQM frameworks to better respond to specific requirements. For instance, Hoang *et al*. (2006) tested a TQM framework that was based on various prestigious quality awards (MBNQA, European Quality Award, Asia-Pacific business excellence standard) in Vietnam's manufacturing and service industries. The measures included 1) Top Management Commitment, 2) Employee Involvement, 3) Employee Empowerment, 4) Education and Training, 5) Teamwork, 6) Customer Focus, 7) Process Management, 8) Information and Analysis System, 9) Strategic Planning, 10) Open Organization and 11) Service Culture and were found suitable for developing countries' industries.

In the public sector, Pun (2002) conducted a survey among the public sectors and government organizations in Hong Kong to study the need for integrating TQM and performance measurement and for developing a model for evaluating the TQM and performance measure integration in organizations. The core concepts were 1) Leadership and Constancy of Purpose, 2) Results Orientation, 3) Management by Process, 4) People Development and Improvement and 5) Continuous Improvement.

Khan (2003) referred to Hendricks and Singhal (1997)'s empirical study to prove that TQM improved the performance of organizations. The study introduced a simple model for TQM. It comprised of two main components: 1) TQM Philosophy and 2) TQM Systems and Tools. His/her TQM philosophy consists of four basic components: 1) Absolute Customer Focus, 2) Employee Empowerment, Involvement and Ownership, 3) Continuous Improvement and 4) Use of Systematic Approaches to Management.

Generally, there are more internationally and nationally accepted QM frameworks than SCM frameworks. This is because the concept of QM was introduced and developed much earlier than SCM. International quality standard such as ISO 9000 leads to a wide diffusion of QM, but there is no similar international SCM in existence (Casadesus and Castro, 2005; Lambert *et al.*, 2005; Croom *et al.*, 2000). In this study, TQM framework of Hoang *et al.* (2006) was applied as QMP framework (see Table 3.3). This was because their TQM framework covered most prestigious quality award criteria which were widely accepted by TQM experts and the framework constituted both hard and soft practices of TQM. Moreover, Hoang *et al.* (2006)'s TQM framework was developed for industries in developing countries and consequently tested in the Vietnamese industries. Thus, their framework should be suitable for the Thai industry.

2.9 Similarity between SCMP and QMP

TQM and SCM are more than simple tools or techniques. They are management philosophies (Tan *et al.,* 2002; Chan and Qi, 2003; Sun, 2000; Khan,

2003; Tan, 2001; Vanichchinchai and Igel, 2009) implemented as large-scale management systems that consist of various sets of practices (Hellsten and Klefsjo, 2000; Khanna *et al.*, 2003; Waldman, 1994). There are similarities and differences between their practices which could support or obstruct each other. For example, Hoang *et al.* (2006)'s TQM framework included Customer Focus which aims to *"develop and manage strong customer relationships for the longer term"*. Accordingly, SCM framework of the Global Supply Chain Forum (GSCF) has Customer Relationship Management which provides *"the structure for how the relationship with the customer is developed and maintained"* (Croxton *et al.*, 2001) and Customer Relationship in Li *et al.* (2005)'s SCM framework includes *"practices that are employed for the purpose of managing customer complaints, building long-term relationships with customers"*. Moreover, Process Management in Hoang *et al.* (2006)'s TQM framework attempts to *"find wasted time and costs in all internal process"* whereas Internal Lean Practices in Li *et al.* (2005)'s SCM framework includes *"practices of eliminating waste (cost, time, etc.) in a manufacturing system"*.

For differences, Hoang *et al.* (2006) reviewed TQM practices extensively and concluded that human resource management related practices received the highest coverage in TQM frameworks. Therefore, their framework of TQM practices comprises employee involvement, employee empowerment and education and training, teamwork. Many SCM frameworks do not include internal human resource practices, for instance, SCM framework of GSCF (Croxton *et al.*, 2001), Tan *et al.* (2002) and Li *et al.* (2005).

There are several TQM and SCM management frameworks and related practices are still being developed. The similarities and differences among SCMP and QMP could either synergize or conflict and this should be carefully explored and confirmed in order to achieve synergy in their co-implementation.

2.10 Supply Performance Framework

Supply chain performance covers supply performance of the whole supply chain; while, firm's supply performance includes supply performance of the members in the supply chain. Supply performance measurements still have not received sufficient attention (Gunasekaran *et al.,* 2001; Chan and Qi, 2003). The two major difficulties of measuring supply performance are lack of a balanced approach and lack of a clear distinction between metrics at strategic, tactical and operational levels (Gunasekaran *et al*.; 2001).

Based on a review of best supply performance measures in the literature, Gunasekaran *et al*. (2001) proposed a supply chain performance metric composed of strategic, tactical and operational levels of measurements. They focus on performance of suppliers, delivery, customer-service and inventory and logistics costs.

Li (2002) reviewed the literature covering supply chain performance, SCMP and competitiveness and identified five FSP measures: 1) Supply Chain Flexibility, 2) Supply Chain Integration, 3) Responsiveness to Customers, 4) Supplier Performance and 5) Partnership Quality. These supply chain measures were empirically tested in various industries in respective to SCMP and competitiveness.

Min and Mentzer (2004) developed the measurement items and frameworks of supply chain orientation, supply chain management and business performance in order to study their linkages. Their business performance framework included 1) Availability, 2) Timeliness, 3) Growth, 4) Product and Service Offering and 5) Profitability.

Beamon (1999) reviewed the literature and found that supply chain models have predominantly employed two performance measures: 1) Cost and 2) Combination of cost and customer responsiveness. Costs included inventory costs, operating costs and so on. In contrast, customer responsiveness included lead time, stock out probability, fill rate, etc. However, Beamon (1999) realized that there are still other qualitative performance measures which are appropriate for supply chain analysis, such as Customer Satisfaction (Christopher, 1994), Information Flow (Nicoll, 1994), Supplier Performance (Davis, 1993) and Risk Management (Johnson and Randolph, 1995). These performance indicators had not yet been used in the FSP model. This is because the quantitative method to measure them is difficult to incorporate into the measurement models. Then, Beamon (1999) introduced the use of Resources, Output and Flexibility as crucial components to measure supply chain performance. The measure of each aspect also affected the others. In the research, Beamon (1999) most emphasized the measurement of flexibility because it has rarely been addressed and quantified.

Moreover, Scannell *et al.* (2000) studied how supplier development, supplier partnering and JIT purchasing in upstream SCM strategy affect a firm's competitive performance such as flexibility, innovation, quality and cost. They studied this because supplier development, supplier partnering and JIT purchasing are complementary and when applied simultaneously, they constitute crucial elements for effective SCM. Consequently, the concurrent use of these practices may offer some synergies. The research focused on strategic business units of the top 150 first-tier suppliers to the Big Three as identified by the Automotive Industry Action Group (AIAG).

From an operational perspective, SCOR model at level 1 provides quantitative measures of supply chain performance under five key attributes. They are 1) Delivery Reliability, 2) Responsiveness, 3) Flexibility, 4) Costs, 5) Asset Management Efficiency (Cohen and Roussel, 2004; Supply-Chain Council, 2003). These five key attributes have 13 specific measures in detail (Cohen and Roussel, 2004; Supply-Chain Council, 2003).

In conventional supply chain or logistic services in manufacturing, Franceschini and Carlo (2000) studied and compared a typical set of indicators suitable for the evaluation of general performance of a logistic service, namely, tangibles, reliability, responsiveness, assurance and empathy with a specific set of parameters used by Federal Express, a company leader in this specific sector. Such indicators were Lead Time, Regularity, Reliability, Completeness, Flexibility, Correctness, Harmfulness and Productivity. The analysis was carried out by considering two kinds of relationships, the strong relationship and the weak relationship, which are different in degree of link between factors and indicators. In

the comparison, it appears that, usually, the Empathy factor was not included in any indicator, although in some situations its contribution could be very important.

In conclusion, there is no universal agreement on what constitutes set of supply performance measures. Industry-specific supply performance framework for the automotive industry in Thailand is required. However, it must be noted that supply performance in this research covered only firm's supply performance of the automotive part suppliers not the supply chain performance of the whole automotive supply chain. Since, supply performance has similarity and can be combined into Cost, Flexibility, Relationship and Responsiveness (see Table 3.5). FSP framework in this research consisted of these four performance measures. The performance measurement items of Min and Mentzer (2004), Li *et al.* (2002) and Gunasekaran *et al.* (2001) were employed to develop FSP framework in this study (see Appendix 3.3).

2.11 Impact of QMP on Performance

Impacts of QMP on business performance have been studied by many researchers in different aspects, for example in different business sectors, countries, QMP components, performance definitions, research methods, assumptions, etc. Generally, they had similar agreements that QMP has some positive impacts to the performance.

Hendrick and Singhal (1997) researched to prove that implementing TQM improved the operating performance of firms that won quality awards. They found that companies which won quality awards outperform the control companies on operating income-based measures and on sales growth. Also, those companies were more successful in controlling costs and increased their capital expenditure over the time period prior to winning quality awards. The test sample companies showed higher growth in employment and total assets.

In the automotive industry, Sime *et al.* (1999) examined the relationships between competitive dimensions of quality (e.g. design quality, conformance quality) and overall firm performance (e.g. ROI, market share) of the Big Three North American automotive suppliers. The study showed that quality dimensions are highly correlated with firm performance in the automotive industry. The quality variables were related to the greatest number of measures of firm performance.

In Australia and New Zealand, Danny and Mile (1999) determined the relationship between TQM and firm performance by utilizing a database of 1,200 Australian and New Zealand manufacturing organizations. Seven MBNQA criteria were referenced as TQM framework to validate these seven criteria and determine the relationships between six practice criteria and the seventh which is performance outcome. The study showed that the relationships between TQM and organizational performance were significant in a cross-sectional sense, explaining the significant difference in performance.

Accordingly, Khan (2003) also tried to prove that implementing an effective TQM would improve the profitability of the organization, increase revenue and reduce costs. The sample companies won quality awards and had financial data

available for a period of ten years. The performance of these organizations was compared with that of a control group that had no efforts on TQM. The result concluded that the total quality culture yields significantly better results in all the performance dimensions such as financial results, customer satisfaction and employee satisfaction. TQM also provided a long term sustainable competitive advantage in an increasingly competitive global market.

Moreover, some researchers were interested in the impacts of TQM/QM on some specific performance dimensions. For example, Hoang *et al.* (2006) as well as Prajogo and Sohal (2003) studied the impacts of TQM on innovation. Eriksson and Hansson (2003) researched the impacts of TQM on financial performance. Li *et al.* (2002a) studied the impacts of QM on customer relationship management. Only few researcher have explored the relationships between TQM/QM and SCM (Gunasekaran and McGaughey, 2003; Robinson and Malhotra, 2005; Casadesus and Castro, 2005; Kuei *et al.,* 2001); while, SCM is critical for competitive advantage (Chin *et al.*, 2004; Robinson and Malhotra, 2005) and the global business competitive is no longer between the organizations but the supply chains of the organizations (Li *et al.,* 2006; Kuei *et al.,* 2001). Moreover, Vanichchinchai and Igel (2009) found similarities and differences between SCM and QM which may facilitate or hinder each other (see Table 2.1). Therefore, it is interesting to study the impacts of QMP on SCMP and FSP.

2.12 Relationship between QM and SCM

Although SCM and QM are critical to the organizational performance and competitiveness, there have been limited empirical research in the relationships between them. Some SCM and QM experts only give private opinions on the importance of and interrelationships between both without empirical study to backup their assertions. Moreover, due to unclear and extending scope of SCM and QM, existing empirical research are different in aspect, objective and methodology.

Kuei *et al.* (2001) reviewed the SCM and QM literature extensively and concluded that, recently, the focus on QMP has changed from the firm-centered setting to the whole supply chain. Supplier quality management and customer quality management are critical to achieve supply chain quality. However, they found that a few research has also explored QMP within the supply chain.

Without empirical evidence, Gunasekaran and McGaughey (2003) reviewed literature regarding SCM and TQM and found that TQM was extensively applied to improve competitive advantage of the organizations. They believed that TQM concept can be used to improve the supply chain. Gunasekaran and McGaughey (2003) finally concluded that few researches are available on TQM in SCM, suggesting that more research on the use of TQM practices in SCM should be conducted.

For empirical research, Romano and Vinelli (2001) used the case of a textile and apparel firm and its relationships with downstream and upstream business partners to study the relationship between QM and SCM. They compared QMP and procedures between two kinds of supply chains namely traditional customer-supplier approach and coordinated customer-supply approach. As a result, the study found

many differences in QMP between these two types of supply chains both at the operational and strategic level.

Furthering another research, Romano (2002) studied sensitivity of the firms in the supply chains to QMP certification. The samples of 100 Italian ISO 9000 certified manufacturing firms were used. The research focused on two points in time namely pre-certification period (six months before the certification process) and post-certification period (six months after the achievement of certification). The studied companies were referred to as focal companies. The supply chain sensitivity to certification within the study referred to the sensitivity of focal firm's suppliers (upstream sensitivity to certification) and the sensitivity of the focal firm's customers (downstream sensitivity to certification). Managerial areas which were examined are 1) Quality, cost, time and volume flexibility performance of the focal firms, 2) Relationship between focal firms and their customers, 3) Internal quality systems of the focal firms, 4) Relationship between focal firms and their suppliers. The result of the study identified four classes of supply chains. They were 1) Supply Chain A - highly sensitive, 2) Supply Chain B - downstream sensitive, 3) Supply Chain C - Upstream sensitive, 4) Supply Chain D - not sensitive. It also showed that, during certification, there was a general improvement of performance. However, this was not statistically significant. The result was also similar for cost measure. The certified supplier had a significant impact on time measure. Similar results could also be found in volume flexibility performance.

Tan *et al.* (1998) conducted an empirical research to study the linkages between QM, supplier evaluation and supply base management. The sample companies came from various industries such as automotive, chemical, computer, construction, consumer products, electronics, industrial products, medical device, packaging and pharmaceutical in the American Society of Quality Control. They found that QM and supply base management should be implemented together to improve financial and corporate performance.

Kannan and Tan (2005) studied the relationships between JIT, SCM and TQM by using the samples from the database of the Institute for Supply Management and American Production and Inventory Control Society. Finally, they advised that there are linkages between JIT, SCM and TQM in strategic and operational levels and they can reinforce each other and then improve the firm performance.

Kuei, *et al.* (2001) conducted an empirical study to examine the role of quality in the supply chain in Taiwan's top 500 organizations by using the modified instrument of Saraph *et al.* (1989). Quality practices such as benchmarking, customers' relations, supplier selection and supplier participation were applied in the research. The researchers found that there is relationship between improvements in organizational performance and in supply chain quality management. Besides, there are significant relationships between improvements in supplier quality management, customers' relations and supplier selection.

Levy *et al.* (1995) conducted an interview-based research with eight suppliers to identify the general features of a quality-based customer-supplier relationship in telecommunications and electronics industries from both the customer and supplier viewpoints. All suppliers involved in this research were approved on supplier lists

which had a demonstrable commitment to TQM. The findings concluded that an effective joint total quality relationship needed to be adapted to meet environmental changes and to extend the customer-supplier relationship into the whole supply chain. Nevertheless, the key issue regarding extending a total quality approach across the organizational interface is the integration.

Choi and Rungtusanatham (2001) compared QM at three supply chain levels (final assemblers, top-tier suppliers, tertiary-tier suppliers) in the automotive, electronics and others industry groups. However, they could not find any statistically valid differences in quality levels across the supply chain.

Casadesus and Castro (2005) applied five SCM strategies to investigate the impact of ISO 9000 on SCM. They were 1) Manage inventory investment in the chain, 2) Establish supplier relationships, 3) Increase customer responsiveness, 4) Build a competitive advantage for the channel and 5) Introduce SCM solutions and enable information technology. Nearly 400 ISO 9000 certified companies were used as samples. However, the results could not confirm that ISO 9000 fully supports SCM.

Besides, some researchers tried to study the relationships of many management systems. For example, Cua *et al.* (2001) developed a common framework that combines the practices of TQM, JIT and TPM (Total Productive Maintenance) and then studied the effect of the framework constructs on the manufacturing performance. Even though these management systems have a similar goal of continuous improvement and waste reduction, they are always implemented separately. Therefore, it is conceptually argued by researchers that the three programs, if implemented jointly, will have a higher impact on the manufacturing performances. The research was carried out by analyzing the data collected from the database of a world class manufacturing study which contains data from manufacturing plants located in the United States, Japan, Italy, Germany and the United Kingdom. The results found that organizations that are identified as high performers have implemented practices from all TQM, JIT and TPM rather than from only individual programs.

In conclusion, the empirical researches in the relationship between QM and SCM still have been limited. Moreover, they were conducted in different industries, countries and by different research methodologies. Thus, it is interesting to study the impacts of QMP on SCMP and FSP in the automotive industry in Thailand which is one of Thailand's competitive industries in the global market. These impacts include the direct effect of QMP on SCMP, the direct effect of QMP on FSP, the total effect of QMP on FSP through SCMP and the effect of individual QMP on individual SCMP. The research should be conducted with rigorous quantitative statistical techniques and in-depth qualitative case study.

2.13 Non-Logistics Theory of Supply Chain Management

Socio-economic theory such as network theory, resource-based view theory, principal-agent theory and transaction cost analysis theory can be applied to structure and analyze management decisions in SCM.

Network Theory

The organizational performance depends on the level of relationships with the business partners because the relationships can integrate the resources of business partners to reap more advantages than individual efforts. Therefore, network theory emphasizes the development of competencies with external partners (Halldorsson *et al.*, 2007). Basically, network theory organizes partners, resources and activities in the supply chain in order to develop trust and long-term relationship among the partners. Relationships are used to access resources and competencies in other firms (Skjoett-Larsen, 1999; Halldorsson *et al.*, 2007). Through the interaction process, all parties improve their knowledge and skills. Therefore, the units of analysis in network theory are the relationships, adaptation and exchange processes between the external parties (Skjoett-Larsen, 1999). Network theory is employed to explain the dynamics in relationships between buyers and suppliers. It was applied in Miles and Snow (2007), Skjoett-Larsen (1999) and Halldorsson *et al.* (2007)'s SCM research.

Resource-Based View Theory

The organization should emphasize its core competencies and request supplementary competencies from other parties. Therefore, resource-based view theory emphasizes capabilities and resources which constitute the core competence and competitive advantage of the organization and outsource complementary competencies to external partners. Similar to network theory, resource-based view theory utilized relationships to access resources and competencies in other firms. Relationship is used to access resources and competencies in other firms (Skjoett-Larsen, 1999). The inter-organizational relationships can be described in term of the opportunity to access the other firms' core competencies through collaboration (Halldorsson *et al.*, 2007). However, resource-based view theory is limited to the internal perspective of the organization' resources and capabilities. Hsu *et al.* (2006), Wu *et al.* (2006), Miles and Snow (2007) and Jayaram *et al.* (2004) applied resource-based view theory in their SCM research.

Principal-Agent Theory

Since, the control and ownership activities between the principal (customer) and the agent (supplier) are separated in supply chains, there may be many difficulties, for example, asymmetric information between the agent and the principal and conflicting objectives. Therefore, principal-agent theory focuses on developing the most efficient contract (e.g. combined behavioral and outcome-based incentives) which can mitigate potential agency problems. It focuses on inter-firm contracting. Principal-agent theory was applied in Logan (2000), Skjoett-Larsen (1999) and Halldorsson *et al.* (2007)'s SCM research.

Transaction Cost Analysis Theory (TCA)

Transaction costs are the costs of processing any exchange, for example, information costs, negotiation costs and monitoring costs. In collaboration with the external business partners and information exchange, a firm may reduce the transaction costs (Hobbs, 1996; Halldorsson *et al.*, 2007).

There are four key concepts influencing the transaction costs namely bounded rationality, opportunism, informational asymmetry and asset specificity (Hobbs, 1996). Bounded rationality means when people attempt to make rational decision, their ability to evaluate all possible choices is physically limited, especially in complex situations. Opportunism arises where individuals or organizations attempt to exploit a situation to their own advantage. For instance, when there are a limited number of suppliers available, the existing suppliers tend to act opportunistically in their own advantage (e.g. price increase). Information asymmetry happens where all business partners have incomplete or do not have the same levels of information which then leads to opportunistic behavior. It can arise both before the transaction (*ex ante* opportunism) and after the transaction (*ex post* opportunism). For example, the seller may not reveal information about the defective products to the buyer before the trading transaction (*ex ante*) and the buyer can not differentiate between the good and the defective products. Or, the seller cannot directly observe the buyer's actions after the buyer has the product insurance (*ex post*). Then the buyer may damage the product intentionally to claim an insurance payment. Asset specificity happens when an organization (company A) invests specific resources for its partner (company B) and these specific resources have limited value in alternative use. Then, company B may act opportunistically by offering a lower price for the products to company A. To prevent against this opportunistic behavior, safeguards should be established (Skjoett-Larsen, 1999), for example, legal ordering (e.g. formal contract covering all aspects of the relationship) and private ordering (balance of reciprocity or credible commitment, e.g. joint ventures).

Generally, the logistics researchers accept TCA as an effective theory for strategic logistics analysis (Skjoett-Larsen, 1999). This is because the transaction costs reduction is a key interest in SCM (Hobbs, 1996). TCA emphasizes the transactions rather than commodities or technology (Logan, 2000) and focuses on the dyad between the organizations and analyzes transactions with external partners (Skjoett-Larsen, 1999). Transaction cost can be improved though internal and cross-functional integrations (Jayaram *et al.*, 2004). Tan *et al.* (1998) suggested that cooperation with suppliers through information sharing can improve financial and business performance. Similarly, Tarn *et al.* (2002) and Gunasekaran and McGaughey (2003) advised that, through information sharing, SCM partners can work more efficiently and lead to lower cost. Based on characteristics of the transaction, TCA is useful for make-or-buy decisions (Halldorsson *et al.*, 2007). It can explain both the existence and organizational structure of the organization and the nature of vertical co-ordination within the supply chain.

Therefore, TCA was applied as a main socio-economic theory for analysis and discussion in this study. This is because the concept of SCM is still new for the automotive industry in Thailand and most companies still focus on efficient flows of information and material at operational level to minimize transaction cost but less emphasizes strategic issues such as partnership and relationship management (in network theory), competency and resource sharing (in resource-based view theory) and inter-firm contracting (in principal-agent theory). TCA was applied for SCM analysis in Singh (2008), Wei and Chen (2008), Muller and Seuring (2007), Ruben *et al.* (2007), Simpson and Power (2005) and Hobbs (1996).

2.14 Summary

Although, SCM and QM have a vital role in enhancing organizational performance and competitiveness, they have been studied in isolation. There are still few empirical research studying the impacts of QM on SCM. Both SCM and QM are large-scale management systems which have many similarities and differences such as philosophical perspective, scope, maturity of application, goal, integrative focus and practices. These could result in synergy or conflict of interests in their integrative implementation. Therefore, there are some research opportunities to study in further details the relationships among SCMP, QMP and FSP. Moreover, the frameworks of SCMP, QMP and FSP are still unclear and no universal definition exists. They are different by applications and are still being developed. The industry-specific frameworks of SCMP, QMP and FSP for developing countries are needed. TCA is suitable for SCM analysis in the automotive industry in Thailand.

CHAPTER 3
CONCEPTUAL FRAMEWORK, HYPOTHESIS AND RESEARCH METHODOLOGY

3.1 Introduction

This chapter presented the conceptual framework, hypotheses and research methodologies used in this study. The research instrument development process and data collection methods were explained. Organizational characteristics such as the positions of the respondents, company ownership, company size, the tier in the supply chain, the management system of the collected samples were primarily examined for further detailed statistical analysis in the next chapter. Finally, statistical techniques for data analysis to be applied in this study were introduced.

3.2 Conceptual Framework and Hypotheses

To respond to the research questions and the objectives of the study, the relationship among SCMP, QMP and FSP was depicted as shown in Figure 3.1.

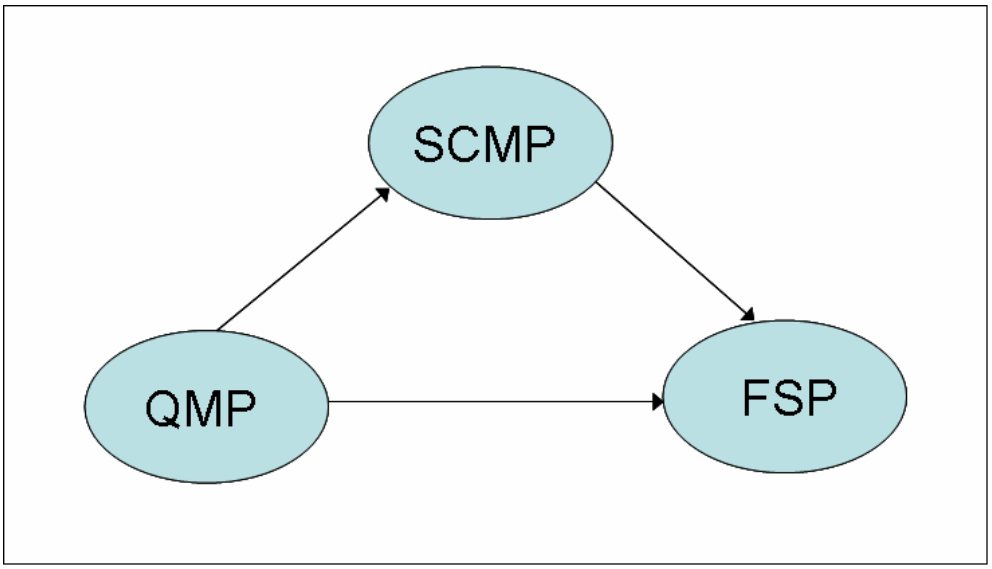

Figure 3.1: The conceptual framework to study the impact of QM on SCM

In accordance with the conceptual framework, the hypotheses of the research were as follows:

H1: A firm's QMP significantly and positively impact SCMP.
H2: A firm's QMP significantly and positively impact FSP.
H3: A combined set of a firm's QMP and SCMP significantly and positively impact FSP.

3.3 Methodology

Figure 3.2 showed a summary of the major research processes. It started with an extensive literature review so as to gather underlying theories for development of measurement instruments and hypotheses. Consequently, the content validity of the instruments was assessed by industry and academic experts in the automotive industry in Thailand. Back translation was done. After a pilot test with twelve automotive part suppliers, the large-scale survey was conducted. Various statistical techniques were applied in order to test hypotheses in accordance with the research questions and objectives of the study. Case studies of two first-tier suppliers were conducted to have more information in a qualitative manner. Finally, the results and the contribution of the study were discussed and concluded with recommendations and issues for further study.

3.4 Research Instrument Development

3.4.1 Supply Chain Management Practice Measure Development

In this study, a dedicated framework for SCMP is developed for the automotive industry in Thailand. Conceptually, the framework, as a measurement model, is composed of dimensions which are latent variables. These latent constructs can not be measured directly. They can be measured from manifest variables or indicators. The manifest variable is observed value of a specific item or question received from respondents (Hair *et al.*, 1998).

Various frameworks of SCMP were identified from the literature review. They were from the works of Li *et al.* (2005), Li *et al.* (2006), Li (2002), Min and Mentzer (2004), Tan *et al.* (2002), Lee and Kincade (2003), Sahay and Mohan (2003), Wong *et al.* (2005), Chin *et al*. (2004), GSCF in Lambert *et al.* (2005), Cooper *et al.* (1997) in Mills *et al.* (2004), and Kim (2006). It should be noted that most of these SCMP frameworks were generic and applicable to any industry in any country. These SCMP frameworks were reviewed in detail to study individual indicator in each latent dimension and to primarily evaluate their quality. A total of 207 items were gathered as the first set of SCMP items, as shown in Appendix 3.1. In detailed analysis, most of these items were found similar and could be grouped together. SCMP measures belonging to four dimensions, namely, 1) Information Management (SCM_IM), 2) Lean System (SCM_LS), 3) Partnership Management (SCM_PM), and 4) Supply Chain Organization (SCM_SO) were chosen as shown in Table 3.1. From careful consideration, each item was reassigned into one of these four dimensions in accordance with its characteristics, content and underlying theories. Items with unclear description were excluded. After that, similar items in the same dimension were grouped together. The second set of SCMP had 41 items as shown in Appendix 3.2.

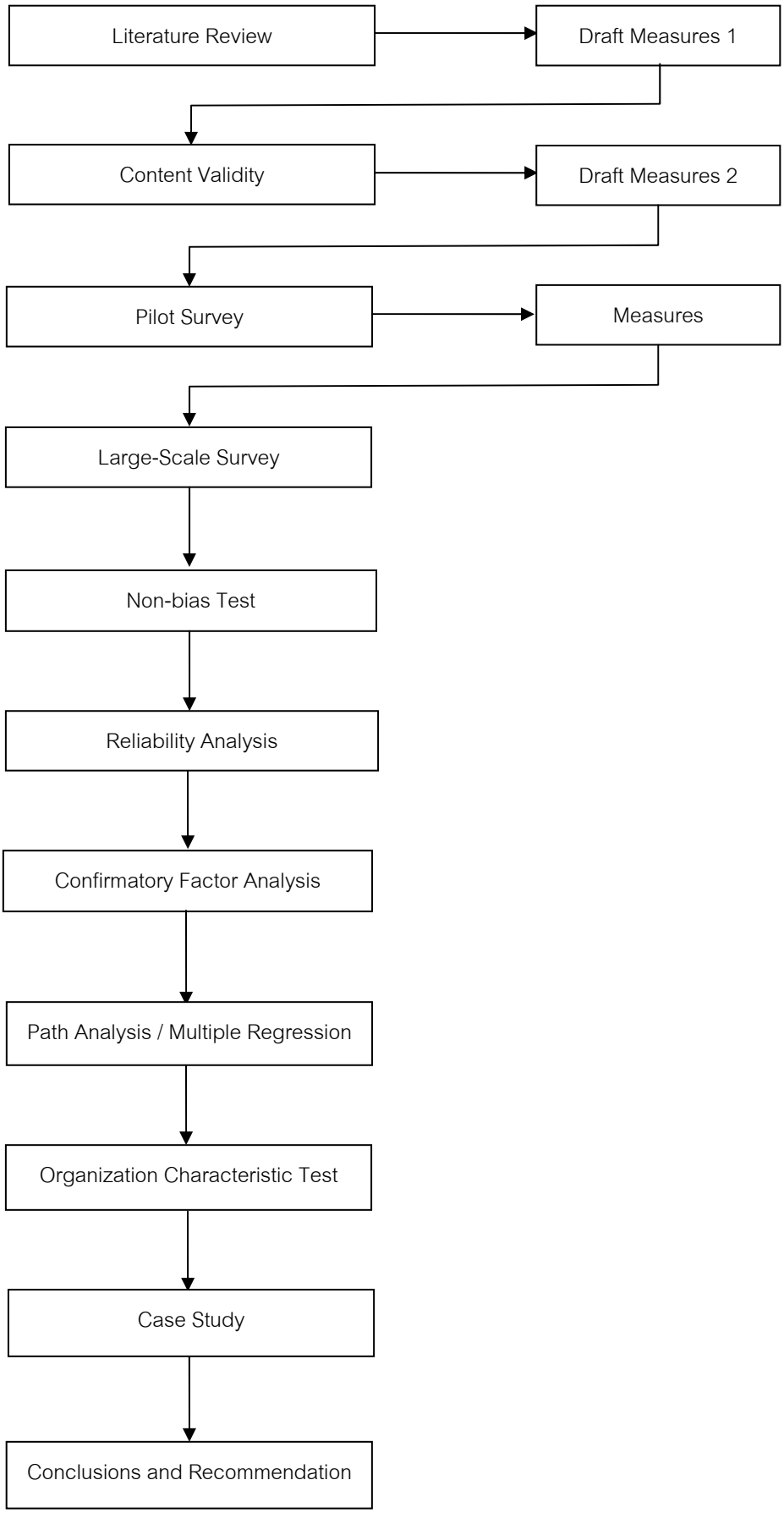

Figure 3.2: The research process

Table 3.1: SCMP construct

SCMP Construct	Description	Supportive Literature
Information Management (SCM_IM)	The extent to which the necessary information is collected, shared, evaluated and utilized in collaboration with business partners.	Employing Information and Communication Technologies (Chin *et al*., 2004), Information Quality (Li *et al*., 2005), Information Sharing (Li *et al*., 2005), Information Sharing (Tan *et al*., 2002), Information Sharing (Min and Mentzer, 2004), Information Technology (Lee and Kincade, 2003), Information Technology (Sahay and Mohan, 2003)
Lean System (SCM_LS)	The extent to which the organizations design and manage the business process to eliminate waste in the supply chain.	Lean System (Li et al., 2005), Inventory Management (Sahay and Mohan, 2003), JIT Capability (Tan *et al*., 2002), Manufacturing Flow Management (GSCF in Lambert *et al*., 2005), Operation Flexibility (Lee and Kincade, 2003), Order Fulfillment (GSCF in Lambert *et al*., 2005), Re-engineering Material Flow (Chin *et al*., 2004), Returns Management (GSCF in Lambert *et al*., 2005), Geographical Proximity (Tan *et al*., 2002), Postponement (Li *et al*., 2005), Process Integration (Min and Mentzer, 2004), Supply Chain Integration (Sahay and Mohan, 2003), Supply Chain Integration (Tan *et al*., 2002), Product Development and Commercialization (GSCF in Lambert *et al*., 2005), Demand Characterization (Lee and Kincade, 2003), Demand Management (GSCF in Lambert *et al*., 2005)
Partnership Management (SCM_PM)	The extent to which the organizations deal with business partners for relationship development and utilization	Building Customer-Supplier Relationships (Chin *et al*., 2004), Cooperation (Min and Mentzer, 2004), Customer Relationship (Li *et al*., 2005), Customer Relationship Management (GSCF in Lambert *et al*., 2005), Customer Service Management (GSCF in Lambert *et al*., 2005), Customer Service Management (Tan *et al*., 2002), Long-term Relationship (Min and Mentzer, 2004), Partnership (Lee and Kincade, 2003), Strategic Supplier Partnership (Li *et al*., 2005), Supplier Relationship Management (GSCF in Lambert *et al*., 2005)
Supply Chain Organization (SCM_SO)	The extent to which the organizations are managed strategically and systematically to facilitate SCM	Agreed Supply Chain Leadership (Min and Mentzer, 2004), Agreed Vision & Goals (Min and Mentzer, 2004), Changing Corporate Culture (Chin *et al*., 2004), Management Commitment (Lee and Kincade, 2003), Risk & Reward Sharing (Min and Mentzer, 2004), Supply Chain Strategy (Sahay and Mohan, 2003)

These items were gathered from research carried out in various industries and countries. They were generic and might not be able to respond to specific situation in the automotive supply chain in Thailand. Therefore, in this research, the measurement items were reviewed by the experts in order to improve the content validity. The content validity would ensure that the measurement items cover the major content of the constructs (Li *et al.*, 2006). Thus, the second set of SCMP items were discussed with three industry experts and four academic experts in the area of SCM and QM in the automotive industry in Thailand. Among these seven experts, only one had been known to the researcher before.

The companies of the industry experts were selected from various criteria to cover necessary characteristics which could affect research questions and quality such as the nationality of major shareholders of the company, the company size and tier in the supply chain. To ensure SCM and QM maturity, these companies were chosen from the leading manufacturers in their market segments. All industry experts were executives who were knowledgeable in strategic SCM of their companies and in the automotive industry in Thailand as a whole. They were the 1) Regional Director of Toyota Motor (Thailand), 2) General Manager of Siam GS Battery, and 3) Supply Chain Management Manager of Valeo Siam Thermal Systems. The academic experts were SCM researchers from well-known government universities in Thailand, namely, King Mongkut's University of Technology Thonburi, King Mongkut Institute of Technology Ladkrabang, Mahidol University and Srinakharinwirot University. All of them hold a Ph.D. and senior academic positions and have made key contributions in SCM research and professional activities such as authoring books, academic committee members/leaders of SCM conferences, heads of SCM research projects or heads of the academic institutes. Moreover, they were active members of the Thai Value Chain Management and Logistics (Thai-VCML), a widely accepted society of SCM researchers in Thailand.

Initially, information about the background, objectives and scope of the research were explained to each expert via telephone. This was done to develop a personal relationship and to have clear understanding about the research and better cooperation. After that, the list of SCMP, QMP and FSP items were sent to the experts via e-mail about one week prior to the interview. Each expert was interviewed separately to prevent bias or dominant opinions. Research background and information were explained again on the interview day prior to the interview. The interview started with discussing issues about SCMP, QMP and FSP, respectively. Clarity of the wording of the items was validated during the discussion. After the interview, comments from the previously interviewed experts were summarized and raised to discuss with the next interviewed experts. Moreover, comment from the latter interviewed experts was re-discussed with the former interviewed experts again during the second round for obtaining better consistency of the findings.

As a result, the second set of SCMP measure contained 37 items in four constructs. They were 1) Information Management (7 items), 2) Lean System (16 items), 3) Supply Chain Organization (7 items) and 4) Partnership Management (7 items), as shown in Table 3.2. Conceptually, these SCMP should correlate one another. For example, material flow improvement (e.g. setup time and lot size reduction) in lean system can be facilitated by sharing information and managing partnership with business partners (Kannan and Tan, 2005). Information management

is influenced positively by supply chain partnership, and shared strategy between supply chain partners (Li and Lin, 2006). A six-point Likert scale, ranging from Never to Always, was applied to validate the existences of the SCMP in the companies surveyed.

Table 3.2: Third set of SCMP items

Construct	Code	Description
Information Management	SCM_IM01	We contact the end users of our products to get feedback on product performance and service
	SCM_IM02	We work with our trade partners to survey and define customer requirement
	SCM_IM03	We have common standard for information sharing (e.g. product order, shipment, inventory) for our trade partners to follow
	SCM_IM04	We evaluate formal and informal complaints as well as satisfaction of our trade partners
	SCM_IM05	We effectively share information with our trade partners to facilitate business planning and react to changes
	SCM_IM06	We apply advanced information technology in our supply chain
	SCM_IM07	We have an information sharing among functions for the objectives of supply chain management
Lean System	SCM_LS01	We delay final manufacturing activities until customer orders have actually been confirmed
	SCM_LS02	We reduce inventory levels
	SCM_LS03	We reduce set-up time
	SCM_LS04	We reduce inspection of incoming materials/components/products
	SCM_LS05	We order in small lot sizes
	SCM_LS06	We streamline business processes (e.g. ordering, shipping, receiving and other paperwork) with our trade partners
	SCM_LS07	We reduce response time
	SCM_LS08	We have continuous improvement activity
	SCM_LS09	We deliver products directly to points of use (e.g. customer's assembly lines)
	SCM_LS10	We involve in teams including our trade partners to improve our supply chain
	SCM_LS11	We use a "pull" production system (pull means producing only when there is demand not to keep high inventory)
	SCM_LS12	We share supply chain management practices or resources (e.g. manufacturing, warehousing, distribution, marketing, etc.) with our trade partners
	SCM_LS13	We place our personnel at the business facilities of our trade partners to facilitate cooperation

	SCM_LS14	We store our goods at appropriate distribution points close to our customers
	SCM_LS15	We design our products for modular or unit part assembly (e.g. brake systems, wiring harness, air-conditioning systems, steering column, instrument cluster)
	SCM_LS16	We have contingency management system for unexpected events (e.g. order change or cancellation, computer network down)
Partnership Management	SCM_PM01	We share knowledge about core business processes with our trade partners
	SCM_PM02	We share improvement benefit as well as other risks and rewards with our trade partners
	SCM_PM03	We develop long-term relationship and trust with our trade partners
	SCM_PM04	We rely on a small number of quality trade partners
	SCM_PM05	We participate in the sourcing decisions of our suppliers
	SCM_PM06	We include our trade partners in our product development projects
	SCM_PM07	We have common agreed to goals with our trade partners
Strategy and Organization	SCM_SO01	We have supply chain performance measurement system
	SCM_SO02	We certify our suppliers by supply chain performance criteria (e.g. quality, cost, delivery)
	SCM_SO03	We extend our trade partners to include partners beyond immediate suppliers and customers
	SCM_SO04	We have organizational structure which facilitates business process integration with our trade partners
	SCM_SO05	Our top level managers strongly encourage employee (worker) involvement in supply chain management
	SCM_SO06	Our employees (workers) are actively involved in supply chain management-related activities
	SCM_SO07	Our organization has an open, trusting culture with low bureaucracy. Our working environment is very good for supply chain management

3.4.2 Quality Management Practice Measure Development

To assess the QMP measures, TQM framework was employed because it has been accepted as a superior QM system. After an extensive literature review, the TQM framework of Hoang *et al.* (2006) was applied in this study; because, this TQM framework constituted both hard and soft practices of TQM. It covered most prestigious quality award criteria which were widely accepted by TQM experts. Moreover, their TQM framework was designed for industries in developing countries,

and tested in the Vietnamese industries. Consequently, the TQM framework of Hoang *et al.* (2006) was deemed more appropriate for the Thai industry. For customization and content validity, the instrument was reassessed again by the same group of experts who validated SCMP measure on the same interview day, using the same steps as those of SCMP measure development.

The second measure of QMP had 17 items in four constructs. They were 1) Customer Focus (QMP_CF), 2) Commitment and Strategy (QMP_CS), 3) Human Resource Management (QMP_HR) and 4) Information Analysis (QMP_IA), as explained in Table 3.3 and Table 3.4, respectively. These QMP should correlate one another. For example, Quality commitment and strategy including human resource management require information analysis and sharing among concerned parties (Kannan and Tan, 2005). Information analysis significantly influences customer focus and satisfaction in MBNQA (Wilson and Collier, 2000). Similar to measuring SCMP, a six-point Likert scale, ranging from Strongly Disagree to Strongly Agree, was used to assess the QMP in the companies.

Table 3.3: QMP construct

QMP Construct	Description
Customer Focus (QMP_CF)	The extent to which the organizations strive for higher customer satisfaction
Commitment and Strategy (QMP_CS)	The extent to which the top management commits to quality with vision, goal and strategy
Human Resource Management (QMP_HR)	The extent to which the employees involve in quality management and improvement
Information Analysis (QMP_IA)	The extent to which information is collected, shared and analyzed for quality improvement

Table 3.4: Second set of QMP items

Construct	Code	Description
Commitment and Strategy	QMP_CS01	Our top level managers strongly encourage employee (worker) involvement in quality management
	QMP_CS02	We have clear vision, mission, policies, long term objectives and plan for improving quality
	QMP_CS03	We have a clear quality goal and short-term business performance plan
	QMP_CS04	Our top managers allocate adequate resources toward efforts to improve quality
Customer Focus	QMP_CF01	We have a system for collecting complaints or suggestions from customers
	QMP_CF02	We actively seeks ways to improve the products in order to achieve greater customer satisfaction
	QMP_CF03	We have introduced and maintained the “customer focus” philosophy for a long time

Human Resource Management	QMP_HR01	We provide training and training resources to employees (workers) and encourage them to attain these training programs
	QMP_HR02	We have many active improvement teams
	QMP_HR03	We actively evaluate and implement employees' suggestions related to quality and supply chain management, if they are suitable
	QMP_HR04	Our line employees (workers) are responsible for and inspect the quality of their own work (or self inspection)
	QMP_HR05	We have an assistance mechanism (or a problem solving network) to help line employees solve quality problems
	QMP_HR06	Our employees (workers) are actively involved in quality management-related activities
	QMP_HR07	We provide awards to individuals (or groups) for excellent suggestions
Information Analysis	QMP_IA01	We have an information sharing among functions for the objectives of quality improvement
	QMP_IA02	We display information on quality performance at most of the work stations and everybody knows it
	QMP_IA03	We uses quality improvement tools and techniques extensively for process management and improvement

3.4.3 Firm's Supply Performance Measure Development

The process of FSP measure development was similar to that of SCMP. It started from extensive literature review to identify FSP dimensions and indicators and to assess their quality. FSP measures proposed by Min and Mentzer (2004), Li *et al.* (2002) and Gunasekaran *et al.* (2001) were applied to develop the main measurement instrument. Primarily, 86 items were collected as shown in Appendix 3.3. This first set of FSP measure was generic and applicable to any industry in any country. After careful consideration, items with unclear description were removed and similar items were grouped together. Consequently, the second set of FSP was formed with 18 items as shown in Appendix 3.4. To improve content validity, these items were customized to specifically correspond to the automotive supply chain in Thailand. They were discussed with the seven experts who assessed SCMP and QMP measure, using the same steps of consistency.

Finally, the third set of FSP measure was composed of 13 items in 4 constructs. They were 1) Cost (FSP_CT), 2) Flexibility (FSP_FL), 3) Relationship (FSP_RL) and 4) Responsiveness (FSP_RS) as shown in Table 3.5 and Table 3.6. Each of these FSP affects the others. For example, cost reduction may negatively affect responsiveness and flexibility in supply chain (Beamon, 1999). There is a correlation between flexibility and responsiveness (Gunasekaran *et al.,* 2001). A Six-point Likert scale, ranging from Strongly Disagree to Strongly Agree, was employed to measure FSP of the companies surveyed.

Table 3.5: FSP construct

FSP Construct	Description
Cost (FSP_CT)	The degree which the organizations can operate with cost effectiveness
Flexibility (FSP_FL)	The degree which the organizations can adapt to changes or customer demand
Relationship (FSP_RL)	The degree which the organizations can develop relationship with business partner
Responsiveness (FSP_RS)	The degree which the organizations can respond to customers requirement

Table 3.6: Third set of FSP items

Construct	Code	Description
Cost	FSP_CT01	We have good overall inventory management performance (e.g. inventory turnover, obsolete, availability)
	FSP_CT02	We have good overall financial performance (e.g. ROA, ROI, ROS)
	FSP_CT03	We have effective and efficient production plan
Flexibility	FSP_FL01	We have ability to produce products with various specification (e.g. features, options, sizes, colors, special specification)
	FSP_FL02	We have ability to rapidly adjust production capacity in response to changes in customer demand
	FSP_FL03	We have ability to handle rapid introduction of new products
Relationship	FSP_RL01	Our suppliers have good overall performance (e.g. quality, cost, delivery)
	FSP_RL02	We have good overall relationship with trade partners
	FSP_RL03	We have accurate demand forecasting
	FSP_RL04	We have effective and efficient business process (e.g. less clerical, documentary, inspection jobs)
Responsiveness	FSP_RS01	We have good overall delivery performance (e.g. on-time, fast)
	FSP_RS02	We have good overall quality of products and services
	FSP_RS03	We have ability to provide our customers real time information about their orders

3.4.4 Back Translation

The reference measurement instruments were developed in English. To avoid linguistic differences in the Thai and English technical vocabulary, back translation

was conducted. Primarily, the survey instrument was prepared in English. A senior Ph.D. student in the area of SCM was asked to translate this English questionnaire version into Thai. The language used in the Thai questionnaire was reviewed by two senior university lecturers in the area of SCM and QM to improve the clarity. Ambiguities or inconsistencies in the technical wording were noted and corrected. To verify the quality and accuracy of the Thai translation, a Ph.D. graduate in the area of management of technology at the Asian Institute of Technology (AIT) with Bachelor's and Master's degrees from the U.S. universities was asked to translate the Thai questionnaire back to English. Finally, the English version of the original and the back-translated questionnaires were compared, validated and assessed as acceptable.

3.5 Pilot Test

The pilot survey was conducted to get feedback and comments from potential respondents about the length, format, content and clarity of the questionnaire in order to ensure that the questions were understandable and represent the underlying issues of interest. Twelve companies were selected from directory of Thai Automotive Business and database of Thailand Automotive Part Manufacturer Association (TAPMA) for this pilot test. The target respondents were executives experienced in strategic SCM and QM in their companies. Initially, the researcher contacted the targeted respondents via telephone to develop personal relationship and ask for cooperation. Information about the background, objectives and scope of the research were explained to them to improve their understanding about this study.

In the pilot questionnaire, questions about background information for general classification and demographic information of the sample companies were included such as the major shareholder, number of employees, products, tier in the supply chain, and QM and SCM systems. Moreover, a cover letter explaining the objectives of the research, qualification of target respondents, reward for the response and guaranteeing the confidentiality of the response was enclosed with the questionnaire. Both paper-based questionnaire and e-questionnaire were planned to employ a large-scale survey. In order to ensure the applicability and convenience of the e-questionnaire, the pilot questionnaire was prepared in electronic form to be delivered via e-mail. Compared with traditional paper-based questionnaire, the e-questionnaire prevent lost questionnaires, lower cost of preparation, distribution and return of the questionnaires.

After receiving the returned e-questionnaires, the researcher contacted the respondents to ask for comments. Many respondents asked the researcher to provide definition of SCM in the questionnaire, because SCM was rather new in Thailand even in the automotive industry. Therefore, its meaning, concept and application might not be clearly understood and could be viewed differently by companies. In response to this, the SCM definition of the Global Supply Chain Forum GSCF was added into the questionnaire. The SCM definition in the questionnaire was "*the integration of key business processes from end user through original suppliers that provide products, services and information that add value to all trade partners*" (Tracey *et al.*, 2005; Lambert *et al.* 2005; Chan and Qi, 2003; Lambert and Cooper, 2000). This SCM definition was applied because it covers a broader and strategic scope of SCM in line with the objectives and scope of this research. Overall, there

was no serious or major comment about length, format, content and clarity of the questionnaire. Therefore, no item was dropped at this stage. Moreover, e-questionnaire form and distribution method was assessed as applicable.

3.6 Large-scale Data Collection

In the questionnaire (Appendix 3.5), questions about background information for general classification and demographic information of the sample companies were included such as the nationality of the major shareholders, the number of employees, products, the tier in the supply chain, and QM and SCM systems. Moreover, cover letter explaining the objectives of the research, qualification of targeted respondents, incentives of the response and guaranteeing the confidentiality of the response was enclosed with the questionnaire. Multiple responses from each company were encouraged by asking at least two respondents per company to answer the questionnaire in order to improve reliability of the information obtained. The questionnaires were prepared in two forms, an e-questionnaire for electronic distribution via e-mail and a paper-based questionnaire for manual distribution. To improve the response rate, rewards such as an e-book about facility and layout design and the research report of this study, were offered to the respondents. After returning the questionnaire, a password was sent to the respondent's e-mail boxes indicated in the questionnaire. The respondents would be able to download the e-book from the researcher's mailbox. The research report of this study would be distributed to the respondents after the research is completed.

Quality of the responses is very important in empirical research. Therefore, the target for the questionnaire was executives who were knowledgeable in strategic SCM and QM of their companies. In this research, responses from the respondents with positions below the manager level were excluded. Moreover, multiple responses from executives in different departments were requested to improve quality and reliability of the responses. Carr *et al.* (2000) advised that many Asian organizations would be reluctant to cooperate in research surveys without first developing a relationship with the researchers. Hoang *et al.* (2006) experienced such attitude and behavior when conducting research in Vietnam. Therefore, to prevent the same obstacle in Thailand, various methods including rewards for respondents were initiated to ensure a higher response rate such as personal request via telephone and supportive request from professional organizations.

For the e-questionnaire distribution, a directory of Thai Automotive Business and the database from Thailand Automotive Part Manufacturer Association (TAPMA), Thailand Automotive Institute (TAI), Federation of Thai Industries (FTI) and Industrial Estate Authority of Thailand (IEAT) were employed to identify the targeted companies. The researcher then contacted the targeted respondents via telephone to develop personal relationship and ask for cooperation. After the telephone conversation, the e-questionnaire was sent to them. Moreover, several professional organizations in the automotive industry in Thailand were asked to distribute e-questionnaire on our behalf to their members. Those professional organizations included TAPMA, TAI, Human Resource Club of Amata Industrial Estate, Human Resource Club of Laem Chabang Industrial Estate and Human Resource Club of Eastern Seaboard Industrial Estate.

The paper-based questionnaire was manually distributed during several public seminars about the automotive industry or SCM, organized by professional organizations such as TAI and Thailand Productivity Institute (TPI). Other distribution methods such as friends recommend respondents were also employed in order to obtain more responses.

The total number of returned questionnaires was as high as 415. All questionnaires were examined to identify missing data and questionnaires from non-eligible respondents. Some missing data could be obtained by contacting the respondent via e-mail or telephone. 146 questionnaires (35.2%) were excluded due to missing data or inappropriate respondent profile (e.g. below manager level, unrelated departments and industries). Almost all of these were paper-based questionnaires because of lack of targeted respondent selection and personal relationship development prior to the distribution during public seminars. Finally, the total number of valid questionnaire received was 269 (64.8%) as shown in Table 3.7.

Table 3.7: Valid and invalid responses

	Frequency	**(%)**
Invalid Response	146	35.2%
Valid Response	269	64.8%
Total Response	415	100.0%

For multiple responses in a company, the answer of each respondent was simply averaged. The averaged score was used to represent practice and performance of the company and determined as only one sample. Single and multiple responses accounted for 81% and 19% of all companies. Therefore, considering multiple responses from 40 companies, the final number of valid samples by company was 211 as shown in Table 3.8.

Table 3.8: Multiple responses

	Person	**Company**	**% Company**
One Respondent	171	171	81.0%
Two Respondents	56	28	13.3%
Three Respondents	21	7	3.3%
Four Respondents	16	4	1.9%
Five Respondents	5	1	0.5%
Total	269	211	100.0%

3.7 Characteristics of the Samples

Some characteristics of the sample companies might influence the results of the study and were chosen for further analysis as follows:

Respondent's Position

In multiple response companies, the highest position among the respondents was used to represent the company as a whole. Thus the majority of respondents were mangers (49.8%); while, 44.1% were Director or equivalence, for example, Vice President, Deputy Managing Director, Plant Manager, and General Manger (Table 3.9). Response from the Managing Director or equivalent such as CEO and President was rather low at 6.2%.

Table 3.9: Classification of respondent's position

Position	Company	% Company
Managing Director	13	6.2%
Director	93	44.1%
Manager	105	49.8%
Total	211	100.0%

Major Shareholder

In term of nationality of the major shareholders, almost half were Japanese; while, 35.9% of the sample companies had Thai major shareholders, 49.8% had Japanese major shareholders and 14.3% had major shareholders from other countries as shown in Table 3.10.

Table 3.10: Classification of major shareholder

Major Shareholder	Company	* % Company
Thai	75	35.9%
Japanese	104	49.8%
Other Nationality	30	14.3%
Missing	2	
Total	211	100.0%

* Not including missing responses

Company Size

The Ministry of Industry in Thailand categorizes manufacturing business firms by the number of employees. They are small-sized companies (less than 50 employees), medium-sized companies (between 50-200 employees) and large-sized companies (more than 200 employees) (Office of Small and Medium Enterprises Promotion, 2008). Because the proportion of small-sized companies in the survey was small (5.2% of the samples), the company size in this study was classified into only two groups, namely, small-to-medium companies (less than 200 employees) and large companies (more than 200 employees). Laosirihongthong *et al*. (2003) and Hoang *et al.* (2006) employed similar criteria in their research in Thailand and Vietnam, respectively. From these criteria, small-to-medium and large companies accounted for 25.6% and 74.4% of the samples as shown in Table 3.11.

Table 3.11: Classification of company size

No. of Employee	Company	% Company
Less than 50	11	5.2%
50 - 100	16	7.6%
100 - 200	27	12.8%
200 - 500	75	35.5%
500 - 1000	56	26.5%
More than 1000	26	12.3%
Total	211	100.0%

Tier in the Supply Chain

In the automotive supply chain, the automotive assemblers are considered as the focal firms of the supply chain. From the survey, 87.2% of the firms were first tier suppliers, 9.4% were second tier suppliers and 3.4% were third tier or other tier suppliers. Because the proportion of the third tier and the others was small, the tier of the sample companies in this research was classified into two groups, namely, 1) first tier suppliers and 2) other tier suppliers. The first tier and the other tier suppliers accounted for 87.2% and 12.8%, respectively, as shown in Table 3.12.

Table 3.12: Classification of tier in the supply chain

Tier	Company	* % Company
Tier 1	177	87.2%
Tier 2	19	9.4%
Tier 3 and others	7	3.4%
Missing	8	
Total	211	100.0%

* Not including missing responses

Quality Management and Supply Chain Management System

As shown in Table 3.13, 43.6% of the firms hold an ISO 9000 certificate and 73.5% obtained ISO/TS 16949, the industry-specific QM for the automotive industry. For SCM, there was still no internationally accepted standard or certificate (Lambert *et al.*, 2005; Croom *et al.*, 2000). Therefore, only 21.3% of the firms had implemented JIT or lean manufacturing or TPS which included many principles and concepts of SCM in the automotive industry.

Table 3.13: Classification of management systems

Management System	Company	% Company
ISO 9000	92	43.6%
ISO/TS 16949	155	73.5%
JIT or Lean or TPS	45	21.3%

3.8 Statistical Test

In this research, various statistical techniques were applied for data analysis. Primarily, non-respondent and multiple respondent biases were tested to confirm similarity between respondents and non-respondents and between single and multiple responding companies. The item-total correlation and Cronbach's alpha were used to examine the reliability or internal consistency of the items and measures.

The main hypotheses were tested with the Structural Equation Modeling (SEM). SEM is a multivariate technique which combines the aspects of factor analysis and multiple regressions. It can examine both the measurement and the structural models in order to ensure that the models are consistent with the underlying theory. The measurement model is concerned with the reliability and validity of the constructs in measuring the latent variables. This can be assessed with Confirmatory Factor Analysis (CFA). Moreover, the second-order CFA can reconfirm the validity and existence of the measurement models in accordance with their sub-factors. For the structural model, path analysis can investigate the relationships among the hypothesized model's constructs (e.g. the direct, indirect and total effects). In this research, these SEM techniques have been extensively applied for analysis. There are many SEM software package such as LISREL, AMOS, EQS, PROC COSAN, LVPLS available in the market. Among them, Linear Structure Relations (LISREL) is the most wildly used software until it has become the standard for notation (Hair *et al.,* 1998). Thus, LISREL 8.53 of the Scientific Software International has been utilized in this research. In LISREL, multiple fit indexes are employed to test the construct validity. However, there is no single measure or set of measures that can best describe the model prediction (Hair *et al.,* 1998). Kline (1998) has recommended to employ at least four measures for assessment, for example, chi-square; GFI, NFI, or CFI, NNFI and SRMR. Other empirical application such as Hoang *et al.* (2006) applied χ^2 / df, GFI, CFI, NNFI and SRMR to study the impact of TQM on innovation in Vietnam. Accordingly, the selected fit indexes in this study were

1) Chi-square divided by degree of freedom (χ^2 / df ratio) or normed Chi-square
2) Goodness-of-Fit Index (GFI)
3) Comparative Fit Index (CFI) or Bentler Comparative Fit Index
4) Non-Normed Fit Index (NNFI) or Bentler-Bonett Non-Normed Fit index or Tucker-Lewis index (TLI)
5) Standardized Root Mean Squared Residual (SRMR) or Standardized RMR

For more detail, χ^2 / df describes the overall fit of the model. GFI and CFI can present the overall proportion of the explained variance. NNFI adjusts the proportion of the explained variance for model complexity, and SRMR presents a standardized summary of the average covariance residuals.

Descriptive statistics were applied to rank the maturity of the factors in the measurement models. In consequence, the Multivariate Analysis of Variance (MANOVA) was employed to investigate differences in SCMP, QMP and FSP of the samples organizations in respect to organizational characteristics. These

characteristics included major shareholders (Thai, Japanese and others), the company size (small to medium and large companies), the tier in the supply chain (first tier suppliers and other tier suppliers) and QM maturity (companies with ISO/TS 16949 and companies without ISO/TS 16949). Moreover, the impact of individual QMP on individual SCMP was assessed by multiple regression analysis.

3.9 Summary

The measurement instruments for assessing SCMP, QMP and FSP were dedicatedly developed for specific needs of the automotive industry in Thailand. To ensure the content validity, related literature was reviewed extensively. Moreover, the collected measurement indicators were assessed and customized by three industry experts and four academic experts in the area of SCM and QM in the automotive industry in Thailand. These experts were carefully selected to cover all necessary academic and professional dimensions of the research. Back translation of the questionnaire was conducted to overcome the problem of linguistic differences in the technical vocabulary in the Thai and English version. Six-point Likert scale was employed in the questionnaire. The pilot survey was conducted to get feedback and comments from potential respondents about the length, format, content and clarity of the questionnaire in order to ensure that the questions were clear and represented the underlying issues of interest. For the large-scale survey, the questionnaire was prepared in two forms, namely, e-questionnaire and paper-based questionnaire. During the data collection process, various methods were initiated to distribute the questionnaires to ensure high response rate. For example, incentives, personal request via telephone, endorsement and support from professional organizations were conducted to encourage responses. The targeted respondents were executives with long experience in strategic SCM and QM of their companies. Multiple responses from the same company were encouraged to improve reliability of the information obtained. Finally, there were 211 valid sample companies. Interesting organizational characteristics such as company ownership, company size, tier in the supply chain and management systems were noted for further analysis.

CHAPTER 4
DATA ANALYSIS AND DISCUSSION

4.1 Introduction

This chapter applied comprehensive statistical techniques in the analysis of the collected data in order to respond to the research questions, objectives of the study and research hypotheses. The statistical tools included non-respondent bias test, multiple respondent bias test, reliability assessment, first-order and second-order confirmatory factor analysis (CFA), path analysis, descriptive statistics analysis and MANOVA. Additionally, the analytical results were interpreted and discussed extensively in this chapter. In this research, the following acronyms were employed to present each construct and sub-construct in the measurement and structural models. The indicators of each sub-construct were numbered after the sub-construct acronym as shown in Table 3.2, 3.4 and 3.6 for SCMP, QMP and FSP items, respectively.

SCMP	Supply Chain Management Practice	
	SCM_IM	Information Management
	SCM_LS	Lean System
	SCM_PM	Partnership Management
	SCM_SO	Strategy and Organization
QMP	Quality Management Practice	
	QMP_CF	Customer Focus
	QMP_CS	Commitment and Strategy
	QMP_HR	Human Resource Management
	QMP_IA	Information Analysis
FSP	Firm' Supply Performance	
	FSP_CT	Cost
	FSP_FL	Flexibility
	FSP_RL	Relationship
	FSP_RS	Responsiveness

4.2 Non-Respondent Bias and Multiple Respondent Bias Test

In this empirical research, non-respondent bias has been a matter of concern. To ensure similarity between the respondent and non-respondent samples in this study, the profiles of 35 non-respondent companies were checked via telephone, the company's website or the database of the Industrial Estate Authority of Thailand. For comparative study, relevant organizational characteristics, i.e., company ownership, company size and tier in the supply chain were examined. Company ownership was classified by the nationality of the major shareholder among three groups, namely, Thai, Japanese and other nationalities. Size was categorized by the number of employees. The companies with employees lower than 200 were considered as small-to-medium companies, and the companies with employees more than 200 were

determined as large companies. The tier in the supply chain was divided into two groups, namely, the first-tier suppliers and the other tier suppliers.

As shown in Table 4.1, there was high percentage of non-respondents in companies that were Japanese owned, small-to-medium companies and the first-tier suppliers. Chi-square test was applied to compare the organizational characteristics between the respondent and non-respondent companies. The results showed no significant difference in company ownership, company size and tier in the supply chain between the respondent and non-respondent samples for every organizational characteristic. At 0.05 significant level, Chi-square value of company ownership was 3.11 which was less than 5.99 for two degrees of freedom. Moreover, Chi-square value of both company size and tier in the supply chain were 0.71 and 0.48, respectively, which were lower than 3.84 at one degree of freedom. All p-values were higher than 0.05. In respect to the Chi-square tests, the respondent and non-respondent samples were similar. Since, the number of multiple responses in a company was small (19%), t-test was conducted to compare mean score of all items between 171 single and 40 multiple responding companies. The results showed that $p = 0.663$ and $\alpha = 0.05$ meaning there was no significant difference between single and multiple responding companies. The responses correctly reflected the company's practices and performance, not respondent's perception or bias.

Table 4.1: Non-respondent bias test

Organizational Characteristic	Response		Non-response		df	Chi-Square	p-value
	Company	%	Company	%			
Thai	75	35.9%	9	25.7%	2	3.11	0.211
Japanese	104	49.8%	23	65.7%			
Other Ownership	30	14.4%	3	8.6%			
Small-to-Medium	54	25.6%	10	28.6%	1	0.71	0.710
Large	157	74.4%	25	71.4%			
First Tier	177	87.2%	32	91.4%	1	0.48	0.479
Other Tier	26	12.8%	3	8.6%			

4.3 Reliability Test

Reliability presents the extent to which a variable or set of variable is consistent in what is intended to be measured (Hair *et al.,* 1998). Since there is no sole perfect measure for reliability, several measures should be used for reliability assessment. In this study, item-total correlations and Cronbach's alpha have been applied to examine the reliability or internal consistency of the measurement items. Generally, the item-total correlation should exceed 0.3. The Cronbach's alpha scores above 0.7 are considered good value, however a score of 0.6 is still acceptable in the empirical research (Hair *et al.,* 1998; Nunnally and Burnstein, 1994).

For SCMP measure, five items of *Lean System* sub-construct and one items of *Partnership Management* sub-construct were dropped because of low item-total correlation value as shown in Table 4.2. These sub-constructs were SCM_LS01, SCM_LS04, SCM_LS13, SCM_LS14, SCM_LS15 and SCM_PM04. The item-total correlation score of every SCMP item were shown in Appendix 4.1.

Table 4.2: Items with low item-total correlation

Code	Description
SCM_LS01	We delay final manufacturing activities until customer orders have actually been confirmed
SCM_LS04	We reduce inspection of incoming materials/components/products
SCM_LS13	We place our personnel at the business facilities of our trade partners to facilitate cooperation
SCM_LS14	We store our goods at appropriate distribution points close to our customers
SCM_LS15	We design our products for modular or unit part assembly (e.g. brake systems, wiring harness, air-conditioning systems, steering column, instrument cluster)
SCM_PM04	We rely on a small number of quality trade partners

It was observed that these six items deal with specific operational issues (mostly lean system) rather than the general management issues of the sample companies. They were unique for individual organization and product produced. The remaining items had item-total correlation scores above 0.3 and their Cronbach's alpha were above 0.7 as shown in Appendix 4.2. For QMP, all items had item-total correlation score well above 0.5. QMP_HR07 had the lowest item-total correlation at 0.5920. Similarly, their Cronbach's alpha well exceeded 0.8. Among them, *Customer Focus* sub-construct had lowest alpha at 0.8228 as shown in Appendix 4.3. As a result, no items were dropped from the study. Similar to QMP, all FSP items had item-total correlation score well above 0.5. The lowest item-total correlation at 0.5684 belonged to FSP_CT02. All Cronbach's alpha exceeded 0.7. In detail, *Cost* sub-construct had the lowest alpha at 0.762 as shown in Appendix 4.4. Consequently, every item was kept for the study. After confirmatory analysis, Cronbach's alpha, composite reliability and average variance extracted will be checked again to ensure reliability in SEM.

4.4 Confirmatory Factor Analysis

Although the minimum number of indicators for a construct in confirmatory factor analysis (CFA) was one (Hair *et al.,* 1998), every sub-construct in this research had at least three indicators. In accordance with this requirement, these sub-constructs served the preferred minimum number of indicators per construct. The CFA with Maximum Likelihood Estimation (MLE) was employed to assess the validity of the measurement models in this study. MLE can improve parameter estimates iteratively in order to minimize a specified fit function. It was the most common estimation procedure for SEM with the preferred sample size of 200, the critical sample size (Hair *et al.,* 1998). The sample size of this study, 211, did fit this requirement.

Individual sub-construct was tested with CFA in order to remove the items with weak loading coefficients, below 0.5. In this validation process, for SCMP sub-construct, two items of *Information Management*, two items of *Lean System* and one item of *Strategy and Organization* sub-constructs were eliminated because of weak

loading coefficient. They were SCM_IM01, SCM_IM02, SCM_LS05, SCM_LS07 and SCM_SO03, as detailed in Table 4.3. Loading coefficient and t-value of every SCMP item before the removal were shown in Appendix 4.5 and those after the removal were shown in Appendix 4.6, respectively.

Table 4.3: Items with low loading coefficient

Code	Description
SCM_IM01	We contact the end users of our products to get feedback on product performance and service
SCM_IM02	We work with our trade partners to survey and define customer requirement
SCM_LS05	We order in small lot sizes
SCM_LS07	We reduce response time
SCM_SO03	We extend our trade partners to include partners beyond immediate suppliers and customers

The main reason of low loading coefficient of these items may be because the sample companies are the automotive part suppliers (mostly the first-tier suppliers) not the automotive assemblers. The automotive part suppliers sell products to the immediate customers rather than to the end customers or the automotive users. The automotive assemblers survey the end users' requirements and then convert those requirements to product specifications. Therefore, the automotive part suppliers merely respond to the automotive assemblers' requirements such as right specification, right order size and right delivery time and pay less attention to the end users' requirement. They do not put much effort to define the customer requirement. Moreover, in the automotive supply chain, the automotive assemblers act as focal organizations which are influential in managing and controlling members in their supply chains. The automotive part suppliers just deal with and focus on their immediate suppliers and customers to reduce management and communication complexity in their supply chain.

For QMP and FSP, every item was validated with the same procedure. The sub-constructs with three items are just-identified. However, they became over-identified by constraining two path coefficients to take on the same value (Hatcher, 2003). Their loading coefficient was well above 0.5 with high t-value. No items had to be deleted due to insufficient loading coefficients. The standardized estimate and t-value between the individual indicator and their sub-constructs of QMP and FSP were shown in Appendix 4.7 and 4.8, respectively.

To assess the overall goodness of fit of each sub-construct, the multiple goodness of fit indexes were applied. They were:

1) Chi-square divided by degree of freedom (χ^2 / df ratio) or normed Chi-square

2) Goodness-of-Fit Index (GFI)

3) Comparative Fit Index (CFI) or Bentler Comparative Fit Index

4) Non-Normed Fit Index (NNFI) or Bentler-Bonett Non-Normed Fit index or Tucker-Lewis index (TLI)

5) Standardized Root Mean Squared Residual (SRMR) or Standardized RMR

Generally, χ^2 / df ratio should be less than 3 or even the more liberal limit of 5.0 (Hair *et al.,* 1998). GFI, CFI and NNFI should be at least 0.9 (Hair *et al.,* 1998) and SRMR should be less and/or 0.1. As shown in Table 4.4, every construct of SCMP, QMP and FSP well met the requirements of these multiple fit indexes. All p-value were well above 0.05.

Moreover, Cronbach's alpha of SCMP after eliminating items with low loading coefficient was reassessed to ensure internal consistency as shown in Appendix 4.9. To ensure reliability in SEM, composite reliability and average variance extracted were employed to confirm reliability of all measurement models (Netemeyer *et al.,* 1990) as shown in Table 4.4. Indicator loadings and indicator error variances were shown in Appendix 4.6, 4.7 and 4.8. Composite reliability of every sub-construct was well above the required value of 0.60. All average variance extracted exceeded 0.50 except that of *Information Management, Lean System and Partnership Management.* Considering Cronbach's alpha, composite reliability and average variance extracted together, all sub-constructs were sufficiently reliable.

Table 4.4: Reliability and multiple fit indexes of sub-constructs

Sub-Construct	No. of Items	Cronbach 's Alpha	Composite Reliability	Average Variance Extracted	χ^2 / df	p-value	GFI	CFI	NNFI	SRMR	SRMEA	IFI	AGFI
Supply Chain Management Practice													
Information Management	5	0.7573	0.78	0.42	0.656	0.5755	0.99	1.00	1.00	0.0310	0.000	1.00	0.98
Lean System	9	0.8529	0.84	0.37	1.631	0.0631	0.98	0.99	0.98	0.0490	0.055	0.99	0.92
Partnership Management	6	0.7541	0.77	0.36	1.358	0.2014	0.98	0.99	0.98	0.0350	0.041	0.99	0.96
Strategy and Organization	6	0.8706	0.87	0.54	1.552	0.1566	0.99	1.00	0.99	0.0220	0.051	1.00	0.95
Quality Management Practice													
Customer Focus	3	0.8228	0.83	0.62	0.030	0.8638	1.00	1.00	1.00	0.0048	0.000	1.00	1.00
Commitment and Strategy	4	0.8526	0.85	0.58	0.570	0.4513	1.00	1.00	1.00	0.0056	0.000	1.00	0.99
Human Resource Management	7	0.8983	0.90	0.57	1.326	0.2094	0.98	1.00	1.00	0.0220	0.093	1.00	0.95
Information Analysis	3	0.8721	0.87	0.70	1.020	0.3119	1.00	1.00	1.00	0.0310	0.010	1.00	0.98
Firm's Supply Performance													
Cost	3	0.7962	0.81	0.59	2.180	0.1398	0.99	0.99	0.98	0.0450	0.076	0.99	0.96
Flexibility	3	0.7996	0.80	0.58	0.080	0.7772	1.00	1.00	1.00	0.0082	0.000	1.00	1.00
Relationship	4	0.8460	0.84	0.57	0.860	0.3546	1.00	1.00	1.00	0.0079	0.000	1.00	0.98
Responsiveness	3	0.8510	0.87	0.69	0.090	0.7613	1.00	1.00	1.00	0.0097	0.000	1.00	1.00

In this research, the second-order CFA or higher-order CFA was conducted so as to illustrate and confirm that these sub-constructs were sub-constructs of a broader and more encompassing constructs, namely, SCMP, QMP and FSP, respectively. In second-order construct, the first-order factors were determined as endogenous constructs, while the second-order factors were exogenous construct. This showed that the second-order factor, which had no manifest indictor, had caused the first-order factors. As a result, it was perfectly unobservable and latent (Hair *et al.,* 1998). The second-order constructs of SCMP, QMP and FSP are illustrated in Figure 4.1, 4.2 and 4.3, respectively.

From the examination, there were existence of the second-order constructs of SCMP, QMP and FSP. The SCMP, QM and FSP constructs were composed of the proposed sub-constructs and indicators in accordance with their supportive theories. No indicator of any sub-constructs was dropped due to weak loading coefficient during the second-order constructs validation process. Moreover, in every second-order construct, the loading coefficient between the second factors and their sub-constructs were well above 0.5. All t-value were higher than the critical value at 1.960 for 0.050 significant level as shown in Table 4.5. In details, for the second-order construct of SCMP, *Information Management* sub-construct had lowest loading coefficient at 0.788 and t-value 8.150. For the second-order construct of QMP, *Customer Focus* sub-construct had the lowest loading coefficient at 0.786 with t-value 9.150. For the second-order construct of FSP, *Flexibility* sub-construct had the lowest loading coefficient at 0.690 with t-value 7.652. The overall fit of every second-order construct was good as shown in Table 4.6. Their χ^2 / df were well below 3 with all p-value above 0.05. All GFI, CFI and NNFI were higher than 0.9, while all SRMR were well lower than 0.1.

Moreover, all measurement models also were tested for convergent, discriminant, and nomological validity. Nine of twelve models had average variance extracted value exceeded 0.50, suggesting good convergent validity as shown in Table 4.4 (Shock *et al.*, 2004). Discriminant validity was assessed by examining correlations between pairs of latent variable (Anderson and Gerbing 1988). All correlation coefficients were well less than one meaning that sub-constructs were distinct as shown in Appendix 4.10. Therefore, discriminant validity could be assumed. Besides the GFI, CFI and NNFI which were measured and confirmed, AGFI, IFI and RMSEA were added to assess nomological validity as shown in Table 4.4 (Steiger, 1990) and it was confirmed that the measurement models were acceptable nomological validity. Based on the overall results, these measurement models were fit and valid.

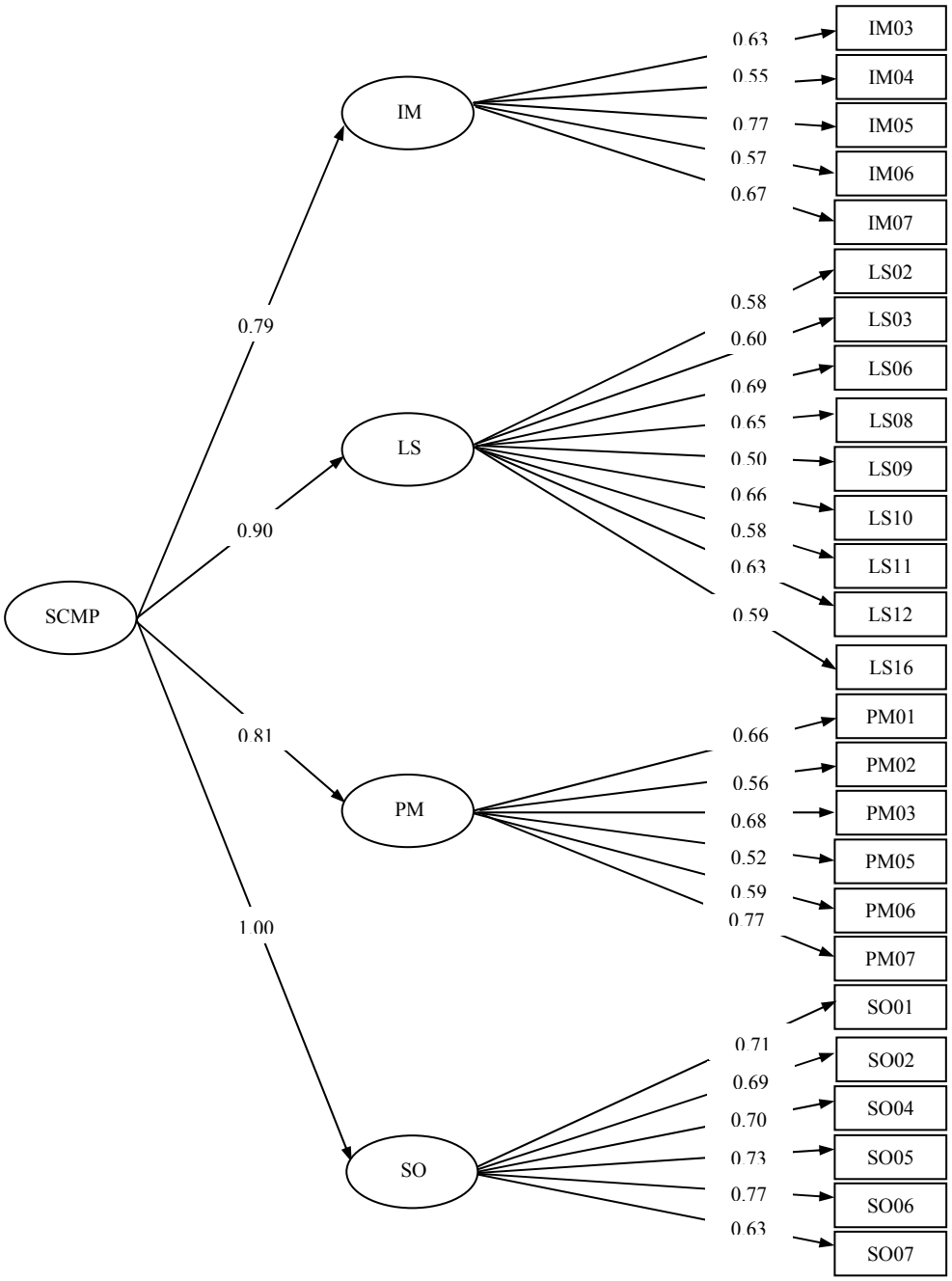

Figure 4.1: Second-order construct of SCMP

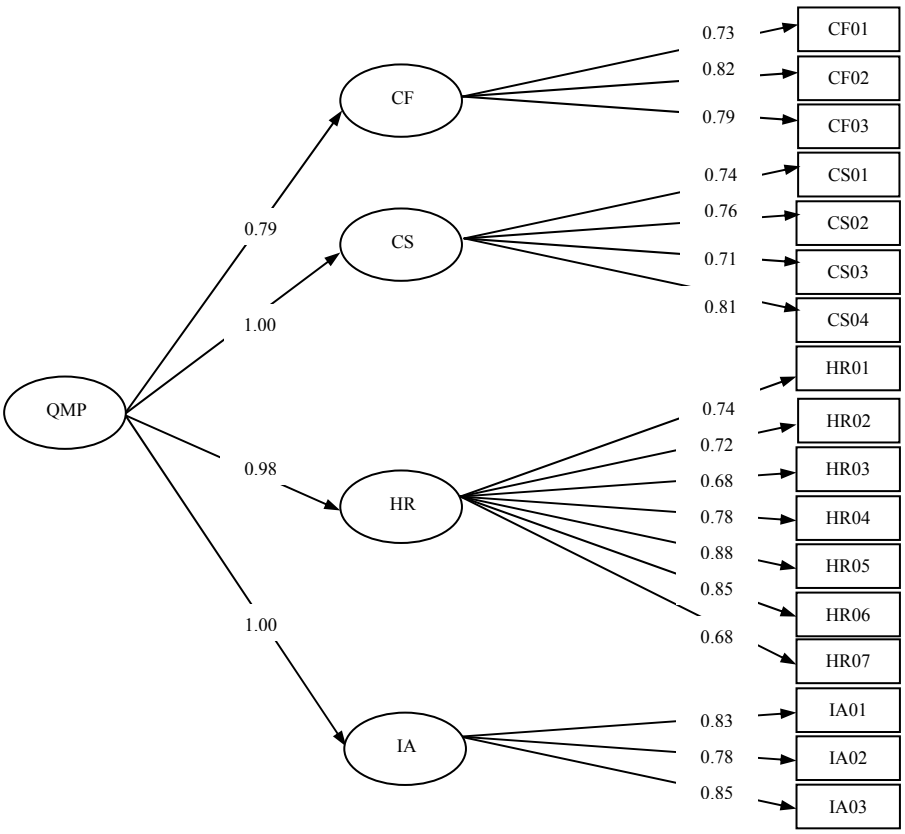

Figure 4.2: Second-order construct of QMP

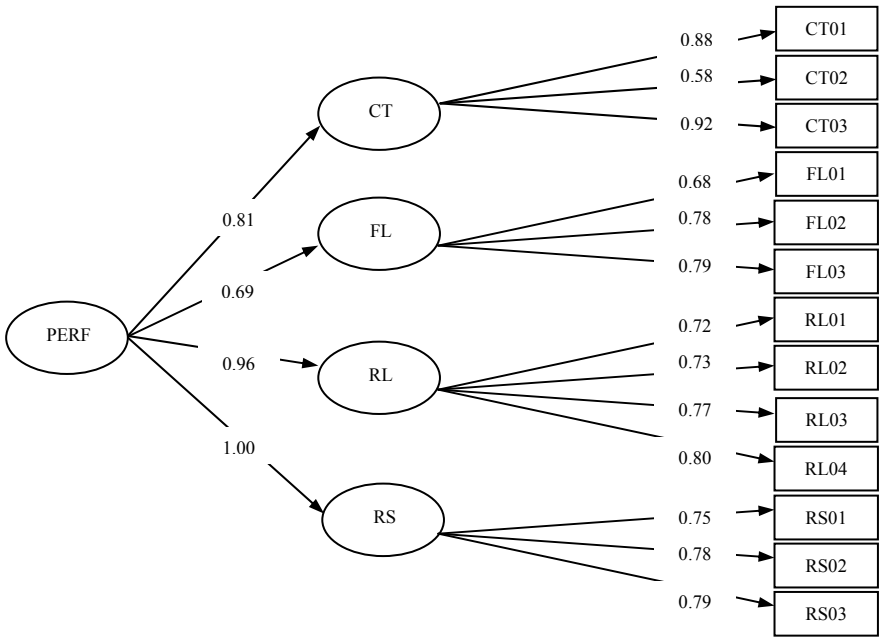

Figure 4.3: Second-order construct of FSP

Table 4.5: Standardized estimate between sub-constructs and second-order construct

Second-order Construct	Sub-Construct	Standardized Estimate	t-value
Supply Chain Management Practice	Information Management	0.788	8.15
	Lean System	0.898	8.42
	Partnership Management	0.808	8.63
	Strategy and Organization	1.000	11.30
Quality Management Practice	Customer Focus	0.786	9.15
	Commitment and Strategy	1.000	12.10
	Human Resource Management	0.982	11.92
	Information Analysis	1.000	14.52
Firm's Supply Performance	Cost	0.805	11.15
	Flexibility	0.690	7.65
	Relationship	0.960	10.91
	Responsiveness	1.000	12.07

Table 4.6: Multiple fit indexes of the second-order construct

Second-Order Construct	χ^2 / df	P-Value	GFI	CFI	NNFI	SRMR
SCMP	0.820	0.9776	0.94	1.00	1.00	0.0379
QMP	1.223	0.0704	0.94	1.00	1.00	0.0302
FSP	0.647	0.9627	0.98	1.00	1.00	0.0223

4.5 Path Analysis of the Whole Samples

An outstanding feature of SEM is its ability to create a pictorial portrayal of the relationships among the variables (called path diagram) to better express such interrelationships in the structural model. In the path diagram, straight arrows show the impacts of exogenous constructs (or independent variables or source variables) on the endogenous variables (dependent variables), while the curved arrows depict the correlation between variables. Accordingly, the hypothesized structural model of this study is shown in Figure 4.4.

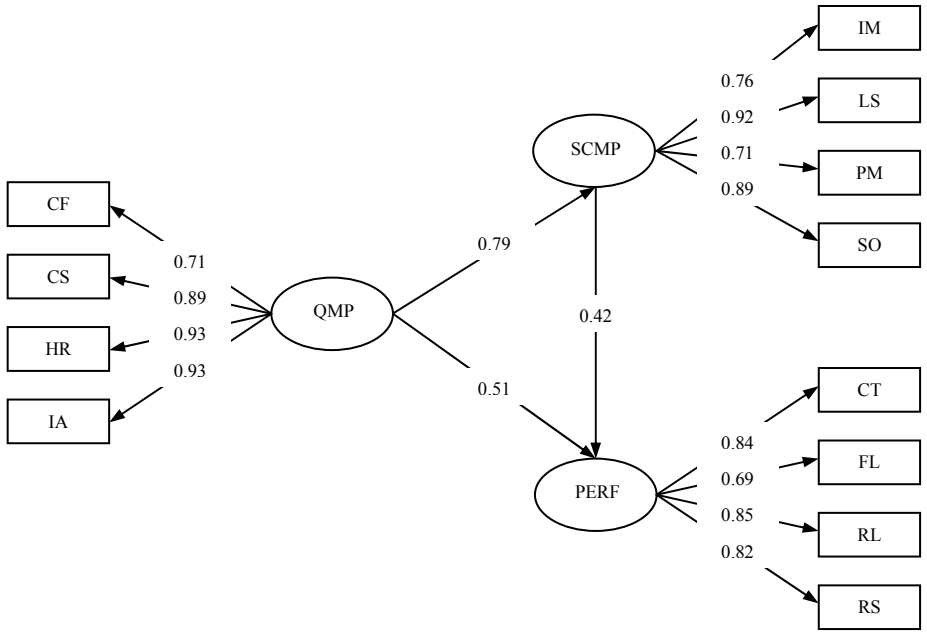

Figure 4.4: Hypothesized structural model

The overall fit of the structural model was assessed with the same set of multiple fit indexes and the same criteria as those of the measurement models. The analytical results showed that χ^2 / df ratio = 1.329 was well below 3 with p-value 0.082. GFI = 0.960, CFI = 1.000, NFI = 0.990, NNFI = 1.000 were above the recommended critical value at 0.900 and SRMR = 0.023 was much lower than the cut-off point at 0.100. These multiple fit indexes indicated good fit of the hypothesized structural model with the collected data.

For path analysis, all t-values were well above the critical value at 1.96 and significant at 0.05 level as shown in Table 4.7. QMP had strong relationship with SCMP as illustrated by the high standardized estimate 0.79 and t-value 9.56. Therefore, H1 which is "a firm's QMP significantly and positively impact SCMP" was supported. This can be explained by the fact that SCM and QM share many similar practices and principles, for example, customer focus (Hoang *et al.*, 2006)'s QMP, customer relationship management of the Global Supply Chain Forum (Croxton *et al.*, 2001), customer relationship (Li *et al.*, 2005)'s SCMP; and process management (Hoang *et al.*, 2006)'s QMP and internal lean practices (Li *et al.,* 2005)'s SCMP. At present, TQM includes all best practices (Vanichchinchai and Igel, 2009) which can be applied commonly to the other modern management systems including, for example, Benchmarking Management (Chen, 2002), Six sigma (Klefsje *et al.*, 2001) and SCM. Martinez-Lorente *et al*. (1998) also defined SCM as an element of TQM. Thus, some QMP facilitated SCMP implementation. Similarly, Flynn and Flynn (2005) studied the synergies between QM and SCM. The database of from 164 plants in the machinery, electronics and transportation components industries in the USA, Germany, Italy, Japan and England was used. They found that firms with stronger QMP achieved better supply chain performance and then summarized that "Quality management and supply chain management go hand in hand". However, the result of this study was different from those of Hsu *et al.* (2009) and Casadesus and

Castro (2005)'s research. Hsu *et al.* (2009) investigated the relationship between operations capability including TQM, SCM and JIT (a specific SCM technique in the automotive industry) and firm performance. Samples were utilized from the database of Institute for Supply Management and the Association for Operations Management. The results did not confirm a significant relationship between TQM capability and SCMP. They explained this surprising finding that the measures employed to assess TQM capability related to internally focused quality initiatives and did not explicitly address boundary spanning quality issues such as supplier quality. Casadesus and Castro (2005) surveyed nearly 400 firms certified to ISO 9000 standard in Spain to explore how QM contributes to SCM implementation. The result could not confirm that ISO 9000 implementation totally supports SCM. For instance, 62 percent of the samples indicated that ISO 9000 had not led to an improvement in inventory management and only 31 percent had benefit in logistics cost reduction. It can be explained that the maturity of QMP frameworks in this research and that of Casadesus and Castro (2005) were different. Casadesus and Castro (2005) used ISO 9000 framework; while, QMP in this research applied TQM framework which can be considered as superior QMP (Vanichchinchai and Igel, 2009). ISO 9000 and even ISO/TS 16949 serve as subset of TQM overall requirement (Kartha, 2004). This explanation confirmed the opinion of the industry experts in qualitative case study in later chapter that ISO 9000 is not enough for SCM in the automotive industry. Dedicated QMP such as ISO/TS 16949 is needed for SCM implementation in the automotive industry. Accordingly, MANOVA result in later section also confirmed that there were significant differences in SCMP between the organization with and without ISO/TS 16949. Therefore, it may be concluded that QM maturity affects SCM implementation and this should be further researched.

A firm's QMP had significantly and positively impact on FSP. The standardized estimate of their relationship was 0.51 with t-value 5.46. Thus, H2 was supported. This explained the fact that QM had customer satisfaction as the ultimate goal (Vanichchinchai and Igel, 2009) which includes supply performance such as on time delivery without defects or rejections. Moreover, many empirical research studies conducted by Rahman (2001), Sun (2000), George and Sherry (1998), Danny and Mile (1999), Khan (2003), Hendricks and Singhal (1997), Prabhu *et al.* (2000), Hsu *et al.* (2009) confirmed that QM/TQM could improve not only quality performance but also the organizational performance as a whole. These corporate performance dimensions also included FSP. For this reason, MBNQA criteria which were acclaimed as the most accepted TQM framework were referred as criteria for performance excellence (Black and Porter, 1996; National Institute of Standards and Technology, 2007). The TQM framework which was applied in this research adopted some principle of MBNQA criteria (Hoang *et al.*, 2006). Thus, some FSP were improved partially by QMP. Besides, SCMP had a significant impact on FSP with standardized estimate 0.42 and t-value 4.55. The stronger SCMP had led to the higher FSP, focusing on supply performance of the firms. Similarly, Li *et al.* (2006) collected data from 169 organizations to investigate the impact of SCMP on competitive advantage and organizational performance. The results showed that higher levels of SCMP led to enhanced competitive advantage and improved organizational performance. Moreover, Tracey *et al.* (2005) collected data from 474 manufacturing managers and concluded that significant positive relationships exist between supply chain management capabilities and firm performance.

In addition to the direct relationship, QMP had also an indirect effect on FSP through SCMP. The standardized estimate of the indirect effect between QMP and FSP was 0.34 with t-value 4.15. The total effect between QMP and FSP was 0.85 with t-value 11.98. This showed that there was a causal link among QMP, SCMP and FSP. Therefore, H3 which was "a combined set of a firm's QMP and SCMP significantly and positively impact FSP" was supported. The mediating effect of SCMP on the relationship between QMP and FSP was confirmed. QMP led to better SCMP which caused higher FSP, respectively. It was because of the aforementioned shared practices and performance measures. Moreover, although, SCMP emphasized external partnership with customers and suppliers, the real SCMP implementation starts from internal collaboration among departments. Coordination within the organizations was a prerequisite of SCM (Lambert and Cooper, 2000). Therefore, QM/TQM which focused on internal participation of all employees was considered a foundation for SCMP which focused on external partnership with all business partners (Vanichchinchai and Igel, 2009). In turn, both contributed to supply chain performance improvement. Accordingly, Kuei *et al.* (2001) studied the relationship between supply chain quality management practices and organizational performance in Taiwan. They reported that companies with higher supply chain quality management tended to perform better than companies with lower supply chain quality management. Similarly, Tan *et al.* (1998) conducted an empirical research to study the linkages between QM, supplier evaluation and supply base management. The samples were identified from the database of American Society of Quality Control. They found that QM and supply base management should be implemented together to improve corporate performance. Moreover, Lin *et al.* (2005) surveyed the impact of supply chain quality management in Taiwan and in Hong Kong. They found that QMP significantly correlated with the supplier participation and selection strategy in SCM and this influenced business performance. Also, Kannan and Tan (2005) concluded that at strategic level there were linkages between TQM, SCM, and JIT which reinforced each other and then improved firm performance. At operational level, TQM, SCM, and JIT could be implemented together to create value.

In conclusion, all three hypotheses have been supported. The total effect, direct effect and indirect effect of each path are shown in Table 4.7.

Table 4.7: Analytical results of the hypothesized structural model

Path	Total Effect		Direct Effect		Indirect Effect	
	Std. Estimate	t-value	Std. Estimate	t-value	Std. Estimate	t-value
QMP → SCMP	0.79	9.56	0.79	9.56	-	-
QMP → FSP	0.85	11.98	0.51	5.46	0.34	4.15
SCMP → FSP	0.42	4.55	0.42	4.55	-	-

Moreover, in this study, the nested model was initiated to compare with the initial model. The nested model was the model that had the same constructs but was different in terms of the number of types of causal relationships. This meant that the model with fewer relationships was nested within the more general model. For the nested model in this study, the link between QMP and SCMP was dropped as displayed in Figure 4.5. After the removal, the standardized estimates were and still

significant. The standardized estimate between QMP and FSP was 0.58 with t-value 6.80 and the standardized estimate between SCMP and FSP was 0.36 with t-value 4.59. For the overall fit of the nested model, χ^2 / df was 1.36. GFI, CFI, NFI, NNFI and SRMR were 0.95, 1.00, 0.99, 0.99 and 0.024, respectively. These multiple fit indexes well met the requirements for the overall fit. Comparing the overall fit between both the initial model and the nested model, the initial model was better fit.

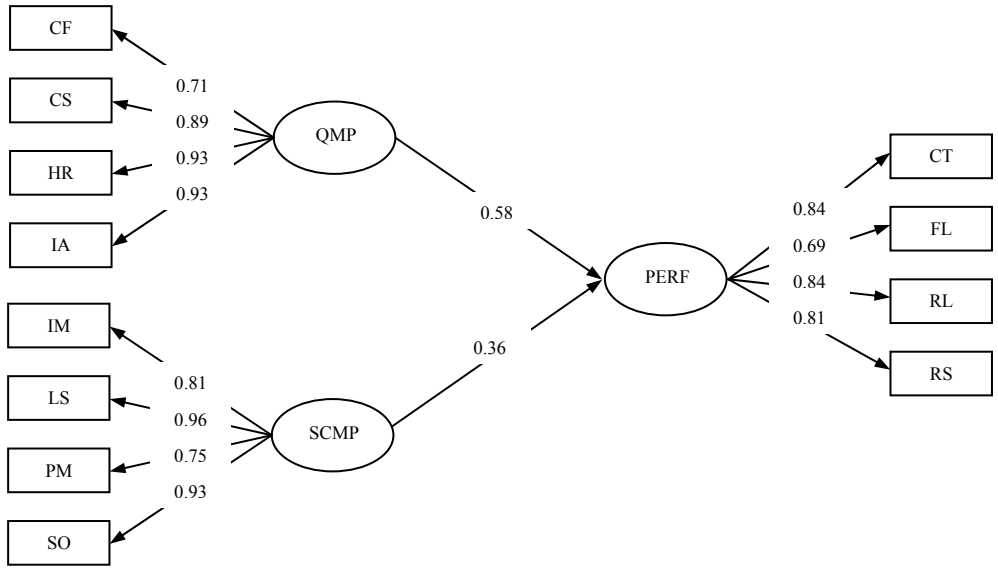

Figure 4.5: Nested structural model

4.6 Path Analysis of the Thai Ownership Sub-samples

The automotive companies in the study included companies with Thai, Japanese and other national major shareholders. Performance of a company might be influenced by management style which might be caused by the company ownership or the major shareholders. Moreover, from organization characteristic analysis in next section, the Thai ownership had, overall, the lowest score in SCMP, QMP implementation and FSP as compared to the Japanese and the other ownerships. Therefore, the relationships among SCMP, QMP and FSP of the Thai ownership sub-samples were emphasized in this study in order to confirm whether the relationships among SCMP, QMP and FSP were still the same for merely Thai ownership.

Although the critical sample size of 200 is recommended for SEM with MLE, the sample size as small as 50 has still been found to provide valid results (Hair *et al.*, 1998). Thus, the sample size 75 of the Thai ownership is considered applicable for the test. The structural model of the Thai ownership is depicted as shown in Figure 4.6.

For the overall fit of the model, χ^2 / df ratio = 1.343 was well below 3 with p-value 0.07916. GFI = 0.900, CFI = 0.990, NFI = 0.970, NNFI = 0.980 were above the recommended critical value at 0.900. Accordingly, SRMR = 0.036 was much lower than the cut-off point at 0.100. These multiple fit indexes indicated good fit of the model with the collected data.

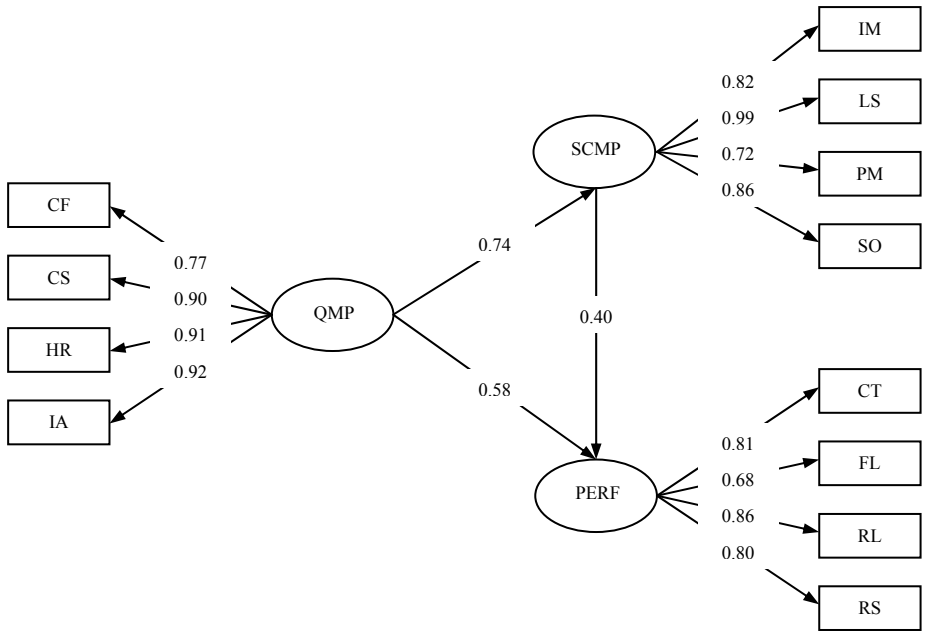

Figure 4.6: Structural model of the Thai ownership

For path analysis, all t-values were well above the critical value at 1.96 and significant at 0.05 level as shown in Table 4.8. QMP had strong relationship with SCMP as illustrated with high standardized estimate 0.74 and t-value 6.05. The standardized estimate between QMP and FSP was 0.58 with t-value 4.28. SCMP had significant relationship with FSP with standardized estimate 0.40 and t-value 2.82. Moreover, QMP had indirect effect on FSP with standardized estimate 0.29 and t-value 2.73, too. As a result, the total effect between QMP and FSP was 0.87 with t-value 6.97. The path analysis showed similar results to those of the whole samples. It still confirmed that QMP had not only direct effect on SCMP and FSP but also indirect effect on FSP for the Thai ownership companies. The structural model was acceptable for the Thai ownership companies.

Table 4.8: Analytical results of the structural model of the Thai ownership

Path	Total Effect		Direct Effect		Indirect Effect	
	Std. Estimate	t-value	Std. Estimate	t-value	Std. Estimate	t-value
QMP → SCMP	0.74	6.05	0.74	6.05	-	-
QMP → FSP	0.87	6.97	0.58	4.28	0.29	2.73
SCMP → FSP	0.40	2.82	0.40	2.82	-	-

4.7 Level of Practice and Performance Analysis

Description statistics were applied to primarily assess and compare the existence of SCMP, QMP and FSP in the sample companies as shown in Table 4.9. SCMP implementation, overall, showed a much lower mean score than QMP. The highest and the lowest SCMP mean value were in *Information Management* (at 4.48) and *Strategy and Organization* (at 4.02), while the top and the bottom rank of QMP were *Customer Focus* (at 5.30) and *Human Resource Management* (at 4.47), respectively. This was caused by the fact that SCM has been much later implemented in the automotive industry in Thailand compared with that of QM. SCM has been rather new especially in the automotive industry in Thailand. There have been various QM standards and even industry specific QM standards for the automotive industry (e.g. ISO 9001, ISO/TS 16949, QS 9000); but, there was no international commonly accepted SCM standard. According to the classification of the management systems of the sample companies in Table 3.13, 73.5% and 43.6% of the sample companies implemented ISO/TS 16949 and ISO 9000, respectively, while 21.3% of them introduced JIT (or Lean Manufacturing or TPS) which was a key SCM tool/technique in the automotive industry (Gimenez, 2004). Moreover, almost every company in the automotive industry in Thailand has QM related departments (e.g. Quality Assurance Department); but, only a minority of them has departments directly responsible for SCM (e.g. Supply Chain Management Department). Besides, SCM focused on external partnerships with customers and suppliers, while QM emphasized internal participation from all employees (Vanichchinchai and Igel, 2009). Therefore, SCM implementation was more complicated in terms of business process integration or communication among the concerned parties.

Among the SCMP implementation, *Information Management* had the highest mean value. This was because it was a basic requirement for SCM and a practice similar to *Information Analysis* of QMP. Therefore, firms may have some shared common practices to manage and analyze information. *Lean System* ranked second. This explained that the automotive industry in Thailand has introduced JIT (also known as Lean Manufacturing or Toyota Production System: TPS) which shared many concepts and principles with SCM (Tan, 2001; Narasimhan *et al.*, 2008; Gimenez, 2004). Currently, some automotive assemblers as well as some professional organizations such as Toyota Motor (Thailand) Co., Ltd. and the Thailand Automotive Institute have encouraged the automotive suppliers to implement JIT, Lean Manufacturing or TPS. However, the existence of SCMP in the Thai automotive industry were different from those of the US industry, in which partnership and information management had the highest and the second highest mean score, respectively (Li *et al.*, 2006). The reason was because the US industry was more sophisticated in SCM and emphasized more on partnership management at strategic level, while the automotive industry in Thailand still focused on effective and efficient transactions of information and material within the organization and between the business partners. According to the TCA, this emphasis had helped the Thai automotive companies reduce transaction cost and cause the high mean score of *Responsiveness* and *Cost* of FSP.

QMP, *Customer Focus* had the highest mean value at 5.3 and *Commitment and Strategy* came second at 4.82 mean score. These can be explained that top management commitment and customer focus were important criteria for ISO 9001

certification and QM for every company. This result was similar to the study of Hoang *et al.* (2006) and Loan (2004). Accordingly, Prajogo and Sohal (2003) and Sohail and Hoong (2003) reported that total quality management emphasized customer focus, leadership and strategic planning practices, respectively.

In term of FSP, the sample companies performed best in *Responsiveness* with a mean value of 4.82. This was because SCM originated within logistics activities and focused on error-free delivery performance (Samaranayake, 2005; Chin *et al.*, 2004; Kuei *et al.* 2001). Especially, the automotive supply chain has been operated according to the JIT concept which aimed at fast and on-time responses. The automotive assemblers would have to fine the part suppliers if their parts delivery was delayed and had caused a halt in the automotive assembly line. *Cost* ranked second. Refer to TCA, the automotive part suppliers in Thailand still focused mainly on transaction cost as reflected by the high score of *Information Management* and *Lean System*. *Relationship* had the lowest mean score at 4.38. This explained that business partnership in developing countries or in low SCM maturity environments was still based on traditional adversarial buyer-supplier relationship, targeting mainly the price for decision making rather than developing a long-term relationship. Consequently, trust, cooperation and relationship in this kind of relationship were low. Jayaram *et al.*, (2004) raised an example of conflict of interest in cost between the automotive assemblers and suppliers and suggested that too much focus on cost as a primary goal and opportunistic behavior can impede their relationship. However, although trusting suppliers was good, hostility might make the company more profitable in some situations even in the long term (Tan, 2001). This may also be a practice of the Thai automotive companies.

Table 4.9: Mean and standard deviation of SCMP, QMP and FSP

Construct	Mean	S.D.
Supply Chan Management Practice		
Information Management	4.48	0.85
Lean System	4.32	0.86
Partnership Management	4.05	0.93
Strategy and Organization	4.02	1.06
Quality Management Practice		
Customer Focus	5.30	0.75
Commitment and Strategy	4.82	0.90
Human Resource Management	4.47	0.93
Information Analysis	4.56	1.03
Firm's Supply Performance		
Cost	4.46	0.89
Flexibility	4.40	0.97
Relationship	4.38	0.81
Responsiveness	4.82	0.88

4.8 Organizational Characteristic Test

MANOVA was applied to investigate the differences across organizational characteristics on SCMP, QMP and FSP. These characteristics included the company ownership, the company size, the tier in the supply chain and the quality management maturity. Many former researches have studied or recommended further study of these characteristics. The researches included those by Hoang *et al.* (2006), Li *et al.* (2006), Rahman (2001), Hendricks and Singhal (2001), and Angel and Andrino (1998).

4.8.1 Company Ownership

In this research, company ownership was represented by the nationality of the major shareholders of the companies, namely, Thai, Japanese and the other national. Table 4.10 showed the result of MANOVA with significant difference in every sub-construct of SCMP, QMP and FSP except for *Customer Focus* and *Commitment and Strategy*. This can be explained by the researches by Loan (2004), Prajogo and Sohal (2003), Sohail and Hoong (2003) and Hoang *et al.* (2006) which indicated that top management commitment and customer focus were critical for QM and ISO 9000 certification. Among them, the Japanese companies had the highest mean score in every sub-construct of SCMP, QMP and FSP. Between the Thai ownership and the others ownerships, the other ownerships had higher mean values in every set of practices and performance except for *Partnership Management, Flexibility, Relationship and Responsiveness* of FSP. This reflected the fact that the Japanese were, comparatively, the most sophisticated and the biggest investors in the automotive industry in Thailand. The Japanese had established automotive part manufacturing bases in Thailand for a long time.

Due to the advanced development in technology and management systems, the other automotive owners in Thailand from US and Europe were accordingly more advanced in SCMP and QMP than the Thai companies. However, they have been and still are minority investors and rather new in this industry in Thailand. Therefore, their *Partnership Management* and *Relationship* development with business partners were not as strong as that of Thai. Moreover, differences in culture and management styles between the Asian partners, which held the majority of the market (e.g. Thai and Japanese), and western shareholders which are the minority in the market (e.g. US and the European) can be the reason for low mean value of FSP of the western companies. On the subject of conflict management style, Boonsathorn (2007) investigated the preferences for conflict management styles between Americans and Thais, and found that, compared to Americans, Thais preferred avoiding and obliging conflict management styles.

Table 4.10: The differences between company ownerships

Factor	Sig.	Thai		Japanese		Others	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
Supply Chain Management Practice							
Information Management	0.01*	4.29	0.79	4.65	0.79	4.36	1.09
Lean System	0.00*	4.12	0.78	4.51	0.87	4.12	0.90
Partnership Management	0.03*	3.91	0.91	4.22	0.91	3.81	0.95
Strategy and Organization	0.03*	3.76	1.14	4.17	0.97	4.11	1.08
Quality Management Practice							
Customer Focus	0.13	5.16	0.80	5.39	0.74	5.33	0.65
Commitment and Strategy	0.09	4.64	0.88	4.94	0.89	4.81	0.98
Human Resource Management	0.00*	4.15	0.97	4.69	0.84	4.51	0.99
Information Analysis	0.00*	4.25	1.05	4.77	0.96	4.56	1.10
Firm's Supply Performance							
Cost	0.01*	4.22	0.88	4.63	0.83	4.45	1.01
Flexibility	0.04*	4.32	0.94	4.55	0.97	4.08	0.96
Relationship	0.00*	4.25	0.76	4.57	0.73	4.08	1.03
Responsiveness	0.00*	4.61	0.90	5.03	0.79	4.57	0.95
Valid N		75		104		30	

* Significant at 0.05

4.8.2 Company Size

Company size was classified into two groups in accordance with the number of employees in the company. They were small-to-medium companies (lower than 200 employees) and large companies (more than 200 employees). Considering the size, large companies had higher mean score than small-to-medium companies in every sub-construct of SCMP, QMP and FSP as shown in Table 4.11. Similarly, Terziovski and Samson (1999) and Terziovski and Samson (2000) found that there was a significant difference in the relationship between QMP and company size as measured by the number of employees. Large companies had stronger QMP than small companies. The mean differences were significant in every sub-construct except for *Information Management, Relationship and Responsiveness*. This was because large-sized companies have more resources and commitment to SCM and QM than small-to-medium companies. Compared to the other sub-constructs in the same construct, the sub-constructs with non-significance difference *(e.g. Information Management, Relationship and Responsiveness)* had highest mean score. This was because the small-to-medium companies gave priority to these factors and attempted to use them for competition.

Among significantly different SCMP, *Lean System* had the highest mean score and *Cost* has significantly different FSP with high mean score for large companies. According to TCA, large companies have more resources, bargaining power and safeguards against opportunistic behavior of the business partners. They gained cost advantage from economy of scale. Moreover, large companies can develop long-term cooperation with key suppliers and customers which led to lower transaction cost. The transaction cost included quality control, goods receiving and invoice control, contact,

contract and control with suppliers, exchange of employees between the partners, join training programs, cost measurement system, supplier certification, supply base reduction, and GPS (Tan *et al.*, 1998; Halldorsson *et al.*, 2007; Hobbs 1996; Skjoett-Larsen, 1999; Logan, 2000). Refer to information from the case companies in Chapter V, large company can invest in advanced information and logistics technology/technique which reduced transaction costs such as SAP (an advanced ERP software), AGV (Automated Guide Vehicle), E-Kanban, Vision Machine, milk run (round trip delivery), Web-based Electronic Data Interchange, and Standardized Packaging with supplier reduction, zero stock, and logistics protocol (goal deployment and alignment among logistics functions).

Table 4.11: The differences between company sizes

Factor	Sig.	Small-to-Medium		Large	
		Mean	S.D.	Mean	S.D.
Supply Chain Management Practice					
Information Management	0.07	4.29	0.82	4.54	0.86
Lean System	0.00*	4.02	0.79	4.42	0.86
Partnership Management	0.04*	3.83	0.97	4.13	0.90
Strategy and Organization	0.00*	3.63	1.03	4.15	1.04
Quality Management Practice					
Customer Focus	0.03*	5.11	0.81	5.37	0.72
Commitment and Strategy	0.00*	4.52	1.04	4.93	0.83
Human Resource Management	0.00*	4.10	1.06	4.60	0.85
Information Analysis	0.00*	4.07	1.03	4.72	0.98
Firm's Supply Performance					
Cost	0.00*	4.15	0.84	4.57	0.88
Flexibility	0.04*	4.16	0.93	4.48	0.97
Relationship	0.14	4.25	0.75	4.43	0.82
Responsiveness	0.07	4.63	0.92	4.88	0.85
Valid N		54		157	

* Significant at 0.05

4.8.3 Tier in the Supply Chain

The tier in the supply chain was categorized into two types, namely, the first tier suppliers and the other tier suppliers. As found from MANOVA, it was not a surprise that the first-tier suppliers had higher mean values in every SCMP, QMP and FSP sub-construct compared with the other tier suppliers except for *Customer Focus* as shown in Table 4.12. This was because the first-tier suppliers had to be sophisticated in SCM and QM enough to be approved as the first-tier suppliers by the automotive assemblers for JIT delivery. In the automotive supply chain, the first-tier suppliers were responsible for managing and controlling their suppliers in the next tiers. Moreover, most of the first-tier suppliers were large companies who can ensure supply capability for the automotive assemblers. According to the company size analysis, the large companies had higher SCMP, QMP and FSP mean values. Unlike the certified first-tier suppliers, the other-tier suppliers have fewer long-term contractual customers. Therefore, they have to put more efforts on focusing on their

customers. However, the difference in *Customer Focus* between these two tiers was small and not significant. This can be explained by the researches of Hoang *et al.* (2006), Loan (2004), Prajogo and Sohal (2003) and Sohail and Hoong (2003) which pointed out that top management commitment and customer focus were important criteria for QM and ISO 9000 certification for every company. In the US automotive industry, Choi (1999) found no statistical difference in the level of three out of four QMP between the first-tier and the tertiary-tier suppliers. He explained this contradiction against the general speculation that quality management would become institutionalized throughout the US automotive supply chain, which was more developed than that in the developing country.

Similar to the analysis of company size, *Lean System* had the highest mean score among significantly different SCMP and *Cost* has significantly different FSP. In accordance with TCA, certified first-tier suppliers must also be sophisticated in JIT (lean manufacturing) which efficiently managed information and material flow to minimize transaction cost. Moreover, almost all of the first-tier suppliers were large company which had supply capability for the automotive assemblers. They have more resources, more bargaining power and safeguards against opportunistic behavior of the business partners. They gain cost advantage from economy of scale. Moreover, they have long-term cooperation with key business partners, especially with the automotive assemblers. These lead to lower transaction cost such as transportation cost (with milk-run technique), quality control, goods receiving and invoice control, contact, contract and control with suppliers, exchange of employees between the partners, join training programs cost measurement system, supplier certification, supply base reduction; GPS (Tan *et al.*, 1998; Halldorsson *et al.*, 2007; Hobbs 1996; Skjoett-Larsen, 1999; Logan, 2000). Toyota Motor (Thailand), Co. Ltd. had established a join training program with their first-tier suppliers to develop Toyota Production System (TPS) or lean manufacturing in the supplier's companies. Additionally, first-tier suppliers have legal ordering (formal contract) and some of them have credible commitment with their automotive assemblers through joint ventures. These safeguards and credible commitment can prevent opportunistic behavior of their suppliers (Skjoett-Larsen, 1999; Halldorsson *et al.*, 2007; Hobbs 1996). Moreover, refer to information from case companies in Chapter V, first-tier supplier can invest in advanced information and logistics technology/technique which can reduce transaction cost such as SAP (an advanced ERP software), AGV (Automated Guide Vehicle), E-Kanban, Vision Machine, milk run (round trip delivery), Web-based Electronic Data Interchange, and Standardized Packaging with supplier reduction, zero stock, logistics protocol (goal deployment and alignment among logistics functions).

Table 4.12: The differences between tiers in the supply chain

Factor	Sig.	First Tier		Other Tier	
		Mean	S.D.	Mean	S.D.
Supply Chain Management Practice					
Information Management	0.08	4.54	0.84	4.22	0.89
Lean System	0.00*	4.42	0.85	3.84	0.76
Partnership Management	0.02*	4.12	0.92	3.66	0.82
Strategy and Organization	0.08	4.09	1.05	3.70	1.10
Quality Management Practice					
Customer Focus	0.85	5.33	0.72	5.36	0.69
Commitment and Strategy	0.14	4.88	0.86	4.61	0.99
Human Resource Management	0.05*	4.56	0.89	4.18	0.99
Information Analysis	0.01*	4.66	0.98	4.12	1.17
Firm's Supply Performance					
Cost	0.01*	4.56	0.84	4.08	1.05
Flexibility	0.18	4.46	0.93	4.19	1.11
Relationship	0.02*	4.46	0.80	4.08	0.69
Responsiveness	0.00*	4.92	0.82	4.36	0.97
Valid N		177		26	

* Significant at 0.05

4.8.4 Quality Management Maturity

QM maturity can be determined by many criteria. The QM standards, with which the companies have been certified, can reflect the QM systems and QM maturity of the companies. ISO 9001 has been considered a general quality management standard which can be applied to any businesses, but was too general for complex industry like the automotive industry. Therefore, ISO/TS 16949 has been initiated and tailored as a dedicated QM system for the automotive industry. ISO/TS 16949 was more sophisticated than ISO 9001. Therefore, in this research, the sample companies were categorized into two groups by quality management certificates with which the companies were certified. The two groups were the companies with ISO/TS 16949 and the companies without ISO/16949. However, it should be noted that some sample companies with ISO/TS 16949 may also apply ISO 9001, while most of the sample companies without ISO/TS 16949 have been certified with ISO 9001.

From Table 4.13, compared with the companies without ISO/TS 16949, those with ISO/TS 16949 had higher mean score of SCMP, QMP and FSP in every sub-construct. The result was similar to the research by Sohail and Hoong (2003) which reported that companies with ISO 9000 have better performance than those without ISO 9000. For SCMP, there were significant differences in every sub-construct except for *Partnership Management*. This was because ISO/TS 16949, a quality management system, focused on internal participation from all employees rather than on external partnerships from all business partners. This resulted in non-significant deference of *Relationship* and *Flexibility* of FSP. The companies which were certified with quality management standard have to follow the written standard operational procedures strictly. For QMP, only *Customer Focus* was not significantly different. However, *Customer Focus* had the highest mean score in both sample groups compared with the

other sub-construct of QMP. This explained that customer focus was an important requirement for quality management standard even for general ISO 9000 certification (Prajogo and Sohal, 2003; Sohail and Hoong, 2003; Hoang *et al.*, 2006 and Loan, 2004). Therefore, the companies with ISO 9000 but without ISO/TS 16949 had performed well in this sub-construct which was a basic foundation of quality management system.

Information Management and *Lean System* of SCMP and *Responsiveness* and *Cost* of FSP were significantly different and had highest mean score. Tan *et al.* (1998) suggested that cooperation with suppliers through information sharing could improve financial and business performances. Refer to TCA, companies with ISO/TS 16949 were more sophisticated in management system. Important information and operational transactions such as quality control, goods receiving, operational instruction, invoice control, contract, etc. were well standardized, recorded, documented and especially audited to prevent non-conformances to quality standard which would lead to higher transaction cost. Also, formal written contract can be a safeguard against opportunistic behavior of the businesses partners (Hobbs 1996; Skjoett-Larsen, 1999; Halldorsson *et al.*, 2007).

Table 4.13: The differences between quality management maturities

Factor	Sig.	ISO/TS 16949		No ISO/TS 16949	
		Mean	S.D.	Mean	S.D.
Supply Chain Management Practice					
Information Management	0.00*	4.58	0.82	4.18	0.88
Lean System	0.01*	4.41	0.82	4.07	0.93
Partnership Management	0.09	4.12	0.88	3.87	1.03
Strategy and Organization	0.00*	4.19	0.98	3.54	1.13
Quality Management Practice					
Customer Focus	0.37	5.33	0.73	5.22	0.82
Commitment and Strategy	0.01*	4.91	0.85	4.57	0.99
Human Resource Management	0.00*	4.61	0.83	4.07	1.08
Information Analysis	0.00*	4.72	0.97	4.11	1.09
Firm's Supply Performance					
Cost	0.00*	4.58	0.81	4.13	1.02
Flexibility	0.26	4.44	0.94	4.27	1.05
Relationship	0.11	4.44	0.75	4.22	0.93
Responsiveness	0.03*	4.90	0.80	4.57	1.03
Valid N		155		56	

* Significant at 0.05

4.9 Impacts of QMP on SCMP

QM and SCM shared many similarities and differences including management practices. Although it was confirmed by path analysis that a set of QMP had a direct impact on a set of SCMP as a whole, this study further examined which individual QMP affected individual SCMP. The study would help facilitate SCMP and QMP implementation, especially integrated implementation in the organizations. Therefore,

the multiple regression analysis was applied to examine the effects of QMP as independent variables on individual SCMP as dependent variable.

Table 4.14 showed the results of the multiple regression analysis for four endogenous (dependent) variables of QMP on all exogenous (independent) variables of SCMP in respect with their measurement indicators (the values of t and p). The bold figures in the cells with asterisk (*) indicated significance relationships. All relationships were validated by a goodness of fit measure, coefficient of determination, which was denoted by R^2. The multiple regression analysis reported that QMP, overall, had significant positive impacts on every SCMP. *Information Analysis*, a QMP, had significant positive impact on every SCMP. This was because information analysis and management were basic requirements of both QM and SCM. *Customer Focus* of QMP had a significant and positive effect on almost every SCMP except for *Strategy and Organization* of SCMP. This was because both SCM and QM had customer satisfaction as an ultimate goal (Gunasekaran and McGaughey, 2003; Gunasekaran *et al.,* 2001; Mills *et al.*, 2004 in Lamey, 1996). They nevertheless had different primary goals (Vanichchinchai and Igel, 2009). QM focused on quality, while SCM emphasized on delivery as primary goal (Sun *et al.*, 2004; Prajogo and Sohal, 2001; Prajogo and Sohal, 2004, Samaranayake, 2005; Chin *et al.*, 2004; Kuei *et al.* 2001). Therefore, quality focus negatively affected supply chain strategy but not significantly. *Human Resource Management* of quality management practices had no significant impact on *Partnership Management* and *Information Management* of supply chain management practices. The reason for this was *Human Resource Management* of quality management practices focused mainly on internal employee participation rather than external business partnership (Gowen III and Tallon, 2003; Hoang *et al.*, 2006; Yeung and Amstrong, 2003; Vanichchinchai and Igel, 2009). *Commitment and Strategy*, a QMP, had a negative but insignificant impact on *Information Management, Lean System* and *Partnership Management* of SCMP. These conflicts reflected the fact that QM and SCM had different primary goals. From qualitative case study as explained in Chapter V, it was founded that the difference between QM and SCM was a trade-off. Moreover, QM was primarily committed to internal participation from all employees, while SCM primarily relied on participation from all external business partners goals (Vanichchinchai and Igel, 2009). However, due to the same ultimate goal and the ultimate integration of both systems toward total integration from all employees and business partners, the impacts were not significant. These relationships were further investigated and reconfirmed by qualitative case study in next chapter.

Table 4.14: Impacts of QMP on SCMP

	Information Management			**Lean System**			**Partnership Management**			**Strategy and Organization**		
	B	**t**	**Sig.**	**B**	**t**	**Sig.**	**B**	**t**	**Sig.**	**B**	**t**	**Sig.**
QMP_CF	0.191	2.573	**0.011***	0.175	2.579	**0.011***	0.181	2.244	**0.026***	-0.003	-0.038	0.970
QMP_CS	-0.175	-1.628	0.105	-0.055	-0.564	0.573	-0.049	-0.418	0.676	0.038	0.384	0.701
QMP_HR	0.220	1.886	0.061	0.280	2.615	**0.010***	0.223	1.762	0.080	0.459	4.244	**0.000***
QMP_IA	0.444	3.867	**0.000***	0.371	3.531	**0.001***	0.249	1.996	**0.047***	0.234	2.198	**0.029***
F	35.665			52.358			22.462			50.002		
Sig.	**0.000***			**0.000***			**0.000***			**0.000***		
R^2	0.409			0.504			0.304			0.493		
Adjusted R^2	0.398			0.495			0.290			0.483		

* Indicate significant at 0.05 level

4.10 Synergy and Mediation Effect

To investigate the synergy in integrative implementation between SCMP and QMP, the following multiple regression model was tested with stepwise method.

$$FSP = \beta_0 + \beta_1 QMP + \beta_2 SCMP + \beta_3 (QMPxSCMP) + \varepsilon$$
$$FSP = 0.803\ (QMPxSCMP)$$

The regression showed significant relationship at 0.05 level, $R^2 = 0.645$, adjusted $R^2 = 0.643$. SCMP and QMP were not significant and were excluded from the model. The integrated SCMP and QMP was statistically significant and positive. The standardized coefficient was strong at 0.803. Therefore, it can be argued that there was a synergistic effect of simultaneously implement SCMP and QMP on FSP. SCMP and QMP should be implemented together.

Moreover, mediation effects of SCMP on the relationship between QMP and FSP was tested by three-step mediated regression analysis (Baron and Kenny 1986). First, SCMP was regressed on QMP. The model was statistically significantly. QMP explained 53.3% of the variance in SCMP as shown in Table 4.15. Regression coefficient of QMP was statistically significant in positive direction. In the second model, FSP was regressed on QMP. The model was statistically significant and QMP accounted for 58.9% of the variance in FSP. Coefficient of QMP also was significant in positive direction. In model three, QMP was regressed simultaneously on FSP and SCMP. The model as well as the coefficient of SCMP was statistically significant. The variance explained increased to 64.8%; while, the coefficient of QMP was weaker from 0.730 to 0.507. This presented partial mediation effect of SCMP on the relationship between QMP and FSP. The results were consistent with that of path analysis in SEM.

Table 4.15: Mediation effect test

	(Model 1) SCMP	**(Model 2) FSP**	**(Model 3) FSP**
QMP	0.730*	0.767*	0.507*
SCMP			0.356*
F	238.495	299.119	191.385
Sig.	0.000*	0.000*	0.000*
R^2	0.533	0.589	0.648
Adjusted R^2	0.531	0.587	0.645

* Coefficients statistically significant at 0.05

4.11 Summary

Various statistical analysis techniques were applied in to this research. Primarily, the Non-respondent bias test reported no significant difference between the response and no-response samples in every organizational characteristic (company ownership, company size and tier in the supply chain) and multiple respondent bias test confirmed no significant difference between single and multiple responses Reliability was ensured by item-total correlation, Cronbach's alpha, composite

reliability and average variance extracted. Then, the first-order CFA, the second-order CFA, convergent validity, discriminant validity, and nomological validity confirmed that the proposed SCMP, QMP and FSP measurement models were fit and valid. Each sub-construct was composed of its measurable items and those sub-constructs were sub-constructs of a broader and more encompassing constructs, namely, SCMP, QMP and FSP. There were existences of the second-order constructs of SCMP, QMP and FSP in respect to their underlying theories. The main hypotheses were examined with path analysis of SEM. The results showed that QMP had not only significant direct impact on SCMP and FSP but also significant indirect impact on FSP through SCMP. These relationships were applicable for both the whole sample organizations and the Thai sub-sample organizations. As a result, all hypotheses of this study were supported. Descriptive statistic analysis indicated that the automotive companies in Thailand applied QMP more extensively than SCMP. MANOVA showed that, overall, there were difference across organizational characteristics on most of SCMP, QMP and FSP. The Japanese companies, large companies, first-tier suppliers and the companies with ISO/TS 16949 had more intensively applied SCMP, QMP and had higher level of FSP. Additionally, the multiple regressions analysis confirmed, on the whole, that every individual SCMP was affected by QMP. There was a synergistic effect of simultaneously implement SCMP and QMP on FSP. There was partial mediation effect of SCMP on the relationship between QMP and FSP. Thus, SCMP and QMP should be implemented together

CHAPTER 5
CASE STUDY

5.1 Introduction

Although quantitative data from structured questionnaires were analyzed by various statistical techniques, this chapter applied the case study method to obtain more in-depth information about the relationships between SCM and QM in the automotive industry in Thailand in a qualitative manner.

5.2 Case Study Methodology

Case studies were conducted with two companies. The reason for doing this is because SCMP, QMP and FSP in different organizations could differ due to issues such as management style, company size, QM experience, SCM maturity, product produced. The case companies were selected based on those criteria in order to maximize what can be studied. Both of them were large companies and represent first-tier suppliers and were selected due to the maturity of their SCM and QM which was appropriate enough for the study. Both case companies were leaders in manufacturing and management systems in their market segments and have received a number of awards and certificates from professional organizations and customers.

One company was a Thai owned firm that specialized in decorating automotive component parts. It represents a management style with less developed SCM and QM. The other company was a French majority company (formerly a Japanese company) which specializes in engineering automotive component parts. It represents a management style with more developed SCM and QM. It is also noteworthy to state that the concept of SCM is relatively new in Thailand; nevertheless, both case companies had departments which were directly responsible for SCM and QM in order to ensure the companies recognized the importance of and were committed to SCM and QM.

The informants were executives who are knowledgeable about strategic SCM and QM of their companies relative to their customers and competitors. As a result, they can represent strategic and operational SCM and QM of their companies as a whole. Furthermore, they had key roles in SCM implementation in their companies since the initial phase. Initially, information about the background, objectives and scope of the research were explained to the individual experts via telephone. This was done to develop a personal relationship and to have a clear understanding and obtain better cooperation. The interview was scheduled in accordance with the informants' availability. After that, a list of questions and necessary information were sent to them via e-mail about one week prior to the interview in order to allow them ample time for preparation. Research background and information were explained again on the interview day prior to the interview. Moreover, the informants were assured that all data and information collected will be used solely for academic purposes so as to avoid over cautious responses and wariness.

The informants were interviewed with open-ended questions in order to gain a wide range of responses and unlimited opinions. Consequently, most of the questions were framed and started with the terms "what", "why" and "how". During the interview, an informal and friendly environment was created to minimize the informants' wariness. Specific wording of the terminology used in the companies was clarified during the discussion. Any problems that emerged during the data collection process were noted for future improvement. To ensure confidentiality of the business information of the case companies, the companies will be referred to as AA and BB.

5.3 AA Co., Ltd.

The first case company, AA Co., Ltd., was a subsidiary company of the biggest Thai automotive parts manufacturing company group. It is located in Samutprakarn province and manufactures stamping welding part, plastic injection, painted plastic part and seat assembly. The company was a large-scale company which employs more than 650 employees. It is a first-tier supplier of many automotive manufacturers such as Honda, Mitsubishi, Nissan, for example. For the QM system, the company was certified ISO 9001: Y2000, ISO/TS 16949 and ISO 14001. Moreover, it also received many management awards from its customers.

Although customers had never encouraged AA to have a dedicated SCM department, AA established an SCM department by itself in order to improve its competitiveness. Even at present, there are only a few companies in the group that have introduced SCM. The case company was selected as a pilot company for SCM implementation for the group because of its more developed management system compared with the other companies in the group. The SCM department of the case company included core functions in SCM or primary activities in the value chain, namely Sales and Marketing, Material Planning and Control (both domestic and imported), Production Planning and Control, Inventory Management and Control, Warehouse Operations, Delivery. Although the company's SCM department covered major activities in SCM, the department was still named the Marketing and Logistics Department. The Marketing and Logistics Manager said "*there is another company in the group that has an SCM department (named Office of Supply Chain Management). But its responsibility and scope is much narrower than ours".*

Given the fact that the company had many buildings, at the initial phase of SCM implementation, interrelated departments were reorganized and relocated together. *"The reorganization and relocation help communication, coordination and information sharing among the different SCM functions better",* the Marketing and Logistics Manager commented. These measures can improve *Strategy and Organization* and *Information Management* of the company's SCMP. Moreover, at the early period of the implementation, the framework, scope and application of the company's SCM were still unclear even among the management staff. Also, most of the staff did not comprehensively understand SCM concept, its importance and its application despite the fact the company had trained and communicated SCM issues to them prior to the implementation. The Marketing and Logistics Manager commented that "*it may be because training is too general and SCM is rather new in Thailand. The trainers just trained about general SCM concepts without knowing*

about the specific structure, scope and application of SCM in our company". As a result, the company attempted to resolve these problems by providing more specific training and communication. There were many meetings at various staff levels. The trainers and training courses were screened to better fit with the company's SCM strategy and application to the company. This experience confirmed that *Information Analysis* and *Human Resource Management* of QMP can support the *Strategy and Organization* of SCMP which was also confirmed by the results of the multiple regression analysis. (see Table 4.14).

For SCM as a production management system of the company, AA initiated its own production management system called AAPS which stands for AA Production System. AAPS represented a *Lean System* of its SCMP as it applied concepts, tools and techniques of the Toyota Production System (TPS) also known as Lean Manufacturing or JIT in order to improve the flow of information and materials as well as to reduce waste in the company's supply chain. AAPS had the main objective of improving its production efficiency (increase production volume and flexibility) and to reduce waste (unnecessary cost) in the company's supply chain. Referring to TCA, AA applied AAPS as the main system to improve transaction costs in its SCM. However, the company still had some quality problems and some machine breakdowns. Therefore, it still had to maintain some additional inventories to address these problems. The Marketing and Logistics Manager shared his opinion that quality is a prerequisite for the AAPS or *Lean System* of the company. Quality and related problems should be analyzed and improved before implementing AAPS. He advised that *"ISO 9000 is too general for SCM implementation in the automotive industry. The company should have at least ISO/TS 16949 or other dedicated quality management systems for the automotive industry before implementing SCM".* The large survey data analyzed using multiple regression also supported his opinion as we found that that *Information Analysis, Human Resource Management and Customer Focus* of QMP significantly impacted the *Lean System* of SCMP (see Table 4.14). Similarly, the hypothesized structural model confirmed that the set of QMP significantly affected the set of SCMP as a whole (see Table 4.7). Moreover, MANOVA reported that sample companies with ISO/TS 16949 had significantly better SCMP than those without ISO/TS 16949 (see Table 4.13).

The Marketing and Logistics Manager accepted that the company's SCM staff still placed emphasis on fast and on-time delivery more than quality performance, *"quality is still secondary for our SCM staffs"*. After delivery, if the customers found some defects, it was the main responsibility of the production and quality assurance departments. This is because of insufficient emphasis on QMP *Commitment and Strategy* from the SCM staff and conflict of interest between quality performance and FSP according to the multiple regression analysis (see Table 4.14). However, the respondent explained that the company provided more training about quality awareness to all SCM staff in order to overcome this problem. Moreover, cross-functional activities across the production and quality assurance departments should be pursued to align the company's quality and SCM goals.

However, the Marketing and Logistics Manager shared some interesting cases about some negative impacts of focusing too much attention on the company's SCM. For example, there were contingency events such as supplier delay, computer network breakdown or urgent orders which could cause delivery delays. Also, some staff were

adhering too strictly to normal working procedures and followed the working instructions as written in the QM manuals of the company word by word. He further explained that *"they are afraid of non-conformance with quality management system and wanted to protect themselves and often neglected to resolve these immediate problems up front"*. For instance, there was a procedure which stated that QA must release quality checked products in the Enterprise Resource Planning (ERP) system before delivery. When there was problem with the ERP or computer network and QA staffs could not release the products in the ERP, QA did not allow SCM to supply raw materials to the production lines or to deliver the finished products to the customers. These contingency issues affected FSP. They were results of non-flexible QM system and conflict of interest between different goals of the company's different departments. However, he advised that these issues can be improved with better education, customer focus and goal alignment among the departments.

Most of the products of AA were decorating parts which required a sensory test using human judgment about the visual appearance of the products. Sometimes the QA staff were overly strict with the specifications in order to protect themselves. They did not want to take risks and tend to reject what could have otherwise been accepted by the suppliers or production lines. This was especially true with specifications using the sensory test e.g. color shades. For sensory quality, the Marketing and Logistics Manager complained that *"even among QA staffs, they have different sensory standards in some cases"*. This human error in judgment may lead to higher quality costs, less responsiveness and worse relationships with suppliers. Now, the company still has no quality problems with customers. These were some quality problems only for newly developed products. However, the expert observed that *"this good quality performance may be due to the fact that quality standards are too strict, and the trade-off is higher cost. This should be investigated"*. To resolve human error and unclear sensory judgment, the company has plans to invest in a vision machine to replace human inspection and judgment in the near future. The vision machine is capable of inspecting product appearances more accurately by comparing the actual product with stored images in the computer system. Although it requires a huge investment, AA considered it may be worthwhile given the high rejection rate from their staff's bias.

Besides, the Marketing and Logistics Manager had a prior experience when quality management standards or certificates (e.g. ISO 9000, ISO/TS 16949) were applied, the staff tended to do only what was written in the quality standards. *"They focused on only their own or their department's job and performance",* he complained. This may be because they did not want to give additional support, or they were afraid of non-conformance to related quality standards. However, the written procedures were only the minimum requirements which did not cover every situation, especially contingency events. Therefore, unwritten supportive work which one department needed may be ignored by other departments, for example cleaning stored products before delivery. This misunderstood QM concept can affect the company as a whole in terms of its team work, flexibility, cost, responsiveness and relationship. However, the expert advised that this can be improved with more emphasis on customer focus, training and goal alignment.

Moreover, the Marketing and Logistics Manager still commented that Thai people are good at working individually, but not good at team work, even staff in the

same company or department. This can also be an obstacle in SCM. Quality improvement activities such as quality control circle or cross functional activity can help improve team work in SCM. However, for the case company itself, those activities were still limited only to quality issues and were only within the company.

Currently, AA has a supplier development department working with suppliers in improving activities with support from the purchasing department, product engineering, QA and logistics. However, the human resource department is still not involved with these activities. Then, the expert suggested that more SCM training should be provided and suppliers and customers included. The scope of quality control circle should be extended to involve both suppliers and customers, and the agenda should cover SCM issues as well. He suggested that *"the Human Resource department should have a more active role in joint improvements in the supply chain of the company"*. Moreover, the expert commented that supplier assessment in ISO 9000 was also a good basis for a supplier development program in SCM.

AA still continuously improved its SCM tools and techniques to strengthen its competitiveness. For the ERP software, the company had formerly used Oracle software. SAP software was implemented to replace Oracle in order to connect business processes together across related functions in the companies and among the group companies in the future. This was because SAP is used more widely and is more compatible with other companies' ERP. Moreover, the case company had a policy to invest in advanced technology to improve quality and resolve human resource problems related to supply chain such as Automated Guide Vehicle (AGV), E-Kanban, Vision Machine etc. Other SCM techniques such as milk run (round trip delivery), factory re-layout, inventory reduction, quality control circle application in SCM are planned to be implemented in the near future to reduce transaction costs through internal and cross-functional integration. Finally, the Marketing and Logistics Manager commented that *"the success of these improvements need involvement from all employees, suppliers and customers rather than sophisticated technologies, tools or techniques"*.

5.4 BB Co. Ltd.

The second case company, BB Co. Ltd., is a French company. The mother company in France had taken over the case company from a Japanese company and changed the name of the company to BB. The company is located in Amata Nakorn industrial estate, Chonburi province. The company is a large company which employs over 550 employees including around 55 SCM staffs. It manufactureds engineering products such as ventilation, air-condition and heating systems and is the first-tier supplier of Nissan, Isuzu, Mitsubishi and Volvo. To ensure quality performance, the company was certified ISO 9001: Y2000, ISO/TS 16949 and ISO 14001. Besides, it received many quality awards from its customers and the mother company as well.

When the case company was owned and managed by the Japanese, it had no dedicated SCM department. Once the French majority owner had taken over, the new management team introduced the corporate policy from the mother company to improve competitiveness. Therefore, with technical and management support from the mother company, a SCM department was established even though there was no

encouragement from their customers. The SCM department of the company is responsible for core SCM functions, namely Sales; Inventory and Operation Planning (SIOP); Inventory Management; Packaging; Logistics Solution; Customer Service; Material Planners (both Local and Import); and Physical Flow Management. The SCM manager commented that *"this organizational structure reorganization is beneficial for coordination and communication among SCM functions"*. This can improve SCMP such as *Strategy and Organization* and *Information Management*, for example internal information flow and sharing, communication and coordination and goal alignment among the interrelated functions. BB just only reorganized its organizational structure to facilitate SCM activities, but it did not relocate the functions because interrelated functions were already located near to each other in the same building. However, the case company faced some difficulties about insufficient training and education of SCM staff during the initial phase of SCM implementation. SCM Manager explained that *"initially, the SCM staff did not clearly understand the new functional job and business process linkage of the new SCM department"*. This was because there was not enough communication and training. The company analyzed and resolved these problems with more specific education and communication to SCM staff. This measure showed that the QMP *Human Resource Management* and *Information Analysis* can improve *Strategy and Organization* of SCMP as shown in the multiple regression analysis in Table 4.14.

Similar to TPS, the company had its own production system (BBPS) as a core production management system and used it to improve transaction cost in its supply chain according to TCA as well. BBPS aimed to improve information flow and material flow as well as to reduce waste in the company's supply chain. With BBPS, production volume and flexibility should increase at lower cost especially inventory cost which is a large expense in the automotive supply chain. BB had rather low inventory level because it has a strong QM as well as Japanese Just-In-Time (JIT) system from its former Japanese owner. This information supported the MANOVA results that the Japanese and the Western companies had better SCMP, QMP and FSP than the Thai owned companies (see Table 4.10). The quality management system of BB was further strengthened with the Western quality management system from the new French owner. The SCM Manager commented that *"BBPS will be efficiently achieved where quality management is strong. We initiated many quality tools and techniques which is a useful foundation for BBPS, for example Quick Response, Quick Control (QRQC), Stop at First Defect, Not Accept, Not Produce, Not Deliver defects (3Not), Quality First, etc. We allow the operations to stop the production lines when they found defects or errors"*. A French SCM director compared this quality concept with a problem in everyday life to make the staff more aware of quality: "*if you lose your way, would you still continue driving, or would you stop and find the right direction before driving further?"* Finally, the SCM Manager suggested that before BBPS implementation, quality problems should be analyzed and resolved. The SCM Manager suggested that *"ISO 9000 is insufficient for SCM in a complex industry like the automotive industry. At least a dedicated quality management for the automotive industry such as ISO/TS 16949 should be introduced before SCM implementation"*. In accordance with this individual opinion, the multiple regressions analysis provided support that *Information Analysis, Human Resource Management* and *Customer Focus* the QMP significantly impact the *Lean System* of SCMP (see Table 4.14). Accordingly, the hypothesized structural model confirmed that the set of QMP significantly affected the set of SCMP as a whole (see Table 4.7). Moreover, sample

companies with ISO/TS 16949 had significantly better SCMP and FSP than those without ISO/TS 16949 (see Table 4.13).

Unlike AA, SCM staff at BB had awareness not only of the delivery performance, but also of the quality performance. They take quality and inspection as their indirect responsibilities and do not allow defect products to be delivered to customers. The SCM manager commented that *"our company has a strong foundation of quality management and awareness from former Japanese and present Western management styles".* They work closer and had more aligned quality and SCM goals with production and QA department. This difference between the two case companies AA and BB supports the MANOVA results in that Japanese and Western companies have significantly better QMP than Thai owned companies (see Table 4.10).

Similar to AA, the SCM Manager said that BB also experienced some negative impacts of QM on SCM. For example, in some instances, the company faced contingency events such as quality problems with raw materials or component parts from the suppliers. QA staffs needed more time to inspect and to judge these raw materials, then simply accept or reject them. In some situations, they could not estimate the exact time to make decisions. Then, in accordance with the written quality management system of the company, QA staff did not allow those raw materials to be supplied to the production lines. They were afraid of non-conformance to such quality management standards. This can lead to a production line stoppage because of the shortage of raw materials which can then lead to delivery delays to customers due to low inventory levels as well. Consequently, it affected the FSP as a whole. The SCM Manager complained that *"this is a conflict of interest between QM and SCM in the company".* To overcome this problem, BB had a policy to resolve this conflict of interest by employing the robbing technique, recently. With this technique, when there are quality problems with raw materials and QA staff does not allow SCM staff to supply those raw materials to the production lines, SCM staff can supply the next batch of raw materials that has passed quality inspection by QA staffs instead. *"Although robbing technique conflicts with quality FIFO rule (First-In-First-Out), it can avoid production line stoppage and delivery delay to the customers"* the SCM Manager explained. However, he advised that this technique can be applied only to the raw materials which do not need to pay strict adherence to FIFO, such as raw materials without expiration dates. He commented that *"this compromising policy is helpful when all staff are educated and focused on customers."* In summary, goals of individual department must be aligned together with the goals of the company as a whole.

Unlike products of AA, most products of BB were engineering component parts which needed to focus on internal functions rather on external appearance of the products. They were not parts used to be displayed. Therefore, BB had fewer significant problems with human judgment or sensory test on the appearance quality of the products. However, similar to staff of AA, some of BB staff still did strictly only what was written in their job descriptions and quality management standards. The SCM manager accepted that *"some staff are still insufficiently service minded. They do not want to provide additional support or do jobs with unclear owners in order to avoid non-conformance to written quality management system".* This misunderstood concept could affect FSP of the company as a whole. However, the

expert revealed that BB tries to improve this problem with more training, customer focus and goal alignment among the departments involved.

BB was still continuously improving its SCM in accordance with the continuous improvement concepts of TQM. SAP, a widely applied ERP software, was used to connect its business processes together. Sophisticated SCM tools and techniques, such as Web-based Electronic Data Interchange, E-Kanban and Standardized Packaging with suppliers were applied. In the near future, the company also plans to implement milk run (round trip delivery), supplier reduction, zero stock, logistics protocol (goal deployment and alignment among logistics functions) to improve transaction costs in its supply chain through internal and cross-functional integration. Similarly, the BB's SCM Manager suggested that *"continuous participation of all business partners (employees, suppliers and customers) is the foundation and key success factor of these improvements"*.

5.5 Summary

The case study research was conducted with two large and first-tier supplier companies to obtain more in-depth information about linkages between SCM and QM. One company, AA Co., Ltd., a Thai owned firm produces decorative automotive component parts. It represents a management style with less developed SCM and QM systems. The other company is a French majority company (formerly a Japanese company) specializes in engineering automotive component parts and is called BB Co. Ltd. It represents a management style with more developed SCM and QM systems. At the initial phase of SCM implementation, most staff of both companies did not comprehensively understand SCM concepts, scope, importance and application. They overcame this problem with more specific training, communication and goal alignment among interrelated functions. Both AA and BB initiated their own production management systems to improve SCM focusing on the flow of information and materials with lower transaction cost. Managers of both companies agreed that dedicated QM such as ISO/TS 16949 is a prerequisite for complex automotive SCM. SCM staff of BB had more quality awareness and commitment than those of AA because of the stronger quality foundation from the Japanese and the Western management systems. Both AA and BB experienced some negative impacts on SCM by overly strict QMP. However, BB reacted to this conflict of interest better than AA because of its more mature QM. AA manufactured decorative products which require human sensory inspection. As a result, results of sensory test can conflict with FSP. Moreover, both experts had experience that when quality management standards were applied, the staff were afraid of non-conformance to such quality standards and tended to do only what is written in the quality standards. Therefore, unwritten jobs supportive to other groups may be neglected. However, these problems can be improved with more mature quality concepts such as training, customer focus and goal alignment. Finally, both case companies are still continuously improving their SCM with involvement from every business partner (e.g. suppliers, customers, employees) according to the concept of continuous improvement of TQM.

CHAPTER 6
CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter provides an overview of the study by summarizing research findings and extensively discussing the implications of these findings. Moreover, the contribution of this research to the existing literatures in the areas of supply chain management and quality management as well as to the automotive industry in Thailand is explained. Finally, the limitations of the study and recommendations for future research are discussed.

6.2 Overview of the Study

This research aims to analyze the impact of quality management practices on supply chain management practices and firm's supply performance. The automotive industry in Thailand was employed as a case study because the automotive supply chain is very complex and very active, not only in terms of their supply chain management but also quality management. Moreover, it is one of a few competitive industries in Thailand which compete in the international market. The research also tests differences among supply chain management practices, quality management practices and firm's supply performance when the samples were categorized by organizational characteristics (ownership, company size, tier in the supply chain and quality management maturity). Besides the statistical quantitative analysis, the case study method was applied to obtain more comprehensive information about the relationships between supply chain management and quality management in a qualitative manner. With these objectives, the following research questions were investigated:

1) Which supply chain management practices, quality management practices and firm's supply performance are commonly applied in the automotive industry in Thailand?
2) Does quality management have any impact on supply chain management?
   2.1) Do quality management practices have any impact on supply chain management practices?
   2.2) Do quality management practices have any impact on firm's supply performance?
   2.3) Do supply chain management practices have any impact on the relationship between quality management practices and firm's supply performance?
3) Are there differences across organizational characteristics on supply chain management practices, quality management practices and firm's supply performance?

From the literature review, instruments were developed and evaluated in two stages, namely, the preliminary and the final surveys. The pilot survey was conducted

to adjust and fine tune the research instrument. The final survey was carried out through questionnaires sent both in electronic and in paper formats. The questionnaires were distributed to senior executives of companies that collaborate with many professional organizations such as the Thailand Automotive Part Manufacturer Association, the Thailand Automotive Institute and the Thailand Productivity Institute. The positions of the respondents were at least at the manager level with responsibilities in supply chain management related departments.

The total number of valid questionnaires received was 269 (64.8%). Considering multiple respondents in one company, companies with single and multiple responses accounted for 81% and 19% respectively. Therefore, the final number of valid samples was 211 companies in total. A non-respondent bias and multiple respondent bias tests were conducted to ensure similarity between respondents and non-respondents and between the single and multiple responding firms. The reliability of the final research instrument were assessed through item-total correlation, Cronbach's alpha, composite reliability and average variance extracted. The first-order Confirmatory Factor Analysis, the second-order confirmatory factor analysis, convergent validity, discriminant validity and nomological validity were conducted to confirm that the measurement models were fit and valid. Each sub-construct comprised its measurable items and those sub-constructs were sub-constructs of a broader and more encompassing constructs, namely supply chain management practices, quality management practices and firm's supply performance. Then, the path analysis of the structural equation modeling was applied to test the main hypotheses for the whole samples, the Thai owned company sub-samples and the alternative conceptual model. Moreover, descriptive statistics were applied to assess and compare the implementation and the existence of supply chain management practices, quality management practices and firm's supply performance in the sample companies. MANOVA was applied to investigate the differences across organizational characteristics on supply chain management practices, quality management practices and firm's supply performance. In addition, the multiples regression analysis was employed to examine the effects of individual quality management practice on individual supply chain management practice, the synergetic effect of integrated supply chain management practice and quality management practice on firm's supply performance and the mediation effect of supply chain management practice on the relationship between quality management practice and firm's supply performance. The case study method was applied by examining two case companies to obtain more information about the relationships between supply chain management and quality management practices.

6.3 Research Finding and Implications

6.3.1 Similarities and Difference between Quality Management and Supply Chain Management

In an extensive literature review, Vanichchinchai and Igel (2009) found that there are many similarities and differences between quality management and supply chain management practices (see Table 2.1). Firstly, both total quality management and supply chain management can be viewed as management philosophies and from this perspective, there is an unlimited potential for scope and applications. In practical

terms, however, implementation is made difficult by the range of unclear definitions. The traditional approach to quality management emphasizes specification-based performance while supply chain management tends to focus on time-based performance. However, the ultimate goal of both is customer satisfaction. There can be synergy as they share the same ultimate goal, but conflicts can also arise from the different primary goals. Although quality management and supply chain management emerged from different starting points, they evolved in similar ways. Both originated at the tactical level of operational functions, which are the primary activities in an organization's value chain and then widened in scope to cover all interrelated parties at the strategic level in order to gain synergy. Although quality management and supply chain management require both internal and external integration, quality management emphasizes the participation of all in-house employees. In comparison, supply chain management focuses on the partnerships with external business partners. Then, this can lead to synergies or conflicts in their integration.

6.3.2 Confirmation of the Measurement Models and the Impact of Quality Management Practices on Supply Chain Management Practices and Firm' Supply performance

The first-order and the second-order confirmatory factor analysis confirmed that the proposed supply chain management practices, quality management practices and firm's supply performance measurement models were fit and valid. Each sub-construct was composed of its measurable items and those sub-constructs were sub-constructs of a broader and more encompassing constructs, namely, supply chain management practices, quality management practices and firm's supply performance.

The path analysis of structural equation modeling indicated that quality management practices had a strong positive relationship with supply chain management practices. Therefore, H1 which is "a firm's quality management practices significantly and positively impact supply chain management practices" was supported. This can be explained by the fact that supply chain management and quality management share many similar practices and principles, for example, customer-focused quality management practices (Hoang *et al.*, 2006), customer relationship management of the Global Supply Chain Forum (Croxton *et al.*, 2001), customer relationship (Li *et al.*, 2005) and supply chain management practices (Li *et al.*, 2004); and process management's quality management practices and internal lean practices (Hoang *et al.*, 2006) and supply chain management practices (Li *et al.*, 2005) . Quality management appears to include all best practices (Vanichchinchai and Igel, 2009) which can be applied commonly to other modern management systems such as benchmarking management (Chen, 2002), six sigma (Klefsje *et al.*, 2001) and supply chain management. Martinez-Lorente *et al*. (1998) actually defined supply chain management as an element of total quality management. Quality management practices can facilitate the implementation of supply chain management practices. Similarly, Flynn and Flynn (2005) found that firms with stronger quality management practices achieved better supply chain performance. However, the result of this study was different from that of Hsu *et al.* (2009) and Casadesus and Castro (2005)'s research. Hsu *et al.* (2009) investigated the relationship between operations capability including total quality management, supply chain management and JIT (a specific supply chain management technique in the automotive industry) and firm

performance. They results did not confirm a significant relationship between total quality management capability and supply chain management practices. The explained this surprising finding that the measures employed to assess total quality management capability related to internally focused quality initiatives and did not explicitly address boundary spanning quality issues such as supplier quality. Casadesus and Castro (2005) explored how quality management contributes to supply chain management implementation. The result could not confirm that ISO 9000 implementation totally supports supply chain management. It can be explained that the maturity of quality management practice frameworks in this research and that of Casadesus and Castro (2005) were different. Casadesus and Castro (2005) used ISO 9000 framework; while, quality management practices in this research applied total quality management framework which can be considered as superior quality management practices (Vanichchinchai and Igel, 2009). ISO 9000 and even ISO/TS 16949 serve as subset of total quality management overall requirement (Kartha, 2004). This explanation confirmed the opinion of the industry experts in qualitative case study that ISO 9000 is not enough for supply chain management in the automotive industry. Dedicated quality management practices such as ISO/TS 16949 is needed for supply chain management implementation in the automotive industry. Accordingly, MANOVA result also confirmed that there were significant differences in supply chain management practices between the organization with and without ISO/TS 16949. Therefore, it may be concluded that quality management maturity affects supply chain management implementation and this should be further researched.

Moreover, it was found that a firm's quality management practices significantly and positively impact its firm's supply performance. Thus, H2 was supported. This is explained by the fact that supply chain management and total quality management have the same ultimate goal which is customer satisfaction (Vanichchinchai and Igel, 2009) as they share supply performance and quality performance such as on time delivery without defects or rejections. Moreover, empirical research studies conducted by Rahman (2001), Sun (2000), George and Sherry (1998), Danny and Mile (1999), Khan (2003), Hendricks and Singhal (1997), Prabhu *et al.* (2000) confirmed that quality management/total quality management can improve not only quality performance but also the organizational performance as a whole. These corporate performance dimensions also include supply performance.

Supply chain management practices also had a significant impact on firm's supply performance. Besides, Li *et al.* (2006) found that higher levels of supply chain management practices leads to enhanced competitive advantage and improved organizational performance. Moreover, Tracey *et al.* (2005) concluded that significant positive relationships exist between supply chain management capabilities and firm performance.

In addition to the direct relationship, quality management practices also had an indirect effect on firm's supply performance through supply chain management practices. The path analysis showed that there was a causal link among quality management practices, supply chain management practices and firm's supply performance. Therefore, H3 which is "a combined set of a firm's quality management practices and supply chain management practices significantly and positively impact firm's supply performance" was supported. Quality management practices lead to

better supply chain management practices which cause higher firm's supply performance because of the aforementioned shared practices and performance measures. Moreover, although supply chain management practices emphasize external partnerships with customers and suppliers, the real supply chain management practices implementation start from collaboration among internal departments. Coordination within the organizations is a prerequisite of supply chain management (Lambert and Cooper, 2000). Therefore, quality management/total quality management, which requires internal participation of all employees, is a foundation for supply chain management practices which focuses on external partnerships with all business partners (Vanichchinchai and Igel, 2009). In turn, both contributed to firm performance improvements. Accordingly, Kuei *et al.* (2001) reported that companies with higher supply chain quality management tend to perform better than companies with lower supply chain quality management. Tan *et al.* (1998) conducted an empirical research to study the linkages between quality management, supplier evaluation and supply base management and found that quality management and supply base management should be implemented together to improve corporate performance. Lin *et al.* (2005) surveyed the impact of supply chain quality management confirmed that quality management practices significantly correlated with the supplier participation and selection strategy in SCM and this influenced business performance. Also, Kannan and Tan (2005) concluded that at strategic level there were linkages between total quality management, supply chain management, and JIT which reinforced each other and then improved firm performance. At operational level, total quality management, supply chain management, and JIT could be implemented together to create value. In conclusion, all three hypotheses have been supported.

Thus, all three hypotheses were supported. Although the companies owned by Thai nationals had the lowest score in implementing supply chain management practices and quality management practices and in firm's supply performance, these findings of the whole sample were equally valid for the Thai ownership sub-samples.

The multiple regression analysis reported that, overall, quality management practices had significant positive impacts on every supply chain management practice (see Table 4.14). *Information Analysis*, a quality management practice, had a significant positive impact on every supply chain management practice. This is because information analysis and management is a basic requirement of both, quality and supply chain management. *Customer Focus* of quality management practices had a significant and positive effect on almost every supply chain management practice, except *Strategy and Organization* of supply chain management practices. This is due to the fact that supply chain management and quality management share customer satisfaction as the ultimate goal (Gunasekaran and McGaughey, 2003; Gunasekaran *et al.,* 2001). However, they have different primary goals (Vanichchinchai and Igel, 2009). Quality management focuses on quality (Sun *et al.*, 2004; Prajogo and Sohal, 2004, Prajogo and Sohal, 2001); while, supply chain management emphasizes delivery as the primary goal (Samaranayake, 2005; Chin *et al.*, 2004; Kuei *et al.* 2001). Therefore, quality focus negatively affects supply chain strategy but not significantly. *Human Resource Management* of quality management practices had no significant impact on *Partnership Management* and *Information Management* of supply chain management practices. The reason for this is *Human Resource Management* of quality management practices focused mainly on internal employee

participation rather than external business partnerships (Gowen III and Tallon, 2003; Hoang *et al.*, 2006; Yeung and Amstrong, 2003; Vanichchinchai and Igel, 2009). *Commitment and Strategy*, a quality management practice, had a negative but not significant impact on *Information Management, Lean System* and *Partnership Management* of supply chain management practices. These conflicts exist because quality management and supply chain management have different primary goals which always result in trade-offs as found from the qualitative case studies which will be explained in more detail in the next topic. Moreover, quality management primarily commits to internal participation from all employees, while supply chain management primarily relies on participation from all external business partners. However, due to the same ultimate goal and the ultimate integration of both toward total integration from all employees and business partners, the impacts were not significant.

The multiple regression also confirmed that there was synergistic effect of simultaneously implemented supply chain management practice and quality management practice on firm's supply performance. Supply chain management practice also had partial mediation effect on the relationship between quality management practice and firm's supply performance. Therefore, supply chain management practices and quality management practices should be implemented together.

6.3.3 Existence of Supply Chain Management Practices, Quality Management Practices and Firm's Supply Performance in the Organizations

Overall, implementation of supply chain management practices showed a much lower mean score than quality management practices. The highest and the lowest supply chain management practices were *Information Management* and *Strategy and Organization* while the top and the bottom rank of quality management practices were *Customer Focus* and *Human Resource Management* respectively. This is caused by the fact that the concept of supply chain management has been developed and implemented much later in the automotive industry in Thailand compared with that of quality management. There are various quality management certificates and even industry-specific quality management certificates for the automotive industry (e.g. ISO 9001, ISO/TS 16949, QS 9000), but there are still no common internationally accepted supply chain management standards. Given that supply chain management focuses on external partnerships with customers and suppliers, implementing supply chain management is more complicated in terms of business process integration or communication among concerned parties than quality management.

Among the supply chain management practices, *Information Management* had the highest mean value. This is because it is a basic requirement for supply chain management, and it is a practice similar to *Information Analysis* within quality management. *Lean System* ranked second. This explains how the automotive supply chain in Thailand has introduced Just-In-Time (JIT) (also known by its other names: Lean Manufacturing or Toyota Production System: TPS) which shares many concepts and principles with supply chain management (Tan, 2001; Narasimhan *et al.*, 2008; Gimenez, 2004). Currently, some automotive assemblers as well as some professional

organizations such as Toyota Motor (Thailand) Co., Ltd. and the Thailand Automotive Institute are encouraging automotive suppliers to implement JIT or Lean Manufacturing or TPS. However, implementation of supply chain management practices in the automotive industry in Thailand were different from those of the US industry (Li *et al.*, 2006) which saw partnership and information management with the highest and the second highest mean scores respectively. This is because the US industry has a more sophisticated supply chain management systems and places more emphasis on partnership management at a strategic level while the automotive industry in Thailand still focuses on effective and efficient transactions of information and materials within the organization and between business partners. According to the transaction cost analysis, this emphasis helps the automotive companies in Thailand reduce transaction costs and may explain the high mean score of *Responsiveness* and *Cost*. As for quality management practices, *Customer Focus* had the highest mean value and *Commitment and Strategy* came second. These results were similar to the studies by Hoang *et al.* (2006) and Loan (2004) who found that customer focus and top management commitment are the most common criteria for ISO 9001 certification. Accordingly, Prajogo and Sohal (2003) and Sohail and Hoong (2003) reported that total quality management emphasizes customer focus, leadership and strategic planning practices. In term of firm's supply performance, the sample companies performed best in *Responsiveness.* This is because supply chain management originated within logistics activities and focuses on error-free delivery performance (Samaranayake, 2005; Chin *et al.*, 2004; Kuei *et al.* 2001). In particular, the automotive supply chain has been operating according to the JIT concept which aims to respond fast and on-time. *Cost* ranked second. Referring to transaction cost analysis, the automotive part suppliers in Thailand still focus on transaction cost according to the high score of *Information Management* and *Lean System*. *Relationship* had the lowest mean score. This shows that business partnerships in developing countries, or in low supply chain management maturity environments, are still based on traditional adversarial buyer-supplier relationships targeting mainly the price for decision making rather than developing a long-term relationship. Consequently, trust, cooperation and relationship in these kinds of relationships are low. Jayaram *et al.*, (2004) raised an example of conflict of interest in cost between the automotive assemblers and suppliers and suggested that too much focus on cost as a primary goal and opportunistic behavior can impede their relationships. However, although trusting suppliers is good, hostility may make the company more profitable in some situations even in the long term (Tan, 2001). This may also be a practice of the automotive companies in Thailand.

6.3.4 Differences across Organizational Characteristics on Supply Chain Management Practices, Quality Management Practices and Firm's Supply Performance

For company ownership (Thai, Japanese and other ownership), there were significant differences in every sub-construct of supply chain management practices, quality management practices and firm's supply performance except for *Customer Focus* and *Commitment and Strategy* of quality management practices. This can be explained by Hoang *et al.* (2006), Loan (2004), Prajogo and Sohal (2003) and Sohail and Hoong (2003)'s research that top management commitment and customer focus are critical for quality management and ISO 9000 certification. The Japanese have

highest levels of supply chain management practices, quality management practices and firm's supply performance; because, they have been the biggest investors in the automotive industry in Thailand for a long time. Due to the degree of the development in technology and management systems, the other owners from US and Europe are more advanced in supply chain management practices and quality management practices than Thai companies. However, the US and European were minority investors and rather new in the automotive industry in Thailand. Therefore, their *Partnership Management* and *Relationship* development with business partners are not as strong as that of the Thais. Moreover, differences in culture and management styles between the Asian partners which hold the majority (e.g. Thai and Japanese) and Western shareholders (Boonsathorn, 2007) which are in the minority (e.g. US and the European) may possibly explain the low mean values of firm's supply performances of Western companies.

Considering company size (large and small-to-medium companies), large companies had higher mean scores than small-to-medium companies in every sub-construct of supply chain management practices, quality management practices and firm's supply performance. Similarly, Terziovski and Samson (1999) and Terziovski and Samson (2000) found that there was a significant difference in the relationships between quality management practices and company size as measured by the number of employees. This can be explained that large companies have more resources and commitment to supply chain management and quality management than small-to-medium companies. According to transaction cost analysis, large companies have more resources, more bargaining power and safeguards against opportunistic behavior of their business partners. They gain cost advantages from economies of scale. Moreover, large companies can develop long-term cooperation with key suppliers and customers which lead to lower transaction costs such as quality control; contracts and controls with suppliers; joint training programs; cost measurement systems; supplier certifications (Tan *et al.*, 1998; Halldorsson *et al.*, 2007; Hobbs 1996; Skjoett-Larsen, 1999; Logan, 2000). Referring to the information from case companies, large companies can invest in advanced information and logistics technology/technique which can reduce transaction costs such as SAP, Automated Guide Vehicle, E-Kanban; Vision Machine and Web-based Electronic Data Interchange.

The first-tier suppliers had higher mean values in every supply chain management practice, quality management practice and firm's supply performance sub-construct compared with the other-tier suppliers. This is because the first-tier suppliers must utilize sophisticated enough supply chain management and quality management in order to be approved as first-tier suppliers by the automotive assemblers for JIT delivery. Moreover, most of the first-tier suppliers are large companies that can ensure supply capability for the automotive assemblers. According to the company size analysis, large companies had higher levels of supply chain management practices, quality management practices and firm's supply performance mean values. In the US automotive industry, Choi (1999) found no statistical difference in the level of three out of four quality management practices between the first-tier and the tertiary-tier suppliers. He explained this contradiction against the general speculation that quality management has become institutionalized throughout the US automotive supply chain which is more developed than what exists in developing countries. In accordance with transaction cost analysis, certified first-tier suppliers must be sophisticated in JIT (lean manufacturing) which efficiently manages

information and material flow to minimize transaction costs. Moreover, almost all of the first-tier suppliers are large companies which ensure supply capability for the automotive assemblers. Therefore, they have more resources, more bargaining power and more safeguards against opportunistic behavior of their business partners. They gain cost advantage from economies of scale. Moreover, they have long-term cooperation with key suppliers, especially with the automotive assemblers. All of these factors lead to lower transaction costs such as transportation costs reduction with milk-run or round trip delivery technique (Tan *et al.*, 1998; Halldorsson *et al.*, 2007; Hobbs 1996; Skjoett-Larsen, 1999; Logan, 2000). In addition, first-tier suppliers have legal ordering (formal contract), and some of them have credible commitment with their automotive assemblers through joint ventures. These safeguards and credible commitment can also prevent opportunistic behavior of their suppliers (Skjoett-Larsen, 1999; Halldorsson *et al.*, 2007; Hobbs 1996). Moreover, referring to information gained from case companies, first-tier supplier can invest in advanced information and logistics technology/technique which can reduce transaction costs.

The companies with ISO/TS 16949 had higher mean scores of supply chain management practices, quality management practices and firm's supply performance in every sub-construct. These results are similar to Sohail and Hoong's (2003) research which reported that companies with ISO 9000 have better performance than those without ISO 9000. The companies which apply quality management standard have to follow the written standard operational procedures strictly. In regards to quality management practices, only *Customer Focus* was not significantly different. However, *Customer Focus* had the highest mean score in both sample groups compared with the other sub-construct of quality management practices. This explains that customer focus is an important requirement for quality management standards and even general ISO 9001 certification (Prajogo and Sohal, 2003; Sohail and Hoong, 2003; Hoang *et al.*, 2006 and Loan, 2004). Therefore, the companies with ISO 9001, but without ISO/TS 16949, perform well in this sub-construct as a basic foundation of quality management system. As for transaction cost analysis, companies with ISO/TS 16949 have a more sophisticated management system. Important information and operational transactions such as quality control, receipt of goods, operational instruction, contract, etc. are well standardized, recorded, documented and especially audited to prevent against non-conformances to quality standard which may lead to higher transaction costs. Formal written contracts can also be a safeguard against businesses partners' opportunistic behavior (Hobbs 1996; Skjoett-Larsen, 1999; Halldorsson *et al.*, 2007).

Generally, the organizational characteristics significantly affect most of the supply chain management practices, quality management practices and firm's supply performance. The Japanese companies, large companies, first-tier suppliers and the companies with ISO/TS 16949 had more intensively applied supply chain management practices, quality management practices and had a higher level of firm's supply performance.

6.3.5 Case Study of Supply Chain Management and Quality Management Application

The case study research examined two large and first-tier supplier companies to obtain more information about linkages between supply chain management and quality management. One company named AA Co., Ltd. is a Thai owned firm that specializes in decorative automotive component parts. It represents a management style with a less developed supply chain management and quality management. The other company is a French majority company (formerly a Japanese company) which specializes in engineering automotive component parts and is called BB Co. Ltd. It represents a management style with a more developed supply chain management and quality management.

At the initial phase of supply chain management implementation, most staff of both companies did not understand supply chain management concepts, scope, importance and application. They overcame this problem with more specific training, communication and goal alignment among interrelated functions. This experience confirms that *Information Analysis* and *Human Resource Management* of quality management practices could significantly support *Strategy and Organization* of supply chain management practices, findings which were also confirmed by the results of the multiple regression analysis (see Table 4.14). Both companies, AA and BB, initiated their own production management systems, AA Production System or AAPS and BB Production System or BBPS, in order to improve their supply chain management and transaction costs with a focus on flow of information and materials with lower inventory levels according to transaction cost theory. Experts of both companies agreed that a dedicated quality management such as ISO/TS 16949 is a prerequisite for complex supply chain management. This finding supports the results of MANOVA between companies with and without ISO/TS 16949 (see Table 4.13), the path analysis of the main hypotheses (see Table 4.7) and the multiple regression analysis of supply chain management practices and quality management practices (see Table A4.14). Supply chain management staff of BB had more quality awareness and commitment than those at AA because of their stronger quality foundation from the Japanese management philosophy according to the results of MANOVA for Thai and Japanese companies (see Table 4.10). Both AA and BB experienced some negative impacts of observing overly strict quality controls on supply chain management. For example, when there were contingency events such as quality problems which could cause delivery delays, some staff were overly strict in following normal working instructions as written in the company's quality management manual. Then, some staff neglected to resolve these immediate problems up front. However, BB reacted to such conflicts of interest better than AA because of their more mature quality management. For instance, when a batch of materials has some quality problems and needs more inspection time, which can affect the production line to stop or delivery delays to the customers, the supply chain management staff is allowed to borrow (called "rob") materials from the next batch which has no quality problems to supply to the production line or deliver to the customers. BB calls this the "robbing" technique. Although it conflicts against quality FIFO rule (First-In-First-Out), this practice can lead to the avoidance of production line stoppages and delivery delays to customers. This information supported the MANOVA results showing that the Japanese and the Western companies had better supply chain management practices and firm's supply performance than the Thai companies (see Table 4.10).

Since AA manufactured decorative products which rely on human sensory inspection, quality of sensory test and human error can have conflicts on delivery and costs in supply chain management as well. Moreover, experts of both companies had experiences when quality management standards were applied, the staff was afraid of non-conformance to such quality standards and tended to do only what was written in the quality standards. Therefore, supportive tasks which were not specified in the job descriptions always were neglected. However, these problems can be improved with stronger quality concepts such as training, customer focus and goal alignment. Finally, both case companies are still continuously improving their supply chain management and transaction costs with involvement from every business partner (e.g. suppliers, customers, employees) according to the concepts of continuous improvement of total quality management though tools/techniques such as AGV (Automated Guide Vehicle); E-Kanban; Vision Machine; milk run (round trip delivery); Web-based Electronic Data Interchange; Standardized Packaging with Suppliers; supplier reduction; and logistics protocol (goal deployment and alignment among logistics functions).

6.4 Contributions of the Study

This research was one of the first to study the relationships among quality management practices, supply chain management practices and firm's supply performance in a developing country and can be used in further research on the new concept of supply chain quality management. It found that supply chain management and quality management have many similarities and differences which can lead to synergies or conflicts (Vanichchinchai and Igel, 2009) and these provide research opportunities in their simultaneous or integrative implementation.

Lack of suitable measurement instruments was one of the major difficulties for this research. Therefore, this study presented the problem of applying the measurement instruments for supply chain management practices, quality management practices and firm's supply performance, which were initially developed and tested in various industries and mainly in the developed countries. Those measurement instruments are quite general and cannot match the competitive and unique industrial environment at present where the customer requirements and business competitions change rapidly. In this study, the measurement instruments for supply chain management practices, quality management practices and firm's supply performance were dedicatedly developed for the automotive industry in Thailand. These measurement instruments were confirmed to be reliable and valid by various statistical techniques.

The main hypotheses confirmed the significant positive impacts of quality management practices on supply chain management practices and firm's supply performance as well as that the combined set of a firm's quality management practices and supply chain management practices on firm's supply performance. The study also confirmed that overall, quality management practice significantly supported every supply chain management practice sub-construct. There was synergistic effect of simultaneously implemented supply chain management practice and quality management practice on firm's supply performance. Besides, supply chain

management practice had partial mediation effect on the relationship between quality management practice and firm's supply performance. However, the case companies experienced some negative impacts of observing overly strict quality controls on supply chain management. Overall, the implementation of supply chain management practices had much lower mean score than quality management practices. Generally, the Japanese companies, large companies, first-tier suppliers and the companies with ISO/TS 16949 had more intensively applied supply chain management practices, quality management practices and achieved a higher level of firm's supply performance.

6.5 Implications

This study presented insights into the debate concerning the impact of quality management practices on supply chain management practices and firm's supply performance. The results suggested that quality management practices can facilitate supply chain management practices implementation and can enhance firm's supply performance. Moreover, quality management practices can improve firm's supply performance through supply chain management practices. This is because quality management has been broadened to cover some supply chain management practices and performance and then quality management can be used as a foundation for supply chain management implementation and can improve firm's supply performance. The results were applicable for the whole samples and the Thai sub-samples. Therefore, it is suggested that although total quality management and supply chain management are large-scale management systems, managers should not consider them as separate systems. But, both should be implemented together to achieve excellent firm's supply performance. Differences in organizational characteristics or different scope and maturity of quality management practices, supply chain management practices and firm's supply performance can affect the results. For example, if quality management foundation is not strong enough, it will not facilitate supply chain management implementation. Thus, industry-specific quality management system such as ISO/TS 16949, sufficient quality awareness training as well as goal alignment among functions are recommended prior to supply chain management implementation. Managers should be aware of these influential issues when implementing supply chain management and quality management together. Companies in Thailand's automotive industry still focus on operational supply chain management to minimize transaction costs. Therefore, they should more emphasize strategic issues such as partnership and relationship management to gain synergy in total supply chain integration.

With some adjustments, the measurement instruments in this study can be applicable in other industries, especially those that require a large number of component parts and have complicated supply networks (e.g. electrical and electronic appliance industries) and in other developing countries which have similar industrial environments (e.g. companies with low supply chain management and quality management applications and employees with low supply chain management and quality management understanding).

6.6 Limitations of the Study and Suggestions for Future Research

Normally, automotive assemblers are considered as focal companies in its supply chain. The samples in this research were composed of only upstream business partners of the automotive assemblers, namely, the automotive part manufacturers. With some adjustments, for future research, automotive assemblers and the downstream business partners should be studied separately, or together with the upstream suppliers in order to investigate the relationship along the whole supply chain in a more comprehensive manner.

The study included the first-tier and other-tier suppliers, but focused on the first-tier suppliers because of their more mature quality and supply chain management systems. Moreover, the first-tier suppliers are very significant for the automotive assemblers. However, the automotive supply chain is very long and complex. There may be interesting issues in supply chain management practices, quality management practices and firm's supply performance of second-tier and higher tier suppliers and these should be investigated in more details. For example, insufficient quality foundation of second-tier suppliers may lead to ineffective supply chain management and low firm's supply performance.

The distribution of the paper-based questionnaires during public seminars was a convenience sampling. Thus, the samples from this distribution method were not random. The future research should apply different random samples for more generalization of the results. Although this study encouraged multiple responses from one company in various ways (e.g. collaboration from professional organizations in the automotive industries) to improve reliability of the responses, only 19% of the sample companies provided more than one response. However, it did not significantly affect the reliability and the research findings because of the large sample size of 211 respondents. Moreover, multiple respondent bias test confirmed no significant different between single and multiple responding companies. The Non-bias test also confirmed that there were no significant differences between the response and no-response samples with regard to every organizational characteristic (e.g. ownership, size and tier in the supply chain). However, for future research if needed, other data collection methods should be carefully initiated to increase the multiple respondent rates, for example, through direct collaboration with the automotive assemblers who have bargaining power over the part suppliers.

Although the measurement instruments as well as hypotheses were comprehensively confirmed with structural equation modeling, replication with the adaptation of these instruments in other industry and country samples should be conducted to confirm the measurement instruments and results. Future research may be conducted in the automotive companies in other developing countries or in industries that have complicated supply networks for numerous components such as electrical and electronic appliance industry.

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Appendix 3.1: First set of SCMP items

	Item	Factor	Source
1	We share a sense of fair play with our customers	Customer Relationship	Li (2002)
2	We periodically evaluate the importance of our relationship with our customers	Customer Relationship	Li (2002)
3	We frequently interact with customers to set reliability, responsiveness, and other standards for us	Customer Relationship	Li (2002)
4	We frequently measure and evaluate customer satisfaction	Customer Relationship	Li (2002)
5	We frequently determine future customer expectations	Customer Relationship	Li (2002)
6	We frequently evaluate the formal and informal complaints of our customers	Customer Relationship	Li (2002)
7	We have frequent follow-up with our customers for quality/service feedback	Customer Relationship	Li (2002)
8	We facilitate customers' ability to seek assistance from us	Customer Relationship	Li (2002)
9	Information exchange between our trading partners and us is timely	Information Quality	Li (2002)
10	Information exchange between our trading partners and us is accurate	Information Quality	Li (2002)
11	Information exchange between our trading partners and us is complete	Information Quality	Li (2002)
12	Information exchange between our trading partners and us is adequate	Information Quality	Li (2002)
13	Information exchange between our trading partners and us is reliable	Information Quality	Li (2002)
14	Our trading partners share proprietary information with us	Information Sharing	Li (2002)
15	We share our business units proprietary information with trading partners	Information Sharing	Li (2002)
16	We and our trading partners exchange information that helps establishment of business planning	Information Sharing	Li (2002)
17	Our trading partners share business knowledge of core business processes with us	Information Sharing	Li (2002)
18	We inform trading partners in advance of changing needs	Information Sharing	Li (2002)
19	Our trading partners keep us fully informed about issues that affect our business	Information Sharing	Li (2002)
20	We and our trading partners keep each other informed about events or changes that may affect the other partners	Information Sharing	Li (2002)
21	We involve our customers in process/product design	Lean System	Li (2002)

22	Our firm reduces set-up time	Lean System	Li (2002)
23	Inspection of incoming materials/components/products has been reduced	Lean System	Li (2002)
24	We order in small lot sizes	Lean System	Li (2002)
25	Our firm streamlines ordering, receiving and other paperwork from suppliers	Lean System	Li (2002)
26	Our firm has continuous quality improvement program	Lean System	Li (2002)
27	Our firm uses a "Pull" production system	Lean System	Li (2002)
28	Our firm pushes suppliers for shorter lead-times	Lean System	Li (2002)
29	Our firm pushes suppliers for shorter lead-times	Lean System	Li (2002)
30	Suppliers' warehouses/factories are located nearby	Lean System	Li (2002)
31	Inspection of outbound materials has been reduced	Lean System	Li (2002)
32	We delay final product assembly activities until customer orders have actually been received	Postponement	Li (2002)
33	We delay final product assembly activities until the last possible position (or nearest to customers) in the supply chain	Postponement	Li (2002)
34	Our product uses modular design	Postponement	Li (2002)
35	Our products are designed for modular assembly	Postponement	Li (2002)
36	Our goods are stored at appropriate distribution points close to the customers in the supply chain	Postponement	Li (2002)
37	Our production process modules can be re-arranged so that customization can be carried out later at distribution centers	Postponement	Li (2002)
38	We actively involve our key suppliers in new product development processes	Strategic Supplier Partnership	Li (2002)
39	We certify our suppliers for quality	Strategic Supplier Partnership	Li (2002)
40	We strive to establish long-term relationship with our suppliers	Strategic Supplier Partnership	Li (2002)
41	We rely on a few dependable suppliers	Strategic Supplier Partnership	Li (2002)
42	We rely on a few high quality suppliers	Strategic Supplier Partnership	Li (2002)
43	We have continuous improvement programs that include our key suppliers	Strategic Supplier Partnership	Li (2002)
44	We regularly solve problems jointly with our suppliers	Strategic Supplier Partnership	Li (2002)
45	We have helped our suppliers to improve their product quality	Strategic Supplier Partnership	Li (2002)

46	We include our key suppliers in our planning and goal-setting activities	Strategic Supplier Partnership	Li (2002)
47	We consider quality as our number one criterion in selecting suppliers	Strategic Supplier Partnership	Li (2002)
48	In our supply chain, there exists a firm that maintains and integrated database and access method to facilitate information sharing with other supply hain members	Agreed Supply Chain Leadership	Min and Mentzer (2004)
49	In certain situations in our supply chain, one firm sets the standards for all supply chain members to follow	Agreed Supply Chain Leadership	Min and Mentzer (2004)
50	In our supply chain, there exists a firm that imposes rules and standards for sharing information about product orders, shipments, and inventory	Agreed Supply Chain Leadership	Min and Mentzer (2004)
51	In our supply chain, there exists a firm that provides supply and/or demand forecasting, which is critical to the other members' supply chain planning and activities	Agreed Supply Chain Leadership	Min and Mentzer (2004)
52	In our supply chain, there exists a firm that acts as a management consultant for other members' supply chain practices	Agreed Supply Chain Leadership	Min and Mentzer (2004)
53	In our supply chain, there exists a firm that benchmarks best practices/processes and shares the results	Agreed Supply Chain Leadership	Min and Mentzer (2004)
54	Our supply chain members have common, agreed to goals for supply chain management	Agreed Vision & Goals	Min and Mentzer (2004)
55	Our supply chain members are actively involved in standardizing supply chain practices and operations	Agreed Vision & Goals	Min and Mentzer (2004)
56	Our supply chain members clearly define roles and responsibilities of each other cooperatively	Agreed Vision & Goals	Min and Mentzer (2004)
57	We all know which supply chain members are responsible for what activity within the supply chain	Agreed Vision & Goals	Min and Mentzer (2004)
58	Our supply chain members are actively involved in our business unit's new product development and commercialization process	Cooperation	Min and Mentzer (2004)
59	Our supply chain members jointly management logistics and inventory in the supply chain	Cooperation	Min and Mentzer (2004)
60	Our supply chain members improve the quality of products and services to the end users in a collaborative manner	Cooperation	Min and Mentzer (2004)
61	Our supply chain members actively propose and implement cost reduction ideas	Cooperation	Min and Mentzer (2004)

62	Our supply chain members share the results of performance measures with each other to improve the efficiency and effectiveness of the supply chain process	Cooperation	Min and Mentzer (2004)
63	Our supply chain members have record of allowing each other to participate in strategic decisions	Cooperation	Min and Mentzer (2004)
64	Our supply chain members regularly (at least once a quarter) exchange supply and demand forecasts with each other	Information Sharing	Min and Mentzer (2004)
65	Our supply chain members frequently (at least once a month) exchange demand change information with each other to facilitate operational plans and reduce reliance on second-guesses	Information Sharing	Min and Mentzer (2004)
66	Our supply chain members practice Electronic Data Interchange, either via VAN or Internet	Information Sharing	Min and Mentzer (2004)
67	Our supply chain members have guidelines for developing maintaining, and monitoring long-term supply chain relationships with each other	Long-term Relationship	Min and Mentzer (2004)
68	Our supply chain members have facilitated a strong and long-term supply chain relationship fostering cooperation with each other	Long-term Relationship	Min and Mentzer (2004)
69	Our supply chain member substantially reduced channel complexity over the past three years to closely work with a selected set of supply chain members	Long-term Relationship	Min and Mentzer (2004)
70	Our supply chain members significantly reduced the number of supply chain members to improve operational integration	Long-term Relationship	Min and Mentzer (2004)
71	Our supply chain members successfully integrate operations with each other by developing interlocking programs and activities	Process Integration	Min and Mentzer (2004)
72	One of our supply chain members owns and/or manages one of the supply chain practices (e.g. manufacturing, transportation, warehousing, distribution, marketing, etc.) for the rest of our supply chain members	Process Integration	Min and Mentzer (2004)
73	Our supply chain members place personnel at the business facilities of each other to facilitate cooperation	Process Integration	Min and Mentzer (2004)
74	An inter-functional team from our business unit, together with the teams from our supply chain members, has meetings to figure out how to serve our mutual customers better	Process Integration	Min and Mentzer (2004)

75	Our supply chain members reduced formal organizational structures to more fully integrate operations with each other	Process Integration	Min and Mentzer (2004)
76	Our supply chain members share research and development costs and results with each other	Risk & Reward Sharing	Min and Mentzer (2004)
77	Our supply chain members share risks an rewards	Risk & Reward Sharing	Min and Mentzer (2004)
78	Our supply chain members help each other finance capital equipment	Risk & Reward Sharing	Min and Mentzer (2004)
79	Contacting the end users of your products to get feedback on performance and customer service	Customer Service Management	Tan et al. (2002)
80	On-time delivery of your firm's products directly to your customers' points of use	Customer Service Management	Tan et al. (2002)
81	Extending your supply chain to include members beyond immediate suppliers and customers	Customer Service Management	Tan et al. (2002)
82	Creating supply chain management teams that include members from different companies	Customer Service Management	Tan et al. (2002)
83	Involving all members of your firm's supply chain in your product/service/marketing plans	Customer Service Management	Tan et al. (2002)
84	Participating in the marketing efforts of your customers	Geographical Proximity	Tan et al. (2002)
85	Locating closer to your customers	Geographical Proximity	Tan et al. (2002)
86	Requiring suppliers to locate closer to your firm	Geographical Proximity	Tan et al. (2002)
87	Determining customers' future needs	Information Sharing	Tan et al. (2002)
88	Participating in the sourcing decisions of your suppliers	Information Sharing	Tan et al. (2002)
89	Communicating customers' future strategic needs throughout the entire supply chain	Information Sharing	Tan et al. (2002)
90	Use of informal information sharing with suppliers and customers	Information Sharing	Tan et al. (2002)
91	Use of formal information sharing agreements with suppliers and customer	Information Sharing	Tan et al. (2002)
92	Aiding your suppliers to increase their JIT capabilities	JIT capability	Tan et al. (2002)
93	Increasing your firm's JIT capabilities	JIT capability	Tan et al. (2002)
94	On-time delivery of your purchased materials directly to your firm's points of use	Supply Chain Characteristics	Tan et al. (2002)
95	Communicating your firm's future strategic needs to your suppliers	Supply Chain Characteristics	Tan et al. (2002)

96	Identifying additional supply chains where your firm can establish a presence	Supply Chain Characteristics	Tan et al. (2002)
97	Creating a greater level of trust among your firm's supply chain members	Supply Chain Characteristics	Tan et al. (2002)
98	Improving the integration of activities across your supply chain	Supply Chain Integration	Tan et al. (2002)
99	Reducing response time across the supply chain	Supply Chain Integration	Tan et al. (2002)
100	Searching for new ways to integrate supply chain management activities	Supply Chain Integration	Tan et al. (2002)
101	Creating a compatible communication/information system with your suppliers and customers	Supply Chain Integration	Tan et al. (2002)
102	Establishing more frequent contact with members of your supply chain	Supply Chain Integration	Tan et al. (2002)
103	Setting production capability	Demand Characterization	Lee and Kincade (2003)
104	Setting production run cycles	Demand Characterization	Lee and Kincade (2003)
105	Raw material purchasing	Demand Characterization	Lee and Kincade (2003)
106	Computer-to-computer communication	Information Technology	Lee and Kincade (2003)
107	Electronic data exchange (EDI)	Information Technology	Lee and Kincade (2003)
108	Improvements in production systems	Management Commitment	Lee and Kincade (2003)
109	Improvements in education training	Management Commitment	Lee and Kincade (2003)
110	Improvements in employee empowerment	Management Commitment	Lee and Kincade (2003)
111	Small lot order on a daily basis	Operation Flexibility	Lee and Kincade (2003)
112	Small lot delivery on a daily basis	Operation Flexibility	Lee and Kincade (2003)
113	Forecasting with suppliers/retailers	Partnership	Lee and Kincade (2003)
114	Information sharing with suppliers/retailers	Partnership	Lee and Kincade (2003)
115	Information sharing with suppliers/retailers	Partnership	Lee and Kincade (2003)

116	Fill rate	Performance Measurement	Lee and Kincade (2003)
117	Order lead-time	Performance Measurement	Lee and Kincade (2003)
118	Order-time delivery rate	Performance Measurement	Lee and Kincade (2003)
119	Product quality	Performance Measurement	Lee and Kincade (2003)
120	Present usage of IT applications	Information Technology	Sahay and Mohan (2003)
121	IT budget and spending	Information Technology	Sahay and Mohan (2003)
122	Pull versus push - inventory replenishment process	Inventory Management	Sahay and Mohan (2003)
123	Inventory planning process for finished goods	Inventory Management	Sahay and Mohan (2003)
124	Non-moving inventory	Inventory Management	Sahay and Mohan (2003)
125	Supply chain processes	Supply Chain Integration	Sahay and Mohan (2003)
126	Management focus on supply chain processes	Supply Chain Integration	Sahay and Mohan (2003)
127	Supply chain processes matrix	Supply Chain Integration	Sahay and Mohan (2003)
128	Supply chain objectives	Supply Chain Strategy	Sahay and Mohan (2003)
129	Mapping business objectives with supply chain objectives	Supply Chain Strategy	Sahay and Mohan (2003)
130	Business objectives	Supply Chain Strategy	Sahay and Mohan (2003)
131	Arms-length, cooperative/partnership, collaboration and integration	Bayer-Seller Relationships	Wong et al. (2005)
132	Demand variability, induced seasonality	Bullwhip Effects	Wong et al. (2005)
133	Direct delivery, cross-docking and merge-in-transit	Distribution and Logistics	Wong et al. (2005)
134	EDI/POS, flow coordination, risk coordination	Information Sharing and Coordination	Wong et al. (2005)
135	Gross margin return on inventory (GMROI), obsolete inventory, markdowns, lost sales, etc.	Inventory and Cost Management	Wong et al. (2005)

136	Time-to-market, time-to-serve, time-to-react	Lead-time Management	Wong et al. (2005)
137	Logistics postponement, manufacturing postponement, standardization, customization	Postponement and Customization	Wong et al. (2005)
138	Physically efficient (MTO), physically responsive (MTS) and market responsive (ATO) for functional, intermediate and innovative products respectively	Product Differentiation	Wong et al. (2005)
139	Location, pricing and mark-up, assortment, performance metrics, forward-buying, delivery destination, replenishment frequency, order batch sizes	Retail Strategy	Wong et al. (2005)
140	Electronic data interchange or point-of-sales (EDI/POS), continuous replenishment planning (CRP), efficient consumer response (ECR), collaborative planning, forecast, replenishment (CPFR), vendor-managed inventory (VMI), radio frequency identification (RF	SCM Initiatives	Wong et al. (2005)
141	Inventory turn, gross margin and profit, average in-stock inventory, ability to measure inventory, etc.	Supply Chain Performance	Wong et al. (2005)
142	NA	Advanced Management and Manufacturing Technology	Kim (2006)
143	NA	Close Location to Suppliers and Customers	Kim (2006)
144	NA	Executive Program for Supply Chain Management	Kim (2006)
145	NA	Formalization of Supply Chain Organization	Kim (2006)
146	NA	Human Resource Management	Kim (2006)
147	NA	Logistics Infrastructure	Kim (2006)
148	NA	Nationwide Information Network	Kim (2006)
149	Develop guidelines for sharing process improvement benefits with customers	Customer Relationship Management	Lambert et al. (2005) Ref. GSCF
150	Identify criteria for categorizing customers	Customer Relationship Management	Lambert et al. (2005) Ref. GSCF

151	Review corporate and marketing strategy	Customer Relationship Management	Lambert et al. (2005) Ref. GSCF
152	Provide guidelines for the degree of differentiation in the product/service agreement	Customer Relationship Management	Lambert et al. (2005) Ref. GSCF
153	Develop framework of metrics	Customer Relationship Management	Lambert et al. (2005) Ref. GSCF
154	Develop customer service strategy	Customer Service Management	Lambert et al. (2005) Ref. GSCF
155	Develop response procedures	Customer Service Management	Lambert et al. (2005) Ref. GSCF
156	Develop infrastructure for implementing responses procedures	Customer Service Management	Lambert et al. (2005) Ref. GSCF
157	Develop framework for metrics	Customer Service Management	Lambert et al. (2005) Ref. GSCF
158	Determine synchronization procedures	Demand Management	Lambert et al. (2005) Ref. GSCF
159	Develop contingency management system	Demand Management	Lambert et al. (2005) Ref. GSCF
160	Determine demand management goals and strategy	Demand Management	Lambert et al. (2005) Ref. GSCF
161	Determine forecasting procedures	Demand Management	Lambert et al. (2005) Ref. GSCF
162	Plan information flow	Demand Management	Lambert et al. (2005) Ref. GSCF
163	Develop framework of metrics	Demand Management	Lambert et al. (2005) Ref. GSCF
164	Review manufacturing, sourcing, marketing, and logistics strategies	Manufacturing Flow Management	Lambert et al. (2005) Ref. GSCF
165	Determine degree of manufacturing flexibility requirement	Manufacturing Flow Management	Lambert et al. (2005) Ref.

			GSCF
166	Determine push/pull boundaries	Manufacturing Flow Management	Lambert et al. (2005) Ref. GSCF
167	Identify manufacturing constraints and determine capabilities	Manufacturing Flow Management	Lambert et al. (2005) Ref. GSCF
168	Development framework of metrics	Manufacturing Flow Management	Lambert et al. (2005) Ref. GSCF
169	Define requirements for order fulfillment	Order Fulfillment	Lambert et al. (2005) Ref. GSCF
170	Define plan for order fulfillment	Order Fulfillment	Lambert et al. (2005) Ref. GSCF
171	Review marketing strategy, supply chain structure and customer service goals	Order Fulfillment	Lambert et al. (2005) Ref. GSCF
172	Evaluate logistics network	Order Fulfillment	Lambert et al. (2005) Ref. GSCF
173	Development framework of metrics	Order Fulfillment	Lambert et al. (2005) Ref. GSCF
174	Establish guidelines for cross-functional product development team membership	Product Development and Commercialization	Lambert et al. (2005) Ref. GSCF
175	Establish new product project guidelines	Product Development and Commercialization	Lambert et al. (2005) Ref. GSCF
176	Review corporate, marketing, manufacturing and sourcing strategies	Product Development and Commercialization	Lambert et al. (2005) Ref. GSCF
177	Develop idea generation and screening processes	Product Development and Commercialization	Lambert et al. (2005) Ref. GSCF
178	Identify product rollout issues and constraints	Product Development and Commercialization	Lambert et al. (2005) Ref. GSCF
179	Develop framework of metrics	Product Development and Commercialization	Lambert et al. (2005) Ref. SCF
180	Determine returns management goals and strategy	Returns Management	Lambert et al. (2005) Ref.

			GSCF
181	Develop avoidance, gate keeping and disposition guidelines	Returns Management	Lambert et al. (2005) Ref. GSCF
182	Develop returns network and flow options	Returns Management	Lambert et al. (2005) Ref. GSCF
183	Develop credit rules	Returns Management	Lambert et al. (2005) Ref. GSCF
184	Determine secondary markets	Returns Management	Lambert et al. (2005) Ref. GSCF
185	Develop framework of metrics	Returns Management	Lambert et al. (2005) Ref. GSCF
186	Develop guidelines for sharing process improvement benefits with suppliers	Supplier Relationship Management	Lambert et al. (2005) Ref. GSCF
187	Identify criteria for categorizing suppliers	Supplier Relationship Management	Lambert et al. (2005) Ref. GSCF
188	Review corporate, marketing, manufacturing and sourcing strategies	Supplier Relationship Management	Lambert et al. (2005) Ref. GSCF
189	Provide guidelines for the degree of customization in the product/service agreement	Supplier Relationship Management	Lambert et al. (2005) Ref. GSCF
190	Develop framework of metrics	Supplier Relationship Management	Lambert et al. (2005) Ref. GSCF
191	Forming cross-functional teams	Building Customer-Supplier Relationships	Chin et al. (2004)
192	Establishing communication Channels	Building Customer-Supplier Relationships	Chin et al. (2004)
193	Management support and commitment	Changing Corporate Culture	Chin et al. (2004)
194	Participative management	Changing Corporate Culture	Chin et al. (2004)
195	Web-based IT tools	Employing Information and Communication Technologies	Chin et al. (2004)

196	Online security	Employing Information and Communication Technologies	Chin et al. (2004)
197	Fact-based decision-making support	Employing Information and Communication Technologies	Chin et al. (2004)
198	Supply-chain wide performance measures	Identifying Performance Measures	Chin et al. (2004)
199	Reducing inventory levels	Re-engineering Material Flow	Chin et al. (2004)
200	Logistics network design	Re-engineering Material Flow	Chin et al. (2004)
201	NA	Customer Relationship Management	Mills et al. (2004) Ref. Cooper et al. (1997)
202	NA	Customer Relationship Management	Mills et al. (2004) Ref. Cooper et al. (1997)
203	NA	Demand Management	Mills et al. (2004) Ref. Cooper et al. (1997)
204	NA	Manufacturing Flow Management	Mills et al. (2004) Ref. Cooper et al. (1997)
205	NA	Order Fulfillment	Mills et al. (2004) Ref. Cooper et al. (1997)
206	NA	Procurement	Mills et al. (2004) Ref. Cooper et al. (1997)
207	NA	Product Development and Commercialization	Mills et al. (2004) Ref. Cooper et al. (1997)

Appendix 3.2: Second set of SCMP items

	Supply Chain Management Practice Item
1	We share research and development costs and results with our supply chain members
2	We share risks and rewards with our supply chain members
3	We have common agreed to goals with our supply chain members
4	We include our supply chain members in product development projects
5	We delay final product assembly activities until customer orders have actually been received
6	We design our products for modular assembly
7	We have supply chain performance measurement system
8	We certify our suppliers by some supply chain performance criteria (e.g. quality, cost, delivery)
9	We contact the end users of our products to get feedback on product performance and service
10	We categorize our supply chain members by some criteria
11	We develop long-term relationship with our supply chain members
12	We rely on a few dependable quality suppliers and customers
13	We reduce inventory levels
14	We work with our supply chain members to define customer requirement
15	We reduce set-up time
16	We reduce inspection of incoming materials/components/products
17	We order in small lot sizes
18	We synchronize and streamline business processes (e.g. ordering, receiving and other paperwork) with our supply chain members
19	We reduce response time
20	We have continuous improvement program
21	We deliver products on-time and directly to points of us
22	We and our supply chain members jointly improve logistics network
23	We use a "Pull" production system
24	We participate in the marketing efforts of our customers
25	We share one of the supply chain practices or resources (e.g. manufacturing, transportation, warehousing, distribution, marketing, etc.) with our supply chain members
26	We place our personnel at the business facilities of our supply chain members to facilitate cooperation
27	We identify new supply chain members and extend our supply chain to include members beyond immediate suppliers and customers
28	We have standard for information sharing (e.g. product order, shipment, inventory) for our supply chain members to follow
29	We involve in teams including our supply chain members to improve our supply chain
30	We participate in the sourcing decisions of our suppliers
31	We have organizational structure which facilitates business process integration with our supply chain members
32	We evaluate formal and informal complaints as well as satisfaction of our supply chain members

33	We share information with our supply chain members to facilitate our business planning
34	We share knowledge about core business processes with our supply chain members
35	We inform our supply chain members in advance about changing needs that affect the members
36	We apply advanced information technology in our supply chain
37	We exchange information with our supply chain member effectively (adequate, timely, accurate, reliable)
38	We have facility or store our goods at appropriate distribution points close to our customers
39	We have contingency management system for unexpected events
40	We identify additional supply chains where our firm can establish a presence
41	We create trust among our supply chain members

Appendix 3.3: First set of FSP items

	Firm Performance Item	Construct	Source
1	Our relationship with trading partners is marked by a high degree of harmony	Partnership Quality	Li (2002)
2	Our overall relationship with trading partners is satisfactory	Partnership Quality	Li (2002)
3	We do not wish to terminate current partnerships with trading partners and establish new ones	Partnership Quality	Li (2002)
4	We believe our relationship with our trading partners is profitable	Partnership Quality	Li (2002)
5	We and our trading partners share any risk that can occur in the supply chain	Partnership Quality	Li (2002)
6	We and our trading partners share benefits obtained from SCM	Partnership Quality	Li (2002)
7	Our firm fills customer orders on time	Responsiveness to Customers	Li (2002)
8	Our firm has short lead-time	Responsiveness to Customers	Li (2002)
9	Our firm has fast customer response time	Responsiveness to Customers	Li (2002)
10	Our suppliers deliver materials/components/products to us on time	Supplier Performance	Li (2002)
11	Our suppliers provide dependable delivery to us	Supplier Performance	Li (2002)
12	Our suppliers provide materials/components/products that are highly reliable	Supplier Performance	Li (2002)
13	Our suppliers provide high quality materials/component/products to us	Supplier Performance	Li (2002)
14	Our suppliers provide materials/component/products to us at low cost	Supplier Performance	Li (2002)
15	Our supplier base has reduced over the past three years	Supplier Performance	Li (2002)
16	Our supply chain is able to handle difficult nonstandard orders	Supply Chain Flexibility	Li (2002)
17	Our supply chain is able to meet special customer specification	Supply Chain Flexibility	Li (2002)
18	Our supply chain is able to produce products characterized by numberous features options, sizes and colors	Supply Chain Flexibility	Li (2002)
19	Our supply chain is able to rapidly adjust capacity so as to accelerate or decelerate production in response to changes in customer demand	Supply Chain Flexibility	Li (2002)
20	Our supply chain is able to handle rapid introduction of new products	Supply Chain Flexibility	Li (2002)

21	Our supply chain is able to rapidly introduce large numbers of product improvements/variation	Supply Chain Flexibility	Li (2002)
22	Our supply chain is able to respond to the needs and wants of the firm's target market(s)	Supply Chain Flexibility	Li (2002)
23	There is a high level of communication and coordination between all functions in our firm	Supply Chain Integration	Li (2002)
24	Cross-functional teams are frequently used for process design and improvement in our firm	Supply Chain Integration	Li (2002)
25	There is a high level of integration of information systems in our firm	Supply Chain Integration	Li (2002)
26	There is a great amount of cross-over of the activities of our firm and our trading partners	Supply Chain Integration	Li (2002)
27	Our supply chain is characterized by full system visibility from suppliers' suppliers to customers' customers	Supply Chain Integration	Li (2002)
28	Our business unit's stock availability relative to our competitors	Availability	Min and Mentzer (2004)
29	Our business unit's does a better job maintaining stock consistently	Availability	Min and Mentzer (2004)
30	Our business unit's does a better job responding to customer emergencies (e.g., stock outs, sudden demand increases, and sudden changes requirement) than our major competitors	Availability	Min and Mentzer (2004)
31	Our business unit's percentage of sales generated by new products relative to our competitors	Growth	Min and Mentzer (2004)
32	Our business unit's sales growth relative to our competitors	Growth	Min and Mentzer (2004)
33	Our business unit's market share growth relative to our competitors	Growth	Min and Mentzer (2004)
34	Our business unit's physical inventory level relative to our competitors	Inventory Management	Min and Mentzer (2004)
35	Our business unit's physical inventory turnover relative to our competitors	Inventory Management	Min and Mentzer (2004)
36	Our business unit's physical inventory as a percent of revenue relative to our competitors	Inventory Management	Min and Mentzer (2004)
37	Our business unit's level of obsolete physical inventory relative to our competitors	Inventory Management	Min and Mentzer (2004)
38	Our business unit's product/service offerings in terms of handling difficult, nonstandard orders to meet special customer specifications relative to our competitors	Product & Service Offerings	Min and Mentzer (2004)
39	Our business unit's product/service offerings in terms of variety of features, options, sizes,	Product & Service	Min and Mentzer (2004)

	and/or colors relative to our competitors	Offerings	
40	Our business unit's product/service offerings in terms of quality relative to our competitors	Product & Service Offerings	Min and Mentzer (2004)
41	Our business unit's return on assets (ROA) relative to our competitors	Profitability	Min and Mentzer (2004)
42	Our business unit's return on investment (ROI) relative to our competitors	Profitability	Min and Mentzer (2004)
43	Our business unit's return on sales (ROS) relative to our competitors	Profitability	Min and Mentzer (2004)
44	Our business unit's customer order-to-delivery cycle time consistency relative to our competitors	Timeliness	Min and Mentzer (2004)
45	Our business unit's customer order-to-delivery cycle time specifications relative to our competitors	Timeliness	Min and Mentzer (2004)
46	Our business unit does a better job providing our customers real time information about their orders than our major competitors	Timeliness	Min and Mentzer (2004)
47	Total inventory as: (Incoming stock level, Work-in-progress, Scrap level, Finished goods in transit)	Operational	Gunasekaran et al. (2001)
48	Cost per operation hour	Operational	Gunasekaran et al. (2001)
49	Information carrying cost	Operational	Gunasekaran et al. (2001)
50	Capacity utilization	Operational	Gunasekaran et al. (2001)
51	Supplier rejection rate	Operational	Gunasekaran et al. (2001)
52	Quality of delivery documentation	Operational	Gunasekaran et al. (2001)
53	Efficiency of purchase order cycle time	Operational	Gunasekaran et al. (2001)
54	Quality of delivered goods	Operational	Gunasekaran et al. (2001)
55	Achievement of defect free deliveries	Operational	Gunasekaran et al. (2001)
56	Frequency of delivery	Operational	Gunasekaran et al. (2001)
57	Driver reliability for performance	Operational	Gunasekaran et al. (2001)
58	Net profit vs. productivity ratio	Strategic	Gunasekaran et al. (2001)
59	Rate of return on investment	Strategic	Gunasekaran et al. (2001)
60	Variations against budget	Strategic	Gunasekaran et al. (2001)
61	Flexibility of service systems to meet particular customer needs	Strategic	Gunasekaran et al. (2001)
62	Range of product and services	Strategic	Gunasekaran et al. (2001)

63	Supplier lead time against industry norm	Strategic	Gunasekaran et al. (2001)
64	Level of supplier's defect free deliveries	Strategic	Gunasekaran et al. (2001)
65	Buyer-supplier partnership level	Strategic	Gunasekaran et al. (2001)
66	Total cash flow time	Strategic	Gunasekaran et al. (2001)
67	Order lead time	Strategic	Gunasekaran et al. (2001)
68	Delivery lead time	Strategic	Gunasekaran et al. (2001)
69	Total supply chain cycle time	Strategic	Gunasekaran et al. (2001)
70	Delivery performance	Strategic	Gunasekaran et al. (2001)
71	Level of customer perceived value of product	Strategic	Gunasekaran et al. (2001)
72	Customer query time	Strategic	Gunasekaran et al. (2001)
73	Effectiveness of master production schedule	Tactical	Gunasekaran et al. (2001)
74	Effectiveness of distribution planning schedule	Tactical	Gunasekaran et al. (2001)
75	Product development cycle time	Tactical	Gunasekaran et al. (2001)
76	Supplier cost saving initiatives	Tactical	Gunasekaran et al. (2001)
77	Supplier ability to respond to quality problems	Tactical	Gunasekaran et al. (2001)
78	Supplier assistance in solving technical problems	Tactical	Gunasekaran et al. (2001)
79	Accuracy of forecasting techniques	Tactical	Gunasekaran et al. (2001)
80	Order entry methods	Tactical	Gunasekaran et al. (2001)
81	Effectiveness of delivery invoice methods	Tactical	Gunasekaran et al. (2001)
82	Purchase order cycle time	Tactical	Gunasekaran et al. (2001)
83	Planned process cycle time	Tactical	Gunasekaran et al. (2001)
84	Delivery reliability	Tactical	Gunasekaran et al. (2001)
85	Responsiveness to urgent deliveries	Tactical	Gunasekaran et al. (2001)
86	Supplier's booking in procedures	Tactical	Gunasekaran et al. (2001)

Appendix 3.4: Second set of FSP items

	Firm Performance Items
1	We have efficient physical inventory turnover
2	We have good overall financial performance (e.g. ROA, ROI, ROS)
3	We have low level of obsolete physical inventory
4	We have good stock availability and consistency
5	We have efficient production planning
6	We are able to handle difficult, nonstandard orders, special specification or emergency
7	We are able to produce products characterized by numerous features options, sizes and colors
8	We are able to rapidly adjust capacity so as to accelerate or decelerate production in response to changes in customer demand
9	We are able to handle rapid introduction of new products
10	Our supplier performance is good (e.g. quality, cost, delivery)
11	We have good overall relationship with supply chain members
12	We have a numbers of improvements
13	We have accurate forecasting
14	We have effective and efficient business process
15	We fill customer orders on time
16	We have fast customer response time
17	We have high quality products and service
18	We are good in providing our customers real time information about their orders

Appendix 3.5: Survey instrument

School of Management
Asian Institute of Technology (AIT)

Part 1: Organizational Profile

Please mark (X) in the square boxes or fill information in space to express your company or your profile

1A. Company's Name ----------

2A. Biggest Shareholder ☐ Thai ☐ Japanese

☐ Others (please specify) ----------

3A. Number of Employees (including subcontracted workers)
☐ Less than 50 ☐ 50 - 100 ☐ 100 - 200

☐ 200 - 500 ☐ 500 - 1,000 ☐ More than 1,000

4A. Main Products ----------

5A. Products to be used for what vehicles (please rank 1, 2 and 3) ☐ Cars ☐ Motorcycles ☐ Others (please specify) ----------

6A. Main Markets (please rank 1, 2, 3 and 4) ☐ Automotive Partmakers ☐ Automotive Assemblers

☐ End Consumers (REM) ☐ Export

7A. Your Tier ☐ 1st Tier ☐ 2nd Tier ☐ Others (please specify) ----------

8A. Management Systems or Certification ☐ ISO 9000 ☐ ISO/TS16949 ☐ TPS or JIT or Lean (including application without certification)

☐ Other (please specify) ----------

9A. Does your company have the unit directly responsible for managing your supply chain?
☐ No ☐ Yes (please specify the name of the unit)

10A. Your Position & Department ----------

11A. For you participation in this survey, do you want the following documents?
☐ No

☐ Yes. I want "Facility and Workplace Design" e-text book
(You will receive the book within 3 days after returning the questionnaire)

☐ Yes. I want research report (e-report)
(You will receive the report after the research finished, around 6 months)

Please specify your e-mail for document delivery ----------

* Please return this questionnaire via e-mail to **supply_chain_research@hotmail.com**
* If you have any queries or do not get response or book within 3 days after returning the questionnaire, please contact

Mr. Assadej Vanichchinchai **Mobile: 081-7003363**
e-mail: supply_chain_research@hotmail.com

Thank you for your participation !

Part 2: Supply Chain Management Practices

Please mark (X) in the square boxes, how much your company is involved in the following supply chain management practices

- *The measurement scale is defined from 1 (Never) to 6 (Always)*
- *Trade partners include both suppliers and customers*
- *Supply chain management is "the integration of key business processes from end user through original suppliers that provide products, services and information that add value to all trade partners"*

		Never					Always
		1	2	3	4	5	6
1B.	We contact the end users of our products to get feedback on product performance and service						
2B.	We work with our trade partners to survey and define customer requirement						
3B.	We have common standard for information sharing (e.g. product order, shipment, inventory) for our trade partners to follow						
4B.	We evaluate formal and informal complaints as well as satisfaction of our trade partners						
5B.	We effectively share information with our trade partners to facilitate business planning and react to changes						
6B.	We share knowledge about core business processes with our trade partners						
7B.	We apply advanced information technology in our supply chain						
8B.	We delay final manufacturing activities until customer orders have actually been confirmed						
9B.	We reduce inventory levels						
10B.	We reduce set-up time						
11B.	We reduce inspection of incoming materials/components/products						
12B.	We order in small lot sizes						
13B.	We streamline business processes (e.g. ordering, shiping, receiving and other paperwork) with our trade partners						
14B.	We reduce response time						
15B.	We have continuous improvement activity						
16B.	We deliver products directly to points of use (e.g. customer's assembly lines)						
17B.	We involve in teams including our trade partners to improve our supply chain						
18B.	We use a "pull" production system (pull means producing only when there is demand not to keep high inventory)						
19B.	We share supply chain management practices or resources (e.g. manufacturing, warehousing, distribution, marketing, etc.) with our trade						
20B.	We place our personnel at the business facilities of our trade partners to facilitate cooperation						
21B.	We store our goods at appropriate distribution points close to our customers						
22B.	We share improvement benefit as well as other risks and rewards with our trade partners						

Part 2: Supply Chain Management Practices

Please mark (X) in the square boxes, how much your company is involved in the following supply chain management practices

- *The measurement scale is defined from 1 (Never) to 6 (Always)*
- *Trade partners include both suppliers and customers*
- *Supply chain management is "the integration of key business processes from end user through original suppliers that provide products, services and information that add value to all trade partners"*

		Never					Always
		1	2	3	4	5	6
23B.	We develop long-term relationship and trust with our trade partners						
24B.	We rely on a small number of quality trade partners						
25B.	We participate in the sourcing decisions of our suppliers						
26B.	We include our trade partners in our product development projects						
27B.	We design or manufacture our products for modular or unit part assembly (e.g. brake systems, wiring harness, air-conditioning systems, steering column)						
28B.	We have common agreed to goals with our trade partners						
29B.	We have supply chain performance measurement system						
30B.	We certify our suppliers by supply chain performance criteria (e.g. quality, cost, delivery)						
31B.	We extend our trade partners to include partners beyond immediate suppliers and customers						
32B.	We have organizational structure which facilitates business process integration with our trade partners						
33B.	We have contingency management system for unexpected events (e.g. order change or cancellation, computer network down)						
34B.	Our top level managers strongly encourage employee (worker) involvement in supply chain management						
35B.	Our employees (workers) are actively involved in supply chain management-related activities						
36B.	Our organization have an open, trusting culture with low bureaucracy. Our working environment is very good for supply chain management						
37B.	We have an information sharing among functions for the objectives of supply chain management						

If you have any comment for supply chain management practices, please advise

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Part 3: Quality Management Practices

Please mark (X) in the square boxes, how much your company is involved in the following quality management practices

- *The measurement scale is defined from 1 (Strongly Disagree) to 6 (Strongly Agree)*
- *Trade partners include both suppliers and customers*
- *Supply chain management is "the integration of key business processes from end user through original suppliers that provide products, services and information that add value to all trade partners"*

		Strongly Disagree					Strongly Agree
		1	2	3	4	5	6
1C.	We have a system for collecting complaints or suggestions from customers						
2C.	We actively seeks ways to improve the products in order to achieve greater customer satisfaction						
3C.	We have introduced and maintained the "customer focus" philosophy for a long time						
4C.	We provide training and training resources to employees (workers) and encourage them to attain these training programs						
5C.	We have many active improvement teams						
6C.	We actively evaluate and implement employees' suggestions related to quality and supply chain management, if they are suitable						
7C.	Our line employees (workers) are responsible for and inspect the quality of their own work (or self inspection)						
8C.	Our top level managers strongly encourage employee (worker) involvement in quality management						
9C.	We have an assistance mechanism (or a problem solving network) to help line employees solve quality problems						
10C.	Our employees (workers) are actively involved in quality management-related activities						
11C.	We provide awards to individuals (or groups) for excellent suggestions						
12C.	We display information on quality performance at most of the work stations and everybody knows it						
13C.	We uses quality improvement tools and technqiues extensively for process management and improvement						
14C.	We have clear vision, mission, policies, long term objectives and plan for improving quality						
15C.	We have a clear quality goal and short-term business performance plan						
16C.	We have an information sharing among functions for the objectives of quality improvement						
17C.	Our top managers allocate adequate resources toward efforts to improve quality						

If you have any comment for quality management practices, please advise

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Part 4: Supply Chain Performance

Please mark (X) in the square boxes to evaluate your supply chain peformance compared with your competitors

- *The measurement scale is defined from 1 (Strongly Disagree) to 6 (Strongly Agree)*
- *Trade partners include both suppliers and customers*
- *Supply chain management is "the integration of key business processes from end user through original suppliers that provide products, services and information that add value to all trade partners"*

		Strongly Disagree					Strongly Agree
		1	2	3	4	5	6
1D.	We have good overall inventory management performance (e.g. inventory turnover, obsolete, availability)						
2D.	We have good overall finanacial performance (e.g. ROA, ROI, ROS)						
3D.	We have effective and efficient production plan						
4D.	We have ability to produce products with various specification (e.g. features, options, sizes, colors, special specification)						
5D.	We have ability to rapidly adjust production capacity in response to changes in customer demand						
6D.	We have ability to handle rapid introduction of new products						
7D.	Our suppliers have good overall performance (e.g. quality, cost, delivery)						
8D.	We have good overall relationship with trade partners						
9D.	We have accurate demand forecasting						
10D.	We have effective and efficient business process (e.g. less clerical, documentary, inspection jobs)						
11D.	We have good overall delivery performance (e.g. on-time, fast)						
12D.	We have good overall quality of products and services						
13D.	We have ability to provide our customers real time information about their orders						

If you have any comment for supply chain performance, please advise

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Appendix 4.1: Reliability analysis of SCMP before deleting item-total correlation

Sub-Construct	Code	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
Information Management Cronbach's Alpha = 0.7536	SCM_IM01	25.5318	25.6845	0.4591	0.7336
	SCM_IM02	25.1879	26.2936	0.4749	0.7257
	SCM_IM03	23.5402	28.4268	0.5305	0.7120
	SCM_IM04	23.1371	31.1267	0.4725	0.7290
	SCM_IM05	23.7945	29.0286	0.5544	0.7102
	SCM_IM06	24.7391	28.3721	0.4753	0.7226
	SCM_IM07	24.2676	29.7592	0.4180	0.7344
Lean System Cronbach's Alpha = 0.8225	SCM_LS01	57.2563	121.9871	0.2653	0.8234
	SCM_LS02	56.0549	116.5439	0.5476	0.8063
	SCM_LS03	56.0933	116.1298	0.5959	0.8041
	SCM_LS04	57.5206	122.8762	0.2165	0.8274
	SCM_LS05	56.8849	118.3641	0.4263	0.8130
	SCM_LS06	55.8855	118.4414	0.5602	0.8072
	SCM_LS07	56.0330	118.8314	0.5081	0.8092
	SCM_LS08	55.4898	119.6233	0.5220	0.8093
	SCM_LS09	55.8169	117.2527	0.4462	0.8117
	SCM_LS10	56.7029	112.8542	0.5933	0.8021
	SCM_LS11	56.4012	113.7433	0.5781	0.8034
	SCM_LS12	56.9033	112.6148	0.6314	0.8001
	SCM_LS13	58.3575	119.9881	0.3039	0.8216
	SCM_LS14	58.0943	120.2873	0.3044	0.8213
	SCM_LS15	57.9492	120.5308	0.1933	0.8355
	SCM_LS16	56.4685	117.2870	0.5257	0.8076
Partnership Management Cronbach's Alpha = 0.7243	SCM_PM01	23.6283	26.4181	0.5613	0.6680
	SCM_PM02	24.3810	25.3193	0.4253	0.6965
	SCM_PM03	22.5466	27.8689	0.4784	0.6875
	SCM_PM04	24.1400	29.9245	0.1688	0.7538
	SCM_PM05	23.5584	26.0660	0.4105	0.6992
	SCM_PM06	23.4916	25.1293	0.5360	0.6673
	SCM_PM07	23.5409	24.2432	0.5421	0.6640
Strategy and Organization Cronbach's Alpha = 0.8674	SCM_SO01	23.8119	36.1911	0.6611	0.8474
	SCM_SO02	22.5762	39.8034	0.6455	0.8484
	SCM_SO03	24.1762	40.3922	0.4878	0.8706
	SCM_SO04	23.3902	39.0512	0.6531	0.8470
	SCM_SO05	23.4487	37.8993	0.7264	0.8371
	SCM_SO06	23.7965	38.1330	0.7547	0.8342
	SCM_SO07	23.4945	40.5282	0.5982	0.8543

Appendix 4.2: Reliability analysis of SCMP after deleting item-total correlation

Construct	Code	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
Information Management Cronbach's Alpha = 0.7536	SCM_IM01	25.5318	25.6845	0.4591	0.7336
	SCM_IM02	25.1879	26.2936	0.4749	0.7257
	SCM_IM03	23.5402	28.4268	0.5305	0.7120
	SCM_IM04	23.1371	31.1267	0.4725	0.7290
	SCM_IM05	23.7945	29.0286	0.5544	0.7102
	SCM_IM06	24.7391	28.3721	0.4753	0.7226
	SCM_IM07	24.2676	29.7592	0.4180	0.7344
Lean System Cronbach's Alpha = 0.8612	SCM_LS02	42.5505	67.4913	0.6167	0.8448
	SCM_LS03	42.5978	67.7614	0.6288	0.8441
	SCM_LS05	43.4029	70.1769	0.4250	0.8596
	SCM_LS06	42.3700	69.9282	0.5912	0.8476
	SCM_LS07	42.5290	70.4134	0.5162	0.8521
	SCM_LS08	41.9818	70.0092	0.5848	0.8480
	SCM_LS09	42.3027	68.7488	0.4756	0.8559
	SCM_LS10	43.1909	66.2273	0.5814	0.8474
	SCM_LS11	42.8758	65.9330	0.6216	0.8441
	SCM_LS12	43.4066	66.5498	0.5996	0.8458
	SCM_LS16	42.9323	69.9907	0.5002	0.8532
Partnership Management Cronbach's Alpha = 0.7541	SCM_PM01	20.2756	22.7426	0.5233	0.7139
	SCM_PM02	21.0464	21.2260	0.4367	0.7378
	SCM_PM03	19.2047	23.9253	0.4617	0.7295
	SCM_PM05	20.2018	21.7314	0.4343	0.7364
	SCM_PM06	20.1409	20.9736	0.5566	0.7012
	SCM_PM07	20.1845	19.8358	0.5893	0.6903
Strategy and Organization Cronbach's Alpha = 0.8674	SCM_SO01	23.8119	36.1911	0.6611	0.8474
	SCM_SO02	22.5762	39.8034	0.6455	0.8484
	SCM_SO03	24.1762	40.3922	0.4878	0.8706
	SCM_SO04	23.3902	39.0512	0.6531	0.8470
	SCM_SO05	23.4487	37.8993	0.7264	0.8371
	SCM_SO06	23.7965	38.1330	0.7547	0.8342
	SCM_SO07	23.4945	40.5282	0.5982	0.8543

Appendix 4.3: Reliability analysis of QMP

Construct	Code	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
Customer Focus Cronbach's Alpha = 0.8228	QMP_CF01	10.5861	2.3455	0.6476	0.7929
	QMP_CF02	10.6125	2.5570	0.7257	0.7141
	QMP_CF03	10.6134	2.5146	0.6698	0.7636
Commitment and Strategy Cronbach's Alpha = 0.8526	QMP_CS01	14.2743	8.2328	0.6394	0.8345
	QMP_CS02	14.3964	7.7656	0.7158	0.8037
	QMP_CS03	14.4285	7.5476	0.7128	0.8043
	QMP_CS04	14.7553	7.2575	0.7102	0.8063
Human Resource Management Cronbach's Alpha = 0.8983	QMP_HR01	26.3330	32.8751	0.7264	0.8813
	QMP_HR02	27.0851	32.0938	0.7054	0.8829
	QMP_HR03	26.9567	32.9824	0.6562	0.8885
	QMP_HR04	26.8180	32.5892	0.7179	0.8818
	QMP_HR05	26.6105	31.6090	0.8094	0.8718
	QMP_HR06	26.7760	31.9165	0.8022	0.8730
	QMP_HR07	27.0092	30.4715	0.5920	0.9048
Information Analysis Cronbach's Alpha = 0.8721	QMP_IA01	8.9284	4.7714	0.7215	0.8490
	QMP_IA02	9.1957	4.4845	0.7397	0.8340
	QMP_IA03	9.2114	4.3920	0.8049	0.7732

Appendix 4.4: Reliability analysis of FSP

Construct	Code	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
Cost Cronbach's Alpha = 0.7962	FSP_CT01	9.0093	3.0194	0.6825	0.6770
	FSP_CT02	8.7246	3.6834	0.5684	0.7944
	FSP_CT03	8.8873	3.4946	0.6781	0.6861
Flexibility Cronbach's Alpha = 0.7996	FSP_FL01	8.6160	4.0723	0.6202	0.7528
	FSP_FL02	8.6228	4.4248	0.6636	0.7145
	FSP_FL03	9.1119	3.7897	0.6591	0.7130
Relationship Cronbach's Alpha = 0.8460	FSP_RL01	13.2619	6.1021	0.6360	0.8267
	FSP_RL02	12.4507	6.8258	0.6777	0.8121
	FSP_RL03	13.4836	5.7343	0.7202	0.7884
	FSP_RL04	13.4062	5.9926	0.7169	0.7896
Responsiveness Cronbach's Alpha = 0.8510	FSP_RS01	9.5038	3.2778	0.7669	0.7493
	FSP_RS02	9.4778	3.5478	0.7638	0.7631
	FSP_RS03	9.9085	3.0776	0.6573	0.8708

Appendix 4.5: Loading coefficient of SCMP items before removal

Construct	Code	Standardized Estimate	t-value
Information Management	SCM_IM01	0.34	4.44
	SCM_IM02	0.35	4.64
	SCM_IM03	0.67	9.28
	SCM_IM04	0.62	8.16
	SCM_IM05	0.74	10.31
	SCM_IM06	0.56	7.66
	SCM_IM07	0.55	7.18
Lean System	SCM_LS02	0.67	9.99
	SCM_LS03	0.67	9.98
	SCM_LS05	0.42	5.83
	SCM_LS06	0.65	9.87
	SCM_LS07	0.53	7.79
	SCM_LS08	0.59	8.65
	SCM_LS09	0.54	7.98
	SCM_LS10	0.68	10.09
	SCM_LS11	0.68	10.52
	SCM_LS12	0.63	9.39
	SCM_LS16	0.53	7.80
Partnership Management	SCM_PM01	0.61	8.62
	SCM_PM02	0.52	7.07
	SCM_PM03	0.52	7.13
	SCM_PM05	0.52	7.12
	SCM_PM06	0.67	9.63
	SCM_PM07	0.71	10.29
Strategy and Organization	SCM_SO01	0.68	10.66
	SCM_SO02	0.61	9.35
	SCM_SO03	0.41	5.98
	SCM_SO04	0.66	9.83
	SCM_SO05	0.85	14.23
	SCM_SO06	0.92	15.92
	SCM_SO07	0.65	9.98

Appendix 4.6: Loading coefficient of SCMP items after removal

Construct	Code	Standardized Estimate	t-value	Error Variance
Information Management	SCM_IM03	0.61	8.81	0.63
	SCM_IM04	0.71	10.66	0.49
	SCM_IM05	0.84	12.90	0.30
	SCM_IM06	0.53	7.43	0.72
	SCM_IM07	0.49	6.85	0.76
Lean System	SCM_LS02	0.67	9.43	0.56
	SCM_LS03	0.63	8.89	0.60
	SCM_LS06	0.64	9.33	0.59
	SCM_LS08	0.64	9.13	0.59
	SCM_LS09	0.54	7.58	0.71
	SCM_LS10	0.50	6.66	0.75
	SCM_LS11	0.65	9.46	0.58
	SCM_LS12	0.60	7.15	0.65
	SCM_LS16	0.59	8.23	0.65
Partnership Management	SCM_PM01	0.61	8.62	0.63
	SCM_PM02	0.52	7.07	0.73
	SCM_PM03	0.52	7.13	0.73
	SCM_PM05	0.52	7.12	0.73
	SCM_PM06	0.67	9.63	0.55
	SCM_PM07	0.71	10.29	0.50
Strategy and Organization	SCM_SO01	0.71	11.05	0.49
	SCM_SO02	0.57	8.72	0.67
	SCM_SO04	0.59	9.18	0.65
	SCM_SO05	0.91	16.18	0.18
	SCM_SO06	0.87	15.32	0.24
	SCM_SO07	0.68	10.98	0.53

Appendix 4.7: Loading coefficient of QMP items

Construct	Code	Standardized Estimate	t-value	Error Variance
Customer Focus	QMP_CF01	0.73	15.62	0.47
	QMP_CF02	0.85	15.62	0.27
	QMP_CF03	0.77	11.90	0.41
Commitment and Strategy	QMP_CS01	0.62	9.20	0.61
	QMP_CS02	0.83	13.54	0.30
	QMP_CS03	0.84	13.68	0.29
	QMP_CS04	0.73	11.40	0.47
Human Resource Management	QMP_HR01	0.74	12.21	0.45
	QMP_HR02	0.80	13.23	0.36
	QMP_HR03	0.74	12.24	0.45
	QMP_HR04	0.81	13.54	0.34
	QMP_HR05	0.84	14.49	0.30
	QMP_HR06	0.78	13.01	0.39
	QMP_HR07	0.55	8.35	0.69
Information Analysis	QMP_IA01	0.79	15.31	0.37
	QMP_IA02	0.78	15.31	0.38
	QMP_IA03	0.92	15.88	0.16

Appendix 4.8: Loading coefficient of FSP items

Construct	Code	Standardized Estimate	t-value	Error Variance
Cost	FSP_CT01	0.83	12.42	0.31
	FSP_CT02	0.70	13.62	0.52
	FSP_CT03	0.77	13.62	0.41
Flexibility	FSP_FL01	0.71	14.28	0.50
	FSP_FL02	0.79	14.28	0.37
	FSP_FL03	0.78	11.61	0.40
Relationship	FSP_RL01	0.72	11.03	0.49
	FSP_RL02	0.69	10.29	0.52
	FSP_RL03	0.76	11.62	0.42
	FSP_RL04	0.85	13.51	0.27
Responsiveness	FSP_RS01	0.88	14.92	0.22
	FSP_RS02	0.89	16.14	0.21
	FSP_RS03	0.71	16.14	0.50

Appendix 4.9: Reliability analysis of SCMP after CFA

Construct	Code	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
Information Management Cronbach's Alpha = 0.7573	SCM_IM03	17.5148	12.0913	0.5268	0.7130
	SCM_IM04	17.1079	13.2507	0.5832	0.7025
	SCM_IM05	17.7679	11.7706	0.6670	0.6645
	SCM_IM06	18.7228	12.0642	0.4535	0.7451
	SCM_IM07	18.2509	12.6564	0.4456	0.7431
Lean System Cronbach's Alpha = 0.8529	SCM_LS02	34.4543	48.4702	0.5838	0.8364
	SCM_LS03	34.5016	48.5668	0.6042	0.8345
	SCM_LS06	34.2738	49.9051	0.6010	0.8359
	SCM_LS08	33.8856	50.0935	0.5858	0.8372
	SCM_LS09	34.2065	48.2839	0.5128	0.8444
	SCM_LS10	35.0947	46.9640	0.5745	0.8378
	SCM_LS11	34.7797	46.6257	0.6211	0.8324
	SCM_LS12	35.3104	47.0774	0.6030	0.8344
	SCM_LS16	34.8361	49.9388	0.5068	0.8438
Partnership Management Cronbach's Alpha = 0.7541	SCM_PM01	20.2756	22.7426	0.5233	0.7139
	SCM_PM02	21.0464	21.2260	0.4367	0.7378
	SCM_PM03	19.2047	23.9253	0.4617	0.7295
	SCM_PM05	20.2018	21.7314	0.4343	0.7364
	SCM_PM06	20.1409	20.9736	0.5566	0.7012
	SCM_PM07	20.1845	19.8358	0.5893	0.6903
Strategy and Organization Cronbach's Alpha = 0.8706	SCM_SO01	20.5391	26.5882	0.6668	0.8528
	SCM_SO02	19.3034	30.0058	0.6316	0.8552
	SCM_SO04	20.1174	29.8688	0.5982	0.8608
	SCM_SO05	20.1759	27.8509	0.7555	0.8337
	SCM_SO06	20.5237	28.1238	0.7801	0.8305
	SCM_SO07	20.2217	30.2175	0.6177	0.8574

Appendix 4.10: Correlation matrix

	IM	LS	PM	SO	CF	CS	HR	IA	CT	FL	RL	RS
SCMP_IM	1.000											
SCMP_LS	0.679	1.000										
SCMP_PM	0.609	0.714	1.000									
SCMP_SO	0.676	0.704	0.657	1.000								
QMP_CF	0.509	0.563	0.457	0.475	1.000							
QMP_CS	0.501	0.599	0.461	0.612	0.656	1.000						
QMP_HR	0.581	0.667	0.515	0.690	0.655	0.832	1.000					
QMP_IA	0.612	0.679	0.518	0.658	0.650	0.827	0.858	1.000				
FSP_CT	0.566	0.653	0.493	0.620	0.496	0.610	0.639	0.688	1.000			
FSP_FL	0.383	0.520	0.412	0.501	0.460	0.594	0.567	0.563	0.590	1.000		
FSP_RL	0.493	0.669	0.569	0.634	0.518	0.657	0.674	0.650	0.718	0.726	1.000	
FSP_RS	0.527	0.639	0.502	0.593	0.485	0.632	0.663	0.647	0.689	0.540	0.759	1.000

All coefficients significant at 0.01 level (2-tailed)