DOCTORAL THESIS

Supply chain performance measurement framework

Case studies on the Thai manufactures

Asawin Pasutham

SUPPLY CHAIN PERFORMANCE MEASUREMENT FRAMEWORK: CASE STUDIES OF THAI MANUFACTURERS

ASAWIN PASUTHAM

Doctor of Philosophy

ASTON UNIVERSITY

May 2012

Aston University

Supply Chain Performance Measurement Framework: Case Studies of Thai Manufacturers

Asawin Pasutham

Doctor of Philosophy

2012

Thesis Summary

One of the most significant paradigm shifts of modern business management is that individual businesses no longer compete as solely autonomous entities, but rather as supply chains. Firms worldwide have embraced the concept of supply chain management as important and sometimes critical to their business. The idea of a collaborative supply chain is to gain a competitive advantage by improving overall performance through measuring a holistic perspective of the supply chain. However, contemporary performance measurement theory is somewhat fragmented and fails to support this idea. Therefore, this research develops and applies an integrated supply chain performance measurement framework that provides a more holistic approach to the study of supply chain performance measurement by combining both supply chain macro processes and decision making levels. Therefore, the proposed framework can provide a balanced horizontal (cross-process) and vertical (hierarchical decision) view and measure the performance of the entire supply chain system.

Firstly, literature on performance measurement frameworks and performance measurement factors of supply chain management will help to develop a conceptual framework. Next the proposed framework will be presented. The framework will be validated through in-depth interviews with three Thai manufacturing companies. The fieldwork combined varied sources in order to understand the views of manufacturers on supply chain performance in the three case study companies. The collected data were analyzed, interpreted, and reported using thematic analysis and analysis hierarchy process (AHP), which was influenced by the study's conceptual framework.

This research contributes a new theory of supply chain performance measurement and knowledge on supply chain characteristics of a developing country, Thailand. The research also affects organisations by preparing decision makers to make strategic, tactical and operational level decisions with respect to supply chain macro processes. The results from the case studies also indicate the similarities and differences in their supply chain performance. Furthermore, the implications of the study are offered for both academic and practical use.

Keywords: Supply chain management, performance measurement framework, performance measurement factors, analysis hierarchy process (AHP), Thai manufacturers

Acknowledgements

The completion of this thesis would not have been possible without the steadfast support of several people. First of all, I would like to express my deep appreciation and sincere gratitude to Doctor Prasanta Kumar Dey, my Supervisor of Studies, for his wisdom, invaluable guidance and professionalism from the beginning to the end in the course of my work. I am also grateful to my second Supervisor, Doctor William Ho. He always gave insightful comments and reviewed my work. They are both excellent mentors and have provided support throughout my Ph.D. study. I would like to extend my heartiest thanks to them for their patience and kind involvement in this study.

Next, I was also indebted to the University of the Thai Chamber of Commerce for the opportunity given to me in pursuing this Doctorate Program. My gratitude also goes to all representatives from participating companies who provided personal accounts and primary material for the thesis. Your contributions, detailed comments and insight have been of great value to me. Let me also say ‘thank you’ to my Thai friend, Chakthong, friends at 11st floor in the south wing, colleagues in Thailand and all others who have rendered assistance and support in one way or another to make this study possible.

My final acknowledgements go to the people in my life who supported me throughout this process. I thank my sisters, my brother and my family members who provided their encouragement through my research. I also thank my lovely mother for always being there for me.

However, most of all my biggest gratitude goes to my beloved wife, Sherry, for her support, patience, understanding and constant love. I dedicate this work to you.

List of Contents

List of Tables

List of Figures

List of Appendices

List of Abbreviations

ABC	Activity Base Costing
ADB	Asian Development Bank
AEC	ASEAN Economics Community
AHP	Analytic hierarchy process
ANP	Analytic network process
AQIS	Australian Quarantine and Inspection Service
ASEAN	Association of Southeast Asian Nations
ATI	Association of Thai Industries
AVL	Approved vendor list
BOI	Board of Investment
BRC	British Retail Consortium
BSC	Balanced scorecard
CA	Customer acquisition
CBR	Case-based reasoning
CFA	Confirmatory factor analysis
CI	Consistency index
CI	Customer integration
COP	Customer order processing and delivery
CR	Consistency ratio
CR	Customer retention
CRM	Customer relationship management
CRS	Coordination and resource sharing
CS	Customer service
CSF	Critical success factor
CSR	Corporate social responsibility
CU	Capacity utilization
DEA	Data envelopment analysis
DEP	Department of Export Promotion
DF	Demand forecasting
DM	Decision making
DMAIC	Define, measure, analyze, improve and control
DMUs	Decision making units
DSM	Design structure matrix
E	Efficiency
ECA	Effective contract administration
ECI	Extent of cooperation to improve quality
ECP	Effective communication with production
EDI	Electronic data interchange
EMPP	Effective management of purchase portfolio
EMS	Environmental management standard
EP	Environmental performance
EPP	Effective procurement processes
EPQ	Economic production quantity
ERP	Enterprise resource planning

F	Facility
F	Flexibility
FDI	Foreign Direct Investment
FLC	Fuzzy linguistic computing
FMS	Flexible manufacturing system
FSP	Forecasting system in place
FTI	Federation of Thai Industries
GA	Genetic algorithm
GBP	Great British Pound
GDP	Gross domestic product
GMP	Good manufacturing practice
GP	Government policy over market equity
GPS	Global positioning system
GS	Green supplier
GSCM	Green supply chain management
GSP	Generalized system of preferences
HACCP	Hazard analysis and critical control points
HCC	Handling customer complaints
HR	Human resources
I	Innovation
I	Inventory
II	Information integration
II	Internal integration
IL	Innovation and learning
IMF	International Monetary Fund
IQR	Internal quick response
ISCM	Internal supply chain management
ISO	International Organization for Standardization
IT	Information technology
JIT	Just in time
JPPCC	Joint Public-Private Sectors Consultative Committee
KPI	Key performance indicator
LAN	Local area network
LNG	Liquefied natural gas
M	Motivation
MA	Market analysis
MACBETH	Multi attractiveness categorical based evaluation technique
MAUT	Multi-attribute utility theory
MD	Managing director
ME	Market equity
NCC	National Competitiveness Committee
NESDB	National Economic and Social Development Board
NESDP	National Economic and Social Development Plan
NGV	Natural gas for vehicles
NIE	Newly Industrialized Economy
O	Operations
OIP	Optimal inventory policy
OP	Operational performance
OR	Organizational relationship
OT	Over time

PO	Purchasing order
POS	Point of sales
PPP	Purchasing power parity
PVC	Polyvinyl chloride
Q	Quality
QCC	Quality control circle
QRPMS	Quantitative relationships performance measurement system
QSS	Quality supplier selection
R	Reliability
R	Responsiveness
R&D	Research and development
RDD	Reliability of demand data
ROI	Return on investment
S	Safety
SCC	Supply Chain Council
SCOR	Supply chain operations reference
SeP	Selection process
SI	Supplier integration
SMART	Simple multi-attribute rating technique
SMART	Strategic measurement and reporting technique
SME	Small and medium enterprise
SRM	Supplier relationship management
SuP	Supplier performance
T	Training
T	Transportation
TCC	Thai Chemical Company
TCO	Total cost of ownership
TFPC	Thai Food Processing Company
TFT-LCD	Thin film transistor-liquid crystal display
THTI	Thailand Textile Institute
TPM	Total preventive maintenance
TQM	Total quality management
TTC	Thai Textile Company
UIT	Use of information technology
USP	Unique selling point
VAS	Value added service
VMI	Vendor managed inventory
WAM	Weighted arithmetic mean
WTM	Work transformation matrix
WU	Warehouse utilization

Chapter 1 Introduction

1.1 Overview

This chapter provides an introduction to the research covered in this study. It starts by explaining the background of this study on supply chain management, especially supply chain performance measurement. The study aim and objectives are outlined first, followed by brief explanations of the study context of the Thai manufacturing industry. Finally, there are details of the structure of this thesis.

1.2 Background of the study

Globalization has a critical impact on manufacturing, both locally and internationally. Through broadening the marketplace and increasing competition, globalization leads customers to place greater demands on manufacturers to increase quality, serviceability and flexibility, while maintaining competitive costs (Laosirihongthong and Dangayach, 2005). Hence, firms are now looking at securing cost, quality, technology and other competitive advantages as strategies to pursue in a globally competitive environment. Currently, one popular route to competitive advantage is to add value for customers by performing supply chain activities efficiently. As a result, many manufacturers are focusing on their supply chain management practices (Goh and Pinaikul, 1998).

Supply chain management is an important multi-disciplinary topic in modern business management and research. It enhances organizational productivity and profitability through a revolutionary philosophy to managing the business with sustained competitiveness (Gunasekaran *et al*., 2004). Supply chain management has become increasingly important to businesses which supply goods and services to the end customers (Waller, 2003). The focus on, and relationships with, different stakeholder groups are of great importance to all businesses, regardless of size or whether they supply products and services. However, supply chain management is perhaps most

easily conceptualized in manufacturing, since there is a physical flow of goods (Waller, 2003).

Manufacturing firms worldwide have embraced the concept of supply chain management as important and sometimes critical to their business (Dangayach and Deshmukh, 2003). For the last few years, a number of companies and organizations in Thailand have taken the lead to develop and improve their supply chain architecture, resulting in marked improvements in their performance (Thai Logistics and Production Society, 2010). They have embraced new innovative technology and new management thinking to cope with the ever increasing competition from local and global players. The pressure is building up and the rest of the industries will need to catch up if they want to remain competitive (Thai Logistics and Production Society, 2010).

A typical supply chain commonly involves a network of tiered suppliers producing raw materials, parts, components, subassemblies, assemblies and final products together with business process and customers (Mentzer *et al.*, 2001). An effective supply chain may be defined as the art of bringing the right amount of the right product to the right place at the right time while minimizing related costs within and between all parties (Saad *et al.*, 2002).

Performance measurement can be used to determine the effectiveness of a supply chain. In recent years, organizational performance measurement framework and factors have received much attention from researchers and practitioners (Gunasekaran *et al*., 2004). However in supply chains with multiple suppliers, firms and customers, whether regionally or globally dispersed, performance measurement is challenging because it is difficult to attribute performance results to one particular entity within the chain. There are also difficulties in measuring performance within organizations and even more difficulties arise in inter-organizational performance measurement (Hervani and Helms, 2005). Performance measurement of supply chain management is a rapidly growing multi-criteria decision making problem owing to the large number of factors affecting decision making. Nevertheless, the right choice of performance measurement factors is critical to the success and competitiveness of firms in the era of globalization (Bhagwat and Sharma, 2007b).

While not easy, the concept of supply chain performance measurement, as an approach to measure the performance of all activity in the chain, can help stimulate continuous improvements. This can be achieved by linking performance measures to specific improvement efforts. This helps to drive performance towards critical strategic objectives and improves the efficiency of all operations, from original suppliers through to the customers, with win-win strategies to create benefits and added value throughout the chain (Shepherd and Gunter, 2006).

Another important concept is a collaborative supply chain. The objective is to gain competitive advantage by improving overall performance through measuring a holistic perspective of the supply chain (Angerhofer and Angelides, 2006). However, contemporary performance measurement theory is somewhat fragmented and fails to support this idea. The contemporary supply chain performance measurement frameworks measure performance from supply chain stakeholders (supplier, focal company and customer) (Otto and Kotza, 2003; Yeh *et al.*, 2007; Chia *et al.*, 2009); measure performance across supply chain processes at the operational level (e.g. SCOR model) (Huang *et al.*, 2005; Berrah and Cliville, 2007; Chae, 2009) or measure performance in the decision making levels (strategic, tactical and operational) (Gunasekaran *et al*., 2001; 2004).

There have been relatively few attempts to systematically collate models for evaluating the performance measurement of supply chains (Gunasekaran and Kobu, 2007). Moreover, there is argument over the most appropriate way to categorise them. From the review of literature, the present supply chain performance measurement frameworks can be classified by the following three main models that are mentioned frequently by other scholars: result based (balanced scorecard) (Kaplan and Norton, 1992; 1996; 1997); hierarchical (decision making levels) (Gunasekaran *et al*., 2001; 2004) and process based (supply chain operations reference, SCOR model) frameworks (Supply Chain Council, 1996).

However, the attention of many researchers has often focused on single area of performance measurement, while research on a combined approach for the whole performance of supply chain management have been relatively neglected (Beamon, 1999; Gunasekaran *et al*., 2001; Chan and Qi, 2003; Otto and Kotza, 2003; Huang *et*

al., 2005; Aramyan *et al.*, 2007; Berrah and Cliville, 2007; Jammernegg and Reiner, 2007; Yeh *et al.*, 2007; Zhu *et al.*, 2008; Chae, 2009; Chia *et al.*, 2009; Lin *et al.*, 2010). This research, therefore, is intended to provide a more holistic approach to the study of supply chain performance measurement framework by combining both supply chain macro processes and decision making levels and taking a cross organizational approach. This framework will provide a balanced horizontal (cross-process) and vertical (hierarchical decision) view for manufacturing companies.

1.3 Study aim and objectives

Most research on supply chain management concerns developed countries. Consequently, there is a lack of significant study of supply chain performance in developing countries, in general, and Thailand, in particular. For both types of the countries, while there are studies of general supply chain management, there is scant research on the performance measurement of supply chain management. In addition, supply chain management is growing in importance in a number of developing countries. Therefore, this study focuses on a supply chain performance measurement framework that applies to the manufacturing sector in a developing country context, specifically, Thailand.

This study aims to develop and to apply an integrated supply chain performance measurement framework. This framework will be developed across decision making levels (strategic, tactical and operational) as well as across supply chain macro processes, which integrate upstream suppliers (supplier relationship management) and downstream customers (customer relationship management) with firms (internal supply chain management). Therefore, the proposed framework can measure the performance of the holistic supply chain. The framework will enable organizations to make enhanced supply chain management decisions at strategic, tactical and operational levels and to measure performance against each performance measurement factor. Additionally, the study will facilitate cross organizational learning.

Three specific research objectives were considered in order to achieve the overall research aim. They were:

1. To identify performance measurement factors with respect to supplier relationship management, internal supply chain management and customer relationship management against strategic, tactical and operational levels for a supply chain performance measurement framework.
2. To develop a conceptual framework based on proposed performance measurement factors.
3. To validate the proposed framework by applying it to the case study companies in the Thai manufacturing sector for the following purposes:
    3.1 To evaluate supply chain performance in relation to performance measurement factors
    3.2 To determine the importance of the performance measurement factors by using the analytic hierarchy process (AHP).

The proposed conceptual supply chain performance measurement framework comprises performance measurement factors with respect to supplier relationship management, internal supply chain management and customer relationship management. The performance measurement factors are further organized hierarchically across the decision making levels (strategic, tactical and operational).

Additionally, the study helps Thai manufacturers to identify performance measurement factors against each supply chain macro processes; enables companies to make enhanced supply chain management decisions at strategic, tactical and operational levels and measures the performance of case study organizations against each performance measurement factor.

1.4 Context of the study: Thai manufacturing industry

In the past, Thailand was a typical agriculture economy. Agriculture was the leading sector in the Thai economy during the two decades of growth in the 1960s and 1970s. Agriculture contributed approximately 40 percent of gross domestic product (GDP), and over 80 percent of the population were engaged in agricultural activities (The World Bank, 2008). Rice was the major crop and primary products for export included rubber, maize, kenaf and tin (Asian Development Bank, ADB, 1995).

The situation changed when the economy was readjusted towards export promotion in the early 1980s (Poapongsaorn and Tangkitvanich, 2000). The manufacturing sector started to replace the agricultural sector as the driving force for exports. Exports of manufactured products surpassed agricultural exports in 1985, and the value of manufactured exports has risen dramatically since then (Poapongsaorn and Tangkitvanich, 2000). In 1986, the industrial sector surpassed agriculture, both in share of GDP and in rate of growth (Kaosa-ard, 1998). As the economy industrialised, the service sector such as banking, finance, insurance and transportation, which provided basic support, grew in step with it (Kaosa-ard, 1998). The declining economic importance of agriculture and rapid growth of the industrial sector are signs of the success of the export promotion strategy. Through this strategy Thailand's manufactured products became competitive in foreign as well as domestic markets (Kaosa-ard, 1998).

Thailand's remarkable economic performance after 1986 is also attributed to external factors ranging from booming export demand to declining interest rates and decreasing oil prices (Poapongsaorn and Tangkitvanich, 2000). The combined result of these factors was two-digit GDP growth in the late 1980s (Kaosa-ard, 1998). Despite rapid economic growth from 1987 to 1997, Thailand's economic structure remained highly unbalanced (Kaosa-ard, 1998). Once the financial crisis struck Thailand in July 1997, the country's real sectors were left with tremendous unserviceable debts and half-idle facilities (Kaosa-ard, 1998). From the database of the Office of the National Economic and Social Development Board (NESDB), Thailand's growth rate was actually negative in the late 1990's, for example, -10.5 percent in 1998 (The Office of the National Economic and Social Development Board, 2008a).

Despite the financial crisis and economic setback, the manufacturing industry remained important. The Bank of Thailand noted that the manufacturing industry in Thailand had become one of the most important sectors in Thailand economy, contributing substantially to employment and GDP (Bank of Thailand, 2002). The dominant sector of economic activity in 2000 was non-agricultural, accounting for 88.8 percent of GDP and 43.32 percent of employment (Bank of Thailand, 2002). Furthermore, the growth rate of manufacturing production index increased from 1.4 percent in 2001 to 7.7 percent in 2002 (Federation of Thai Industries, 2003). Thailand experienced a

significant economic growth rate that averaged 4.5 to 5 percent annually from 2005 to 2007 (The Office of the National Economic and Social Development Board, 2008a). This was partly a result of the many firms playing an increasingly important role in both intra-Asian and international supply chains (The Department of Export Promotion, 2008).

In 2010, the Thai economy expanded by 7.8 percent with manufacturing remaining the strongest sector steering the nation's economic growth (Bank of Thailand, 2011). The country's strong export performance has been enhanced by foreign investment that has seen major brand names setting up manufacturing operations for both the domestic and international markets, especially in automobiles and auto parts, textiles, electronics (computer components), processed food and petrochemicals (The Department of Export Promotion, 2008). Major export markets include neighbouring Association of Southeast Asian Nations (ASEAN) countries, the European Union, Japan and the United States. Foreign Direct Investment (FDI) is actively welcomed and encouraged, and steps have been taken by the Thai government to further liberalise foreign investment regulation, particularly in the manufacturing sector (The Department of Export Promotion, 2008).

From a database of the Federation of Thai Industries (FTI), the manufacturing sector in Thailand is divided into thirty nine industrial groups. However, it is the three main industrial groups (chemical, food processing, and textile) that contribute significantly to GDP and employment (Bank of Thailand, 2004). Much of this strong performance has been driven by intensive Foreign Direct Investment during the past ten years (Bank of Thailand, 2004).

Manufacturers in many developing nations have been sheltered from competition through protectionism at home and government intervention in foreign trade. However, rapid deregulation, globalization of markets and gradual acceptance of competition are making it increasingly difficult to continue to protect local markets (Madu, 1997). In response to liberalization and globalization, manufacturing organizations in Thailand are striving hard to introduce new approaches such as supply chain management to enhance their performance and competitive advantage.

In the context of a developing country like Thailand, where the local technological capabilities are relatively low and most of the technology and management concepts have been acquired and transferred from a foreign country, the problem of not fully realising the benefits of these new approaches could be even more apparent. Therefore, the Thai manufacturing sector has provided the researcher with a suitable context in which to investigate how to measure the performance of its supply chain. To date, very few studies on supply chain performance measurement have been conducted in Thailand, despite its wide usage. This circumstance, therefore, provides further motivation for the research to seek evidence from the Thai manufacturing industry.

1.5 Structure of the thesis

Table 1.1 briefly explains the structure of the thesis and the focus of each of the chapters. There are nine chapters, including this chapter, in the thesis, and the details of each are explained in turn.

Table 1.1: Structure of the thesis and the focus of each chapter

Chapter	Focus of the Chapter
Chapter One Introduction	Overall introduction to the thesis
Chapter Two Literature Review	Key theories and key concepts used in the study
Chapter Three Methodology	Methodology and methods used in the study
Chapter Four The Conceptual Framework	Development of the conceptual framework
Chapter Five Supply Chain Performance	Investigation of research findings related to performance of supply chain in the three case study companies
Chapter Six Supply Chain Performance Measurement	Detailed analysis of research findings concerning the measurement of supply chain performance by using the analytic hierarchy process (AHP)
Chapter Seven Conclusion	Study conclusions and assessment of the value of the conceptual framework

Chapter One provides an overall introduction to the thesis, including the background of the study, the study aim and objectives, brief details of the study context of the Thai manufacturing industry and the process of investigation for the study.

Chapter Two explains the academic approaches and key concepts use in the study. It presents literature on supply chain management, performance measurement and supply chain performance measurement. These key concepts and approaches help to establish and justify the study's theoretical basis and they assist in an understanding of the subsequent conceptual framework that was developed for the study. These keys areas of literature also provide insights into the character of, and influences on, supply chain performance measurement in the Thai manufacturing sector.

Chapter Three provides details of the research methodology and methods used in this study. It explains the theoretical position for researching the supply chain performance measurement. Based on a constructivism paradigm, the study uses a case study and a qualitative research approach which is explained in the chapter. There are details of each of the research methods used and of the processes of data collection employed in the fieldwork. There is also a discussion of research ethics in relation to preparation for the field work and also its application, a discussion of the approach to data analysis, and consideration is also given to limitations of the research.

Chapter Four introduces the conceptual framework that was developed for the study. The framework was in part devised based on ideas arising from the approaches and concepts identified in the literature review in Chapter Two. The purpose of the framework is to explicate the conceptual logic and direction of this study, bringing together key concepts of relevance to understanding supply chain performance measurement from the manufacturers' perspective. It engages leading ideas and demonstrates the significance of the study's conceptual thinking. The conceptual framework is also subsequently applied and evaluated in relation to the case study in the results chapters and, more generally, in the conclusion chapter.

Chapter Five and Six are results chapters. Chapter Five provides detailed investigation of the supply chain performance in relation to performance measurement factors in the three case study companies. These performance measurement factors are identified in

the study's conceptual framework as explained in Chapter Four. The results are mainly drawn from interviews with three different types of departments to represent the three supply chain macro processes and to cover the whole supply chain system of each participating company. This chapter comprises three themes: supplier relationship management, internal supply chain management and customer relationship management.

Chapter Six provides a detailed analysis of the performance measurement in order to understand the supply chain performance of the three case study companies by using the analytic hierarchy process (AHP). The detailed analysis of the supply chain performance measurement was based on the performance measurement factors that were presented in the study's conceptual framework as explained in Chapter Four and AHP that was introduced in Chapter Three. This chapter contains three main parts: supplier relationship management, internal supply chain management and customer relationship management, plus the supply chain macro processes in order to provide an overall view of supply chain performance. The results are mainly drawn from interviews with three different types of departments to represent the three supply chain macro processes.

Chapter Seven presents the overall research conclusions and the final remarks. The chapter reviews the theoretical purpose and implications of the conceptual framework and the contribution of the conceptual framework. It also focuses on the study's main findings from the application of the conceptual framework. Finally, the chapter identifies the key strengths of the research and some limitations of the research, and it concludes by making recommendations for future research.

1.6 Conclusion

This chapter introduced the overall research introduction of this study on supply chain performance measurement in the manufacturing sector in Thailand. First, the chapter introduced the background of the study and the importance of supply chain management to manufacturing firms in both developed and developing countries. Then, it explained the study's overall aim and its specific objectives. As the study is based on

case study companies in the Thai manufacturing sector, this chapter also introduced some of the relevant context of the Thai manufacturing industry. The next chapter reviews the literature, key concepts and theoretical ideas related to the study.

Chapter 2 Literature Review

2.1 Introduction

This literature review examines key concepts and approaches used in the study. This study examines supply chain performance measurement framework for manufacturing sector, including measurement of supply chain performance, benchmarking for supply chain performance and also suggestion of improvements on supply chain performance, exploring these issues in one developing country, Thailand.

There are three interconnected themes in this literature review, covering the themes of supply chain management, performance measurement and supply chain performance measurement. The review begins with a discussion of supply chain management, including definitions and development, evolution of supply chain management, advantages of supply chain management for manufacturers and supply chain management practices. The review then considers the performance measurement. This performance measurement perspective assists in understanding the relationships between performance measurement and supply chain management. Then, the review focuses on supply chain performance measurement that involves on the issues of: 1) Supply chain performance measurement models or frameworks and 2) Performance measurement factors for supply chain performance measurement.

2.2 Supply chain management

This section outlines definitions and development of supply chain management, evolution of supply chain management, advantages of supply chain management for manufacturers and supply chain management practices. They are explained in turn.

2.2.1 Definitions and development

Supply chain management is a concept that originated in the manufacturing industries in the early 1980s. It is developed from innovations such as just in time (JIT) (Vrijhoef and Koskela, 2000) and total quality management (TQM) (Wong and Fung, 1999). Supply chain management can be seen as an example of evolutionary and cumulative innovation, which is often described as emanating from internal programs aimed at improving overall effectiveness (Saad *et al.*, 2002). The focus is not only limited to increasing the internal efficiency of organizations, but also has now been broadened to include methods of reducing waste and adding value across the entire supply chain (Harland *et al.*, 1999). Supply chain management has shifted the emphasis from internal structure to external linkages and processes, and is dependent on the interaction between the organization and its external environment, with strong feedback linkages and collective learning. It is seen as a set of practices aimed at managing and coordinating the whole supply chain from raw material suppliers to end customers (Slack *et al.*, 2001), which develop greater synergy through collaboration along the whole supply chain (New and Ramsay, 1997).

The Council of Supply Chain Management Professionals also defines that supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers and customers. In essence, supply chain management integrates supply and demand management within and across companies.

Supply chain management is an integrating function with primary responsibility for linking major business functions and business processes within and across companies into a cohesive and high-performing business model. It includes all of the logistics management activities noted above, as well as manufacturing operations, and it drives coordination of processes and activities with and across marketing, sales, product design, finance and information technology (The Council of Supply Chain Management Professionals, 2009).

Chopra and Meindl (2007) go further and state that a supply chain consists of all stages involved, directly or indirectly, in fulfilling a customer request. The supply chain not only includes the manufacturer and suppliers, but also transporters, warehouses, retailers, and customers themselves. Within each organization, the supply chain includes all functions involved in filling a customer request. These functions include, but are not limited to, new product development, marketing, operations, distribution, finance and customer service.

Supply chain management is associated with the effective management of the interfaces between all the organizations involved (Von Hipple, 1986), and the integration of both upstream and downstream processes (Christopher and Juttner, 2000). This significant emphasis on co-ordination and integration is strongly linked to the development of more effective and longer-term relationships between buyers and suppliers (Kosela, 1999).

These new types of relationships are increasingly perceived as a means to utilize resources better through the whole supply chain (Dubois and Gadde, 2000). In addition, they can also lead to greater transparency in transactions, increased trust and commitment (Ali *et al.*, 1997). There are successful examples of where supply chain management is delivering significant performance improvements across the entire supply chain (Holti, 1997). It can also be an important element in innovation in products, processes and organization (Edum-Fotwe *et al.*, 2001). Information can be more readily shared and knowledge identified, captured and disseminated throughout the organizations in the chain (Mowery, 1988). This has led to an increasing adoption of partnership approaches and inter-organizational alliances to achieve significant mutual benefits involving sharing resources, information, learning and other key assets (Akintoye *et al.*, 2000).

However, supply chain management is a long, complex and dynamic process. Its successful implementation needs to be associated with a thorough understanding of the concept itself (Whipple and Frankel, 2000). Its implementation is also seen as being closely dependent upon the ability to create, manage and reshape relationships between individuals, organizations and networks within the supply chain (Spekman *et al.*, 1998).

It requires new organizational arrangements and culture (Neely, 1998) which calls for considerable commitment, resources and time to develop.

It is important to recognize that supply chain management is complex and has proved to be difficult to implement. It is described as a multi-factor process, reliant upon close and long-term relationships within and between organizations (Saad *et al.,* 2002). Its success is associated with the challenging and difficult development of a new culture based on shared learning, greater transparency and trust. With a greater reliance on suppliers and the increasing emergence of outsourcing and fierce competition, the main challenge for supply chain management is to sustain and continuously improve the coordination and integration of all interactions and interfaces in order to enhance the overall performance of the supply chain. It is, therefore important to associate the concept of supply chain management based on continuous improvement with performance measurement.

2.2.2 Evolution of supply chain management

It has been noted that discussions of supply chain management often use complicated terminology, thus limiting management's understanding of the concept and its effectiveness for practical application (Ross, 1998). The definition of 'supply chain' seems to be more common across authors than the definition of 'supply chain management' (Lambert *et al.,* 1998). La Londe and Masters (1994) propose that a supply chain is a set of firms that pass materials forward. Normally, several independent firms are involved in manufacturing a product and placing it in the hands of the end user in a supply chain – raw material and component producers, product assemblers, wholesalers, retailer merchants and transportation companies are all members of a supply chain (La Londe and Masters 1994). By the same token, Lambert *et al.* (1998) define a supply chain as the alignment of firms that brings products or services to market. Note that these concepts of supply chain include the final consumer as part of the supply chain. Another definition notes a supply chain is the network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services delivered to the ultimate consumer (Christopher 1992). In other words, a

supply chain consists of multiple firms, both upstream (i.e., supply) and downstream (i.e., distribution) and the ultimate consumer.

Mentzer *et al.* (2001) express the evolution of supply chain into 3 steps as follows:

1) A direct supply chain

A supply Chain is a set of 3 or more companies directly linked by one or more of the upstream and downstream flows of products, services, finances and information from a source to a customer.

Figure 2.1: A direct supply chain

Source: Mentzer *et al.* (2001)

2) An extended supply chain

An extended supply chain includes supplier of the immediate supplier and customer of the immediate customer, all linked by one or more of the upstream and downstream flows of products, services, finances and information.

Figure 2.2: An extended supply chain

Source: Mentzer *et al.* (2001)

3) An ultimate supply chain

An ultimate supply chain includes all the companies involved in the upstream and downstream flows of products, services, finances and information flow from the initial supplier to the ultimate customer.

Figure 2.3: An ultimate supply chain

Source: Mentzer *et al.* (2001)

2.2.3 Advantages of supply chain management for manufacturers

Tan *et al.* (2002) note that as product life cycles shrank and global competition intensified in the 1990s, many manufacturers collaborate with their suppliers to improve product quality and lead time. Correspondingly, many wholesalers and retailers also integrate their logistics functions to enhance competitive advantage. Eventually, these two functional areas of a corporation evolve and merge into a holistic and strategic approach to materials and logistics management. Supply chain management is viewed as a viable initiative to enhance competitive advantage (Tan *et al.*, 1998a).

Scott and Westbrook (1991) describe supply chain management as the chain linking each element of the manufacturing and supply process from raw materials through to the end user, encompassing several organizational boundaries and treating all organizations within the value chain as a unified virtual business entity. Supply chain management focuses on how firms utilize their suppliers' processes, technology and capability to enhance competitive advantage (Farley, 1997); and the coordination of the manufacturing, logistics, materials, distribution and transportation functions within an organization (Lee and Billington, 1992). While ideally supply chain management emphasizes total integration of all the business entities within the supply chain, a practical approach is to consider only strategic suppliers and customers since most supply chains are too complex to achieve full integration of all the supply chain members (Tan *et al.*, 1998b).

Many manufacturers and merchants have embraced the concept of supply chain management to improve product development, quality and delivery goals, and to eliminate waste. It has enabled firms to exploit supplier strengths and technologies to support new product development efforts (Morgan and Monczka, 1995), and seamlessly integrate logistics functions with transportation partners to deliver directly to the point of use. Supply chain management is a management philosophy that extends traditional internal activities by embracing an inter-enterprise scope, bringing trading partners together with the common goal of optimization and efficiency (Harwick, 1997).

Manufacturers often include strategic suppliers to participate in their new product development efforts. The result is cost-effective design choices, often leading to innovation in process and materials and the ability to compete effectively in the global market (Tan *et al.*, 2002). By involving suppliers early in the design stage, manufacturers are able to develop alternative conceptual solutions, select the best components and technologies, and help in design assessment (Burt and Soukup, 1985). Supply chain management seeks improved performance through elimination of waste and better use of internal and external supplier capability and technology (Morgan and Monczka, 1996).

The transportation and logistics functions of the retailing industry focus on a different aspect of supply chain management, that is, one of location and logistics issues more

often than product transformation. Its origin can be traced to an effort for better managing the transportation and logistics functions (Fisher, 1997). In this respect, supply chain management incorporates logistics into the strategic decisions of the business (Carter and Ferrin, 1995). It enables channel members to compete as a unified logistics entity instead of pushing inventory down the supply chain. Supply chain management reaps the benefits of vertical integration by coordinating the logistics functions of independent firms in the supply chain (La Londe and Masters, 1994).

Where logistics once meant saturating warehouses with inventory, supply chain management emphasizes the integration of internal and external activities, including inventory management, vendor relationships, transportation, distribution and delivery services. The goal is to replace inventory with information to provide visibility, so that raw materials and finished goods can be replenished quickly and arrive at the points of use in smaller lot sizes, especially in a just-in-time system (Handfield, 1994). Therefore, short and reliable order cycles, and the ability to fill entire orders are critical customer service elements. As a result, as the twenty-first century begins, supply chain management has become a significant strategic tool for firms striving to improve quality, customer service and competitive success (Tan *et al.*, 2002).

2.2.4 Supply chain management practices

While there is plenty of published literature that explains or espouses supply chain management, there is a relative lack of empirical studies examining supply chain management practices. Galt and Dale (1991) study ten organisations in the UK, and find that they are working to reduce their supplier base, and to improve their communications with the suppliers urgently. Watts and Hahn (1993) report on a survey carried out to assess the extent and success of supplier development programs. They find these programs to be broad in scope and quite prevalent (63 per cent), especially among the larger firms surveyed. The aim of these programs is more to improve the quality and cost of the purchased products than to improve the capability of the supplier.

Fernie (1995) carries out an international comparison of supply chain management in the grocery retailing industry. He finds significant differences in inventory held in the

supply chain by the US and European grocery retailers, which can be explained by their supply chain management adoption.

McMullan (1996) examines the state of supply chain management practices in the Asia Pacific region and presents results of a survey distributed to some of the region's biggest companies, representing, for example, the chemical, food, transport, communications and automotive industries. The research examines the manner by which managers in the Asia Pacific region are responding to the pressures of competition and the strategies they are either implementing, or planning to implement, to enhance management of the supply chain. The research is initiated to gain greater insight into how widespread supply chain management activities are in this region, how these activities are structured, and the organizational changes precipitated by such an approach. The study finds that in order to maintain a competitive advantage, firms must enhance their ability to plan, take action and manage and control products, services and information from supplier through customer as an integrated process rather than as a series of discrete functions. To achieve this, many firms will be required to change their organizational structures, relationships with supply chain members and performance measurement systems. New information technology to enhance communication throughout the supply chain will be required as well in order to increase service levels and reduce operating costs.

Krause (1997) carries out a survey of firms on the extent of supplier development activities and on the benefits accrued from the activities. The responding firms participate more often in limited involvement such as supplier evaluation and feedback, site visits, requests from improved performance, and promises of increased present or future business, than in extensive involvement such as training or education of suppliers' personnel or investment in suppliers' operations. While the supplier development efforts are generally fruitful, the buying firms are not very satisfied with the results. From this study, Krause (1997) suggests a three-pronged approach of competition, business incentives, and direct involvement in supplier's operations.

Tan *et al*. (1998b) seek a relationship between firms' supply chain management practice and their performance. They are able to show positive and significant correlation

between certain supply chain management practices and performances of their respondent firms.

Kwan (1999) investigates the use of information technology (IT) in supply chain management in Singapore electronics and chemical industries, and finds that the top two supply chain management strategies are; first, to position logistics as one of the core competencies within the company and, second, to produce to demand rather than to forecast. The top barrier to the use of IT is a lack of education and training. The number of published findings on supply chain management practices is obviously small, and there is scope for research in this area.

Basnet *et al*. (2003) carry out on supply chain management activities of manufacturing organisations in New Zealand. They find that a significant problem for many New Zealand businesses is the geographical isolation of New Zealand. Supply chain management requires quick movement of materials, information, and close communication. Thus, supply chain management efforts are especially vulnerable to this isolation. Even though the flow of information and communications can be greatly speeded through the latest telecommunication technologies, the delay in the physical movement of materials is going to continue to be a barrier to supply chain management in New Zealand. Another problem bring out by the survey is the relative lack of leverage of New Zealand firms to bring about change. Even when there is a strong motivation for a New Zealand firms to adopt supply chain management, the small size of New Zealand firms makes it very difficult to pull all the supply chain members into the implementation. However, New Zealand's firms need to realise they can compete more effectively with larger overseas corporations by forming strategic alliance partnerships with their suppliers and customers, instead of competing individually.

Sahay and Mohan (2003) outline the supply chain practices followed by Indian organizations. They primarily focus on the status of four major supply chain dimensions namely supply chain strategy, supply chain integration, inventory management, and information technology. The study recommends that Indian organizations should align supply chain strategy with business strategy in order to deliver highest customer satisfaction, streamline processes for supply chain integration to achieve operational excellence, form partnerships to minimize inventory and maximize profits, and focus on

infrastructure and technology deployment to build an Indian specific supply chain. Moreover, coupled with this is the action required by the Indian government to improve the infrastructure for the smooth functioning of supply chain.

Quayle (2003) designs a survey to identify current trends of supply chain management practice in UK industrial small to medium sized enterprises (SMEs). The analysis identifies the adaptation of supply chain management techniques and relationships between customers and smaller suppliers. The outcome indicates a lack of effective adaptation from traditional adversarial relationships to the modern collaborative electronic commerce for supply chain. Another result identifies issues businesses need to address to improve the performance of their supply chains, and improve their competitive position by grasping the benefits of effective supply chain management.

To recent knowledge, there is scant published study of supply chain management practice in Thailand. However, previous study by Goh and Pinaikul (1998), they examine the case of logistics management practices and development in Thailand. They find that firms prefer agile suppliers. Companies tend to choose suppliers who can respond quickly to their needs rather than suppliers who are committed to sustaining excellence. Most incurred logistics costs are transportation and warehousing costs. Because the traditional view of logistics as mainly focusing on transportation and warehousing still persists in Thailand. Moreover, logistics managers in Thailand are lacking of modern technology and skilled logistics operations.

Regarding to this study, the prevalence of supply chain management practices in Thailand is not very promising. Therefore, this research will investigate and contribute new knowledge of supply chain management practices for the Thai manufacturing sector.

2.3 Performance measurement

Performance measurement is defined as the process of quantifying effectiveness and efficiency of action (Neely *et al.*, 1995). Effectiveness is the extent to which a customer's requirements are met and efficiency measures how economically a firm's

resources are utilised when providing a pre-specified level of customer satisfaction. Performance measurement systems are described as the overall set of factors used to quantify both the efficiency and effectiveness of action.

Sink and Tuttle (1989) claim that "you cannot manage what you cannot measure". Many manufacturing and service organisations have used performance measures and measurement systems to determine their performance. Browne *et al*. (1998) develop the ENAPS approach of performance measurement, which consists of a generic set of performance measures and indicators and uses a process-oriented top down approach. It contains a large number of performance measures or factors. Hudson *et al*. (2001) investigate strategically aligned performance measures, which can help stimulate continuous improvements; this is achieved by linking performance measures to specific improvement efforts and helping to drive performance towards critical strategic objectives, which are designed to be revisited and updated regularly. Rouse and Putterill (2003) argue that a performance measurement framework assists in the process of performance measurement system building, by clarifying performance measurement boundaries, specifying performance measurement dimensions or views and may also provide initial institutions into relationships among the performance measurement dimensions. Folan and Browne (2005) present different performance measurement frameworks specifically designed for the inter-organisational environment. They further develop a performance measurement system looking into the requirements of extended enterprise, via two performance measurement frameworks: the structural extended enterprise balanced scorecard and the procedural framework for the selection and implementation measures.

Development of the literature on performance measurements can be divided into two distinct phases (Dixon *et al.*, 1990). The first phase relates to the period until the 1980s and concentrates on financial measures such as profit, return on investment and productivity. The second phase, which commences in the late 1980s, corresponds to the emergence of new management concepts such as supply chain management. It attempts to place a greater emphasis upon the inclusion of less tangible and non-financial measures in performance measurements.

Turner *et al*. (2005) suggest that application of performance measures has developed in the last decade or so from what are traditional financial performance measures to now encompass a wide range of non-financial performance measures. This growth in the use of non-financial performance measures is stimulated by various approaches such as the strategic measurement and reporting technique (SMART) (Cross and Lynch, 1988-1989), the balanced scorecard (Kaplan and Norton, 1992), the ABCD checklist for operational excellence (Wight, 1993) and the European excellence model (The European Foundation for Quality Management, 2009).

There are the range of limitations of existing measurement systems for manufacturing, including: they lack strategic focus (the measurement system is not aligned correctly with strategic goals, organization culture or reward systems) (Banks and Wheelright, 1979); they encourage short termism (Hayes and Garvin, 1982); they encourage local optimisation (Fry and Cox, 1989); they encourage minimisation the variances from standard, rather than seek to improve continually (Lynch and Cross, 1991) and they do not being externally focused (Kaplan and Norton, 1992). In an attempt to overcome these and other criticisms, performance measurement frameworks have been developed and provide a balanced view between levels in the organisation (Cross and Lynch, 1988-1989), between external and internal focus (Keegan *et al*., 1989), between results and determinants (Fitzgerald *et al*., 1991), between the four perspectives of the balanced scorecard (Kaplan and Norton, 1992) and the multiple perspective of the stakeholders (Kennerley and Neely, 2002).

The excellent overview of performance measurement provided by Neely *et al.* (1995) has been widely cited in recent research into supply chain performance measurement systems and metrics (e.g. Beamon, 1999; Beamon and Chen, 2001; Gunasekaran *et al.*, 2001, 2004). These, and other studies, have highlighted how the majority of the limitations cited by Neely and his collaborators remain salient in the case of performance measurement systems for supply chains. Moreover, they have stressed the need for new measurement systems and metrics which address these deficiencies. Whilst this represents an important step forward, this research argues that there is a need for reflection on contemporary research that has investigated a number of important issues.

2.4 Supply chain performance measurement

To answer the research aim and objective, the extensive review of the literature concentrates on the issues surrounding supply chain performance measurement which involves the variety of: 1) Supply chain performance measurement models or frameworks and 2) Performance measurement factors for supply chain performance measurement also sometimes known as performance metrics, critical success factors (CSFs) or key performance indicators (KPIs). This section reviewed the literature of these two main issues of supply chain performance measurement from international journal articles from 1999 to 2010 that searched via Emerald, Ingenta, MetaPress, ProQuest and ScienceDirect.

2.4.1 Frameworks of supply chain performance measurement

The performance of supply chain management is required to measure with respect to some standard models or frameworks. Beamon (1999) presents an overview and evaluation of the performance measures used in supply chain models and also presents a framework for the selection of performance measurement systems for manufacturing supply chains. Three types of performance measures (resources, output and flexibility) are identified as necessary components in any supply chain performance measurement system, and flexibility quantitative measurement approach for supply chains are proposed. However, it lacks of system thinking, in which a supply chain must be measured widely across the whole.

Gunasekaran *et al*. (2001) illustrate and discuss different performance measures and metrics of the supply chain management with the help of a framework that gives cohesive picture to address what needs to be measured, and how it can be dealt with. The framework is classified into strategic, tactical and operational levels of management. The metrics are also divided into financial and non-financial so that a suitable costing method based on activity analysis can be applied. However, due to the large number of metrics and measures given in the framework, firms find it difficult to use. Not many firms use all metrics and measures in day-to-day business operations. Also, the framework does not provide guidelines to prioritise these metrics. Further,

firms require a comprehensive way to analyse their operations from every angle that covers all perspectives of business.

Chan and Qi (2003) propose an innovative performance measurement method to contribute to the development of supply chain management from five core processes: supplying, inbound logistics, core manufacturing, outbound logistics and marketing & sales. These process-based systematic perspectives are employed to build an effective model to measure the holistic performance of complex supply chains (cross organization). Fuzzy set theory is introduced to address the real situation in judgment and evaluation processes. However, this proposed model overlooks the decision making ability across strategic, tactical and operational levels.

Otto and Kotza (2003) design suitable metrics to measure the effectiveness of supply chain management in six unique sets of supply chain metrics from six perspectives on supply chain management. Each perspective follows a particular set of goals, which consequently leads to a particular set of performance metrics. The various perspectives refer to these disciplines, which contributed the most to the development of supply chain management: system dynamics, operations research or information technology, logistics, marketing, organization and strategy. Each perspective has its very own notion of a supply chain, its standard problems and solutions, and its performance metrics. However, all the metrics are not used in business practice to measure supply chain performance.

Gunasekaran *et al*. (2004) develop a framework to promote a better understanding of the importance of supply chain management performance measurement and metrics. The proposed framework considers the measurement of supply chain processes (plan, source, make and deliver) with respect to strategic, tactical and operational levels and evaluates a score for prioritize for each metric by three level: highly, moderately, and less important level from an empirical study of selected British companies. It lacks identifying critical success factors for the whole supply chain system. Furthermore, for evaluating the score, the organization, suppliers and customers should come together to discuss how they will address the measurement and improvement of supply chain management performance. Industry consortiums, consultants and researchers could be helpful in promoting supply chain management performance measurement generally, and in developing measures and measurement techniques specifically.

Huang *et al.* (2005) summarize the supply chain operations reference (SCOR) model, its benefits along with illustrative case stories and describe a computer-assisted tool to configure supply chain threaded diagram per SCOR specification. Supply chain configuration is an integral part in SCOR project implementation. Currently, the configuration of 'as-is' or 'to-be' threaded-diagram describing a supply chain is done manually. To automate this process, a computer-assisted configuration tool has been developed and described in this paper. However, the configuration tool can so far only deal with a single manufacturing facility of a company. It does not take into account the interactions among multiple manufacturing facilities. Thus, this research limits to only single manufacturing facility of a company for studying.

Aramyan *et al.* (2007) propose conceptual framework that founds to be useful for measuring performance of the Dutch-German tomato supply chain. From the case study, it is concluded that four main categories of performance measures (efficiency, flexibility, responsiveness and food quality) are identified as key performance components of the tomato supply chain performance measurement system. This study also develops an integrated performance measurement system that contains financial as well as non-financial indicators combined with the specific characteristics of agri-food supply chains. Given the fact that the framework was evaluated in one particular case study (the Dutch-German tomato supply chain), caution is needed when generalizing the results. It also can be the limitation of this research to investigate only one food company.

Berrah and Cliville (2007) propose to build performance measurement systems by linking an overall performance expression to elementary performance. The overall performance is associated to a global objective whose break-down provides elementary objectives. Elementary performances are thus aggregated in a corollary way. This study deals with the supply chain performance formalization as it uses the performance indicators extend form Gunasekaran *et al.* (2004). These main strategic, tactical and operational indicators respect to SCOR model's processes: plan, source, make and deliver. The case study concerns a bearing company with its suppliers and deliverers. The overall performance expression results from the aggregation, by the weighted arithmetic mean (WAM), of the involved elementary performances. Besides, the multi

attractiveness categorical based evaluation technique (MACBETH) methodology has been applied to the performance expression of the four main processes of a supply chain. Indeed, this methodology gives a structured framework, which links the elementary performance expression to the overall performance. Factually, the SCOR model is originally founded on five distinct management processes, namely: plan, source, make, deliver and return. This study, however, the return process is not consider on the supply chain overall performance propose model.

Bhagwat and Sharma (2007a) develop a balanced scorecard (BSC) for measuring and evaluating day-to-day business operations of supply chain management from following four perspectives: finance, customer, internal business process and learning and growth. Three case studies develop and apply in small and medium sized enterprises (SMEs) in India. The balanced scorecard developed in this paper provides a useful guidance for the practical managers in evaluation and measuring of supply chain management in a balanced way and proposes a balanced performance measurement system to map and analyze supply chains. However, addition research is recommended in order to determine whether the proposed perspectives and measures are a necessary and sufficient set.

Jammernegg and Reiner (2007) discuss the opportunities and challenges for improving the performance of supply chain processes by coordinated application of inventory management and capacity management. The propose technique by using process simulation to approach a supplier in the telecommunication and automotive industry, where a manufacturer (production facility) is located in a country with low labour costs and high worker deployment flexibility. Using process simulation, the authors demonstrate how the coordinated application of methods from inventory management and capacity management result in improved performance measures of both intraorganizational (costs) and interorganizational (service level) objectives. But it lacks to view the whole supply chain process as this research concentrates only costs and service level.

Yeh *et al.* (2007) propose a modified 2-tuple fuzzy linguistic computing (FLC) model to evaluate the performance of supply chain management. In this model, the management implication of high precision setting involving in the Six Sigma: define,

measure, analyze, improve and control (DMAIC) processes is employed to construct the evaluation framework. The original 2-tuple fuzzy linguistic representation model is modified as the proposed model to provide the aggregation algorithm toward ensuring the consistent property. In this study, the Delphi method is used to precisely integrate the experts' opinions on criterion selection, weighting identification and performance appraisal that are realistically expressed by fuzzy linguistic variables. The modified 2-tuple FLC technique is formed by utilizing a geometric operator and a couple of new symbol translation functions to aggregate precisely the 2-tuple terms involved. However, this framework lacks of combining the decision making levels.

Hwang *et al.* (2008) investigate the sourcing processes and their accompanied performance metrics in the SCOR model version 7.0 by using the stepwise regression model. The regression model was applied to examine the sourcing process of SCOR at level 2 and its performance metrics. The results obtained were further extended for discussion on the sourcing process of level 3. The researchers develop the questionnaire survey to collect empirical information from the thin film transistor-liquid crystal display (TFT-LCD) industry in Taiwan. In addition, this study also elaborates the institutionalization of the SCOR model and justifies the project planning system based on the SCOR model. However, this research concentrates on SCOR model version 7 only. When the newly developed version comes out, this study will have to consider for revision again.

Robb *et al.* (2008) propose and develop a model exploring the relationship between supply chain or operations practice and operational or financial performance by using a structural equation model with China furniture manufacturers of study. The industry is of particular interest in that, while labour productivity remains relatively low, exports have undergone substantial growth. The research highlights the relative importance of supply chain and operations practices and shows that the impact of practice on business performance is mediated by capabilities on operations dimensions. Another key finding is that practices are related to the importance placed on various dimensions the strongest link being between human resources and innovation, thus training can be seen to be a key to securing competitive advantage. The limitation of this research is it studied only operations dimension performance, not for the whole supply chains.

Theeranuphattana and Tang (2008) revisit the recent work of Chan and Qi (2003) which proposed an innovative performance measurement method for supply chain management. This research aims to propose a more user-friendly alternative performance measurement model by using fuzzy logic technique. The performance measurement model is a combination of two existing methods: Chan and Qi's model and the supply chain operations reference (SCOR) model. To demonstrate the applicability of the combined approach, actual SCOR level 1 performance data and the measurement information from a case supply chain are collected and processed by Chan and Qi's measurement algorithm. These two methods complement each other when measuring supply chain performance. However, only one Thai manufacturing company case study is presented to demonstrate the measurement and the application of the performance measurement method.

Zhu *et al.* (2008) aim to empirically investigate the construct of and the scale for evaluating green supply chain management (GSCM) practices implementation among manufacturers., the measurement scale instrument in the form of a survey questionnaire developed from the various literature sources and interview academics and practitioners among Chinese manufacturers. Two measurement models of GSCM practices implementation were tested and compared by confirmatory factor analysis. The multi-item five-point Likert measurement scales using to evaluate the different facets of green supply chain management practices implemented and evaluate their strengths and weaknesses. However, this study concentrates only environmental performance with operational performance, not for the whole supply chain performance.

Cai *at el.* (2009) propose a framework using a systematic approach to improve the iterative key performance indicators (KPIs) accomplishment in a supply chain context. The proposed framework quantitatively analyzes the interdependent relationships among a set of KPIs. This framework can provide an effective approach to managing supply chain performance in a dynamic environment. A KPI accomplishment cost transformation matrix (PCTM) analysis proposes in this paper, it is a new extension of the existing eigen structure analysis methods, work transformation matrix (WTM) derived from the design structure matrix (DSM) model from engineering to business performance management. However, the results from PCTM analysis method should not be adopted as direct decisions, but as supporting information for decision making.

Chae (2009) offers an industry-oriented, practical approach to performance measurement in supply chain management contexts and proposes key performance metrics which can be easily adapted for different businesses. A list of essential key performance indicators (KPIs) is presented. Potential KPIs develop for each of the SCOR model's four meta-process (plan, source, make and delivery) and have to be hierarchically grouped such as primary and secondary metrics. The review of industry standards and best practices in supply chain performance measurement suggest that 'less is better' as to developing performance metrics. Companies should focus on only a small list of KPIs which are critical for their operations management, customer service, and financial viability. The lack of this development model is the return process not consider in this work.

Chia *et al.* (2009) apply the balanced scorecard (BSC) approach on the logistics industry for measuring supply chain performance. This research empirically examines what senior supply chain executive's measure and how they perceive performance measurement from a balanced scorecard. A survey designed from the four perspectives of the balanced scorecard framework is conducted on senior executives involved in the supply chain functions of client firms, and those executives from the logistics service provider industry. This study suggests that the measurement of performance of supply chain entities could be improved by using a more balanced perspective as provided for by the BSC framework. Further, the results show an apparent lack in the focus on drivers of strategic future performance, as implied in the results of the measurement of internal business processes and learning and growth indicators. These two perspectives contain measures that create future value, and address the development of core competencies but they were not as well measured. The limitation of this work is the sizes of some respondent clusters are smaller than others. Hence, the results may not be representative of the individual clusters.

Rodriguez *et al.* (2009) propose the quantitative relationships performance measurement system (QRPMS) that clearly establishes traceability between a group of strategic objectives and associated key performance indicators (KPIs). This study presents a unique proposal able to objectively identify and quantify relationships between KPIs defined within a performance measurement system base on the balanced scorecard (BSC), that offering additional information to managers to make cross-

enterprise decisions. Then, the research projects KPIs upstream in the performance measurement system, establishing meaningful cause and effect relationships at the objectives levels. The proposed model is applied to a baby clothing manufacturer in Spain. As the research studied only one manufacturing company, it may be the disadvantage for this paper.

Thakkar *et al.* (2009) propose an integrated supply chain performance measurement framework for the case of small and medium scale enterprises (SMEs) in India using set of qualitative and quantitative insights gained during the case study research. The proposed framework integrates the features of balanced scorecard (BSC) and supply chain operation reference (SCOR) model to deliver a comprehensive performance measurement framework for SMEs. It also outlines the detailed guideline for the implementation and use of the framework. This research reports set of performance indicators for the supply chain processes like source, make and deliver in SMEs. It also relates the measures with various supply chain cycles like procurement, manufacturing, replenishment and customer order, but it does not consider in decision making levels.

Bigliardi and Bottani (2010) develop a balanced scorecard (BSC) model that is designed and delimited for performance measurement in the food supply chain. The research provides a structured performance measurement system tailored for the food supply chain. The BSC model developed could serve as a reference for the food industry, to establish applicable performance appraisal indicators. The study starts from the literature concerning performance measurement and metrics, the food industry and the BSC model, the relevant financial and non-financial indicators, suitable to be used for companies belonging to the food industry. Then, indicators are submitted to a panel of experts, which operate following the Delphi technique, to gather possible suggestions or amendments. In its final form, the resulting BSC model is tested on two companies operating in the food industry, for a final validation. However, the fact that a specific industry field (the food industry) is examined could be seen as a limitation of the work as the results presented are not suitable to be generalized or extended to other contexts.

Flynn *et al.* (2010) study the relationship between three dimensions of supply chain integration, operational and business performance, from both a contingency and a configuration perspective. This research defines supply chain integration as the degree

to which a manufacturer strategically collaborates with its supply chain partners and collaboratively manages intra- and inter-organizational processes, in order to achieve effective and efficient flows of products and services, information, money and decisions, to provide maximum value to the customer. In applying the contingency approach, hierarchical regression is used to determine the impact of individual supply chain integration dimensions (supplier, internal and customer integration) and their interactions on performance. In the configuration approach, cluster analysis is used to develop patterns of supply chain integration, which are analyzed in terms of supply chain integration strength and balance. Analysis of variance is used to examine the relationship between supply chain integration pattern and performance. However, it overlooks the decision making ability across strategic, tactical and operational levels.

Lin *et al.* (2010) present a proposed model which addresses the drivers of innovation in channel integration in supply chain management of Taiwan qualified high-tech manufacturers. This research surveys the previous studies of strategy orientation, the innovation in channel integration and supply chain performance to construct a theoretical model and hypotheses specifications. The study tests the measurement model for overall factors with a confirmatory factor analysis (CFA) through AMOS 7.0 analysis. The results indicate that a significant relationship has been established between market orientation (customer focus, competitor-oriented and cross-functional coordination) and supply chain performance. However, this model only concentrates on innovation perspective.

There is a summary of the review on these literatures as shown in table 2.1.

Table 2.1: A summary of supply chain performance measurement frameworks

Author(s)	Framework or measurement area	Remarks
Beamon (1999)	Supply chain processes	**Pro:** Identify three types of performance measures and propose flexibility quantitative measurement approach for supply chains **Con:** Lack of system thinking of measuring supply chain widely across the whole
Gunasekaran *et al.* (2001)	Decision making levels	**Pro:** Combine decision making levels with financial and non-financial criteria **Con:** Too many number of metrics and measures
Chan and Qi (2003)	Supply chain processes	**Pro:** Identify five core processes as holistic complex supply chain measurement and introduce fuzzy set theory for judgment and evaluation processes **Con:** Overlook on the decision making ability
Otto and Kotza (2003)	Supply chain perspectives	**Pro:** Design six unique sets of supply chain metrics to measure the effectiveness of supply chain management **Con:** All the metrics are not used in business practice to measure supply chain performance

Author(s)	Framework or measurement area	Remarks
Gunasekaran *et al.* (2004)	Decision making levels	**Pro:** Consider supply chain processes with respect to decision making levels **Con:** Need collaboration from all stakeholders of supply chain system to evaluate the framework
Huang *et al.* (2005)	Supply chain operations reference (SCOR) model	**Pro:** Summarize SCOR model and describe a computer-assisted tool to configure supply chain **Con:** Limit to one manufacturing company for studying
Aramyan *et al.* (2007)	Financial versus non-financial	**Pro:** Develop an integrated performance measurement system that contains financial as well as non-financial indicators **Con:** Investigate only single food company
Berrah and Cliville (2007)	SCOR model	**Pro:** Use performance indicators from Gunasekaran *et al.* (2004) and apply MACBETH methodology to the supply chain processes **Con:** Does not consider the return process
Bhagwat and Sharma (2007a)	Balanced score card perspective	**Pro:** Develop a balanced scorecard for supply chain management and apply in SMEs in India **Con:** Need to determine the proposed perspectives and measures

Author(s)	Framework or measurement area	Remarks
Jammernegg and Reiner (2007)	Intraorganizational versus Interorganizational	**Pro:** Deal with performance measurement and improvement of supply chain processes by coordinated application of inventory management and capacity management **Con:** Lack to view the whole supply chain process as concentrate only costs and service level
Yeh *et al.* (2007)	Six Sigma (DMAIC) processes	**Pro:** Propose a modified 2-tuple fuzzy linguistic computing (FLC) model to evaluate the performance of supply chain management **Con:** Lack of combining the decision making levels
Hwang *et al.* (2008)	SCOR model	**Pro:** Aim to find out important SCOR sourcing performance metrics by using the stepwise regression model **Con:** Concentrate on SCOR model version 7 only as version 11 will launch soon this year
Robb *et al.* (2008)	Operations practice and performance	**Pro:** Propose a model exploring operations practice and performance of supply chain management **Con:** Study only operations dimension, not for the whole supply chains
Theeranuphattana and Tang (2008)	Combined Chan and Qi (2003) model and SCOR model	**Pro:** Develop a practical and efficient measurement model by incorporating the strengths of two different models **Con:** Present only one Thai manufacturing company case study

Author(s)	Framework or measurement area	Remarks
Zhu *et al.* (2008)	Green supply chain management	**Pro:** Investigate green supply chain practices implementation **Con:** Concentrate only environmental performance with operational performance
Cai *at el.* (2009)	Supply chain processes	**Pro:** Propose a framework using a systematic approach to improving the KPIs in a supply chain context **Con:** Result from PCTM analysis can use as only supporting information for making decision, not as direct decision
Chae (2009)	SCOR model	**Pro:** Offer a practical approach to performance measurement and propose key performance metrics **Con:** The return process is not consider in this work
Chia *et al.* (2009)	Balanced score card perspective	**Pro:** Apply the balanced scorecard approach on the logistics industry to measure performance of supply chain **Con:** The sizes of respondent clusters are differently
Rodriguez *et al.* (2009)	Balanced score card perspective	**Pro:** Propose the quantitative relationships performance measurement system base on the balanced scorecard **Con:** Study only one manufacturing company

Author(s)	Framework or measurement area	Remarks
Thakkar *et al.* (2009)	Integrated balanced score card and SCOR model	**Pro:** Develop an integrated performance measurement framework for supply chain evaluation and planning in SMEs **Con:** Do not consider in decision making levels
Bigliardi and Bottani (2010)	Balanced score card perspective	**Pro:** Develop a balanced scorecard model for measuring performance in the food supply chain **Con:** Examine only specific industry field (the food industry)
Flynn *et al.* (2010)	Supply chain integration, operational and business performance	**Pro:** Study the relationship between three dimensions of supply chain integration, operational and business performance **Con:** Overlook the decision making ability
Lin *et al.* (2010)	Supply chain innovation	**Pro:** Propose a model of innovation drivers in channel integration in supply chain management **Con:** Concentrate on innovation perspective only

A review of previous research in relation to supply chain performance measurement framework has highlighted that the attention of many researchers has often focused on single area of performance measurement (Beamon, 1999; Gunasekaran *et al*., 2001; Chan and Qi, 2003; Otto and Kotza, 2003; Huang *et al.*, 2005; Aramyan *et al.*, 2007; Berrah and Cliville, 2007; Jammernegg and Reiner, 2007; Yeh *et al.*, 2007; Zhu *et al.*, 2008; Chae, 2009; Chia *et al.*, 2009; Lin *et al.*, 2010), while research on a combined approach for the whole performance of supply chain management have been relatively neglected. Concerning these research gaps, this research, therefore, is intended to provide a more holistic approach to the study of supply chain performance measurement framework by combining both supply chain macro processes and decision making levels and taking a cross organizational approach.

These concepts are used in supply chain management research in general, but they have not been applied together before to supply chain performance measurement framework. This approach will help to understand the holistic perspective on supply chain performance. The framework will provide a balanced horizontal (cross-process) and vertical (hierarchical decision) view on supply chain performance.

2.4.2 Typology of supply chain performance measurement models

There have been relatively few attempts to systematically collate models for evaluating the performance measurement of supply chains. Moreover, there is argument over the most appropriate way to categorise them. Gunasekaran and Kobu (2007) indicate that researchers have classified or categorized performance measurement according to several different criteria as follows:

- Balanced score card perspective
  (Financial, customer, internal business process, and learning and growth)
- Components of performance measures
  (Resource, output, and flexibility)
- Location of measures in supply chain links
  (Plan, source, make, and deliver)
- Decision making levels
  (Strategic, tactical, and operational)

- Nature of measures
  (Financial and non-financial)
- Measurement base
  (Quantitative and non-quantitative)
- Traditional vs. modern measures
  (Function-based and value-based)

In summary, as the review of literature from many authors above, this research presents a typology of models or frameworks that identifies the main streams in the field of supply chain performance measurement. These frameworks have classified from three main models that are mentioned frequently by other scholars as follows: result based (balanced scorecard), hierarchical (decision making levels) and process based (supply chain operations reference, SCOR, model) frameworks as shown in table 2.2.

Table 2.2: Categories of supply chain performance measurement models

Key references	Criteria	Approaches
Kaplan and Norton (1992; 1996; 1997)	Result based	Balanced score card (BSC)
Gunasekaran *et al*. (2001; 2004)	Hierarchical	Decision making levels
Supply Chain Council (1996)	Process based	Supply chain operations reference (SCOR) model

2.4.2.1 The result based model

The result based model mobilizes both generic performance factors and cause and effect hypotheses specifying the interrelations between performance measures. The most widespread performance measurement tool is the balanced scorecard (BSC). The concept of BSC is proposed by David Norton, the CEO of Nolan Norton Institute, and Robert Kaplan, a professor at Harvard University. The BSC measures organizational performance from four perspectives, including financial, customer, internal business process and learning and growth, in relation to the four functions of accounting and finance, marketing, value chain, and human resource (Kaplan and Norton, 1992). These measures include both financial and non-financial from all four perspectives. The BSC,

which results from the process proposed, is designed to provide top management with a global information system that will enable them to evaluate performance multi-dimensionally. The BSC provides managers with the instrumentation tools they need to navigate towards future competitive success (Kaplan and Norton, 1996). The essential principle of the BSC is that standard financial measures must be balanced with non-financial measures. The BSC method has been extensively used to develop a more realistic strategic plan incorporating the goal and initiatives to achieve the targets (Kaplan and Norton, 1997). The development of a set of appropriate metrics related to the four perspectives of the BSC has been discussed in many articles (Bhagwat and Sharma, 2007a; Chia *et al.*, 2009; Rodriguez *et al.*, 2009; Thakkar *et al.*, 2009; Bigliardi and Bottani, 2010)

2.4.2.2 The hierarchical model

The second model of performance measurement system evaluates performance through various hierarchical levels of the organization. The reason for studying the supply chain performance measures and metrics at the strategic, tactical and operational levels is to make the right decisions so that they can support each other in achieving the overall goals and objectives of an organization. The success of strategy formulation depends upon the degree of translation strategy into operations. Gunasekaran *et al*. (2001), based on literature survey, develop a framework of performance that distinguishes measures according to classis decision horizons: strategic, tactical and operational. The complexity of supply chain management prompts them to compile a list of the most indicative performance metrics for each hierarchical level. The authors underline the influence of hierarchical level measures to achieve the objectives of each hierarchical level. Financial indicators that include intangible elements are most appropriate for the strategic level (Gunasekaran and Kobu, 2007). In additon, Gunasekaran *et al*. (2004) developed a framework for supply chain management in case of performance measurement and metrics. The framework considers the measurement of supply chain processes (e.g. plan, source, make and deliver) with respect to strategic, tactical and operational levels, evaluates a score for prioritize for each metric by three levels: highly, moderately and less important levels from an empirical study of selected British companies.

2.4.2.3 The process based model

According to the importance of the operational dimension, it is important to clearly understand the activities and key processes of the supply chain to better structure performance measures. Integrating key processes from the final customer to the suppliers is crucial to supply chain management. To recognize the multidimensionality of the supply chain, researchers and practitioners have sought to develop new approaches that can take into account the performance of key operational processes in the supply chain. A prominent framework for the process based model is the supply chain operations reference (SCOR). The SCOR model is introduced in 1996 and has been endorsed by the Supply Chain Council (SCC), a global organization of firms interested in supply chain management. The SCC defines SCOR as: "the only supply chain framework that links performance measures, best practices, and software requirements to a detailed business process model" (The Supply Chain Council, 2009a). The scope of SCOR model includes all elements of demand satisfaction beginning with the initial signal of demand (the order or forecast) and ending with the final signal that demand has been satisfied (final invoice and payment). The SCOR model is a business process reference model, which provides a framework that includes supply chain business processes, metrics, best practices, and technology features. The SCOR model attempts to integrate the concepts of business process reengineering, benchmarking, process measurement, and best practice analysis and apply them to supply chains. The SCOR model is originally founded on five distinct management processes, namely: plan, source, make, deliver and return. Moreover, the SCOR model advocates hundreds of performance metrics used in conjunction with five performance attributes: reliability, responsiveness, flexibility, cost and asset metrics (The Supply Chain Council, 2009b). Development of a set of performance metrics according to the SCOR model has been taken up by several works in the supply chain field (Huang *et al.*, 2005; Berrah and Cliville, 2007; Hwang *et al.*, 2008; Theeranuphattana and Tang, 2008; Chae, 2009; Thakkar *et al.*, 2009).

2.4.2.4 The advantages and disadvantages of reviewed models

Clearly, the approaches proposed in the literature vary in their general orientation. The result based model is oriented toward explanation of internal factors that influence

external results. In this sense, it can be grouped under the term result-oriented approach. The best known model in this group is that of the balanced scorecard (BSC) proposed by Kaplan and Norton (1992). The BSC is a powerful and balanced strategic management system that facilitates the implementation of strategy, using measures to ensure that corporate vision and strategy are implemented and achieved (Kaplan and Norton, 1996). Therefore, one of advantages of this model is that the BSC can help senior executives clarify and operate the vision and strategy of the organization, focusing management's attention on a few but critical indicators of both current and future performance (Chia *et al.,* 2009). A balanced performance evaluation of supply chain management such as balanced scorecard not only helps organizations in faster and wider progress monitoring of their operations but can also help them in improving their internal and external functions of business such as engineering and design applications, production, quality improvement, materials management, quick response, gaining lost market shares and proper implementation of business strategies (Bhagwat and Sharma, 2007a). Furthermore, Bremser and Barsky (2004) highlight the following benefits that a company may obtain from the use of a BSC:

- the simplicity to translate a company's strategy into operational terms;
- the alignment of the organization structure with the strategy;
- the transformation of the strategy into a continual process;
- the implementation of a process for learning and adapting the firm's strategy;
- the creation of a leadership for change in the strategic management system.

However, Thakkar *et al*. (2009) summarize the disadvantages of the BSC model compared to the advantages of the SCOR model as follows:

- BSC does not provide a mechanism for maintaining the relevance of defined measures. SCOR adopts a building block approach and offers complete traceability.
- BSC fails to integrate top level, strategic scorecard, and operational level measures potentially making execution of strategy problematic. SCOR clearly defines the type of process (planning, execution and enabling) and configures them to suit the supply chain requirements.
- BSC fails to specify a user-centered development process. A detailed exercise on SCOR generates sufficient information to even develop tailor made software system.

The second category of approach emphasizes the hierarchy. The main model in this category is that of Gunasekaran *et al*. (2001). In recent years, a number of firms realized the potentials of supply chain management in day-to-day operations management. However, they often lack the insight for the development of effective performance measures and metrics needed to achieve a fully integrated supply chain management due to lack of a balanced approach and lack of clear distinction between metrics at strategic, tactical, and operational levels (Hudson *et al.*, 2001). Therefore, it is clear that for effective supply chain management, measurement goals must consider the overall scenario and the metrics to be used. These should represent a balanced approach and should be classified at strategic, tactical and operational levels, and be financial and non-financial measures, as well. Gunasekaran *et al*. (2001; 2004) fulfill the lack of clear distinction between metrics at strategic, tactical and operational levels. Metrics that are used in performance measurement influence the decisions to be made at strategic, tactical and operational levels. Using a classification based on these three levels, each metric can be assigned to a level where it would be most appropriate. Therefore, Gunasekaran *et al*. (2001; 2004) develop the frameworks that link strategic and operational measures. These frameworks can support the manager to make the right decisions on each level. However, as the frameworks base on the hierarchical model that focus on vertical way, these frameworks need to combine with other models that focus on horizontal way such as result based model or process based model. Then, the framework can cover for the holistic supply chain system.

Process based approach completes the typology. The supply chain operations reference (SCOR) model is certainly the most representative of this last group. The SCOR model is a well recognized supply chain model used in various industries around the world. The model allows supply chain partners to ‘speak a common language’ because it provides standardized definitions for processes, process elements and metrics. Since, the SCOR model offers standardized definitions of performance metrics for the supply chain, it is easier for managers to identify relevant measures and use them. More and more companies have adopted SCOR performance metrics as standard criteria for evaluating their supply chain performance (Theeranuphattana and Tang, 2008). The SCOR model enables enterprises to analyse their supply chain performance in a systematic way, to enhance communication among the members in the supply chain, and to design a better supply chain network (Hwang *et al.*, 2008). Besides from

Thakkar *et al*. (2009) that summarize the advantages of the SCOR model compared to the disadvantages of the BSC model, another strength of the SCOR model is that it provides a standard format to facilitate communication. It is a useful tool for the upper management of a firm to design and reconfigure its supply chain to achieve desired performance (Huan *et al*., 2004). However, some authors (Gammelgaard and Vesth, 2004; Angerhofer and Angelides, 2006) have noted that although oriented towards process and efficiency, the SCOR model is not oriented towards strategy. Another limitation of this model is that it does not offer a systematic method for prioritizing measures. However, recently there has been an attempt to augment it by combining it with decision making tools such as analytic hierarchy processing (AHP) (Huan *et al*., 2004). Moreover, SCOR's lack of explicit connections between functional strategies and corporate strategies might jeopardize the organization wide alignment of resources. Management pursuing the implementation of SCOR and interested in having the framework provide the broadest impact should focus on positioning SCOR within the overall corporate strategy. This will help to align resources and goals, and prioritize implementation initiatives that result from the use of the framework (Lambert *et al*, 2005). Table 2.3 illustrates the advantages and disadvantages of these models.

Table 2.3: Advantages and disadvantages of reviewed models

	Result based model	**Hierarchical model**	**Process based model**
Contributors	Kaplan and Norton (1992)	Gunasekaran *et al*. (2001)	Supply Chain Council (1996)
Advantages	- Provide the balances of financial measures with non-financial measures - Advocate expression of a coherent strategy in the organization	- Link the company's strategic plan down to operational level - Support decision makers to make the right decisions on each level	- A well recognized and widely used as a standard for measure the performance - Provide a systematic way to analyze supply chain performance
Disadvantages	Fail to integrate top level, strategic scorecard, and operational level measures	Need to integrate with other models to cover for the whole supply chain system	Lack of systematic method for prioritizing measures

The contemporary supply chain management performance measurement frameworks are criticized by authors (Holmberg, 2000; van Hoek, 2001; Hudson *et al*., 2001) for not being connected with strategy, lack of system thinking, lack of balanced approach to integrate financial and non financial measures and losing of supply chain context, thus promoting local optimization.

Many researchers (Simatupang and Sridharan, 2005; Angerhofer and Angelides, 2006; Busi and bititci, 2006) propose supply chain relationships as a measure of organizational performance, but fail to integrate these with other supply chain variables as not measure the performance of the whole supply chain system. Moreover, there are number of conceptual frameworks and discussions on supply chain performance measurements in the literature; however, there is a lack of empirical analysis and case studies, especially from developing countries, on performance metrics and measurements in a supply chain environment (Gunasekaran *et al*., 2004). Thus, this research will bridge these gaps by developing performance measurement framework of the holistic supply chain that provides a balanced horizontal (cross-process) and vertical (hierarchical decision) view. The proposed conceptual framework will combine supply chain macro processes from upstream suppliers (supplier relationship management) and downstream customers (customer relationship management) along with firm or business (internal supply chain management) and across decision making levels (strategic, tactical and operational).

2.4.3 Performance measurement factors for supply chain performance measurement

From a systems perspective, feedback is necessary for every system or organization's survival. The role of performance measurement factors or critical success factors is the feedback in the supply chain management (Chae, 2009). Measuring supply chain performance reveals the gap between planning and execution and helps companies to identify potential problems and areas for improvement. However, it is recognized that developing performance measurement factors, is very challenging and a set of practical guidelines is not readily available for companies and supply chain management practitioners (Lambert and Pohlen, 2001).

From the articles that were reviewed in previous section (2.4.1 frameworks of supply chain performance measurement), the researcher has identified performance measurement factors for supply chain performance measurement as shown in table 2.4. The performance measurement factor is the term for an element, activity or variable that is required for an organization to achieve its mission (Rockart and Bullen, 1981). For this study, therefore, these performance measurement factors refer to the number of areas in which the companies should consider when they measure the performance of supply chain.

Table 2.4: Performance measurement factors for supply chain performance measurement

Author(s)	Measurement area	Performance measurement factors
Beamon (1999)	Resources	- Total cost of resources used - Total cost of distribution including transportation and handling costs - Total cost of manufacturing including labour, maintenance, and re-work costs - Inventory costs associated with held inventory: inventory investment, inventory obsolescence, work-in-process inventories, finished goods inventories - Return on investment (ROI)
	Output	- Sales - Profit - Fill rate: target fill rate achievement, average item fill rate - On-time deliveries: product lateness, average lateness of orders, average earliness of orders, percent on-time deliveries

Author(s)	Measurement area	Performance measurement factors
Beamon (1999)	Output	- Backorder or stock-out: Stock-out probability, number of backorders, number of stock-outs, average backorder - Customer response time - Manufacturing lead time - Shipping errors - Customer complaints
	Flexibility	- Reductions in the number of backorders - Reductions in the number of lost sales - Reductions in the number of late orders - Increased customer satisfaction - Ability to respond to and accommodate demand variations - Ability to respond to and accommodate periods of poor manufacturing performance - Ability to respond to and accommodate periods of poor supplier performance - Ability to respond to and accommodate periods of poor delivery performance - Ability to respond to and accommodate new products, new markets or new competitors
Gunasekaran *et al.* (2001)	Strategy	- Total supply chain cycle time - Total cash flow time - Customer query time - Level of customer perceived value of product - Net profit versus productivity ratio

Author(s)	Measurement area	Performance measurement factors
Gunasekaran *et al.* (2001)	Strategy	- Rate of return on investment - Range of product and services - Variations against budget - Order lead time - Flexibility of service systems to meet particular customer needs - Buyer-supplier partnership level - Supplier lead time against industry norm - Level of supplier's defect free deliveries - Delivery lead time - Delivery performance
	Tactical	- Accuracy of forecasting techniques - Product development cycle time - Order entry methods - Effectiveness of delivery invoice methods - Purchase order cycle time - Planned process cycle time - Effectiveness of master production schedule - Supplier assistance in solving technical problems - Supplier ability to respond to quality problems - Supplier cost saving initiatives - Supplier's booking in procedures - Delivery reliability - Responsiveness to urgent deliveries - Effectiveness of distribution planning schedule
	Operational	- Cost per operation hour

Author(s)	Measurement area	Performance measurement factors
Gunasekaran *et al.* (2001)	Operational	- Information carrying cost - Capacity utilisation - Total inventory as: incoming stock level, work-in-progress, scrap level, finished goods in transit - Supplier rejection rate - Quality of delivery documentation - Efficiency of purchase order cycle time - Frequency of delivery - Driver reliability for performance - Quality of delivered goods - Achievement of defect free deliveries
Chan and Qi (2003)	Supplying (delivery)	- Delivery cost - Delivery reliability: timeliness, error-free - Delivery flexibility; frequency, amount
	Inbound logistics (transportation)	- Transport cost - Transport productivity - Transport flexibility - Facility utilization

Author(s)	Measurement area	Performance measurement factors
Chan and Qi (2003)	Core manufacturing (international manufacturing operations)	- Product quality - Operation cost - Efficiency - Flexibility - Productivity
	Outbound logistics (warehousing)	- Warehouse costs - Inventory flow rate - Inventory accuracy - Stock capacity - Facility utilization
	Marketing and sales (customer order processing and delivery)	- Response time - Order fill rate - Order flexibility; frequency, amount - Delivery reliability: timeliness, error-free
Otto and Kotza (2003)	System dynamics	- Capacity utilization - Cumulative inventory level - Stock-outs - Time lags - Time to adapt - Phantom ordering

Author(s)	Measurement area	Performance measurement factors
Otto and Kotza (2003)	Operations research or information technology	- Logistics costs per unit - Service level - Time to deliver
	Logistics	- Integration - Lead times - Order cycle time - Inventory level - Flexibility
	Marketing	- Customer satisfaction - Distribution costs per unit - Market share or channel costs
	Organization	- Transaction costs - Time to network - Flexibility - Density of relationships
	Strategy	- Time to network - Time to market - ROI of focal organization

Author(s)	Measurement area	Performance measurement factors
Gunasekaran *et al.* (2004)	Strategy	
	- Plan	- Level of customer perceived value of product - Variances against budget - Order lead time - Information processing cost - Net profit versus productivity ratio - Total cycle time - Total cash flow time - Product development cycle time
	- Source	N/A
	- Make/assembly	- Range of products and services
	- Deliver	- Flexibility of service system to meet customer needs - Effectiveness of enterprise distribution planning schedule
	Tactical	
	- Plan	- Customer query time - Product development cycle time - Accuracy of forecasting techniques - Planning process cycle time - Order entry methods - Human resource productivity
	- Source	- Supplier delivery performance - Supplier lead time against industry norm

Author(s)	Measurement area	Performance measurement factors
Gunasekaran *et al.* (2004)	- Source	- Supplier pricing against market - Efficiency of purchase order cycle time - Efficiency of cash flow method - Supplier booking in procedures
	- Make/assembly	- Percentage of defects - Cost per operation hour - Capacity utilization - Utilization of economic order quantity
	- Deliver	- Flexibility of service system to meet customer needs - Effectiveness of enterprise distribution planning schedule - Effectiveness of delivery invoice methods - Percentage of finished goods in transit - Delivery reliability performance
	Operational - Plan	- Order entry methods - Human resource productivity
	- Source	- Efficiency of purchase order cycle time - Supplier pricing against market
	- Make/assembly	- Percentage of defects - Cost per operation hour - Human resource productivity index

Author(s)	Measurement area	Performance measurement factors
Gunasekaran *et al.* (2004)	- Deliver	- Quality of delivered goods - On time delivery of goods - Effectiveness of delivery invoice methods - Number of faultless delivery notes invoiced - Percentage of urgent deliveries - Information richness in carrying out delivery - Delivery reliability performance
Huang *et al.* (2005)	Delivery reliability	- Delivery performance - Fill rates - Perfect order fulfilment
	Responsiveness	- Order fulfilment lead times
	Flexibility	- Supply chain response time - Production flexibility
	Cost	- Cost of goods sold - Total supply chain management cost - Value-added employee productivity - Warranty or return processing costs
	Assets	- Cash-to-cash cycle time - Inventory days of supply - Asset turns

Author(s)	Measurement area	Performance measurement factors
Aramyan *et al.* (2007)	Efficiency	- Production costs - Transaction costs - Profit - Return on investment - Inventory
	Flexibility	- Customer satisfaction - Volume flexibility - Delivery flexibility - Backorders - Lost sales
	Responsiveness	- Fill rate - Product lateness - Customer response time - Lead time - Customer complaints - Shipping errors
	Food quality - Product quality	- Sensory properties and shelf-life: appearance, taste, shelf life - Product safety and health: salubrity, product safety

Author(s)	Measurement area	Performance measurement factors
Aramyan *et al.* (2007)	- Product quality	- Product reliability and convenience: product reliability, convenience
	- Process quality	- Production system characteristics: traceability, storage and transportation conditions, working conditions - Environmental aspects: energy use, water use, pesticide use, recycling or reuse - Marketing: promotions, client service, display in stores
Berrah and Cliville (2007)	Same as Gunasekaran *et al.* (2004)	Same as Gunasekaran *et al.* (2004)
Bhagwat and Sharma (2007a)	Finance perspective	- Net profit versus productivity ratio - Rate of return on investment - Variations against budget - Buyer-supplier partnership level - Delivery performance

Author(s)	Measurement area	Performance measurement factors
Bhagwat and Sharma (2007a)	Finance perspective	- Supplier cost saving initiatives - Delivery reliability - Cost per operation hour - Information carrying cost - Supplier rejection rate
	Customer perspective	- Customer query time - Level of customer perceived value of product - Range of products and services - Order lead time - Flexibility of service systems to meet particular customer needs - Buyer-supplier partnership level - Delivery lead time - Delivery performance - Effectiveness of delivery invoice methods - Delivery reliability - Responsiveness to urgent deliveries - Effectiveness of distribution planning schedule - Information carrying cost - Quality of delivery documentation - Driver reliability for performance - Quality of delivered goods - Achievement of defect free deliveries
	Internal business process perspective	- Total supply chain cycle time - Total cash flow time - Flexibility of service systems to meet particular customer needs

Author(s)	Measurement area	Performance measurement factors
Bhagwat and Sharma (2007a)	Internal business process perspective	- Supplier lead time against industry norms - Level of supplier's defect free deliveries - Accuracy of forecasting techniques - Product development cycle time - Purchase order cycle time - Planned process cycle time - Effectiveness of master production schedule - Capacity utilization - Total inventory cost: incoming stock level, work-in-progress, scrap value, finished goods in transit - Supplier rejection rate - Efficiency of purchase order cycle time - Frequency of delivery
	Innovation and learning perspective	- Supplier assistance in solving technical problems - Supplier ability to respond to quality problems - Supplier cost saving initiatives - Supplier's booking in procedures - Capacity utilization - Order entry methods - Accuracy of forecasting techniques - Product development cycle time - Flexibility of service systems to meet particular customer needs - Buyer-supplier partnership level

Author(s)	Measurement area	Performance measurement factors
Bhagwat and Sharma (2007a)	Innovation and learning perspective	- Range of products and services - Level of customer perceived value of product
Jammernegg and Reiner (2007)	Costs (Intraorganizational)	- Shipping costs - Inventory carrying costs - Transportation costs
	Service level (Interorganizational)	- Service level (fill rate) of finished goods storage - Distribution centre delivery performance - Work in process pallets (manual production manufacturer to distribution centre)
Yeh *et al.* (2007)	Customer satisfaction improvement	- Improve delivery efficiency toward customer demands - Improve delivery efficiency toward promises - Decrease lead time for completing orders - Improve service quality - Improve response to customer demands
	Business process and information integration	- Improve purchasing process - Improve data validity - Strengthen information sharing - Increase stock turnover - Increase supply chain response - Improve efficiency for order processing - Shorten lead time for raw material providing - Decrease prediction errors - Increase flexibility of production schedule

Author(s)	Measurement area	Performance measurement factors
Yeh *et al.* (2007)	Business process and information integration	- Lower material shortage - Decrease payment time
	Organization innovation capability	- Production innovation - Cooperative design capability increasing - Innovation in production process - Diversification in products - Market entry lead time decreasing - Customization capability increasing
	Enterprise profit increasing	- Increase marginal profits of supply chain - Increase quality of material supply - Lower stock costs - Lower purchase costs - Lower operation costs - Increase cash turnover - Increase sales volume - Increase asset rewards ratio
	Human resource management	- Increase working efficiency - Increase employee's capability in learning new knowledge - Increase employee's adaptation for changes - Increase positive interaction between employee and the environment - Increase employee capability in independently completing a task

Author(s)	Measurement area	Performance measurement factors
Hwang *et al.* (2008)	Reliability	- Perfect order fulfilment
	Responsiveness	- Order fulfilment cycle time
	Flexibility	- Upside supply chain flexibility - Upside supply chain adaptability - Downside supply chain adaptability
	Cost	- Supply chain management cost - Cost of goods sold
	Asset management	- Cash-to-cash cycle time - Return on supply chain fixed assets
Robb *et al.* (2008)	Operations dimension performance	- Delivery dependability - Product reliability - After-sale service - Consistent quality - Product durability - Low production cost - Production time - New products - Delivery time - New product development time - Product mix flexibility - Volume flexibility - Modification flexibility

Author(s)	Measurement area	Performance measurement factors
Robb *et al.* (2008)	Human resources factors	- Improve worker safety - Motivate workers - Increase supervisor training - Provide more worker training - Give workers a broader range of tasks - Heavily involved in product design decisions from production personnel - The worker's skills at doing their own jobs - Level of training given to workers - Training workers to manage different stages of the production process - Consulting with workers in deciding the production schedule - Having no role for workers in improving the manufacturing process - Give workers more planning responsibility
Theeranuphattana and Tang (2008)	Reliability	- Perfect order fulfilment
	Responsiveness	- Order fulfilment cycle time
	Flexibility	- Upside supply chain flexibility - Upside supply chain adaptability - Downside supply chain adaptability
	Cost	- Supply chain management cost - Cost of goods sold
	Asset management	- Cash-to-cash cycle time - Return on supply chain fixed assets - Return on working capital

Author(s)	Measurement area	Performance measurement factors
Zhu *et al.* (2008)	Environmental performance	- Reduction of air emission - Reduction of waste water - Reduction of solid waste - Decrease of consumption for hazardous, harmful or toxic materials - Decrease of frequency for environmental accidents - Improvement of an enterprise's environmental situation
	Eco performance	- Decrease cost for materials purchasing - Decrease cost for energy consumption - Decrease fee for waste treatment - Decrease fee for waste discharge - Decrease fine for environmental accidents
	Operational performance	- Increase delivered on time - Decrease inventory levels - Decrease scrap rate - Promote products' quality - Increase product line - Improve capacity utilization
Cai *at el.* (2009)	Resource	- Total supply chain management costs - Distribution costs - Inventory costs - Manufacturing costs - Total turnover costs - Information management costs - Value-added employee productivity

Author(s)	Measurement area	Performance measurement factors
Cai *at el.* (2009)	Resource	- Warranty costs - Return on investment
	Output	- Sales (or profit) - Rates of stock-outs (lose sales) - Fill rate: target fill rate achievement, average item fill rate - Order fulfilment lead time - Percent of on-time deliveries - Perfect of order fulfilment - Customer satisfaction - Rates of customer complaints - Planned process cycle time - Cash-to-cash cycle time
	Flexibility	- Supply chain responsiveness - Manufacturing flexibility - Procurement flexibility - Logistics flexibility - Delivery flexibility - New products flexibility - Information systems flexibility
	Innovativeness	- Rates of sales in new products - Number of new products launched - Process improvement

Author(s)	Measurement area	Performance measurement factors
Cai *at el.* (2009)	Innovativeness	- Supply chain stability
	Information	- Information accuracy - Information timeliness - Information availability - Information sharing
Chae (2009)	Sales and marketing	- Forecast versus order - Forecast volatility - Inventory days of supply at sales subsidiaries
	Production	- On time departure from manufacturing subsidiaries - Production plan versus result - Inventory days of raw material supply - Inventory days of (finished goods) supply at manufacturing subsidiaries - On time arrival to sales subsidiaries (or distribution centres) from manufacturing subsidiaries
	Purchasing	- Supplier fill rate - Automatic purchasing order (PO) rate
	Operation strategy	- Forecast accuracy - Planning cycle - Inventory days of supply - Cash-to-cash cycle

Author(s)	Measurement area	Performance measurement factors
Chia *et al.* (2009)	Financial perspective	- Return on investment - Gross revenue - Profit before tax - Cost reduction
	Customer perspective	- Market share - Number of customers retained - Customer satisfaction
	Business processes perspective	- Quality of services - New services implemented per year - On time delivery - Waste reduction
	Learning and growth perspective	- Employee satisfaction - Employee turnover per year - Number of suggestions implemented per employee yearly - Money invested in employee training yearly
Rodriguez *et al.* (2009)	Financial perspective	- Net benefit (sales) - Turnover increment - Costs of structure - Financial indebtedness - Final stock of cloths per campaign

Author(s)	Measurement area	Performance measurement factors
Rodriguez *et al.* (2009)	Customer perspective	- Customer average order - Number of customers that ask for repetition divide by number of total customers - Number of repeating requests per model and customer divide by number of customers that ask for repetition - Percentage of annulled models - Efficacy of the model - Global efficacy of each collection per intermediary - Average order per intermediary - Number of new customers captured - Number of orders per week (sales speed) - Increment of customers - Number of captured customers that are already customers of other enterprise of the organization divide by number of new customers - Number of non-accomplished orders divide by total number of orders - Number of customers that make a claim divide by total number of customers - Number of claims per model and customer divide by total number of customers that make a claim - Increment of incidences occurred between the last two years - Average reaction time to one customer's claim
	Internal perspective	- Stock variability - Percentage of return item per model - Percentage of customer acceptation - Total number of exited models divide by total number of produced models - Number of clothes with deviations respect to the standard scaled - Customer accomplishment degree

Author(s)	Measurement area	Performance measurement factors
Rodriguez *et al.* (2009)	Internal perspective	- Deviation between the order date and the reception date - Total number of innovative clothes divide by total number of produced clothes - Number of innovative successful clothes divide by total number of innovative clothes - Number of re-processed clothes divide by total number of clothes - Number of customers buying a determined style divide by total number of customers - Number of annulled catalogues divide by total number of catalogues
	Learning and growth perspective	- Number of critical processes totally documented divide by total number of critical processes - Number of critical processes controlled by the follow-up tool divide by total number of critical processes - Number of yearly training hours divide by number of yearly work hours - Hours needed of real training (detected by the enterprise) divide by hours needed of theoretical training (that employees think they should have) - Number of established inter-areas work or communication protocols divide by number of essential processes - Establishment of inter-areas work or communication protocols (Yes/No) - Number of inter-areas personnel interchanges divide by number of areas susceptible of interchange within the enterprise - Development of an inceptive plan (Yes/No) - Number of employees that know exactly the objective to be reached divide by total number of employees

Author(s)	Measurement area	Performance measurement factors
Thakkar *et al.* (2009)	Customer service	- Service quality - Product quality - Timely delivery - Responsiveness - Order fill rate - After sales service - Perfect order fulfilment
	Finance and marketing	- Profit margins - Pre-tax return on assets - After tax return on investment - Return on investment - Return on assets - Total supply chain cost - Growth in market share - Return on capital employed - Improved cash flow - Warranty or returns processing cost
	Internal business	- Inventory turnover ratio - Throughput time - Percentage scrap - Accuracy of documentation - On-time delivery - Unit cost reduction

Author(s)	Measurement area	Performance measurement factors
Thakkar *et al.* (2009)	Innovation and learning	- Flexible work force - Product innovation - Process innovation - Information sharing across supply chain - Training to managers and workers - Vendor development initiatives - Design modification based on customer requirements
Bigliardi and Bottani (2010)	Financial perspective	- Information carrying cost - Supplier cost saving activities - Variations against budget - Cost per operation hour - Return on investment
	Customer perspective	- Customer query time - Order lead time - Distribution lead time - Distribution performance - Delivery reliability - Effectiveness of distribution planning schedule - Quality of delivery goods - Customer perceived value of product - Flexibility of service system to meet particular customer needs - Responsiveness to urgent delivery

Author(s)	Measurement area	Performance measurement factors
Bigliardi and Bottani (2010)	Internal process perspective	- Accuracy of forecasting techniques - Purchase order cycle time - Planned process cycle time - Effectiveness of master production schedule - Supplier rejection rate - Total inventory cost - Frequency of delivery
	Learning and growth perspective	- Supplier assistance in solving technical problems - Supplier ability to respond to quality problems - Buyer-supplier collaboration in problem solving - Order entry method - Level of information sharing
Flynn *et al.* (2010)	Customer integration	- Level of linkage with customer through information networks - Level of computerization for customer's ordering - Level of sharing of market information from customer - Establishment of quick ordering systems with customer - Level of communication with customer - Follow-up with customer for feedback - Frequency of period contacts with customer - Sharing point of sales (POS) information of major customer with company - Sharing demand forecast of major customer with company - Sharing available inventory of company with major customer - Sharing production plan of company with major customer

Author(s)	Measurement area	Performance measurement factors
Flynn *et al.* (2010)	Supplier integration	- Level of information exchange with supplier through information networks - Establishment of quick ordering systems with supplier - Level of strategic partnership with supplier - Stable procurement through network with supplier -Participation level of supplier in the process of procurement and production - Participation level of supplier in the design stage - Sharing production schedule of major supplier with company - Sharing production capacity of major supplier with company - Sharing available inventory of major supplier with company - Sharing production plan of company with major supplier - Sharing demand forecasts of company with major supplier - Sharing inventory levels of company with major supplier - Helping major supplier to improve process to better meet company's needs
	Internal integration	- Data integration among internal functions - Enterprise application integration among internal functions - Integrative inventory management - Real-time searching of the level of inventory - Real-time searching of logistics-related operating data - Utilization of periodic interdepartmental meetings among internal functions - Use of cross functional teams in process improvement - Use of cross functional teams in new product development - Real-time integration and connection among all internal functions from raw material management through production, shipping and sales

Author(s)	Measurement area	Performance measurement factors
Flynn *et al.* (2010)	Operational performance	- Quickly modify products to meet major customer's requirements - Quickly introduce new products into the market - Quickly respond to changes in market demand - Outstanding on-time delivery record to major customer - Lead time for fulfilling customers' orders - Provide a high level of customer service to major customer
	Business performance	- Growth in sales - Return on sales - Growth in return on sales - Growth in profit - Growth in market share - Return on investment (ROI) - Growth in ROI
Lin *et al.* (2010)	Innovation	- Flexibility of delivery systems to meet the customer needs - Strengthen the supplier partnerships - Cost competitiveness - Shorter order cycles - Flexible customer response

In recent years, a number of firms realized the potentials of supply chain management in day-to-day operations management. However, they often lack the insight for the development of effective performance measurement factors needed to achieve a fully integrated supply chain management due to lack of a balanced approach and lack of clear distinction between performance measurement factors at strategic, tactical and operational levels (Gunasekaran *et al.*, 2001). Therefore, it is clear that for effective supply chain management, measurement goals must consider the overall scenario and the performance measurement factors to be used. These should represent a cover for the whole processes of supply chain and should be classified at strategic, tactical and operational levels, as well.

Developing a performance measurement tool set (performance measurement factors) involves a rather complicated process and can be very challenging for ordinary businesses (Chan and Qi, 2003; Aramyan *et al.,* 2007). A typical firm already has a certain number of performance metrics such as return on investment (ROI) for assessing its financial performance, but supply chain related performance metrics have not been widely adopted and businesses are typically uninformed of them. Companies often find that there is a lack of practical guidelines on how to develop performance metrics (Lapide, 2000). Therefore, this research will bridge these gaps by developing supply chain performance measurement framework comprises performance measurement factors with respect to supplier relationship management, internal supply chain management and customer relationship management. The performance measurement factors are further organized hierarchically across the decision making levels (strategic, tactical and operational).

2.5 Conclusion

This review has outlined key areas of literature that may enhance an understanding of views regarding supply chain performance frameworks and their performance measurement factors. It focused on supply chain performance measurement. The literature identified a number of frameworks and performance measurement factors for supply chain performance measurement. Based on the literature, the contemporary supply chain performance measurement frameworks measure performance in many

different aspects. They measure the performance from supply chain stakeholders (supplier, focal company and customer), measure performance across supply chain processes (e.g. SCOR model) or measure performance in the decision making levels (strategic, tactical and operational). In summary, this research categories the supply chain performance measurement frameworks into three main models as follows: result based (balanced scorecard), hierarchical (decision making levels) and process based (supply chain operations reference, SCOR) models. Each model focuses only its perspective and has its own advantages and disadvantages as mentioned earlier. There is no coalition framework that can measure for the whole supply chain performance. Therefore, to fulfil these gaps, this study is intended to provide a more holistic approach to the study of supply chain performance measurement framework by combining both supply chain macro process and decision making levels. This framework will provide a balanced horizontal (cross-process) and vertical (hierarchical decision) view on one developing country, specifically, Thailand.

The proposed conceptual supply chain performance measurement framework comprises performance measurement factors will be developed across supply chain macro processes, which integrate upstream suppliers (supplier relationship management) and downstream customers (customer relationship management) along with firm (internal supply chain management) and across decision making levels (strategic, tactical and operational). The framework will enable organizations to make enhanced supply chain management decisions at different levels. The research methodology is discussed in the next chapter. It presents the philosophy and methodology that has guided the research designs, methodology and methods.

Chapter 3 Methodology

3.1 Introduction

The chapter reviews the research methodology and methods used in this study. It starts by providing an overview of the research process used in this study. Then, it explains the philosophical considerations behind the research methodology. Based on a constructivism paradigm, the study uses a qualitative research approach and a case study approach which are explained in the next two sections. There are then details of each of the specific research methods used and the process of data collection used in the fieldwork. This study collects data from the three case study companies in Thai manufacturing sector to realize the research aim of understanding the supply chain performance measurement, using the conceptual framework developed in the next chapter (Chapter Four). This is followed by a discussion of the conduct of the interviews. There are also the discussion of the approach to data analysis, the research validity and reliability and the limitations of the research. The research ethics in relation to preparation for the fieldwork and also its application is discussed in the last section.

3.2 Research process

The research process followed in this study consisted of three steps. First, at the initial stage of the research, problems were identified from preliminary review of the literature. This process involved stages of revision of the original ideas until gaps were identified within the area of research interest. Several potential research questions were generated from the research problems. The literature was thoroughly checked to determine whether those questions had been answered. The research aim was then identified based on the final selection of research questions, and the research objectives were derived from the main aim, being refined several times in the process. Then, to answer the research aim, literature was further studied to establish an appropriate theory. Key concepts or variables involved in the subject of research were identified.

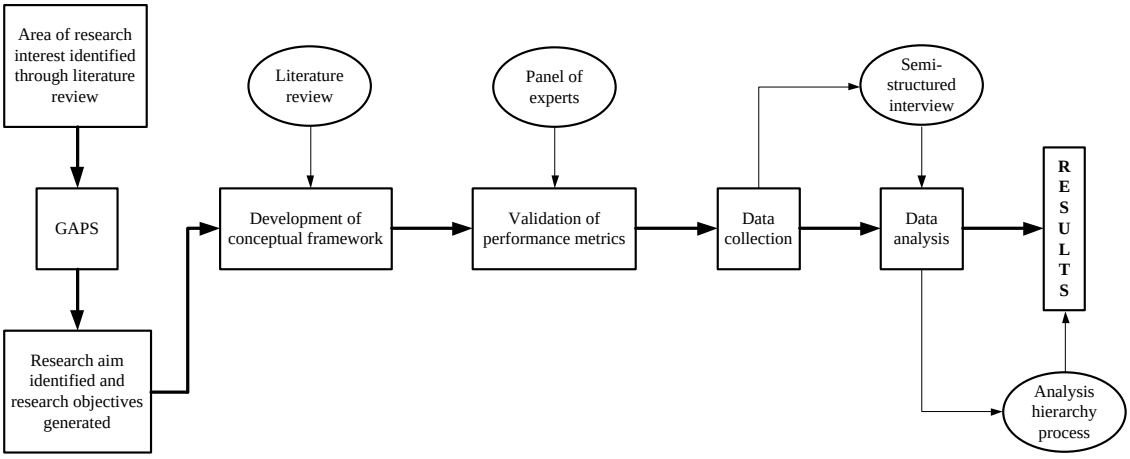
The literature review concentrated on several areas. Firstly, supply chain management was considered, secondly, performance measurement systems were explored, and finally, the issues surrounding supply chain performance measurement and involving the variety of frameworks and performance measurement factors were focused on. Thereafter, the conceptual supply chain performance measurement framework was developed, and the performance measurement factors were identified according to the extensive review of the literature.

Second, as a result of the previous step, a set of performance measurement factors suitable to be adopted in the context of manufacturing sector companies emerged. Performance measurement factors were examined and validated by an appropriate panel of experts to gather possible suggestions or amendments. This multidisciplinary panel of experts from both academic and industrial aspects was set up for this purpose. From the academic aspect, the panel encompassed many scholars in the operation management field from universities in the United Kingdom, Australia and Thailand, chosen from among people whose research studies were mainly focused on supply chain management, performance measurement or manufacturing industry issues. From the industrial aspect, managers of manufacturing companies in the United Kingdom and Thailand were included in the panel. Panel members were selected from among people reporting directly to the firm's top management and operating in supply chain management. The use of external experts experienced was one of the ways to assess the reliability of the case study method.

Finally, during the third step of the research, the proposed conceptual supply chain performance measurement framework was applied to three companies, operating in the Thai manufacturing sector. The data collection exercise involved a qualitative approach using in-depth interview as the main data gathering method. The information was obtained through semi-structured interviews with the key informants of three case study companies in the Thai manufacturing sector. This research also used documents and reports from the case study companies, plus other public documents as secondary data. This multi research method called 'data triangulation'. This study also employed 'informant triangulation' which simply involved considering a broad range of informants and comparing what they say. Multi sources of evidence were used when conducted the interviews with different members of the departments (e.g. manager,

deputy manager, assistant manager and officers). By combining data sources, informants and methods, triangulation opens the way for response to the question of validity of the research. A case study approach was adopted for this study, with these issues examined for the specific case of Thailand. The researcher chose a case study that appears to illustrate some typical features of the Thai manufacturing sector. In this study, qualitative data were used primarily to ascertain the issues pertaining to supply chain performance in the Thai manufacturing sector. Then, the analytic hierarchy process (AHP) was used to measure the performance of participating organizations from quantitative data. This research also asked respondents to refine their comments as it was hoped that their responses were the truest representation. This process called respondent validation and was used to validate the research. Furthermore, the feedback interview questions were asked to capture the perceptions of the respondents after each interview, specifically in order to validate the conceptual framework. Figure 3.1 provides an overview of the research process.

Figure 3.1: Research process



3.3 Research philosophy

It is widely accepted that philosophies have an important and at times ambivalent relationship with research. Patton (2002) suggests that good philosophy does not necessarily produce good research, nor necessarily help to make effective researchers, but it can enhance our ability to understand the social world. Creswell (1994, 2003) and Guba (1990) argue that, while there are several classifications used to differentiate

research paradigms, most of them share three fundamental elements a focus on: ontology, epistemology and methodology. Ontology concerns the nature and form of reality in the physical world; while epistemology concerns the nature of knowledge, or the ways of knowing. Finally, methodology concerns the rationales behind the procedures used to research what it is believed it is possible to be known (Creswell, 1994; Guba and Lincoln, 1994).

Supply chain management studies can be undertaken with several research paradigms shaping the research design. It is possible to locate the present study in relation to the five main research paradigms discussed by Lincoln and Guba (2000): positivism, postpositivism, critical theory, constructivism and participatory. For this study, constructivism is the most relevant and it was used as the research paradigm to shape this study of supply chain performance measurement. The five main research paradigms that are mainly based on Lincoln and Guba (2000) and Heron and Reason (1997) are discussed as follows:

3.3.1 Positivism

The positivism paradigm perceives the world as 'real', what Lincoln and Guba (2000) call a 'naive realism', where the reality can be identified and apprehended. The findings of research conducted under this paradigm are seen as 'true', knowledge is seen as objective – there is no research bias. The research takes place in a controlled setting where hypotheses can be verified through quantitative methods; the results are believed to be either true or false.

Supply chain management studies, such as this one, are not so easily quantifiable. 'Reality' is not so clear; results are blurry and open to the researcher's interpretation and, to some extent, bias. This is because management is socially constructed and 'reality' in management research context dependent. No matter how objective the researcher tries to be, there will always be a degree of preconceived notions of the world that will influence the research process and results. Therefore, in general, this research paradigm does not suit the nature of the research being conducted here. It may only be used in such a supply chain management study as part of the investigation, not

as the defining philosophical assumption and approach that characterise the research methodology and methods.

3.3.2 Postpositivism

Postpositivism differs from the positivism paradigm in the sense that it perceives the world in a less naive, more critical, way. Although reality can be apprehended, it can only be so in a partial and probabilistic manner. Studies conducted under the postpositivism paradigm can only indicate there is a probability that the hypotheses are true or false. It adds a more critical approach to the research. Although unbiased research is ideal, there is some influence of the researcher on the investigation. Qualitative methods may be used to some extent, but modified forms of experimental and manipulative methods (field studies) dominate the methodological approach to postpositivism research (Lincoln and Guba, 2000).

This paradigm is more suitable to supply chain management studies than the previous one since there is a more critical understanding of the world. A mix of qualitative and quantitative methods can be used to interpret and quantify findings. To a study like this – which aims to hear the voices of respondents, however, a more open-ended approach is necessary. The researcher is not looking for the probability of a hypothesis being true or false. Instead, the researcher is trying to make sense of the meanings of the respondents' opinions about a topic – supply chain performance measurement.

3.3.3 Critical Theory

This paradigm perceives reality as shaped by the values of society, politics, culture, economy, ethnicity and gender. Knowledge is subjective because findings are dependent on such values (Lincoln and Guba, 2000). The methodologies applied in studies conducted under this paradigm try to confront the notions of a phenomenon commonly held by respondents. The data analysis takes place as a dialogue between researcher and researched.

This paradigm is more suitable to studies on the views of groups that share a characteristic that define their self, such as an ethnic group or a group of people from

the same gender, for example. It is a highly political approach to research. Kincheloe and McLaren (2005) argue that critical theory is concerned with finding new ways to ease human suffering and produce psychological health. It can be the main paradigm that shapes research on supply chain management, depending on the researcher's aims. However, for this work, the views of respondents are not researched in light of their ethnicity, gender or political orientation, for instance. As a result, this paradigm is not the most appropriate for this research.

3.3.4 Constructivism

Under the constructivism paradigm, reality is relative. It is socially constructed and knowledge (research findings) is subjective (Lincoln and Guba, 2000). Knowledge is created by the researcher and the participants. Respondents' realities are subject to the researcher's realities and vice versa. The constructivists' view of the world is that there is no meaning or truth without the minds of humans; therefore, meaning is constructed rather than discovered (Crotty, 1998). Constructivists claim that meaning is constructed by human beings when they engage with the world they are interpreting. Humans do not create meaning, rather they construct meanings instead. However, Burr (2003) notes that in the construction of meaning or truth, humans may respond differently, even in the same situation or in response to the same phenomenon. Methodologically, reality is reconstructed through informed consensus. Qualitative methods are, then, the main data collection tools for research taken under this paradigm.

Supply chain management studies can be undertaken with several research paradigms shaping the research process. Constructivism, for its characteristics, is indeed a possible research paradigm to shape a supply chain management study, depending on the researcher's aim. Stakeholders' views of the supply chain performance measurement, for instance, can be effectively investigated using qualitative methods and constructivist assumptions. For that reason, this was the paradigm chosen to mould the most significant parts of this research.

3.3.5 Participatory

The participatory paradigm was added to Lincoln and Guba's initial list of main paradigms after the work of Heron and Reason (1997). Since paradigms are constantly, but slowly, changing, it is difficult to classify a current trend in research as a paradigm. Be it a paradigm in itself or a variation of the constructivism paradigm, the participatory approach to enquiry is presented here to highlight the constant development of research paradigms and knowledge. Heron and Reason (1997) argue that, under this research paradigm, reality is subjective-objective. The approach involves a more extensive epistemology than the others since it engages with four different ways of knowing: experiential, presentational, propositional and practical. Methodologically speaking, the participatory paradigm suggests a collaborative form of enquiry. In such an approach, researchers and researched work cooperatively as co-researchers and co-subjects.

This is a possible approach to supply chain management studies, especially those where stakeholders' views on matters related to the topic are being investigated. It uses qualitative methods and tries to avoid researcher bias by transforming researcher in co-subject and subjects in co-researchers. Although it could be used for a study on supply chain performance measurement such as this one, the participatory paradigm was discharged because the researcher would not be able to interact with respondents for a prolonged period of time. Becoming co-researchers and co-subjects is a process that requires a relationship between the researcher and the researched. Since data collection took place in Thailand with respondents unknown to the researcher during a brief period of time, it was not possible to base the research on this paradigm. At the same time, the author wanted to hear the respondents' own voices, not have an own voice in the discussion.

3.4 Research approach

According to Silverman (2000), before conducting research it is important clearly to set out the research approach, as well as the related concepts, theories, methodologies and methods. In the first place, the research approach provides a framework for how we look at reality (Silverman, 2005). In social research like this study, there are two kinds

of research approach that are linked to the methods used. They are quantitative and qualitative research approach, which are well known terms among researchers. Quantitative and qualitative research approaches are two broad ways to approach a research issue but they capture the world differently, each with its advantages and limitations. They differ in many aspects and depend on a number of things, such as research questions, research paradigms and methods. Most importantly, they have to serve the aims of the research. If an issue is characteristically either quantitative or qualitative in nature, common sense assists in the choice of the corresponding methods. Miles and Huberman (1994) compare quantitative and qualitative research approach as shown in Table 3.1.

Table 3.1: Features of quantitative and qualitative research approach

Source: Miles and Huberman (1994)

3.4.1 Quantitative approach

Quantitative approach produces results in broad terms. This approach has been described as entailing the collection of numerical data; exhibiting a view of the relationship between theory and research that is often deductive; having a predilection for a natural science approach; and having an objectivist conception of social reality (Bryman, 2004). Quantitative research is the most traditional existing form of enquiry. Denzin and Lincoln (2005) argue that the positivist sciences that use only quantitative methods are generally perceived as the crowning achievements of Western civilization, with which the truth can be verified and the researcher's opinion is insignificant to the investigation. In this approach, there is no space for researcher bias. Quantitative enquiry puts the emphasis on the measurement and analysis of casual relationships between variables, not processes (Denzin and Lincoln, 2005).

Quantitative approach usually has its basis in positivism, and it "sets out to establish a general cause-effect relationship to solving a social problem with the linking of abstract ideas of the relationship to precise measurement of the social world" (Neuman, 1997:67). If researchers are interested in teasing out the relative importance of various causes of social phenomenon, a quantitative approach may be appropriate for this purpose (Bryman, 2004). By doing so, quantitative researchers believe they can measure the associations among variables of a phenomenon and fully understand the existing relationships. Since findings are defined by statistical procedures, results can be generalised to a whole population of the sample investigated. Researchers have come to think of quantitative approach as the technique of randomised experiments, quasi-experiments, multivariate statistical analyses and sample surveys (Cook and Reichardt, 1979).

However, it was not the intent of this research to establish a cause-effect relationship between the stakeholders related to supply chain performance measurement factors. Therefore, this approach was not considered appropriate for the purpose of this study. Moreover, a quantitative approach was considered much less appropriate for this study since the intention was to gain in-depth insights in a natural setting, based on understanding the entirety of the given phenomenon and situation, and there was very little intention to seek representativeness (Denscombe, 1998).

3.4.2 Qualitative approach

According to Denzin and Lincoln (2005), qualitative approach is difficult to define clearly. It has no theory or paradigm that is distinctly its own nor does qualitative research have a distinct set of methods or practices that are entirely its own. It is important to note that any definition of qualitative research in itself needs to be qualitatively analysed in the context in which it is presented. Denzin and Lincoln (2005) provide the following initial, generic, definition of qualitative approach as a situated activity that locates the observer in the world. It consists of a set of interpretive, material practices that make the world visible. These practices transform the world. They turn the world into a series of representations, including field notes, interviews, conversations, photographs, recordings and memos to the self. At this level, qualitative research involves an interpretive, naturalistic approach to the world. This means that qualitative researchers study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them.

The qualitative approach is based on foundations which set it apart from a quantitative approach (Sarantakos, 2001). The qualitative approach allows researchers to capture data on "the perception of respondents in the context of their setting, through a process of attentiveness and empathetic understanding" (Miles and Huberman, 1994:6). It helps to gather of detailed data, generally from small numbers of people, through interactions of the researcher with respondents (Veal, 1997). If researchers are curious about the world views of members of particular social group and the interpretations of social actors about their world, then a qualitative approach may fit the researchers' needs (Bryman, 2004).

For this study, it is contended that a qualitative approach is more suited to the research's aim. A qualitative approach to enquiry was adopted because the researcher's position suggests that people's knowledge, views, understandings, interpretations, experiences and interactions are meaningful properties of the social reality which their research questions are designed to explore (Mason, 2002). The research concerned the views and opinions of manufacturers about supply chain activities, and the performance of their supply chain.

As this study aimed to discover descriptions and to explore social actors' meanings in society, the study applied a qualitative approach. A qualitative research approach was employed as this was an interpretative study of specified issues or problems, with the researcher being central to the interpretation. Compared to quantitative research, this qualitative approach has the following advantages. First, qualitative research is concerned with describing social groups or situations so as to gain an understanding of how and why the participants function and behave as they do within their cultural context (McQueen and Knussen, 2002). This clearly applied to the study of the views of manufacturers in the case study companies in Thailand. Second, qualitative research permits the collection of open-ended, emerging data, which is important when the primary intent is to develop themes from the data rather than to 'test' pre-determined themes against the data. Third, qualitative approach is appropriate in situations where the topic is new or has not been applied previously to a specific sample group, or where the researcher is unsure about what are the important variables (Creswell, 2003). Again this applied to the application of Thai manufacturers' perspective to supply chain performance measurement, which has not been attempted previously in the way developed here. So, qualitative approach was used for this study to collect data which was applicable to the research. Furthermore, qualitative research is exploratory, and it is useful when the researcher does not know the important variables to examine. This type of approach may be needed because the topic is new, the topic has never been addressed with a certain sample or group of people, or existing theories do not apply with the particular sample or group under study (Morse, 1991). Several of these characteristics apply to this study, so that a qualitative approach was most appropriate here.

3.5 Case study approach

According to Robson (1993), a case study is a strategy for doing research which involves the empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence. Case study research typically is employed to explore real life events over which the researcher has little control, and where the boundaries between the context and events are not readily evident (Yin, 1994). It consists of a detailed investigation, often with data collected over a period of time, of one or more organizations, or groups within organizations, with a view to

providing an analysis of the context and processes involved in the phenomenon under study (Hartley, 1994). Stake (1995) states that from the use of case studies researchers can establish generalizations that hold in diverse situations. A case study approach can thus be used to provide models, frameworks, or theories, which can then be extended to other cases in similar situations. The major aim of this research is to develop conceptual framework and to apply this proposed framework in a developing country context, specifically, Thailand – in order to better understand supply chain performance in less developed countries. Research on supply chain management is not very developed for developing countries. Therefore, case studies can be particularly valuable because they generate rich subjective data.

3.5.1 Selection of the case study companies

The aim of selecting a case study approach was to focus on specific case areas within Thailand, with the cases needing to be reasonably representative of the Thai manufacturing sector. The researcher used three case study companies in Thailand. Stake (1995) notes that to select the case studies, an early understanding of the study contexts is important for decisions about the criteria for the selection of the cases for study. After the researcher's consideration of diverse criteria (the representative of the main industrial groups and the practical feasibility of access to the case study companies), three case studies were selected. They are the Thai Food Processing Company (TFPC) (stands for the case study company that represented for food processing industrial group), the Thai Chemical Company (TCC) (stands for the case study company that represented for chemical industrial group) and the Thai Textile Company (TTC) (stands for the case study company that represented for textile industrial group). The three case study companies were selected on the basis of the following criteria. Moreover, for research ethics reason, all names and references of these participating companies have been omitted to comply with confidentiality rights of the case study companies (see Section 3.11 research ethics).

The first criterion was the representative of the main industrial groups of manufacturing sector in Thailand. This study investigates supply chain performance in Thai manufacturing sector because the manufacturing industry in Thailand has become one of the most important sectors in Thailand economy, contributing substantially to

employment and gross domestic product (GDP) (Bank of Thailand, 2002). In Thai manufacturing sector, the most important delegation is the Federation of Thai Industries (FTI), the non-profit organization under the supervision of the Minister of Industry. The FTI is the sole representative of all industrial enterprises in Thailand. From a database of the FTI, the manufacturing sector in Thailand is divided into thirty nine industrial groups (The Federation of Thai Industries, 2008). However, the main three industrial groups (chemical, food processing and textile) contribute significant outcome to GDP and employment (Bank of Thailand, 2004). Thus, all three selected case study companies were the member of the Federation of Thai Industries. Furthermore, each case study company was purposively selected to be a representative of each main industrial group.

Apart from the above criteria, the selection of the case studies was also influence by consideration of the practical feasibility of access to the case study companies. Regarding to this concern, the researcher selected Thailand as it is his country of origin, with this allowing him the convenience of collecting data in his native language. Further, he had networks of contacts that helped him to gain access to key informants in the case study companies. Therefore, all three case study companies that took part in the study were self-selective. The researcher selected these three companies for the case studies based on their willingness to participate in the research, their ability to provide information on the subject, and availability for the interview.

3.6 Data collection

This study used a case study approach combined with qualitative methods. In accordance with these approaches, multi research methods were developed, including interviews, observation and secondary data gathering. This mix of methods was used to allow for method and data triangulation so as to increase the strength of the study findings. The research methods are explained in the next section.

3.6.1 Overview of the research methods

One key type of data collection used in the study was in-depth interviews, with these being used to understand the views of manufacturers related to supply chain

performance measurement factors in Thailand. Interviewers are increasingly seen as active participants in an interaction with respondents, and interviews are seen as negotiated accomplishments of both interviewers and respondents that are shaped by the contexts and situations in which they take place (Fontana and Frey, 2005). King (1994) notes that the purpose of an interview is to see the research topic from the interviewee's perspective and to understand how and why the interviewee has this particular perspective. A key feature of in-depth interviews is their depth of focus on the individual (Legard *et al.*, 2003). Thus, this method allowed rich data to be collected whilst enabling the researcher to respond to answers and verify responses.

As mentioned earlier, this research used a variety of methods because it allowed the researcher to feel more confident in the trustworthiness of the study conclusions. Thus, observation and secondary data analysis were also used to collect data. Bryman (2004) describes how observation is a data collection approach that allows a researcher to observe subjects' behaviour directly. It is unlike interviews or surveys which only allow subjects' behaviour to be inferred. Bryman (2004) also lists problems with the use of surveys or interviews to investigate behaviour. One of them is the likely gap between the stated and actual behaviour: how interviewees say they are likely to behave and how they actually behave may not be consistent. Observation is used to discover complex interactions in natural social settings. Even with in-depth interviews, observation plays an important role as the researcher notes the interviewee's body language and emotions in addition to the interviewee's words (Marshall and Rossman, 2006). Thus, the researcher used observation to explore the behaviour of the subjects of interest in particular situations. In addition, the researcher could check the accuracy of what the respondents told him through other observations (Marshall and Rossman, 2006).

Secondary data analysis was also used by the researcher as a means to help him gain more data. These data were analysed using content analysis. Marshall and Rossman (2006) note that the greatest strength of content analysis is that it is unobtrusive and non-reactive: it can be conducted without disturbing the setting in any way. Minutes of meetings, logs, announcements, formal policy statements, letter and so on are all useful in developing an understanding of the setting or group studies (Marshall and Rossman, 2006). This study made use of work process documents, handouts and reports from the

case study companies, plus other public documents and notifications from the Federation of Thai Industries.

3.6.2 Collection of the interview data

May (2001) notes that there are four main types of interviews: structured interviews, semi-structured interviews, unstructured interviews and group interviews. In this study, semi-structured interviews were considered to be more flexible than structured interviews and thus more appropriate for the objectives of this study, especially in the situation when the researcher was uncertain about what and how much information he would get from the interview (King, 1994). Structured interviews ensure that bias is reduced, however, flexibility is severely restricted Sarantakos (2001). The use of semi-structure interviews meant that the researcher had a list of questions as an interview guide, so he was able to ask questions that were not listed and he also could change the order of the questions according to the flow of the discussion (Bryman, 2004). In this study, semi-structured interviews were used to collect both qualitative data (words) and quantitative data (numbers). Qualitative data were used for studying supply chain characteristics of each case study company, and identifying their supply chain performance. By contrast, quantitative data were used for measuring performance of case study companies.

3.6.3 Collection of the observation data

Observation constitutes a more 'humanistic methodology' (Jorgensen, 1989), and it entails the systematic noting and recording of events, behaviours, and artefacts in the social setting chosen for study (Marshall and Rossman, 2006). In this study, observation was chosen as one of data collection approaches during the interview period. The researcher's observations were used to record the respondents' body language and implied attitudes, as this might give clues about what they really thought about the issues. Marshall and Rossman (2006) argue that such clues mean it is vital to combine observation with in-depth interviews. According to Legard *et al.* (2003), people often convey their state of mind through their tone of voice, manner, or body language, so the researcher should be constantly receptive to these clues. Observation assisted in the building of holistic picture of the various stakeholders. The researcher noted these

observations, included the respondent's gesture, the external distractions such as phone calls or interruptions by colleagues, the perceived level of openness and the potential implied responses behind a specific comment. These observations were combined with the interview transcripts and other data sources for the analysis.

3.6.4 Collection of secondary data

The collection of secondary data relevant to the research was also undertaken. Together with the other data collection, this helped the researcher to gain a holistic overview, and in some instances helped him to clarify information collected in the interviews with the respondents. According to Yin (1994), it is necessary to pay considerable attention to the contextual conditions affecting the phenomenon being studied. Secondary data is useful because it can provide additional evidence or arguments, particularly about the wider context. In this study, the secondary data used included work process documents, handouts and reports from the case study companies, plus other public documents and notifications from the Federation of Thai Industries. These documents were widely used in the case study context chapter and also to an extent in the results chapters.

3.7 Conduct of the interviews

"Maintaining and generating conversations with people on a specific topic, and the interpretations which social researchers make of the resulting data, constitute the fundamentals of interviews and interviewing" (May, 2001:120). Rubin and Rubin (1995) explain that every step of an interview brings out new information and opens up windows into the experiences of the people interviewed. Qualitative interviewing is a way of finding out what others feel and think about their worlds. It addresses people's knowledge of their human situation, including the meanings, ambiguities, contradictions and their inter-subjectivity (Kvale, 1996).

3.7.1 Selection of the interviewees

Qualitative research uses non-probability samples to select the population for study. Ritchie *et al.* (2003a) state that in a non-probability sample, units are deliberately

selected to reflect particular features of the population, or groups within it. The sample is not intended to be statistically representative but, instead, the characteristics of the population are used as the basis of selection. It is this feature that makes this sampling approach well-suited to small-scale and in-depth studies (Ritchie *et al.*, 2003a). This research adopted a purposive sampling approach for key informants who were of interest for the research objectives.

"Purposive sampling is based on the assumption that one wants to understand as much as possible, and thus the sample is selected deliberately in a way that most can be learned" (Merriam, 1998:61). This is an accepted research procedure and it involves the researcher using judgment to select cases that fulfil a specific research objective (Babbie, 1998). The selected sample in purposive sampling can represent a location or type in relation to key criteria. Two principle aims of a purposive sample as stated by Ritchie *et al.* (2003a) are: to ensure that all the key constituencies of relevance to the subject matter are covered; and, second, to ensure that, within each of the key criteria, some diversity is included so that the impact of the characteristic concerned can be explored. The researcher used a purposive sample for his study so that the selected samples would be representative of certain types of job operators and certain periods of involvement in supply chain management business. Based on the conceptual framework, this study aims to identify performance measurement factors with respect to upstream suppliers (supplier relationship management) and downstream customers (customer relationship management) along with firm or business (internal supply chain management). Thus, the target interviewees of this study were divided into four categories: the respondents from purchasing department to represent the relationship with supplier, the respondents from marketing department to represent the relationship with customer, and the respondents from production department to represent the internal supply chain of the company. In addition, to understand the overall of company's supply chain management and to measure the supply chain performance on supply chain macro processes, the top management of case study companies would be selected as the first category. Then, the managing director (MD) was the first respondent in this purposive sampling.

Qualitative samples are usually small in size. Ritchie *et al.* (2003a) note that there is no requirement to ensure that the sample is of sufficient scale to provide estimates, or to

determine statistically significant discriminatory variables. Instead, the type of information that qualitative studies yield is rich in detail. Therefore, the number of interviewees with different types of actors was 57 as shown in Table 3.2.

Table 3.2: Summary of key actors who were interviewed

Interviewees group	Actors	Number of interviewees
Top management	Managing director	1 actor in each company
Purchasing department	Manager Deputy manager Assistant manager Officers	1 actor in each company 1 actor in each company 1 actor in each company 3 actors in each company
Marketing department	Manager Deputy manager Assistant manager Officers	1 actor in each company 1 actor in each company 1 actor in each company 3 actors in each company
Production department	Manager Deputy manager Assistant manager Officers	1 actor in each company 1 actor in each company 1 actor in each company 3 actors in each company
Total number of interviewees 57		

3.7.2 Interview questions

The research had been conducted using semi-structured interviews. The interviews were semi-structured in order to facilitate comparative research as different respondents answer the same common questions, although there was scope to probe and explore the specific responses provided by individuals. The flexibility of a semi-structured interview allowed for the interview to develop in unique ways for each respondent. This allowed each interviewee to relate the issues to their own 'life-world' and their own values and beliefs, and to use their own language and to organize these around their own ideological frameworks or knowledge (Wengraf, 2001).

The interview questions were carefully designed to reflect each of the themes in the research's conceptual framework and its elements as well as with the research aim and objectives. As stated earlier (Table 3.2: summary of key actors who were interviewed),

there were four main stakeholder groups, the first group was the respondent for collecting the overall company's information. In this group, the interview was conducted with the managing director of the company to understand company's overall supply chain performance and to measure and compare three supply chain macro processes. Interview questions for this group of respondent are shown in Appendix 1.

The three remain groups were the respondents from purchasing department; the respondents from marketing department; and the respondents from production department. In these groups, the interviews were conducted with the manager, deputy manager, assistant manager, and three officers of each department. The interviews were collected both qualitative data (words) to study company's supply chain performance and quantitative data (numbers) to measure the performance of supply chain. The interview questions for each group of respondents are shown in order as follows:

- Appendix 2 is interview questions for studying supply chain performance on supplier relationship management in purchasing department.
- Appendix 3 is interview questions for measuring the performance of supply chain on supplier relationship management in purchasing department.
- Appendix 4 is interview questions for studying supply chain performance on internal supply chain management in production department.
- Appendix 5 is interview questions for measuring the performance of supply chain on supplier relationship management in production department.
- Appendix 6 is interview questions for studying supply chain performance on customer relationship management in marketing department.
- Appendix 7 is interview questions for measuring the performance of supply chain on customer relationship management in marketing department.

The coding schemes for the interview questions of Appendix 2, 4 and 6 are shown in Appendix 8, 9 and 10 respectively. The coding is conducted and analyzed from the performance measurement factors by decision making levels in hierarchically. The performance measurement factors that contain in the conceptual framework are identified from the literature review on Chapter Two then examined and validated by an appropriate panel of experts to gather possible suggestions or amendments.

Additionally, the researcher added introductory questions with respect to the respondents' background information and amending to their stakeholder groups. For instance a question was asked about the number of years the respondents had been involved in department and/or in company, the role of the respondents' organisation in supply chain initiatives, the respondents' responsibilities in supply chain activities, etc. In order to gather quantitative data from each department to use for measuring the performance, the proposed conceptual framework containing all performance measurement factors were shown to respondents. Those charts could assist them to answer related questions. The researcher also advised them while answering those questions. Finally, the interview questions, which were first designed in English, were subsequently translated into Thai.

3.7.3 Pilot interviews

An assessment of the translation into Thai of the research questions was carried out with three colleagues of the researcher at the University of the Thai Chamber of Commerce, Bangkok, Thailand in order to assess whether the translation retained the original intended meanings. Two of three colleagues were from the department of foreign translation in the Faculty of Humanities, and the third was in the department of industrial management in the Faculty of Business. Their comments led to slight amendments in the wording of some questions so that they were more comprehensible for respondents.

After the review of the translation, four pilot interviews were conducted prior to the actual interviews in order to assess whether the translated questions were appropriate and could be understood easily. Pilots also helped the researcher to assess if the length of interview and sequence of questions were appropriate. Long interviews can cause

respondent fatigue, and an inappropriate order of questions could cause respondent confusion. The first pilot interview was carried out with a managing director of the Thai Chemical Company, the second was with a deputy manager in purchasing department from the Thai Food Processing Company, the third was with a manager in production department from the Thai Textile Company and the last was with an officer in marketing department from the Thai Chemical Company. Besides the regular questions, all respondents were asked to provide comments on the questions after the interviews. Only a few questions were adjusted after these pilots, with more appropriate wording being developed.

3.7.4 Interview process

The interviews were conducted from January to April 2009, and additional visits to the case study companies in January 2010 and in August 2010. The data from a target of fifty seven respondents were collected. The interviews took place in three locations related to the case study companies' locations examined in the study. Those places included the capital city of Thailand (Bangkok) as the head office location of the Thai Chemical Company and the Thai Food Processing Company; Samutprakarn province as the plant location of the Thai Chemical Company and the head office and plant location of the Thai Textile Company; and Samutsakhon province as the plant location of the Thai Food Processing Company. The process around the interviews went through a number of stages.

As mentioned earlier (Section 3.5.1 selection of the case study companies), all three case study companies that took part in the study were self-selective. The researcher selected these three companies for the case studies based on their willingness to participate in the research, their ability to provide information on the subject, and availability for the interview. First, before appointments were made with the target respondents, the researcher contacted the owners of all three case study companies to confirm the permission for collecting the data from their companies. Next, the researcher contacted each respondent by telephone in order to introduce himself and to explain the interview aims. If they accepted to be interviewed, an appointment was made. The researcher would send out a letter by fax if any respondent asked for an initial contact letter with background information which explained the researcher's

academic affiliations, the research aims, and the assurance that the researcher would use any information only for study research purposes and not for any other purposes.

Second, a number of steps were taken with the interviews themselves. Interviews were conducted in the respondent's workplace, or an agreed on social setting. The researcher started the interview by introducing himself again, giving his business card, clarifying the research aims and giving a brief outline of the types of questions to be asked, and by assuring respondents that all information gained from them would be used only for research purposes and would remain confidential. According to Ritchie *et al.* (2003a), a good working relationship is achieved where the researcher seeks to put the participant at ease and to create a climate of trust. Thompson (2000) also notes that creating a good rapport also involves demonstrating interest and respect, being able to respond flexibly to the interviewee, and being able to show understanding and empathy. These attitudes and skills were sought by the researcher in undertaking the interviews at all times.

Respondents were asked if they were willing to allow the interviews to be recorded. All respondents agreed to this procedure. The sequencing of the questions was also considered to be important for the interviewees. Thus, the background information questions were placed at the start of the interview, with these questions considered to help build a positive relationship with the respondents. In other words, these early questions encouraged the respondent to feel more comfortable and relaxed to talk. This led to greater openness and helped to build a level of trust between the respondents and the researcher.

Data from the interviews were recorded with digital voice recording equipment or MP3. The importance of tape recordings utilizes in the belief that, while memories allow for summaries of what other people have said, it is not possible to remember the detail of what was said, nor the nuances, such as pauses, overlaps, and the emotion involved in the conservation (Silverman, 2000). The interview guide was employed for the interviews. This helped to remind the researcher about the prepared questions and ensured that similar information was obtained from all respondents. Patton (1990) notes that the advantage of an interview guide is to ensure that the best use is made of the time available for each interview and to ensure that all relevant topics are covered. Thus, the interview guide also helped to ensure that the study aims were met. However,

additional questions emerged during some interviews in order to clarify issues or points made by the respondents. These additional questions were not included in subsequent interviews as they might not be relevant to the specific context and issues raised by the other respondents. Furthermore, the feedback interview questions were asked to capture the perceptions of the respondents after each interview, specifically in order to validate the conceptual framework.

After each interview, the researcher thanked the participants warmly. However, the researcher stayed a little longer after finishing the interview if the participant seemed to want to talk, either about the interview topic or more generally. Some interesting comments sometimes arose from these more informal interactions, and these were noted in a note book kept by the researcher. The researcher also took notes during the interviews. Some key words and additional questions were noted here, as well the participants' manner and body language. After each interview, other notes were immediately made to record the circumstances and atmosphere during the conversation, and any particular concerns shown by each interviewee.

At the end of this process a total of fifty seven respondents were interviewed. The interviews themselves ranged from two hours to three hours in duration. Excerpts of these conversations were then transcribed to help out the organisation of ideas in the data analysis process.

3.8 Data analysis

This research was a qualitative study, with case study research that involved detailed descriptions of the settings and the individuals for each case study company, followed by analysis of the data for chosen themes and issues (Stake, 1995). This qualitative method utilized the interviews and observations that took the form of a large corpus of unstructured textual material which was not straightforward to analyse. The data that were collected from case study companies had both qualitative (words) and quantitative (numbers). Qualitative data were used for studying supply chain characteristics of each case study company, and identifying their supply chain performance. These data were analyzed by thematic analytical approach. By contrast, quantitative data were used for

measuring performance of case study companies, and analyzed by the analytic hierarchy process (AHP). Both data analysis are explained in the next section.

3.8.1 Qualitative data analysis

Qualitative data are usually voluminous, and raw data come in various forms but most commonly they comprise verbatim transcripts of interviews, observation notes or written documents of other kinds (Ritchie *et al.*, 2003b). Thus, data reduction is a central task in qualitative analysis, and the researcher must find a way of getting an understanding of, or a handle on the data (Ritchie *et al.*, 2003b). The analysis of the interviews began with their verbatim transcription, which took about six months. The amount of time involved in preparing the transcriptions was much greater than expected because the interviews were conducted in Thai and after transcribing they were translated back into English. This process, however, made the researcher very familiar with the content of the transcripts. The data was analysed using content analysis, a technique that provides new insights and increases the researcher's understanding of particular phenomena. The approach to content analysis used here was thematic analysis, where the coding scheme was based on categories designed to capture the dominant themes present in the text (Franzosi, 2004). Thematic analysis is a method for identifying, analyzing, and reporting themes with data. The process starts with the analyst looking for and noticing patterns of meaning and issues of potential interest in the data. The endpoint is the reporting of the content and the meaning of patterns or themes in the data, where "themes are abstract constructs the investigators identify before, during, and after analysis" (Ryan and Bernard, 2000: 780). The six phases of analysis are shown in Table 3.3.

Table 3.3: Phases of Thematic Analysis

Source: Braun and Clarke (2006)

Thematic analysis has some phases that are similar to the phases involved with other forms of qualitative study, thus these stages are not necessarily unique to thematic analysis. Patton (1990) considers it important to recognize that such qualitative analysis guidelines need to be applied flexibly to fit the research objectives and data. Moreover, analysis is not a linear process of simply moving from one phase to the next. Analysis involves a constant moving back and forth between the entire data set, the coded extracts of data and the analysis of the data. In this research, the study findings and the study's theoretical framework were closely interlinked and related. Since the framework was integrated, flexible and interactive, it was adopted as a key guide for analyzing relevant data, including for the organization of the qualitative data derived from the semi-structured interviews and also for their coding analysis.

As processes of analysis on this studying were based on the conceptual framework and also relied on Braun and Clarke's phases of thematic analysis, the data analysis of this study took the following steps. First, the researcher read through all transcriptions and at the same time took notes or marked ideas for coding. Second, initial codes were produced from the data. Codes identify a feature of data that appears interesting to the researcher, and refer to "the most basic segment, or element, of the raw data or information that can be assessed in a meaningful way regarding the phenomena" (Boyatzis, 1998: 63). The researcher worked systematically through the entire data set; gave full and equal attention to each data item; and identified and coded possibly interesting aspects in the data. A little of the surrounding data was kept if relevance, since a common criticism of coding is that the context can be lost (Bryman, 2004). In the third and fourth step, the different codes were sorted into potential themes and all the relevant coded data extracts were collated within the identified themes. Some initial codes went on to form main themes, whereas others formed sub-themes, and still others were discarded. The literature review and the conceptual framework also assisted in identifying these themes. Nothing was discarded at this stage, as it was uncertain whether the themes were to remain as they were, or whether some needed to be combined, refined and separated, or discarded.

The fifth step focused on refining and naming the themes. During this step, the candidate themes were refined so that they formed a coherent pattern. If the candidate themes did not fit, re-coding took place as coding was an ongoing organic process. Sub-themes were identified as part of the refinement. Then the final refinements of the themes were applied, and the researcher analysed the data within them. The final analysis and write-up of the thesis was the last step of this process. Furthermore, at every stage, the coding was subject to modifications to ensure its appropriateness, accuracy and coherence, with this process continuing through to the end.

3.8.2 Quantitative data analysis

From interviews, the quantitative data about comparing the importance of each performance measurement factor from the conceptual framework also collected for measuring performance of supply chain for each case study company by using the analytic hierarchy process (AHP). The analytic hierarchy process is a multi-criteria

decision making tool developed by Saaty (1980). AHP is a systematic procedure for representing the elements of any problem, hierarchically. According to Jagdev *et al*. (2004) since decision making in the strategy formulation domain is often fraught with uncertainty, the decision maker should be able to express a degree of belief and confidence in its judgment. AHP provides a theory and a corresponding methodology, which support the modelling of unstructured problems.

AHP involves the following steps:

- *Problem decomposition and hierarchy construction:* The top level of the hierarchy is the overall objective. The next level is the criteria. Below this level are the sub criteria.
- *Determine alternatives:* The decision alternatives are constructed and added to the lowest level of the hierarchy.
- *Pair-wise comparison:* Pair-wise comparison aims at determining the relative importance of the elements in each level of the hierarchy. It starts from the second level and ends at the lowest level. The decision maker needs to express the preference between each pair of the elements.
- *Weight calculation:* Mathematical normalization methods are used to calculate the priority weights for each level.
- *Consistency check:* A consistency ratio (CR) is calculated. If it is greater than 10 per cent, then the decision maker is not consistent in making the pair-wise comparison. The decision maker should review the comparison and make adjustment.
- *Hierarchical synthesis*: The calculated priority weights at different hierarchy levels are integrated to allow overall evaluation of the alternatives.
- *Determine priority for all alternatives:* The alternative with the highest overall priority weight is chosen (Huan *et al.*, 2004).

The analytic hierarchy process was developed to reflect the way people naturally behave and think. It is a decision making tool that can help describe the general decision operation by decomposing a complex problem into a multi-level hierarchic structure of objectives, criteria, sub criteria and alternatives. AHP's hierarchic structure

reflects the natural tendency of the human mind to sort elements of a system into different levels and to group like elements in each level, which can facilitate decision maker's easy understanding from a human factor point of view (Huan *et al.*, 2004).

The AHP method has the following advantages (Abdul-Hamid, 1999):

- A subjective decision process can be formalised owing to the hierarchy structure. This leads to accurate decisions.
- Ensures consistency of the decision judgment.
- Clearer understanding of the problem by dividing it into sub-problems.
- The comparison may be made by teams or an iterative process until an agreement is reached by the team members.
- Sensitivity analysis may be performed by the results using computers before final judgment is rendered.

AHP has been used in a wide range of applications such as operations management decision making (Partovi *et al*., 1990), risk of projects management (Dey *et al.*, 1994), plant layout (Dweiri and Meirer, 1996), quality function deployment (Bergquist and Abesysekera, 1996), new product screening (Calantone, 1999), part-machining grouping (Ziilal and Arikan, 2000), benchmarking project management (Dey, 2002), performance assessment (Jagdev *et al*., 2004), project evaluation and selection (Dey, 2004, 2006), material selection (Dweiri and Al-oqla, 2006), operational performance measurement (Dey *et al.*, 2006) and site selection (Dey and Ramcharan, 2008). This research proposes the use of the analytic hierarchy process as aid in measuring the performance of supply chain of participating organizations.

3.8.3 Triangulation

Triangulation generally has been considered a process of using multiple perceptions to clarify meaning, verifying the repeatability of an observation or interpretation (Stake, 2008). Triangulation helps to identify similar and different realities (Stake, 2008). Method triangulation involves collecting information from a range of individuals and settings using various methods. The use of a variety of methods can reduce the risk that the conclusions may only reflect the systematic biases or limitations of a specific

method. Fontana and Frey (2005) state that humans are complex and that their lives are ever changing. Thus, the more methods we use to study humans, the better our chances will be to gain some understanding of how they construct their lives and the stories they tell us about them (Fontana and Frey, 2005). Triangulation can also allow the researcher to gain a better assessment of the validity and generality of the explanations that the researcher develops and give the researcher's conclusions more credibility (Maxwell, 1996). Therefore, a strategy of triangulation was used to increase the likely trustworthiness of the interpretations emerging in this study. The types of triangulation used here combined multiple methods approach and data sources to add analytical rigor and depth.

A multi-methods approach or method triangulation (Decrop, 1999) was used in this present study. This entails the use of a combination of methods, including interviews, non-participant observation, and secondary data analysis for this study. In this case, the findings from interviews were cross-checked with the results of observations made during the site visits and with documentation analysis.

Another type of triangulation used in this study was data triangulation (Decrop, 1999) which involves the use of various data sources. In this study, the findings were generated from the use of a variety of secondary data, such as organisational reports, work process documents, handouts, notifications, and public documents, as well as primary data, such as interviews and observational evidence. This mix of sources allowed for additional cross-checking of the findings in order to evaluate their internal consistency and to increase reliability.

3.9 Validity and reliability

As mentioned earlier, this study was a qualitative research and used case study approach. Qualitative research does have its criticisms; the two most common criticisms are 'reliability' and 'validity' (Silverman, 2000). The issue of 'validity' is usually posed in terms of what constitutes a credible claim to the truth. The validity of an explanation can sometimes be doubted because the research has clearly made no attempt to deal with the contrary cases (Silverman, 1993). Qualitative research is, by

definition, stronger on long descriptive narrative than on statistical tables (Silverman, 2000). The problem of 'reliability' that arises here is how a qualitative researcher goes about categorising the events or activities described. Even when the study is tape-recorded and transcribed, the reliability of the interpretation of the transcripts may be questioned (Silverman, 2005).

Silverman (2000) suggests two responses to the question of validity; they are 'triangulation' and 'respondent validation'. Triangulation refers to the attempt to get a true 'fix' on a situation by combining different ways of looking at the findings. For example, 'data triangulation' involves the use of a variety of data source. This research uses interviews as primary data; and documents and reports from the case study companies, plus other public documents as secondary data. Data triangulation also encompasses the field notes written during and immediately after each interview. This study also employs 'informant triangulation' which simply involves considering a broad range of informants and comparing what they say. Multi sources of evidence were used when conducted the interviews with different members of the departments (e.g. manager, deputy manager, assistant manager and officers). By combining data sources, informants and methods, triangulation opens the way for more credible interpretations (Decrop, 2004).

Respondent validation suggests that we should go back to the subjects with tentative results and refine them in light of our subjects' reactions. This research asked respondents to refine their comments as it was hoped that their responses were the truest representation. Therefore, the respondents had the opportunity to further comment on the issues identified by the researcher. Respondents were also assured that their names would not appear in the study, and it was hoped that this would encourage respondents to provide real opinions without concern for recrimination.

Although the term 'reliability' is a concept used for testing or evaluating quantitative research, the idea is most often used in all kinds of research. Eisner (1991) states that if we see the idea of testing as a way of information elicitation then the most important test of any qualitative study is its quality. A good qualitative study can help us understand a situation that would otherwise be enigmatic or confusing (Eisner, 1991). This relates to the concept of a good quality research when reliability is a concept to

evaluate quality in quantitative study with a purpose of explaining while quality concept in qualitative study has the purpose of generating understanding (Stenbacka, 2001). To ensure reliability in qualitative research, examination of trustworthiness is crucial. Seale (1999) points that the trustworthiness of a research report lies at the heart of issues conventionally discussed as validity and reliability.

One of the ways to assess the reliability of the case study method which was used in the research is to use external experts experienced. Churchill (1979) argues that external experts can become an important source of knowledge and better judgment. This research uses an appropriate panel of experts from both academic and industrial aspects to finalize a suitable set of performance measurement factors for the conceptual framework. On the other hand, to increase internal consistency, this study also collected data from multiple sources (i.e. semi-structured interviews, observation, work process documents, handouts and reports from the case study companies, plus other public documents and notifications from the Federation of Thai Industries).

3.10 Research limitations

The research followed a well-prepared process based on a carefully developed research design. Despite this, there were four main limitations affecting this study. First, the researcher was a novice in the use of interviews. The researchers' necessary skills are to make the interview flow as planned, and here the researcher considered he had advantages of being a good listener and of having an enquiry mind, and these helped him to achieve the task. Legard *et al.* (2003) note that among the abilities of researchers listening is fundamental to the art of interviewing. The researcher must hear, digest and comprehend the participant's answers in order to decide how to probe further. An enquiring mind or curiosity is also an essential asset for an in-depth interviewer. It greatly helps if the researcher wants to know more about what they have been told (Legard *et al.,* 2003). Furthermore, the four pilot interviews supported the researcher to exercise and develop his skills.

A second limitation was that there were limited resources for the research. Financial resources and time available were concerns for the researcher as the fieldwork was

undertaken in Thailand and in locations away from the researcher's own residence in Thailand. It was costly to travel to Thailand and to make frequent trips between the researcher's own residence and the case study areas, and the actual expenses were greater than expected. Third, during some interviews, there was interference, such as from working machine noise, which caused some difficulty in the later transcribing. Note-taking, however, to some extent overcame this problem. Thus, field notes supported the data gained through the recorded files, particularly in this type of situation. Finally, there was scant previous research and secondary data on the topic being studied, including statistical data, public documents, and previous academic research on supply chain management in Thailand. It is clear that this issue is under-researched for Thailand. However, the researcher put his efforts and time to search for what secondary data there was by visiting various related public and private organisations.

3.11 Research ethics

Ethical issues are highly regarded amongst academic institutions. Ethical issues are concerned with the morality of human conduct, and are especially relevant in relation to research. Their vital role is to protect the rights of human subjects. Ethics is becoming an increasingly prominent issue for all researchers. This comprehensive and accessible guide introduces students to the field and encourages knowledge of research ethics in practice (Israel and Hay, 2006).

Stake (2008) states that qualitative researchers are guests in the private spaces of the world. Qualitative research shares an intense interest in personal views and circumstances, and those people whose lives and expressions are portrayed risk exposure and embarrassment (Stake, 2008). Thus, it is important that great caution is exercised to minimize the risks to participants (Stake, 2008). Consequently, ethical issues were prominent throughout this research process, including during the preparation prior to the fieldwork, the fieldwork and also during the analysis and writing up. First, when making contact with respondents, the researcher clarified the research aims and explained that the information would be used only for research purposes.

Second, when conducting the interviews, both honesty and respect for the rights of individuals were the priority. According to Kimmel (1988), voluntary informed consent is considered by many as the central norm governing the relationship between the researcher and the participants. In order to gain informed consent in this study, the interviewees were told that their participation was voluntary, that they might leave questions that caused them any concern and that they might end the conversation any time they wanted. The interviewees were again reassured about their confidentiality and that the research findings would be used only for academic purposes. Christians (2005) notes that confidentiality must be assured as the primary safeguard against unwanted exposure. Thus, all personal data were kept secure and made public only behind a shield of anonymity.

Finally, the privacy of companies' identities was maintained throughout the research process. Privacy and confidentiality differ in the sense that the former pertains to persons and the latter pertains to information and data (Kimmel, 1988). An extension of privacy refers to agreements between persons that limit others' access to private information (Kimmel, 1988). Thus, access to the recorded files was limited only to the researcher, and the companies' identities were protected by using anonyms. Assumed names were based on the industrial groups to which companies belonged as follows: the Thai Food Processing Company (TFPC) stands for the case study company that represented for food processing industrial group, the Thai Chemical Company (TCC) stands for the case study company that represented for chemical industrial group, and the Thai Textile Company (TTC) stands for the case study company that represented for textile industrial group. Also, great care was taken to accurately transcribe data (remaining within the participants' own language) and to interpret the findings with honesty and sensitivity.

3.12 Conclusion

This chapter has presented the philosophy and methodology that has guided the research designs, methodology and methods. The approaches used were greatly influenced by a constructivist approach to understanding the reality of supply chain management and of responses to supply chain performance of manufacturing sector in

Thailand. The use of a qualitative research approach was considered appropriate in order to understand the social reality from the respondents' perspectives and to obtain in-depth and rich data. This research used a case study approach and various qualitative methods: in-depth interviews, observation and secondary data gathering. These were used to allow for method and data triangulation so as to increase the strength of the study findings. Semi-structured, in-depth interviews were the main method used to obtain data, and these were obtained using a purposive sampling approach. Three main industrial groups were used as the target case study companies: chemical, food processing, and textile. The interviews were conducted from January to April 2009 and two additional visits to the case study companies in Thailand. The results of the study emerged through the use of carefully developed coding, thematic analytical approach, and the analytic hierarchy process (AHP). This study also encountered some limitations, despite the well-prepared research process, and these were explained.

The following chapter identifies the development of conceptual framework that uses for this research. The proposed framework has the intention to explain the conceptual logic and direction of this study.

Chapter 4 The Conceptual Framework

4.1 Introduction

This chapter is introduced the conceptual framework that has been developed for this study. The framework developed for this study was devised based on approaches and concepts identified in the literature review in Chapter Two. The purpose of the framework is to explicate the conceptual logic and direction of this study. It engages leading ideas and helps to explain the significance of this study's concepts.

The following four sections outline purpose and development of the framework, framework themes, performance measurement factors in the framework and application of the framework to the study. The first section is presented to explain development of the framework which is influenced by the research aim and objectives, as well as by measurement's framework of decision making levels and supply chain macro processes concept. The second section outlines six key themes of the study. This seeks to explain their significance as the theoretical basis of this study. Next, there are details of each of performance measurement factor that are contained in the proposed framework, based on six keys themes. A discussion of application of the framework is identified in a final section.

4.2 Purpose and development of the conceptual framework

A key aim of this research was to develop a conceptual framework to understand supply chain performance measurement as a form of the holistic performance of supply chain management by combining both supply chain macro processes and decision making levels. This framework will provide a balanced horizontal (cross-process) and vertical (hierarchical decision) view in the developing world context, in this case, Thailand. The specific research objectives in this study (in Table 4.1 and Chapter One) have influenced the development of the themes in the framework.

Table 4.1: Specific objectives of research

1. To identify performance measurement factors with respect to supplier relationship management, internal supply chain management and customer relationship management against strategic, tactical and operational levels for a supply chain performance measurement framework. 2. To develop a conceptual framework based on proposed performance measurement factors. 3. To validate the proposed framework by applying it to the case study companies in the Thai manufacturing sector for the following purposes: 3.1 To evaluate supply chain performance in relation to performance measurement factors 3.2 To determine the importance of the performance measurement factors by using the analytic hierarchy process (AHP).

In line with the research objectives of the study, the framework has been developed with a view to its application in the context of the three case study companies in the Thai manufacturing sector: the Thai Food Processing Company (TFPC) (stands for the case study company that represented for food processing industrial group), the Thai Chemical Company (TCC) (stands for the case study company that represented for chemical industrial group) and the Thai Textile Company (TTC) (stands for the case study company that represented for textile industrial group). However, it was considered that a subsequent review of the framework, post-fieldwork, might allow the researcher to adjust the framework according to its applicability in this case, and to evaluate its potential application for other case study companies or other business sectors in developing country contexts.

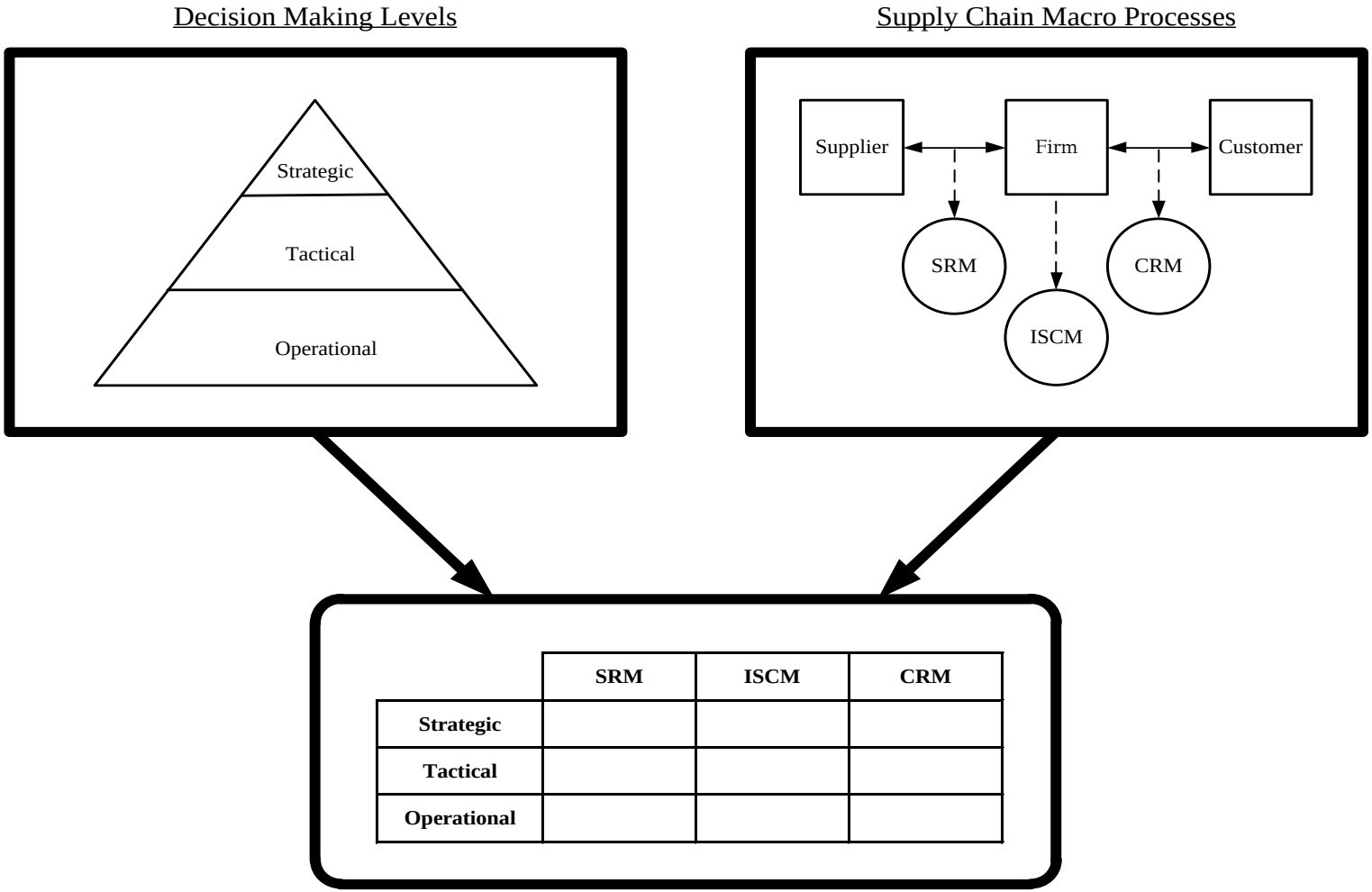
When the framework was first developed it was fairly loose, in order to accommodate different circumstances in different types of business sectors at different points in time. It should be able to accommodate different patterns of supply chain system in different businesses, different stages of supply chain management. It also allows topics and trends to emerge from the field work, without predetermining what these might be. Moreover, it allows these topics and trends to emerge from the interviews and other data sources used in the study.

A review of previous research in relation to supply chain management has highlighted a lack of consideration of performance measurement for supply chain, particularly in developing countries. By exploring the themes relating to supply chain performance as a form of performance measurement, it is anticipated that the research will lead to a more comprehensive understanding of supply chain performance measurement in developing countries, in this case Thailand. The framework also allows the researcher to evaluate its potential application for the performance measurement of supply chain system in other case study companies or other business sectors in developing country contexts. The framework is meant to apply in developing countries. However, the application of framework to the develop nations is also possible.

The attention of many researchers has often focused on single area of performance measurement, while they have relatively neglected research on the whole performance of supply chain management. Concerning these gaps, the framework developed for this study uses the concept of decision making levels and supply chain macro processes as its approach to the study of the holistic supply chain performance measurement. The concept of decision making levels and supply chain macro processes is related to the various performance measurement factors through their interactions. These performance measurement factors are identified in the six key themes of the conceptual framework as follows: three decision making levels in strategic, tactical and operational; and three supply chain macro processes on supplier relationship management (SRM), internal supply chain management (ISCM) and customer relationship management (CRM).

Figure 4.1 illustrates the conceptual framework investigated in this study. The conceptual framework presents the concept of integrated performance measurement approach by combining both decision making levels and supply chain macro processes for measuring the holistic performance of supply chain management. The framework comprises two elements in rectangles and one element in a rounded rectangle. It suggests that the combination between these two rectangles will influence on the development of the more holistic performance measurement of supply chain system.

Figure 4.1: The conceptual framework of supply chain performance measurement



The decision making levels concept (the left rectangle in Figure 4.1) is the intention to measure the performance in vertical (hierarchical decision) view. By contrast, the supply chain macro processes concept (the right rectangle in Figure 4.1) is the intention to measure the performance in horizontal (cross-process) view. Both of them have relationship through their interactions to develop an integrated supply chain performance measurement conceptual framework (the central rounded rectangle in Figure 4.1) in this study.

4.3 The conceptual framework themes

The framework has been developed from concepts in two fields of study, namely decision making levels and supply chain macro processes for measuring the holistic performance of supply chain system. In each concept, it comprises of three themes of study. Decision making levels divide into strategic, tactical and operational. For supply chain macro processes, it can be classified into supplier relationship management (from upstream supplier), internal supply chain management (within company) and customer relationship management (from downstream customer). Therefore, the total themes of the conceptual framework are six key themes. These six conceptual themes (shown in Figure 4.1) and their detailed elements are discussed in next turn.

4.3.1 Decision making levels

There is a close connection between the design and management of supply chain flows (information, product and funds) and the success of a supply chain (Chopra and Meindl, 2004). Some companies have built their success on superior strategy and operation of their supply chain. In contrast, the failure of many businesses can be attributed to weaknesses in their supply chain strategy and operation. Successful supply chain management requires many decisions relating to the flow of information, product, and funds (Chopra and Meindl, 2004). Each decision should be made to raise the supply chain profitability (supply chain surplus), the difference between the revenue generated from the customer and the overall cost across the supply chain (Chopra and Meindl, 2010). These decisions fall into three categories or levels: strategic, tactical and operational; depending on the authority decision level, the frequency of each decision

and the time frame which a decision level has an impact. As a result, each category of decisions must consider uncertainty over the decision level (Chopra and Meindl, 2007).

4.3.1.1 Strategic decision making level

During this level, given the marketing and pricing plans for a product, a company decides how to structure the supply chain over the next several years (Chopra and Meindl, 2010). It decides what the chain's configuration will be, how resources will be allocated, and what processes each stage will perform. Strategic decisions made by top level management decision makers include whether to outsource or perform a supply chain function in-house, the location and capacities of production and warehousing facilities, the products to be manufactured or stored at various locations, the modes of transportation to be made available along different shipping legs and the type of information system to be utilized (Gunasekaran *et al*., 2004). A firm must ensure the supply chain configuration supports its strategic objectives and increases the supply chain surplus during this level. Supply chain strategic decisions are typically made for the long term (a matter of years) and are very expensive to alter on short notice. Consequently, when companies make these decisions, they must take into account uncertainty in anticipated market conditions over the next few years (Chopra and Meindl, 2007).

4.3.1.2 Tactical decision making level

For decisions made during this level, the time frame considered is a quarter to a year. Therefore, the supply chain's configuration determined in the strategic level is fixed (Chopra and Meindl, 2010). This configuration establishes constraints within which tactic must be done. The goal of tactic is to maximize the supply chain surplus that can be generated over the tactical level given the constraints established during the strategic level. Companies start the tactical level with a forecast for a coming year (or a comparable time frame) of demand in different markets (Chopra and Meindl, 2010). Tactical decisions made by mid-level management decision makers include making decisions regarding which markets will be supplied from which locations, the subcontracting of manufacturing, the inventory policies to be followed, and the timing and size of marketing and price promotions (Gunasekaran *et al*., 2004). Tactic

establishes parameters within which a supply chain will function over a specified period of time. In the tactical level, companies must include uncertainty in demand, exchange rates, and competition over this time level in their decisions (Chopra and Meindl, 2007). Given a shorter time frame and better forecasts than the strategic level, companies in the tactical level try to incorporate any flexibility built into the supply chain in the strategic level and exploit it to optimize performance. As a result of the tactical level, companies define a set of operating policies that govern short-term operations (Gunasekaran *et al*., 2004).

4.3.1.3 Operational decision making level

The time frame here is weekly or daily, and during this level companies make decisions regarding individual customer orders. At the operational level, supply chain configuration is considered fixed, and tactic policies are already defined (Chopra and Meindl, 2010). The goal of supply chain operations is to handle incoming customer orders in the best possible manner. During this level, operational decisions made by low level managers include allocate inventory or production to individual orders, set a date that an order is to be filled, generate pick lists at a warehouse, allocate an order to a particular shipping mode and shipment, set delivery schedules of trucks and place replenishment orders (Gunasekaran *et al*., 2004). Because operational decisions are being made in the short term (minutes, hours, or days), there is less uncertainty about demand information (Chopra and Meindl, 2007). Given the constraints established by the configuration and tactic policies, the goal during the operational level is to exploit the reduction of uncertainty and optimize performance (Huan *et al.*, 2004).

The strategic, tactical and operational decision making levels of a supply chain have a strong impact on overall profitability and success. It is fair to state that a large part of the success of firms can be attributed to their effective supply chain strategic, tactical, and operational decision making levels (Gunasekaran and Kobu, 2007). The reason for studying the performance measurement system and performance measurement factors at the strategic, tactical, and operational levels is to make the right decisions so that they can support each other in achieving the overall goals and objectives of an organization. The success of strategy formulation depends upon the degree of alignment of strategies at different levels (Gunasekaran and Kobu, 2007).

4.3.2 Supply chain macro processes

All supply chain processes can be classified into the following three macro processes: supplier relationship management which represents for all processes that focus on the interface between the company and its suppliers; internal supply chain management which represents for all processes that are internal to the company; and customer relationship management which represents for all processes that focus on the interface between the company and its customers. The three macro processes manage the flow of information, product, and funds required to generate, receive, and fulfil a customer request (Chopra and Meindl, 2004). Customer relationship management and supplier relationship management form the critical links in the supply chain and the internal supply chain management process is coordinated through them. Each of the macro processes is cross-functional and cross-firm. Cross-functional teams are used to define the structure for managing the process at the strategic level and implementation at the operational level (Lambert *et al.*, 2005).

4.3.2.1 Supplier relationship management process

The supplier relationship management provides the structure for how relationships with suppliers are developed and maintained (Croxton *et al.*, 2001). Cross-functional teams tailor product and service agreements with key suppliers (Lambert *et al.*, 2005). Supplier relationship management macro process aims to arrange for and manage supply sources for various goods and services. Supplier relationship management processes include the evaluation and selection of suppliers for various products; negotiation of pricing and delivery terms with suppliers; the placement of replenishment orders; sharing of demand and supply plans with suppliers; and communication regarding new products and orders with suppliers (Croxton *et al.*, 2001).

4.3.2.2 Internal supply chain management process

The internal supply chain management macro process aims to fulfil demand generated by the customers in a timely manner and at the lowest possible cost (Chopra and Meindl, 2004). Internal supply chain management process needs to balance the

customers' requirements with the company's supply capabilities, which includes forecasting demand and synchronizing it with production, procurement, and distribution (Vollmann *et al.*, 1997). A key to effective internal supply chain management is to meet customer requirement in terms of order fulfilment. Effective order fulfilment requires integration of the firm's manufacturing, logistics, and marketing plans. The company should develop partnerships with key members of the supply chain to meet customer requirements and reduce total delivered cost to customer (Kumar and Sharman, 1992). Moreover, the internal supply chain management process deals with making the products and establishing the manufacturing flexibility needed to serve the target markets, which includes all activities necessary for managing the product flow through the manufacturing facilities and for obtaining, implementing, and managing flexibility (Lambert *et al.*, 2005). Internal supply chain management processes include the planning of internal production by deciding which products to carry at each warehouse; planning of storage capacity for the location and size of warehouses; preparation of demand and supply plans by defining inventory management policies; and fulfilment of actual orders by picking, packing and shipping that orders (Croxton *et al.*, 2001).

4.3.2.3 Customer relationship management process

The customer relationship management provides the structure for how relationships with customers are developed and maintained (Croxton *et al.*, 2001). Management identifies key customers and customer groups to be targeted as part of the company's business mission. Cross-functional customer teams tailor product and service agreements to meet the needs of key accounts, and segments of other customers (Lambert *et al.*, 2005). Customer relationship management macro process aims to generate customer demand and facilitate the placement and tracking of orders. Customer relationship management processes include pricing; the preparation of catalogues and other marketing materials; sales; management of the web site; order management and management of the call centre that takes orders and provides service (Croxton *et al.*, 2001).

From the fact that all three macro processes are serving the same customer, for a supply chain to be successful, it is crucial that the three macro processes are well integrated (Croxton *et al.*, 2001). The organizational structure of the firm has a strong influence on

the success or failure of the integration effort. In most common companies, purchasing oversees the supplier relationship management macro processes, manufacturing handles the internal supply chain management macro processes and marketing is in charge of the customer relationship management macro processes – with very little communication among them (Chopra and Meindl, 2010). It is not unusual for marketing and manufacturing to have two different forecasts when making their plans. The lack of integration hurts the supply chain's ability to match supply and demand effectively, leading to dissatisfied customers and high costs. Thus, companies should structure a supply chain organization that mirrors the macro processes and ensures good communication and coordination among the owners of processes that interact with each other (Chopra and Meindl, 2007).

4.4 The performance measurement factors in the conceptual framework

As this study developed the integrated conceptual framework by combining two main concepts, the performance measurement factors that contained in the conceptual framework are indentified on the three supply chain macro processes along with three decision making levels. Based on the literatures that were reviewed on Chapter Two in section 2.4.3 performance measurement factors for supply chain performance measurement (Table 2.4), the initial performance measurement factors are identified to represent the six key themes of the study.

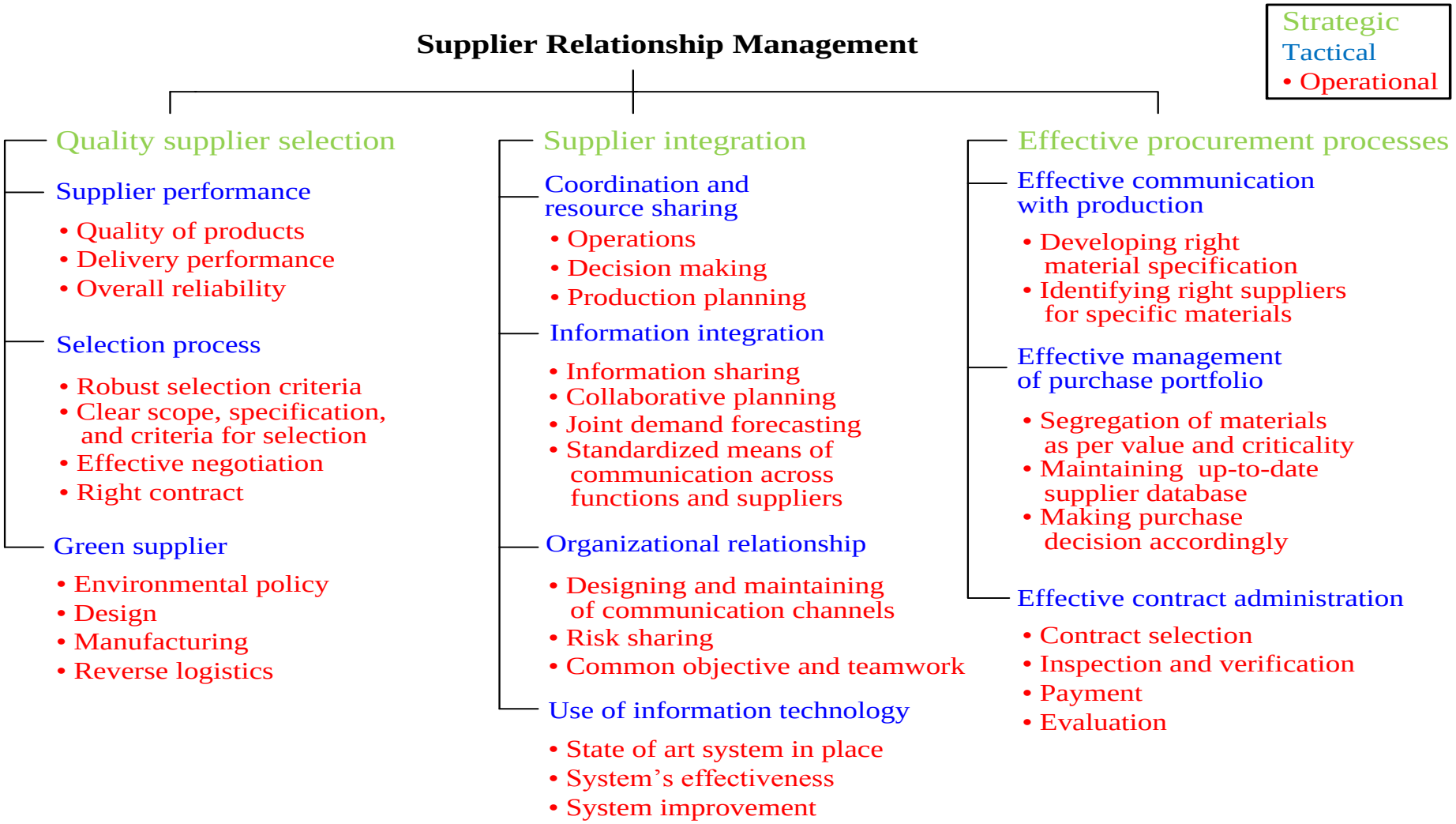
Then, to finalize a suitable set of performance measurement factors for this conceptual framework, the multidisciplinary panel of experts from both academic and industrial aspects was set up for this purpose. Performance measurement factors were examined and validated by an appropriate panel of experts to gather possible suggestions or amendments. From the academic aspect, the panel encompassed many scholars in the operation management field from universities in the United Kingdom, Australia and Thailand, chosen from among people whose research studies were mainly focused on supply chain management, performance measurement or manufacturing industry issues. From the industrial aspect, managers of manufacturing companies in the United Kingdom and Thailand were included in the panel. Panel members were selected from among people reporting directly to the firm's top management and operating in supply

chain management. After all, the particular sets of performance measurement factors were established and detailed as follows:

4.4.1 The performance measurement factors in supplier relationship management process

In Figure 4.2, the performance measurement factors of the supplier relationship management process are categorized hierarchically in three decision making levels: strategic, tactical and operational.

Figure 4.2: The performance measurement factors in supplier relationship management



4.4.1.1 The performance measurement factors in strategic decision making level

In strategic level of the supplier relationship management process, there are three performance measurement factors: quality supplier selection, supplier integration and effective procurement processes. *Quality supplier selection* refers to key criteria to select the suppliers that qualify the company's standard of quality. *Supplier integration* refers to a collaborative relationship between company and supplier which recognises some degree of interdependence and cooperation on a specific project or for a specific purchase agreement (Ellram, 1991). *Effective procurement processes* refers to the efficiency of the whole purchasing process to obtain the right materials from suppliers. Each performance measurement factor contains their related performance measurement factors in tactical level.

4.4.1.2 The performance measurement factors in tactical decision making level

From quality supplier selection in strategic level, there are three performance measurement factors: supplier performance, selection process and green supplier. *Supplier performance* refers to a measurement to describe how good a supplier can deliver raw materials to production facilities on time and in good conditions (Chan *et al.*, 2003). *Selection process* refers to the process to select the quality suppliers including selection criteria and negotiation. *Green supplier* refers to the environmental issues to evaluate and choose the suppliers.

For supplier integration, there are four performance measurement factors: coordination and resource sharing, information integration, organizational relationship and use of information technology. *Coordination and resource sharing* refers to the cooperation and sharing in resource with supplier. *Information integration* refers to the extent to which all functions between company and supplier can pass information smoothly (Chan *et al.*, 2003). *Organizational relationship* refers to the management of communication channels with supplier including shared objective and risk. *Use of information technology* refers to the capability of the current company's information technology system.

For effective procurement processes, there are three performance measurement factors: effective communication with production, effective management of purchase portfolio and effective contract administration. *Effective communication with production* refers to the procurement of specific materials for production department. *Effective management of purchase portfolio* refers to the administration of material classification and supplier database update. *Effective contract administration* refers to the management of payment and supplier's verification. Each performance measurement factor contains their related performance measurement factors in operational level.

4.4.1.3 The performance measurement factors in operational decision making level

From supplier performance in tactical level, there are three performance measurement factors: quality of products, delivery performance and overall reliability. According to Stewart (1995), an increase in delivery performance is possible through a reduction in lead-time attributes. Stewart (1995) also mentions that another important aspect of delivery performance is on-time delivery. On-time delivery reflects whether perfect delivery has taken place. For selection process, there are four performance measurement factors: robust selection criteria; clear scope, specification, and criteria for selection; effective negotiation and right contract. All of these performance measurement factors refer to the process to select company's quality supplier. For Green supplier, there are four performance measurement factors: environmental policy, design, manufacturing and reverse logistics. These performance measurement factors use for evaluating and choosing the suppliers in concern with environmental issues.

From coordination and resource sharing, there are three performance measurement factors: operations, decision making and production planning. For information integration, there are four performance measurement factors: information sharing, collaborative planning, joint demand forecasting and standardized means of communication across functions and suppliers. For organizational relationship, there are three performance measurement factors: designing and maintaining of communication channels, risk sharing and common objective and teamwork. All of the relationships within the supply chain contain inherent risk. *Risk sharing* describes the degree to which these risks are shared (Chan *et al.*, 2003). For use of information technology,

there are three performance measurement factors: state of art system in place, system's effectiveness and system improvement.

From effective communication with production, there are two performance measurement factors: developing right material specification and identifying right suppliers for specific materials. For effective management of purchase portfolio, there are three performance measurement factors: segregation of materials as per value and criticality, maintaining up-to-date supplier database and making purchase decision accordingly. For effective contract administration, there are four performance measurement factors: contract selection, inspection and verification, payment and evaluation.

4.4.2 The performance measurement factors in internal supply chain management process

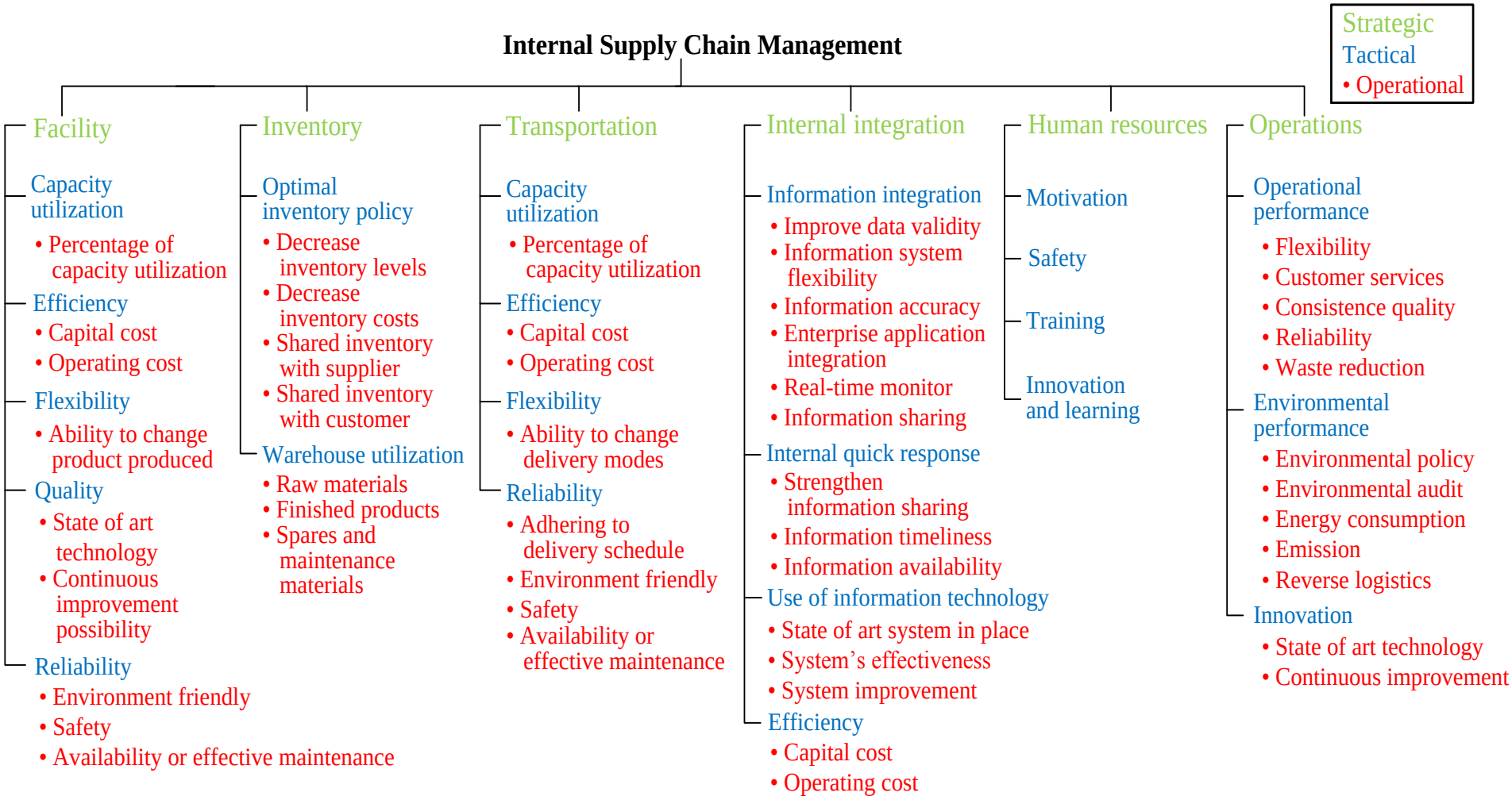
In Figure 4.3, the performance measurement factors of the internal supply chain management process are categorized hierarchically in three decision making levels: strategic, tactical and operational.

4.4.2.1 The performance measurement factors in strategic decision making level

In strategic level of the internal supply chain management process, there are six performance measurement factors: facility, inventory, transportation, internal integration, human resources and operations. *Facility* is the actual physical location in the supply chain network where product is stored, assembled or fabricated (Chopra and Meindl, 2007). The two major types of facility are production site and storage site. Decisions regarding the capacity, efficiency, flexibility, quality and reliability of facility have a significant impact on the supply chain's performance. *Inventory* encompasses all raw materials, work in process and finished goods within a supply chain. Changing inventory policies can dramatically alter the supply chain's efficiency and responsiveness (Chopra and Meindl, 2004). *Transportation* entails moving inventory from point to point in the supply chain. Transportation can take the form of many combinations of modes and routes, each with its own performance characteristics (Chopra and Meindl, 2010). *Internal integration* refers to a collaborative relationship

within company which recognises some degree of interdependence and cooperation on a specific project (van Hoek, 2001). Internal integration consists of information concerning facility, inventory, transportation, costs and prices throughout the supply chain. *Human resources* refer to the management of employees' improvement for a better company's internal supply chain. *Operations* refer to operational performance and environmental performance of the company including company's operational improvement. Each performance measurement factor contains their related performance measurement factors in tactical level.

Figure 4.3: The performance measurement factors in internal supply chain management



4.4.2.2 The performance measurement factors in tactical decision making level

From facility in strategic level, there are five performance measurement factors: capacity utilization, efficiency, flexibility, quality and reliability. According to Slack *et al.* (1995), *capacity utilization* directly affects the speed of response to customer demand through its impact on flexibility and lead-time. *Efficiency* measures how well the facility is utilized (Lai *et al.*, 2002). *Flexibility* indicates the degree to which the facility can respond to a changing environment and extraordinary demand requests (Beamon, 1998). *Quality* refers to technology and the process to improve facility performance. *Reliability* refers to the trustworthiness of the facility including its kindly with environment and safety.

For inventory, there are two performance measurement factors: optimal inventory policy and warehouse utilization. *Optimal inventory policy* refers to the policy to improve inventory management. *Warehouse utilization* refers to the usage of warehouse for all inventory materials.

For transportation, there are four performance measurement factors: capacity utilization, efficiency, flexibility and reliability. *Capacity utilization* directly affects the speed of response to delivery order through its impact on flexibility and deliverability (Slack *et al.*, 1995). *Efficiency* measures how well the transportation is utilized (Lai *et al.*, 2002). *Flexibility* may be measured as the ability to change or react with little penalty in time, effort, cost or performance (Upton, 1994). *Reliability* refers to the trustworthiness of the transportation including its delivery schedule, environment kindly and safety.

For internal integration, there are four performance measurement factors: information integration, internal quick response, use of information technology and efficiency. *Information integration* refers to the extent to which all functions within company can pass information smoothly (Chan *et al.*, 2003). *Internal quick response* refers to the sharing and availability of information between related departments in company. The role of information technology is shifting from a general passive management enabler through databases, to a highly advanced process controller that can monitor activities and decide upon an appropriate route for information (Gunasekaran *et al.*, 2004).

Modern information technology, through its power to provide timely, accurate and reliable information, has led to a greater integration of modern supply chains than possible by any other means (Benjamin and Wigand, 1995). *Efficiency* measures how well the internal supply chain is integrated by considering the related costs.

For human resources, there are four performance measurement factors: motivation, safety, training and innovation and learning. *Motivation* refers to the method to inspire employees to improve their ability. *Safety* refers to the degree to which the risks can reduce from work process. *Training* refers to the process to provide the professional skill to the work force. *Innovation and learning* refer to the management of increasing employee's capability in learning new knowledge.

For operations, there are three performance measurement factors: operational performance, environmental performance and innovation. *Operational performance* measures the quality, flexibility and reliability of company's procedure. *Environmental performance* relates to the environmental issues of the operational processes. *Innovation* refers to technology and the way to improve operating performance of the company. Each performance measurement factor contains their related performance measurement factors in operational level.

4.4.2.3 The performance measurement factors in operational decision making level

From capacity utilization in tactical level, there is one performance measurement factor: percentage of capacity utilization. For efficiency, there are two performance measurement factors: capital cost and operating cost. Both costs use to measure the efficiency of facility. For flexibility, there is one performance measurement factor: ability to change product produced. For quality, there are two performance measurement factors: state of art technology and continuous improvement possibility. For reliability, there are three performance measurement factors: environment friendly, safety and availability or effective maintenance.

From optimal inventory policy, there are four performance measurement factors: decrease inventory levels, decrease inventory costs, shared inventory with supplier and shared inventory with customer. For warehouse utilization, there are three performance

measurement factors: raw materials, finished products and spares and maintenance materials.

From capacity utilization, there is one performance measurement factor: percentage of capacity utilization. For efficiency, there are two performance measurement factors: capital cost and operating cost. For flexibility, there is one performance measurement factor: ability to change delivery modes. For reliability, there are four performance measurement factors: adhering to delivery schedule, environment friendly, safety and availability or effective maintenance.

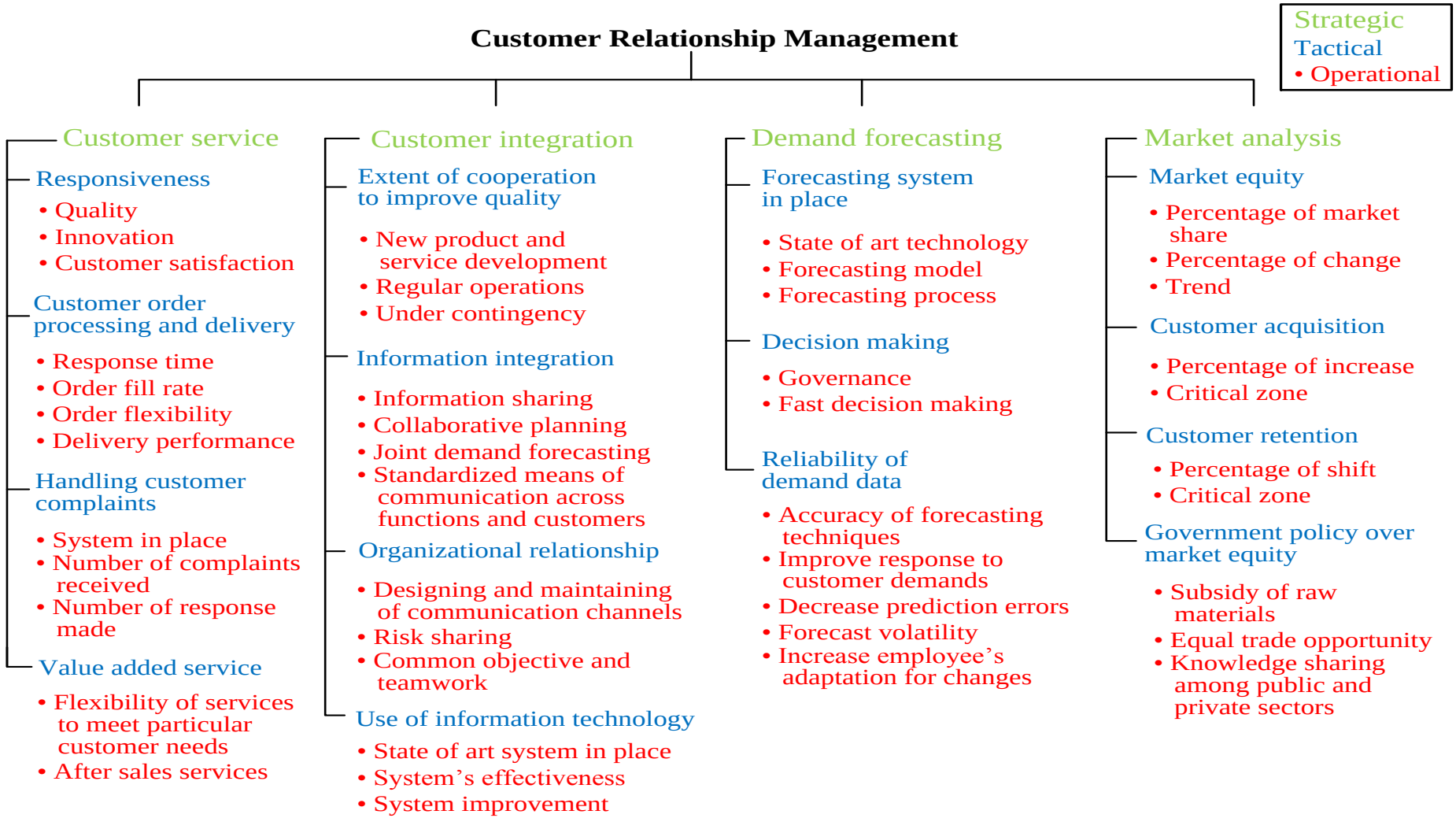
From information integration, there are six performance measurement factors: improve data validity, information system flexibility, information accuracy, enterprise application integration, real-time monitor and information sharing. For internal quick response, there are three performance measurement factors: strengthen information sharing, information timeliness and information availability. For use of information technology, there are three performance measurement factors: state of art system in place, system's effectiveness and system improvement. For efficiency, there are two performance measurement factors: capital cost and operating cost.

From operational performance, there are five performance measurement factors: flexibility, customer services, consistence quality, reliability and waste reduction. For environmental performance, there are five performance measurement factors: environmental policy, environmental audit, energy consumption, emission and reverse logistics. For innovation, there are two performance measurement factors: state of art technology and continuous improvement possibility.

4.4.3 The performance measurement factors in customer relationship management process

In Figure 4.4, the performance measurement factors of the customer relationship management process are categorized hierarchically in three decision making levels: strategic, tactical and operational.

Figure 4.4: The performance measurement factors in customer relationship management



4.4.3.1 The performance measurement factors in strategic decision making level

In strategic level of the customer relationship management process, there are four performance measurement factors: customer service, customer integration, demand forecasting and market analysis. *Customer service* refers to the provision of labour and other resources, for the purpose of increasing that value that buyers receive from their purchases and from the processes leading up to the purchase (Aramyan *et al.*, 2007). *Customer integration* refers to a collaborative relationship between company and customer which recognises some degree of interdependence and cooperation on a specific project or for a specific order agreement (Ellram, 1991). Generally, supply chain planning relies on forecast data, which becomes the basis for its production, material sourcing, inventory management, and all other activities in supply chain (Chae, 2009). *Demand forecasting* usually takes demand data from salespeople who receive sales and demand information from customers. *Market analysis* refers to the degree of company's market share and total number of customers including the government policy that affects the policy of company. Each performance measurement factor contains their related performance measurement factors in tactical level.

4.4.3.2 The performance measurement factors in tactical decision making level

From customer service in strategic level, there are four performance measurement factors: responsiveness, customer order processing and delivery, handling customer complaints and value added service. *Responsiveness* relates to the way it takes for a firm to respond to a customer query with the required information. It is not unusual for a customer to enquire about the status of order, potential problems on stock availability or delivery. A fast and accurate response to those requests is essential in keeping customers satisfied (Gunasekaran *et al*., 2004). *Customer order processing and delivery* aim to providing the requested products with a short lead-time (Persson and Olhager, 2002). *Handling customer complaints* refers to the process to deal with registered complaints from customers about product or service (Aramyan *et al.*, 2007). *Value added service* refers to the services to satisfy customer needs in both before and after sales.

For customer integration, there are four performance measurement factors: extent of cooperation to improve quality, information integration, organizational relationship and use of information technology. *Extent of cooperation to improve quality* refers to the collaboration with customers to improve products' quality and to develop new product in both normal situation and under contingency. *Information integration* refers to the extent to which all functions between company and customer can pass information smoothly (Chan *et al.*, 2003). *Organizational relationship* refers to the management of communication channels with customer including shared objective and risk. *Use of information technology* refers to the capability of the current company's information technology system.

For demand forecasting, there are three performance measurement factors: forecasting system in place, decision making and reliability of demand data. *Forecasting system in place* refers to the current forecasting system of the company including its technology and process. *Decision making* refers to the degree of transparency and speed of decision. *Reliability of demand data* refers to the trustworthiness of the demand data including its accuracy of forecast and decreasing of errors and volatility.

For market analysis, there are four performance measurement factors: market equity, customer acquisition, customer retention and government policy over market equity. *Market equity* refers to the number and the movement of market share. *Customer acquisition* refers to the number of customer increase and its source. *Customer retention* refers to the number of customer remain and its base. *Government policy over market equity* refers to the support from government and equal opportunity in the market. Each performance measurement factor contains their related performance measurement factors in operational level.

4.4.3.3 The performance measurement factors in operational decision making level

From responsiveness in tactical level, there are three performance measurement factors: quality, innovation and customer satisfaction. *Customer satisfaction* refers to the degree to which customers are satisfied with the product and/or service received (Chan *et al.*, 2003). For customer order processing and delivery, there are four performance measurement factors: response time, order fill rate, order flexibility and delivery

performance. *Response time* refers to the amount of time between an order being made and its corresponding delivery (Aramyan *et al.*, 2007). *Order fill rate* refers to the proportion of orders that can be filled immediately (Chan, 2003). *Order flexibility* can influence the decision of customers to place orders, and thus can be regarded as important in enchanting and retaining customers (Novich, 1990). Being flexible means having the capability to provide products or services that meet the individual demands of customers (Gunasekaran *et al*., 2004). For handling customer complaints, there are three performance measurement factors: system in place, number of complaints received and number of response made. For valued added service, there are two performance measurement factors: flexibility of services to meet particular customer needs and after sales services. *Flexibility of services to meet particular customer needs* refers to the flexibility in meeting a particular customer needs requirement at an agreement (Gunasekaran *et al*., 2004). The function of a supply chain does not end when goods are provided to the customer. *After sales services* play an important role in customer service and provide valuable feedback that can be used to further improve supply chain performance (Gunasekaran *et al*., 2004).

From extent of cooperation to improve quality, there are three performance measurement factors: new product and service development, regular operations and under contingency. Since time to markets determines the potential to realize premium prizes, the ability to, rather quickly, introduce new product and service becomes a prerequisite for sufficient profits (Otto and Kotza, 2003). For information integration, there are four performance measurement factors: information sharing, collaborative planning, joint demand forecasting and standardized means of communication across functions and customers. For organizational relationship, there are three performance measurement factors: designing and maintaining of communication channels, risk sharing and common objective and teamwork. All of the relationships within the supply chain contain inherent risk. *Risk sharing* describes the degree to which these risks are shared (Chan *et al.*, 2003). For use of information technology, there are three performance measurement factors: state of art system in place, system's effectiveness and system improvement.

From forecasting system in place, there are three performance measurement factors: state of art technology, forecasting model and forecasting process. For decision making,

there are two performance measurement factors: governance and fast decision making. For reliability of demand data, there are five performance measurement factors: accuracy of forecasting techniques, improve response to customer demands, decrease prediction errors, forecast volatility and increase employee's adaption for changes.
From market equity, there are three performance measurement factors: percentage of market share, percentage of change and trend. For customer acquisition, there are two performance measurement factors: percentage of increase and critical zone. For customer retention, there are two performance measurement factors: percentage of shift and critical zone. For government policy over market equity, there are three performance measurement factors: subsidy of raw materials, equal trade opportunity and knowledge sharing among public and private sectors.

4.5 The application of the conceptual framework to this study

The conceptual framework which has been outlined in previous sectors helps to connect to all aspects of this research inquiry, including its purpose, literature review, methodology, data collection and analysis. It was applied to this study in various ways. First, it assisted as a guideline in outlining the themes in the earlier literature review chapter. Second, the framework was used to guide the fieldwork, notably in developing the topics in the questions for the interviews with respondents. The questions reflected the detailed elements of each theme. Third, the results chapter is also drawn from the framework. Two results chapters were then developed to explain the critical analysis. These included the chapters on the performance of supply chain of the three case study companies and the measurement of case study companies' supply chain performance. Finally, the framework provided guidance for data analysis, as it helped to outline the themes in the results chapters. The broad themes were developed to generate and categorise the data to be interpreted, analysed and subsequently reported in the results chapters.

4.6 The validity of the conceptual framework

As mentioned earlier (Section 4.4 the performance measurement factors in the conceptual framework), the appropriate panel of experts was conducted after the initial performance measurement factors had been constructed, specifically in order to examine and validate them. Finally, the particular sets of performance measurement factors for the conceptual framework were established.

This study uses a qualitative research and a case study approach, and develops a conceptual framework for supply chain performance measurement. The proposed framework is applied to three companies of manufacturing sector in a developing country, Thailand in order to test the conceptual framework. Then, to validate the conceptual framework, the feedback interview questions were issued to capture the perceptions of the respondents after each interview. These feedback questions were about the:

- usability of the framework;
- usefulness of the framework for organizational decision making;
- comparability with their existing performance measurement framework;
- possibility of adopting the framework into the company;
- future improvement of the framework.

In overall response, the respondents were fairly positive about the conceptual framework for measuring performance of supply chain of their department, as well as other departments, in order to adopt a uniform approach to improving performance across the company. They were also in favour of adopting the framework for decision making about the companies' effective supply chain system. They indicated that the understanding of the principle and usability of the framework were not at all difficult and the conceptual framework was compatible with their system of work. Their perceptions revealed that they appreciated the holistic and integrated nature of the framework and realized the importance of involving every level of stakeholder opinion before reaching a consensus decision. However, they agreed that the success of its use would largely depend on the effectiveness of the application processes and experiences of the stakeholders involved. Although they had little doubt about the performance measurement factors in operational decision making level from the proposed

framework, they did express some concerns about the variety of the performance measurement factors in operational level. They had different aspects of the performance measurement factors in operational level, due to the different type of business on these case study companies. Some factors might not be the performance measurement factors for them but they could be the performance measurement factors for other companies. They suggested that the performance measurement factors in strategic and tactical level could fully apply to the companies but the performance measurement factors in operational level might be adapted to suitable for each particular company. The researcher also agreed with these ideas because the detailed analysis of the supply chain performance on performance measurement factors in tactical decision making level would provide sufficient information to measure the supply chain performance for the case study companies. Therefore, the decision of selecting the appropriate performance measurement factors in operational level should assign to the proper actor.

4.7 Conclusion

This chapter has explained the purpose and the development of the conceptual framework, as well as the application of the conceptual framework to this study. The conceptual framework was developed to explore and to understand the performance of supply chain management in a developing world context. The framework was influenced by several concepts from a developed world context. However, it also considered the practices and realities of developing world contexts. The framework worked as a guide and it directed the literature reviews, the interview questions, and the data analysis.

The framework was developed from concepts in two fields of study: decision making levels and supply chain macro processes for measuring the holistic performance of supply chain system. In each concept, it comprises three themes of study. Decision making levels divide into strategic, tactical and operational; depending on the authority decision level, the frequency of each decision and the time frame which a decision level has an impact. On other hand, supply chain macro processes classify into supplier relationship management (from upstream supplier), internal supply chain management (within company) and customer relationship management (from downstream customer).

The three macro processes manage the flow of information, product, and funds required to generate, receive, and fulfil a customer request. The concept of decision making levels and supply chain macro processes was related to the various performance measurement factors through their interactions. These performance measurement factors were identified in the six key themes to complete the proposed framework of this study. Each performance measurement factor represented in the conceptual framework was categorized hierarchically in three decision making levels for each supply chain macro process. Therefore, the performance measurement factors that have been outlined in conceptual framework help to connect both decision making levels and supply chain macro processes for measuring the holistic performance of supply chain system.

From the idea of integrated way for the conceptual framework, the proposed model of this study has been developed from the review of literature concentrated on the issues surrounding supply chain performance measurement and involving the variety of frameworks and performance measurement factors. As a result, the initial model was created. Then, the multidisciplinary panel of experts from both academic and industrial aspects was set up for examining and validating set of performance measurement factors. After all, the conceptual framework that comprises a suitable set of performance measurement factors is presented and applied to Thai manufacturing companies.

The next two chapters discuss the study findings and present a critical analysis of the research. The first of these chapters investigates the supply chain performance based on the performance measurement factors in the three case study companies. These performance measurement factors are identified in the proposed conceptual framework as explained in this chapter.

Chapter 5 Supply Chain Performance

5.1 Introduction

This chapter provides a detailed investigation of the supply chain performance in relation to performance measurement factors in the three case study companies: the Thai Food Processing Company (TFPC), the Thai Chemical Company (TCC) and the Thai Textile Company (TTC). These performance measurement factors were identified in the study's conceptual framework as explained in Chapter Four. The chapter discusses the details of the supply chain performance based on the two main concepts: the supply chain macro processes and the decision making levels that emerged from the qualitative analysis of Thai manufacturers. The results are mainly drawn from interviews with three different types of departments to represent the three supply chain macro processes and to cover the whole supply chain system of each participating company. There are the respondents from purchasing department to represent the relationship with supplier, the respondents from marketing department to represent the relationship with customer and the respondents from production department to represent the internal supply chain of the company. The observation and company documents also provide relevant information about the topic. Additional, the analysis of the data relates to the question themes in Appendix 2 (interview questions for studying supply chain performance on supplier relationship management), Appendix 4 (interview questions for studying supply chain performance on internal supply chain management), and Appendix 6 (interview questions for studying supply chain performance on customer relationship management). This chapter comprises three themes: supplier relationship management, internal supply chain management and customer relationship management. As a result, the insights from the cases help to understand the current performance of supply chain on the Thai manufacturing sector companies.

5.2 Supplier relationship management

The supplier relationship management provides the structure for how relationships with suppliers are developed and maintained (Croxton *et al.*, 2001). This supplier relationship management process represents for all processes that focus on the interface between the company and its suppliers (Chopra and Meindl, 2004). Supplier relationship management macro process aims to arrange for and manage supply sources for various goods and services. Based on the proposed supply chain performance measurement framework in Chapter Four, supplier relationship management has three performance measurement factors in strategic decision making level. They are quality supplier selection, supplier integration and effective procurement processes. In summary, there is the brief comparison of each performance measurement factor in tactical decision making level for three case study companies as shown in Table 5.1.

5.2.1 Quality supplier selection

Quality supplier selection refers to key criteria to select the suppliers that qualify the company's standard of quality. Under quality supplier selection, there are three performance measurement factors in tactical decision making level. They are supplier performance, selection process and green supplier.

5.2.1.1 Supplier performance

Supplier performance refers to a measurement to describe how good a supplier can deliver raw materials to production facilities on time and in good conditions (Chan *et al.*, 2003). The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The Thai Food Processing Company has about 200 to 300 suppliers in total but there are only 120 suppliers as its majority. Because of the character of the product, food process industry, the company expects high level of products quality from suppliers. Thus, the TFPC needs a supplier who can transfer the materials being pass the required

international standard, the export regulation, food safety and materials being arrived on time is also matter. The company measures delivery performance of suppliers by the delivery time as it affects the operational management and finished products. Thus, the delivering time has to be on time and materials have to be right. The standard of the quality of products is also the criteria. The TFPC has set the clear standard for each type of products.

There is the supplier performance measurement procedure in place. The TFPC has set the clear specification. The company always keeps contact with the supplier so that the TFPC can have preliminary evaluation and test the materials. If the materials have been passed its condition, the company will send its team to check at the suppliers' factories. In summary, the TFPC will place the identification in qualified documents under the ISO system and put the further indicators.

The overall reliability from suppliers is very important to the TFPC as it produces customized products. Quality of products, delivery performance and overall reliability of suppliers are very good.

The Thai Chemical Company (TCC)

The Thai Chemical Company has about 20 to 30 suppliers. 60 percent of the suppliers are international firms. The company buys its raw materials directly from the suppliers. Some materials such as chemical items come in with standard forms. On the other hand, some materials such as fabric have to be customized to meet Thai Chemical Company's specific needs.

The TCC faces two issues when dealing with suppliers: quality and delivery performance. Even though these issues have been found problematic perpetually, the company can solve the issues well. Because its main objective is to make quality products for customers, the TCC stresses more on the quality of supplies than the delivery performance. The company believes that even if the supplies can be delivered on time, the poor supplies can cause huge delay for the company and, importantly, for its customers. However, in the case that the customers require prompt delivery; the

TCC will monitor its suppliers closely to make sure that everything will go under control.

The Thai Textile Company (TTC)

The Thai Textile Company has a little number of suppliers even though there are lots of products to serve customers' needs. The reason of limited number of suppliers is the type of raw materials for production is uncomplicated. Only 7 to 8 suppliers have dealings with the TTC. Raw materials quality and delivery performance of its existing suppliers are reasonably good. However the current worldwide economic crisis has influenced the administration team to adjust company's strategy. One of its strategies is searching for new suppliers from overseas, particularly from Asian countries. Raw materials gained from those new suppliers are better quality and cheaper price. This also results in building competitive advantage for the TTC.

The quality of all dyed clothes or threads from suppliers has to be proved by the TTC. The company has selected only suppliers who can control used chemical under law forced. The control is precisely strict because those products are exported to overseas such as EU countries where they have definite rules.

Order wise inspection is carried out on receipt of the materials. A decision mainly relies on the capacity of human resources and machine and the ability to deliver products in time. A production is flexible manufacturing system (FMS) which emphasizes on a strategy of customer oriented with a quick response.

The TTC does not have supplier performance measurement procedure in place. However, there have been criteria such as the speediness of delivery, the available quantity of delivered raw materials, the quantity of broken raw materials, and the quantity of errors in collaboration. The TTC deals with customized products, high level of reliability from suppliers is critical to its business. The suppliers' performance of the company is acceptable because one of Thai Textile Company's strengths is keeping good and long relationship with suppliers. However, suppliers are competitors of the TTC in some situation. The important strategy which the company concerns is that supplier has to delivery raw materials on time because the TTC emphasize on

customer's satisfaction. Moreover, the stock of raw materials and finished goods is not Thai Textile Company's strategy.

5.2.1.2 Selection process

Selection Process refers to the process to select the quality suppliers including selection criteria and negotiation. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The Thai Food Processing Company selects suppliers from the quality of material, price, and reliability of suppliers. There is a standard procedure in place. The company has set the manual for quality and work instruction under ISO 9001. The TFPC has revised its work and has continuously developed its system. As the company exports products to various countries and each country has a variety of food standard, the TFPC is certified by many food safety standards such as hazard analysis and critical control points (HACCP), good manufacturing practice (GMP).

The TFPC research and development department build the specification so that the suppliers can provide the standard materials and the output will be qualified. Also, there is usually test and check the materials at the supplier's factory, the inspection is under the committee of research and development department, purchasing department, quality assurance department and system control department. The inspection can give a signal when the order and supply should be finished. It also can provide the useful suggestion in order to work effectively.

Although the TFPC has set rules for effective negotiation procedure, purchasing department cannot follow all rules because its employees are different in skills. Also the TFPC has a standard contract for all suppliers. The procurement process starts when market department receives a purchase requirement from customers, then market department sends this requirement to the purchasing department. Next, the purchasing department issue the purchasing order and send it to the supplier. In order to confirm

the delivery, purchasing department will provide the tracking delivery paper two days ahead of the due date of delivery.

The Thai Chemical Company (TCC)

The Thai Chemical Company selects its suppliers based on quality, service, delivery performance, and price. The company points out that its selection criteria are so stringent that if the suppliers can pass Thai Chemical Company's standard, then they can sell the products to any companies in the industry. The TCC also sets up the criteria that correspond to the ISO 14000 EMS.

Thai Chemical Company's policy regarding the selection process is to use multiple suppliers. The company believes that using this approach the company will alleviate risks that will occur when the company relies too much on just one supplier. This approach also increases its bargaining power. To adhere to this policy, sometimes the TCC has to buy materials at higher price from some companies. By doing so, the company can strengthen relationship with more than one suppliers. The TCC hopes that when the company urgently needs some materials, the company is still in good shape. After all, the company can keep the promise with its customers. The last but not lease important issue when dealing with the suppliers is to pool the demand with its joint venture parties. The TCC then gains more economy of scale than the competitors.

The Thai Textile Company (TTC)

The Thai Textile Company does not have a system for selecting supplier however there is a clear process. The company selects suppliers on the basis of quality of material, delivery performance, competitive price and reliability of supplier based on previous history and financial status. Thai Textile Company's main production is make-to-order and the TTC can make product mix in the situation of order fluctuation. A process of supplier selection somehow may cause the problem of tardy administration.

Quality factors play major role in selection. The specification concerning to quality management systems such as ISO 9001 is also important for screening supplier. The TTC collects 'quality' certificate from its suppliers. Additionally, research and

development department inspects material specification thoroughly. The company has to control the problem of raw materials at the beginning and it is the primary condition in the process of supplier selection. In summary, the TTC selects only supplier being accredited by ISO standard and this is a mutual agreement. In doing this, it can help prevent a risk when products have been distributed to markets which have trade barrier.

Qualified supplier will be selected after assessing its criteria in each perspective. These perspectives are delivery time (on time or before schedule), quantity and quality of raw materials. However, the criteria is not very strict and it is acceptable as this can help the TTC maintains good relationship with suppliers. The company has also considered suppliers from overseas. Thus, the regulation of international trade, related laws and support from government are primary issues which the TTC has carefully concerned.

Although the TTC does not have any standard tool for measuring supplier's performance, purchasing manager uses her skill to measure critical suppliers' performance. There is no standardized supplier performance measurement framework. The TTC has strategic alliance with its major suppliers through appropriate contractual relationship.

5.2.1.3 Green supplier

Green supplier refers to the environmental issues to evaluate and choose the suppliers. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The Thai Food Processing Company environmental policy is to be friendly with the environment. The company is certified by ISO 14000 environmental management standard (EMS) for environmental issue. Purchase is one of the key processes, which is assessed in ISO 14000 EMS because it is responsible for not only procurement of the materials but also their disposal at the end of their useful life. To ensure that suppliers is following Thai Food Processing Company' environmental policy and environmental friendly manufacturing process, the TFPC tries to select suppliers who apply ISO 14000

EMS too. However, not all suppliers are certified by ISO 14000 EMS. Then, the company will provide environmental information to suppliers and requests them to concern with the environmental issue. Also when suppliers deliver materials to the TFPC, quality assurance department will approve the delivered products and make sure that they are passed company environmental standard.

The Thai Chemical Company (TCC)

Thai Chemical Company's business is strongly regulated by the government including the environmental agencies. The TCC was certified ISO 14001 EMS in 2007 and the company follows ISO 14000 EMS earnestly. The TCC environmental policies are the company's environmental awareness and legislation compliance. The main criterion to select suppliers is legislation compliance. If the suppliers can meet the legislation standards, it means that they become eligible suppliers to the TCC. Waste management is managed by recovering and reusing of chemical in the process, and appropriate treatment and final disposal of waste. Recycling of chemical waste is regulated by government, which requires the TCC to list the composition of its waste and send it only to authorised recyclers that mostly support by suppliers.

The Thai Textile Company (TTC)

Thai Textile Company's customers are clearly categorized. Domestic customers may not pay much attention on green products. However, some customers concern about environment. Such customers expect product to be controlled under the regulation of environment. Thus, the TTC has adjusted strategy by focusing on output which must be followed the condition. Those conditions are suppliers have to be accredited with ISO 14000 EMS and ISO 9000. The company environmental policy allows purchasing materials only from reliable and recognized suppliers, who can conform to the TTC stringent environmental requirements. The introduction of the ISO 14000 EMS certification standard focuses attention on the performance of the company's environmental impact of its processes. Although the TTC has stringent purchase procedure but there is no evidence that its suppliers have good environmental practices embedded in their manufacturing processes.

The inspection of raw materials with unqualified chemical and the inspection of process of buying raw materials are also applied here. Supplier has to send the samples of raw materials, especially a new item, to the TTC for inspection before making a sale contract. The existing supplier also has to send raw materials to the company for regular inspection under the mutual agreement. The TTC also has regular scheduled to visit suppliers' plant for auditing once a year. The company has made a forthcoming arrangement to collect data for statistic analysis and to create warning system for supplier breaking a requirement laid down in a contract. However, the TTC would give them a notice to make an improvement before ending contract. This arrangement can support the company to develop toward green purchasing system. Such issue is quite new for textile industry in Thailand.

5.2.2 Supplier integration

Supplier integration refers to a collaborative relationship between company and supplier which recognises some degree of interdependence and cooperation on a specific project or for a specific purchase agreement (Ellram, 1991). Under supplier integration, there are four performance measurement factors in tactical decision making level. They are coordination and resource sharing, information integration, organizational relationship and use of information technology.

5.2.2.1 Coordination and resource sharing

Coordination and resource sharing refers to the cooperation and sharing in resource with supplier. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The Thai Food Processing Company has co-ordinators in purchasing department to cooperate with suppliers directly. There is an action plan to evaluate the potential of each supplier. In case of new supplier (having contact less than five years), the company plans to visit supplier twice a year. On the other hand, for the long term relationship or high potential supplier, the TFPC can visit only once a year. However,

when some problems occur, the purchasing department will contact the supplier directly and has additional visit to that supplier. This process can build the confidence that the TFPC will gain quality and efficient products from suppliers. However, the purchasing department is a sole responsible department to cooperate with suppliers, without any assistance for evaluating the potential of suppliers from other departments. If the TFPC can build a team including all departments which are related to supplier, thus a team can improve the collaboration process between the company and its suppliers. For decision making, the TFPC can visit and suggest some useful advice to suppliers but the company cannot intrude to any critical decision of suppliers.

The TFPC has a very close relationship to suppliers. Thus, when the company needs any extra requirement of materials, the TFPC can inform suppliers a short period ahead of requirement of materials. When the TFPC has an urgent requirement, the company will send a truck to carry the materials from supplier's factory instead of waiting a supplier to deliver materials. Sometimes, the TFPC has to prepare its warehouse in early morning for delivery from supplier when the company has an urgent requirement.

The Thai Chemical Company (TCC)

The Thai Chemical Company has good relationship with its suppliers. Nevertheless, the company is the active part of the partnership. For example, the TCC always monitors the material price. If the company founds that the price of materials will increase in a foreseeable month and the company needs them, the TCC will ask the suppliers for the quota of those materials in advance.

The suppliers also cooperate very well. This is because the TCC often orders materials in high volume. The suppliers will do anything to meet the order specification. The suppliers also customize their products to meet Thai Chemical Company's specification cordially. Sometimes the suppliers agree to change their practice as the TCC requests. However, the partnership between the company and its suppliers still lack of trust in some degree. Some suppliers, especially the conservative ones, are afraid that the TCC may learn too much and use the knowledge at their disadvantage.

The Thai Textile Company (TTC)

The textile industries in Thailand have been trying to gather as a group with the support from government and private sector but it is not achieved. Most manufacturers think of others as competitors and they concern if they have to disclose their business secret. Specification and price are only information that can be shared. As mentioned earlier in Chapter Six (section 6.3.3.3.2 competitor), some suppliers are also in the same business and have competitive products with the Thai Textile Company.

The TTC has exposed business information with some strategic supplier such as information related with trends in product. An international professional is hired to design the trends in each quarter. Thus, the company has to share information about the trends with suppliers as they can support the TTC by providing the required raw materials. The company and suppliers have thus planned to take part in doing research and development together afterward.

The TTC works closely ways with its major suppliers. The company coordinates with its suppliers for critical decision making for deriving materials specification, design option selection and production planning. However, purchasing manager feels that there is room for improvement of providing more technical support to suppliers.

In recent situation, the TTC tries to search more international suppliers as it needs qualified raw materials with low cost. Joint venture is a next Thai Textile Company's aim.

5.2.2.2 Information integration

Information integration refers to the extent to which all functions between company and supplier can pass information smoothly (Chan *et al.*, 2003). The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

To make forecasting jointly with suppliers, the Thai Food Processing Company shares its sale forecast and production plan information with suppliers. Then, suppliers can plan and prepare their materials for the company but the TFPC still need to contact suppliers to confirm each order. Data accuracy is very important for the company and suppliers because when the requirement of material changes, those changes have to be passed to all related departments and suppliers. Then, the TFPC will try to contact suppliers immediately by phone. Thus, suppliers can adjust their production plan to suit with Thai Food Processing Company' need. Mostly traditional communication system (e.g. telephone, fax and e-mail) is used for information integration, which proved inefficient in many occasions. Therefore, the TFPC plans to develop an enterprise resource planning (ERP) system that can link with suppliers.

The Thai Chemical Company (TCC)

Since the Thai Chemical Company is stuck in the middle of the supply chain, the company hardly predicts the demand accurately. The demand of its product depends on the consumers' need of the final products which are out of its control. To make things more complicated, its products are highly customized and have to be in fashion. They are made to order. Joint demand forecasting with the suppliers is therefore not valuable, if not impossible. One thing for sure, there is no one in the supply chain who wants to take the risks.

To lower the risks, the TCC turns to its joint venture partners. They share the information about market situation with each other. Its partners are in the same level of the supply chain but operate in the global market. The partners also have longer experience in this industry. Consequently, the TCC gains more insight about market trend when compared with the competitors. The company also examines its market demand regularly by itself. After synthesizing the information, the TCC then goes back to discuss the trend with the suppliers and talks about collaborative planning. Mostly traditional communication means such as telephone, fax and e-mail are used for information integration with its suppliers.

The Thai Textile Company (TTC)

The forecasting system has been run by the Thai Textile Company only, no planning together with supplier. Then a result would be informed to supplier. However, a data of manufacturing and orders of customers are altered very quick because the structure of product is not complicated and the machine system is modern.

Ordering and designing are generally done with close coordination and through information sharing using traditional mode of communication (e.g. e-mail, telephone and fax). Information integration with the suppliers rather loose during manufacturing and after sales services stage. Formal vendor managed inventory (VMI) has not been implemented. Lack of dynamic information integration with the suppliers create considerable problem when there is sudden surge in demand of raw materials. Information integration is rather informal and depends on individual manager's communication skill.

Customers can call to check the current situation of manufacturing and delivery. Likewise, the TTC can call to check the status of raw materials from supplier. E-mail is a primary communication channel for cooperation and data exchange and the calling is made afterward.

5.2.2.3 Organizational relationship

Organizational relationship refers to the management of communication channels with supplier including shared objective and risk. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

To keep good communication with suppliers, the purchasing department keeps contact with suppliers every week via telephone or email. However, the TFPC does not share any risk with its suppliers. But Thai Food Processing Company' business objective is common with its suppliers. Thai Food Processing Company' objective is to contribute high quality and safety product on time and with right quantity. Therefore, to achieve

company's objective with suppliers, the TFPC has to set clear objective. Then, when the company selects its suppliers, both the TFPC and suppliers should share the same common objective at the first stage.

The Thai Chemical Company (TCC)

The managing director (MD) of the Thai Chemical Company and its suppliers always have meetings to discuss problems they currently facing together. Generally, communication channels among them are informal. Because of Thai culture, participants always ask for a favour rather than compel by using power. This approach reduces the level of conflicts as well.

Even though there are no explicit common objectives, the TCC tries to call for cooperation in producing high quality products. The company succeeds in showing the members of its supply chain that a high quality product is a key success factor in this industry. Thai Chemical Company's successful story also reinforces the 'win-win' attitude and leads the TCC to be the captain of its supply chain. To some extent, the collaboration can be viewed as an effective risk sharing mechanism. That is, the members of the supply chain can now focus on the same risks with the same view, thereby managing them properly.

The Thai Textile Company (TTC)

Organizational relationship is built by exchanging of factory visits and giving an advice each other. There has not been an official department to run this organizational relationship yet because of a few number of suppliers. In future, if there is an expansion of supplier, especially from overseas, an official department for organizational relationship will be needed. A means of communication to easily approach to executive and administrator is also important. This means should be able to update recent and real time data.

In addition, another task is sending staff to make a connection regularly. Other than formal contractual relationship, communication channels are rather informal and mainly depend on concerned managers' skills. The Thai Textile Company closely works with

its major suppliers in order to address any uncertainty within the supply chain (e.g. change in demand, adoption of new technology).

The latter issue is very important for the TTC as Thailand is moving towards ASEAN Economics Community (AEC) in 2018. Thus, AEC provides the TTC opportunity to look for more international suppliers among member countries of AEC.

5.2.2.4 Use of information technology

Use of information technology refers to the capability of the current company's information technology system. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

During procurement process, the Thai Food Processing Company uses telephone to contact with suppliers and send purchasing order (PO) via fax to confirm the order. Each department that get involved in any order can access to that order by company intranet system. There is no any state of art electronic business (e-Business) in place. The current company website has only primary information of company and product information. The TFPC intends to apply electronic data interchange (EDI) and e-Business to its system. There is a plan in the future to use ERP system to create e-Business via internet. However, the present information technology system is still okay but there is some confusion when the TFPC has to change many purchasing order with many suppliers in the same time. Also the present information technology system wastes the paper and space to keep the order record because there are many copies of purchasing order for each order. The company plans to develop the paperless system by working on computer and link the procurement process via internet. Thus, the use of information technology (IT) between the TFPC and suppliers is the issue that has to be improved.

The Thai Chemical Company (TCC)

Because the Thai Chemical Company uses the multiple supplier policy, it is hard to force the suppliers to invest in information technology. Although there is no integrated information system, the company uses its information system as the information centre for the whole supply chain. The TCC information technology is quite a state of the art system. The timeliness and accuracy of the information help the supply chain operate more efficiently. This strategy balances the tensions between Thai Chemical Company's need to control the supply chain and its policy to be flexible simultaneously. However, simple communication system such as telephone, fax, and e-mail is used for communicating with suppliers.

The Thai Textile Company (TTC)

Although the Thai Textile Company internal purchase processes are integrated through legacy information technology based system, there is no IT-based communication link with its major suppliers. The communication system with suppliers is quite conventional, simple and cost effective (e.g. telephone, fax and e-mail). Hence, a state of art information system could help the TTC to improve its supplier integration.

ERP system is needed as the TTC has to quickly respond to customers' needs. The main aim is building loyalty among customers. In order to maintain customers, rapid task is crucial although this may cause non-profit return to the company. Therefore, IT system is a main key of manufacturing as when decision is made information has to be suddenly informed to supplier. However, the recent and real time information has not been yet applied thoroughly in the TTC.

There has been a close coordination between production and sale department only. When all data are connected the cost can be estimated precisely. As a result, an administration team can make a right decision and choose supplier who is suitable in each situation. However, the TTC does not consider only the cost. The low cost may not be an absolute solution as some supplier providing high cost of raw materials but profit return is high. In summary, IT system is very important as in order to gain competitive advantage, production and distribution need a rapid process.

5.2.3 Effective procurement processes

Effective procurement processes refers to the efficiency of the whole purchasing process to obtain the right materials from suppliers. Each performance measurement factor contains their related performance measurement factors in tactical level. Under effective procurement processes, there are three performance measurement factors in tactical decision making level. They are effective communication with production, effective management of purchase portfolio and effective contract administration.

5.2.3.1 Effective communication with production

Effective communication with production refers to the procurement of specific materials for production department. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The Thai Food Processing Company has a material specification list in place to guide suppliers and updates a list once a year. By receiving evaluation information from customers, the TFPC applies these feedbacks to design the products which are more suitable to customers' need. To decide right specification and quantity required for purchase, the research and development department will identify the specification and the marketing department will decide the quantity from the customer's order. Then, to match right suppliers with required specification, the research and development department will set the specification and then the supplier will send the data of materials for the research and development department to prove. The TFPC has more than one supplier in 90 percent of all required materials to reduce supplier power.

The Thai Chemical Company (TCC)

Some Thai Chemical Company's materials, e.g. fabric, need modifications to respond to the customer needs. In such situation, the TCC specifies detailed requirements and then asks the suppliers to make some prototypes. According to its multiple supplier policy, the company often asks two or three suppliers to offer proposals. The company

then selects the best available proposal based on quality and price. Nevertheless, the company still concerns about the relationship. Consequently, the TCC rewards these suppliers with continuous orders.

The Thai Textile Company (TTC)

The purchasing with supplier is a rapid process. The Thai Textile Company focuses on product and assigns trends of products and lets supplier know this information in ahead. Thus, there is no problem in communication with production. The quality of raw materials from suppliers is quite similar except the difference in effectiveness of delivery of materials.

Through legacy information technology based system, purchasing department receives requisitions for materials from production department with detailed information on materials specification, delivery requirements, and possible suppliers. The coordination and communication are happened between purchasing and production department. The production manager can change process or postpone a production in order to make it right with each circumstance. In order to employ the noted process, production manager use flexible manufacturing system and other competitors cannot operate this system. Thus, production manager is a key person for communication in both internal and external organization.

Production manager has to hand over the information related to raw materials in term of quantity, means of delivery and deadline of delivery to each supplier. E-mail is a main communication and calling must be made to confirm final information. In case of emergency, 24 hours communication is also employed. Although current communication system is adequate to deal with normal requirements, it fails to address any contingency, which require good coordination among suppliers, purchasing and production departments.

5.2.3.2 Effective management of purchase portfolio

Effective management of purchase portfolio refers to the administration of material classification and supplier database update. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The Thai Food Processing Company adopts direct purchase from the leading suppliers, which reduces cost and increases reliability. A few critical suppliers sometime fail to deliver materials on time, which affects overall performance. The TFPC has critical items about 10 percent of total 700 items. The company checks safety stock every day to keep safety inventory level of those critical items. The TFPC has suppliers designated for supply critical items and also has alternative supplier to supply the critical items in emergency. The TFPC updates supplier database every month by using approved vendor list (AVL). Every supplier which passes the preliminary standard will be included in the approve vendor list. Then the TFPC will evaluate them every month.

The Thai Chemical Company (TCC)

The Thai Chemical Company has a system and database to record its suppliers' performance. The company updates this database regularly. The TCC also grades the suppliers based on their performance. As the main suppliers, firms which obtain lower ranks will be audited more often than the ones that obtain higher ranks. This grading system motivates the suppliers to bring about better performance than before. This system also benefits the suppliers who have more materials to offer and thus have more stakes with the TCC.

The Thai Textile Company (TTC)

Purchase portfolio has not been applied yet as the number of supplier is quite few. Dynamic evaluation of purchase portfolio and performance of supplier is not practiced in formal ways. Purchase portfolio is mostly managed using concerned managers' skill. The Thai Textile Company has to monitor each supplier when raw materials are

delivered to maintain the overall performance of suppliers. The company has to check whether supplier follows the agreement. Each supplier does business with the TTC quite long time so the dealing is based on trust of each other. However, it is different when dealing business with new supplier and international supplier. More strict criteria are applied with them when comparing with existing supplier. Such criteria are quality of material, material price, on time delivery, capability of transportation and reliability of communication. Moreover, a formal contingency plan needs to be adopted for every critical delivery.

5.2.3.3 Effective contract administration

Effective contract administration refers to the management of payment and supplier's verification. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

To inspect and verify supplied materials, the Thai Food Processing Company sets the condition and passes it to suppliers. Thus, they can know its condition and specification. Then the company requests suppliers to send the sample of materials back. The TFPC will pass those samples to its laboratory to check if they are matched with its specification. First, the company will go to audit the materials at suppliers' factories. Then, the TFPC will follow up. The suppliers selected to be its suppliers will be evaluated every month. They will be graded every six months. This grading can build the competition atmosphere around them and encourage them to improve themselves. If any suppliers are ranked as grade 'A' they have to send the TFPC the self-evaluation form, then the internal audit will send the results back. If they are ranked with the low grade the company will go to audit at the suppliers' factories.

The TFPC has two system of payment. In case of the first purchase between the company and suppliers, the TFPC has to pay with full payment. Then, the company can gain a credit for more than 30 days for the next purchase. This payment procedure is agreed with suppliers and this payment procedure helps the TFPC to maintain improved

cash flow. The company has a satisfaction evaluation of the purchasing department once a year in November.

There are some mistakes in communication between the TFPC and suppliers. When the suppliers change any staff the company has to start up in communication with those new staff in order to reduce the risk of mistake from the communication.

The Thai Chemical Company (TCC)

The Thai Chemical Company verifies the supplier performance in two levels. In a broad level, the company uses cross functional team to do this job. The team consists of staff from purchasing, research and development, and warehousing departments. This audit will occur at the suppliers' sites. The team will reward superior suppliers with higher ranks and sends the results to all suppliers.

The TCC evaluates supplier performance on a case-by-case basis as well. The company has its own laboratory to assess the quality of the crucial material and the suppliers have to wait until they pass the inspection. The TCC also evaluates the supplier behaviours, such as their willingness to collaboration and their trouble making behaviours.

The Thai Textile Company (TTC)

Selection of right contract and management of this contract as per the satisfaction of suppliers is practiced. For payment system, there have been two types, cash with a few existing suppliers and credit with most of existing suppliers and new supplier. Organizing deferred credit with major suppliers from 30 days to 90 days helps the Thai Textile Company to maintain improved cash flow. Problem of payment is rarely happened with existing supplier because of a long time relationship. Through effective contract administration, the TTC could reduce raw material inventory. The company needs to reveal the feasibility of inspecting critical raw materials at suppliers' premises in order to enhance supply chain effectiveness. With new supplier, the TTC gives more concern and orders only a few quantities of raw materials in the initial period.

There is s summary of each performance measurement factor as shown in table 7.1.

Table 5.1: A summary of the performance measurement factors on supplier relationship management for three case study companies

Companies / Factors	The Thai Food Processing Company (TFPC)	The Thai Chemical Company (TCC)	The Thai Textile Company (TTC)
(Quality supplier selection) Supplier performance	Material quality has to pass the food safety standard, then on-time delivery is the next consideration.	Quality of supplies is more stressful than the delivery performance because of the strict environmental rules connected to on chemical products.	Current performance of existing suppliers is good but the company is looking for new suppliers from overseas for better quality and cheaper price.
Selection process	The company establishes an inspection team to test and check the materials at the supplier's factory before approving.	The company applies multiple supplier policy to reduce the risk of single supplier dependence and increase bargaining power.	The company selects suppliers on the basis of quality of material, delivery performance, and competitive price based on previous history and financial status.
Green supplier	The company tries to select suppliers who are certified by ISO 14000 or supports them on environmental issues if they do not have certification.	The environmental awareness and legislation compliance are the environmental policies of the company.	The company allows purchasing materials only from reliable and recognized suppliers, who can conform to the company's stringent environmental requirements.

Companies / Factors	The Thai Food Processing Company (TFPC)	The Thai Chemical Company (TCC)	The Thai Textile Company (TTC)
(Supplier integration) Coordination and resource sharing	Purchasing department is a sole co-ordinator to suppliers and the need of involvement from other related department is request.	The suppliers cooperate very well when the company asks for the quota of material in advance because the company often orders in high volume.	Only general information can be shared with suppliers because of the high competition in textile business and some suppliers are also the competitors.
Information integration	Sale forecast and production plan information are shared with suppliers for joint demand forecasting.	The company considers of joint venture with partners instead of joint demand forecasting with suppliers.	There is no joint demand forecasting. The forecast result is run by the company and inform to supplier.
Organizational relationship	A weekly contact between purchasing department and suppliers is generated to keep good communication.	Informal meetings with suppliers by the managing director always happen to discuss their problem together.	Communication channels are rather informal and mainly depended on concerned managers' skill.
Use of information technology	Telephone, fax and e-mail are used to contact with suppliers. There is a plan to develop the paperless system.	Simple communication system such as telephone, fax and e-mail is used for communicating with suppliers.	There is no IT-based system link with suppliers. Only conventional communication means (e.g. telephone, fax and e-mail) are used.

Companies / Factors	The Thai Food Processing Company (TFPC)	The Thai Chemical Company (TCC)	The Thai Textile Company (TTC)
(Effective procurement processes) Effective communication with production	R&D department sets the material specification and then the supplier will send the data of materials back to the department for testifying.	The company specifies detailed requirements and asks the suppliers to make some prototypes. Then, the best available proposal based on quality and price is selected.	Purchasing department receives requisitions for materials from production department with detailed information to place an order with supplier.
Effective management of purchase portfolio	The company has suppliers designated for supply critical items and also has alternative supplier to supply the critical items in emergency.	The company updates suppliers' performance database regularly and also grades the suppliers based on their performance.	Dynamic evaluation of purchase portfolio and performance of supplier is not practiced in formal ways. They are mostly managed using concerned managers' skill.
Effective contract administration	The company plans to audit the materials at suppliers' factories first and the follow up is scheduled later. The evaluation for selected suppliers is processed every month and they are graded every six months.	A cross functional team uses to inspect and verify the suppliers' performance. The company has its own laboratory to assess the quality of the crucial material and suppliers have to pass the inspection.	The company needs to reveal the feasibility of inspecting critical raw materials at suppliers' premises in order to enhance supply chain effectiveness.

5.3 Internal supply chain management

The internal supply chain management process represents for all processes that are internal to the company (Chopra and Meindl, 2004). This internal supply chain management aims to fulfil demand generated by the customers in a timely manner and at the lowest possible cost (Chopra and Meindl, 2004). Internal supply chain management process needs to balance the customers' requirements with the company's supply capabilities (Vollmann *et al.*, 1997). Based on the study's conceptual framework in Chapter Four, internal supply chain management has six performance measurement factors in strategic decision making level. They are facility, inventory, transportation, internal integration, human resources and operations. In summary, there is the brief comparison of each performance measurement factor in tactical decision making level for three case study companies as shown in Table 5.2.

5.3.1 Facility

Facility is the actual physical location in the supply chain network where product is stored, assembled, or fabricated (Chopra and Meindl, 2007). Under facility, there are five performance measurement factors in tactical decision making level. They are capacity utilization, efficiency, flexibility, quality and reliability.

7.3.1.1 Capacity utilization

Capacity utilization directly affects the speed of response to customer demand through its impact on flexibility and lead-time (Slack *et al.*, 1995). The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The Thai Food Processing Company currently use around 70 percent of its full capacity utilization, except for peak period which sometimes must to be operated on double shifts. The critical constraint in optimum capacity utilisation is the case of a few of order. This can cause a high cost per unit and high price of products. Because of some man skills cannot be replaced with machine then to optimise the idle time caused by

non scheduled work or end of shift, the TFPC has tried to apply the flexibility with its labour force so as workers will have versatility and will be able to substitute other absent workers.

The Thai Chemical Company (TCC)

As for synthetic resin, the Thai Chemical Company can achieve 70 to 80 percent of its capacity utilization, while the company can attain only 50 percent of the capacity utilization for polyurethane synthetic leather. There are three reasons that can explain the unequal level of capacity utilization for these two types of products.

First, the TCC can leverage its synthetic resin's capacity with its joint venture partners who sell the product in the global market. Because of this synergy, the company gains impressive economy of scale for this product. Second, synthetic resin is a product that can sell in a high standard form. It does not require being neither customized nor modified to match up with the market trend. It competes mainly on price. Therefore, the cost saving from highly utilized facilities is a crucial competitive advantage. On the other hand, polyurethane synthetic leather competes on quality and differentiation. These conditions make economy of scale irrelevant. Third, the company chooses to use the niche strategy for its polyurethane synthetic leather products. Specifically, the TCC emphasizes the high grade and high margin products. Even though the markets are small, the company does not have to fight on price.

The Thai Textile Company (TTC)

A production will be happened when an agreement of order is confirmed. Thus, there is time available for the Thai Textile Company to plan for production and prepare raw materials. The current capacity utilization of facility is about 70 percent. The TTC emphasizes on using skilled labour as its products are delicate. Apart from workers, machine is used to substitute some works. Strength of machine is it can adjust work capacity to be suit needs of markets because the available machines are not complex and only a few main functions of machine is operated.

An electrical system is also an obstacle as it is not stable. Thus, maintenance is difficult. When a machine is run over 24 hours it will stop working. A whole system of capacity utilization thus relies on a readiness of machine. If a machine can work nonstop a production will be reached to its capacity.

5.3.1.2 Efficiency

Efficiency measures how well the facility is utilized (Lai *et al.*, 2002). The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The challenge of efficient use of facility is the case of shortage of labour force. This problem can affect to the production process. Thus, the Thai Food Processing Company has tried to substitute labour force with machine. The machine is designed to facilitate work and have versatility.

The TFPC plans to increase the productivity as this can reduce the labour cost. Currently, the labour cost is about 20 percent of product cost. The productivity can be increased by providing instrument to help facilitate work and designing the appropriate instrument for specific jobs such as specific knives for fish cutting. The company does not have a planning for full preventive maintenance. Thus when the machine has to be stopped and a repair is needed this can affect to the production. The TFPC has still a shortage of activities to reduce a damage of production. Further, a statistical analysis has not been applied yet. Thus, there cannot view the damage as a whole perspective. Building work ethics among workers is also important as this can reduce the damage of production.

The Thai Chemical Company (TCC)

The Thai Chemical Company started its business by producing polyurethane synthetic leather first. The company had to purchase synthetic resin as its raw material. Because of the company's high demand, its supplier of synthetic resin seemed to be inactive and unwilling to cooperate when requested. As a result, the TCC decided to backward

integrate to make synthetic resin by itself. Actually, the company is the only one company in Thailand who manufactures both synthetic resin and polyurethane synthetic leather. The backward integration then result in unparalleled competitive advantage for the firm. It renders the firm to obtain lower costs and higher quality control.

Another important problem the company faces regarding the productivity is the seasonal nature of its products' demand. In particular, the TCC has to deal with a period of lower demand that sometimes needs to shut down the plants. To reduce overhead outlay that incurs every time it starts the production line, the company attempts to run the production lines continuously rather than intermittently. The TCC also has to ask the workers to be flexible concerning their working day.

The Thai Textile Company (TTC)

Efficiency mainly varies on capacity of machine and work skill of worker. Worker can fully work if machine effectively runs. The pattern of product is often changed so it is hard to maintain a machine. An error in stocking of part of machine can cause expenses. In addition, there is no preventive maintenance. Maintenance team has usually checked up machine, thus when problem occur it will immediately be fixed. In case of machine suspension, a foreman has to adjust production plan, make another order instead of current order, or make other segment until the machine has been fixed. Production of the Thai Textile Company is continuous. Thus when problem occurs it is unavoidable to affect to other processes.

The skilled workers can support an increase of efficiency. Workers are mainly classified from their expertise and work type which they are responsible. A novice worker is assigned with less complicated job. This can help prevent damage which may occur from unskilled workforce. The TTC encourages workers with compensation such as money.

5.3.1.3 Flexibility

Flexibility indicates the degree to which the facility can respond to a changing environment and extraordinary demand requests (Beamon, 1998). The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The Thai Food Processing Company reacts during sudden demand fluctuation by planning ahead and forecasting production capacity during festivals and high orders. There should be an adaptation of work process or the TFPC should move the place of production to facilitate work and respond the needs of customers. If the company can apply flexible manufacturing system, it can mitigate the problem. However, the sale sector from marketing department has to deal and take order from customers by avoiding any problems which can affect production and delivery. Otherwise, problems are still existed.

The Thai Chemical Company (TCC)

Flexibility is a key factor for Thai Chemical Company's success. The TCC has a capability to deliver customized products. This happens because the company currently produces under its full capacity. The company can modify the production line without disturbing productivity as a whole. The firm's backward integration also contributes to its flexibility. Because the TCC produces synthetic resin by itself, the company has knowledge reservoir that can be exploited when facing with customers' special need. The company also learns the knowhow from its joint venture partners who have specialization in different fields. This knowledge enables the TCC to change its product mix.

The Thai Textile Company (TTC)

Planning for production and taking an order from customer are critical strategies as products of the Thai Textile Company are more various and delicate than those of competitors. However, there is a concern related to machine as it dictates delicacy of

work. If there is something wrong with machine it will affect production efficiency. A machine that cannot make a neat pattern is substituted by more modern machine. There has been an analysis of those dated machine which may have some function compatible with updated machine. This analysis can help to keep some usable parts and they can be used as spare parts. This strategy makes the flexibility of planning and production. Teamwork of the TTC has planned to work out on analysis of capacity of machine to increase its efficiency and reduce a replacement of machine.

5.3.1.4 Quality

Quality refers to technology and the process to improve facility performance. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The Thai Food Processing Company measures equipment performance from the duration of production. The machine utilization is the core measurement of Thai Food Processing Company' equipment performance. However, in the future, the TFPC plans to apply system reliability of machine as the core measurement of equipment performance. This can help to evaluate the efficiency of performance. The management of maintenance can help increase the performance of system. The percentage increase of production due to automation is only 20 percent as there is a limited number of automation. The factor drives the TFPC to improve further is to reduce labour cost by providing labour force sufficiently. The company has tried to reduce the overtime work loads and solve the problem of labour shortage. Furthermore, the TFPC has to apply the productivity for the whole system.

The Thai Chemical Company (TCC)

The Thai Chemical Company has implemented international quality standard. The company has been awarded ISO 9001:2000. As stated in its web site:

> "The quality policy is to continually improve quality system for serving and enhancing customers' satisfaction."

The TCC emphasizes on human resource training, system management, resource management and technology development. The company also adopts S-5 activity which will drive the company to be disciplined in continuously improving the state of the workplace and in embracing new standards and procedures. The quality policy is established so as to increase the firm's business efficiency and effectiveness which in turn will drive growth and sustainability of its business.

The Thai Textile Company (TTC)

Workforce and machine directly affected a quality of product. Presently, workers have created satisfactory output as they are fully trained. While an analysis of relation of machine maintenance is still needed. Some machine has an error in work which can directly affect a quality of product. For instance, if temperature of hot oil container is over limit a cooling system will work to reduce hot temperature and other equipments can work smoothly. Another example is boiler. A quality of hot stream from boiler has to be standard as it is used to iron clothes.

A system of quality assessment has been carried on in order to inspect product in each product line. Supervisor picks up products to examine whether their qualities are matched with standard in check list. In case of an error, a production will be suspended and a problem will be sorted out. A quality control circle (QCC) or Kaizen system is applied before products are passed to next process. This system can encourage workers to participate in jobs.

5.3.1.5 Reliability

Reliability refers to the trustworthiness of the facility including its kindly with environment and safety. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

Thai Food Processing Company' facility is environment friendly. Thai Food Processing Company' system has been accredited with ISO 14000. An ISO 14000 EMS can be an

assurance that the environmental management and waste management of the TFPC have been controlled under the condition and the international standard. Furthermore, the TFPC has continuously invested in sustainable environment and energy development. Currently, there have been four wastewater treatment plants. Also, another wastewater treatment which can produce biogas is being built.

The TFPC rates safety level in 9 from 10. Sensors are set at gas point and boiler to control when there is leaking. There are also alarm systems to increase safety. Operating instruction cannot be posted near every machine because some areas are wet. However, there are operating instruction kept at maintenance department and the TFPC provides knowledge and training for staff. Moreover, there is an energy and safety department to monitor works of maintenance department. This can help cross check safety system and increase confidence in work.

The TFPC maintains minimum stock level for critical spares such as spare parts (electronic equipment) from Japan. In case of maintenance, there are spare parts in stock and machine can be repaired immediately. For other spare parts produced in Thailand, there is no need to stock them. However, there is a challenge that is to create an automatic order system for spare parts.

The Thai Chemical Company (TCC)

The Thai Chemical Company faces challenge regarding safety issues. The company still has reports about accidents. The main cause of these accidents is the carelessness of the workers. Therefore, the TCC launches safety activity which sets the zero accident target.

The TCC takes responsible for environment seriously by implementing international environmental management system standard (ISO14000). Since 2007, the TCC has reduced the fuel oil consumption by 25 percent, while have reduced CO_2 emission by 20 percent.

The Thai Textile Company (TTC)

A working system of the Thai Textile Company is centre oriented administration. It allows a prompt decision and management. In addition, there has been a strong relationship among the TTC, customers, and suppliers. A process of supplier and customer selection has been focused on sustainability. Thus, there is no fluctuation in production and administration. The TTC focuses on reducing risk of work and increases reliability of working process by splitting order. The TTC does not buy a whole amount of raw materials in one time. There has been a follow up process and measurement of performance for ordering and production process.

A maintenance process still needs a development as there is no suitable management such as total preventive maintenance (TPM). If there is a suspension from accident or suspension for maintenance production will be stopped and delivery will be delayed. Furthermore, there is no safety stock. The TTC has been accredited with ISO 9001. There is a standard from management and reliability in doing business with domestic and international customers. In future, the TTC has planned to extend production capacity by building a new plant that will focus on modern machines. Those machines will be able to produce a variety of patterns. This can help the TTC reach more market shares and build competitive advantage.

5.3.2 Inventory

Inventory encompasses all raw materials, work in process, and finished goods within a supply chain. Changing inventory policies can dramatically alter the supply chain's efficiency and responsiveness (Chopra and Meindl, 2004). Under inventory, there are two performance measurement factors in tactical decision making level. They are optimal inventory policy and warehouse utilization.

5.3.2.1 Optimal inventory policy

Optimal inventory policy refers to the policy to improve inventory management. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

Thai Food Processing Company' type of production is made to order so three types of inventory including: 1) Raw materials, 2) Finish goods products and 3) Ingredient, have to be fulfilled in order to produce products in time. The work with suppliers to provide materials must be quick and focus on continues inventory policy. The TFPC measures performance of inventory management from turnover of inventory. Turnover of inventory must be high as there are limited storages. Also, the type of production is made to order so only few of materials can be stocked.

The TFPC reduces inventory cost by developing system towards just in time (JIT) system. JIT can be started by making an order and delivery in production system, not keeping at warehouse. The TFPC manages risks during inventory level optimisation by buying raw materials when their prices are low. However, there is stock during the fluctuation of order and some materials have to be kept in cooler.

The bottleneck in internal supply chain process can happen sometimes when there are too many raw materials from customers such as cod fish. This can waste the space at storage and force the TFPC to increase production unnecessarily. Thai Food Processing Company' production system is made to order so sudden fluctuation in customer demand has hardly been happened. Also, the TFPC convinces customers to make an order in ahead.

The TFPC has VMI arrangement with supplier but it is still not 100 percent. The company tries to control this arrangement with ERP system. The challenges are the TFPC tries to control and adjust level of inventory upon demand of customers and tries to respond customers' needs by the time promised, not over agreed due date.

The Thai Chemical Company (TCC)

The Thai Chemical Company employs several strategies to keep its inventory at optimum level. First, it classifies items into three categories: high movement, low movement and no movement. The TCC then determines the minimum stock requirement for each category accordingly. The goal is to meet the required

replenishment lead time which is one month by average. The company tries not to keep stock for a long period of time because it will affect the quality of the finished products. In contrast, by shortening the stock-keeping time, the TCC can extend the usage lifetime of its final products.

Second, the TCC reduces its stock-keeping units by trying to carry semi-finished products in its inventory. Before delivering them to customers, the company has to work on the last stage of the production process. Upon the customers' request, the TCC will make patterns on and dye the semi-finished polyurethane synthetic leathers. Even so, there are some exceptions. When the company realizes that some customers use some kind of products repeatedly, the TCC will make the finished products in advance since it is cheaper provided that these finished products are produced in a big amount. In other case which may require the company to make finished products in advance, the TCC will store only the polyurethane synthetic leather that uses basic patterns and classic colours, e.g. black, white, gray, and brown. The latter policy is needed because leather products are generally fashion ones. This policy helps the firm to take fewer risks.

Third, the TCC also shares the stock of synthetic resin with its customers. For large accounts, the company agrees to install big tanks filled with synthetic resin solvent at customers' site. On a regular basis, the TCC fills up the tanks to make sure that the customers have their own supply. In such cases, customers must own other necessary equipments, have mechanics to operate the tanks, and have to look after those operations.

The Thai Textile Company (TTC)

A production has focused on make-to-order. There is no big warehouse and no risk for stocking raw materials as products are made on orders. Moreover, products rely on fashion and are always changed. Thus, there are a few stocks of raw materials. A planning of production between the Thai Textile Company and customers allows economy and precise inventory. In case of defected products occurred, rework will be applied with them, but not all of them. Defected products which cannot be fixed are sold with decreased price.

Selected suppliers are capable of prompt delivery of raw materials with short lead time. ERP system can support a precise prediction of quantity of raw materials' usage. There is a stock for raw materials ordered from overseas as this can reduce a risk of fluctuation in currency. An order of stock, especially stock of high cost raw materials, is made during a low exchange rate as this can save expenses and reduce inventory stock out.

5.3.2.2 Warehouse utilization

Warehouse utilization refers to the usage of warehouse for all inventory materials. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

To select suitable channel, scheduling and location of warehouses, initially, there is on only one factory so warehouse is in the factory. Then there are an expansion of factories from one to five and an expansion of warehouse. These warehouses are located right in the factories. When there are lots of orders some inventories have to be kept at warehouse located outside factory. These warehouses have to be near factory in order to facilitate transportation. Good service, sanitary and low rent are critical for selecting these warehouses.

To deal with obsolete raw material in the stock, some obsolete raw materials are destroyed while some are produced and sold as lower grade products. However, these obsolete raw materials must not affect customers' health. To improve space utilisation, there is a separation of storing raw materials. For example, flour and bread are kept in separated freezer with -10 degree Celsius. This can save energy. Boxes and cartons are similar size or shape as this can facilitate storing.

There are about 70 percent of finished products are not delivered immediately after finishing. And about 20 percent of materials are always in 'work in progress' condition. The challenges that the Thai Food Processing Company faced for optimisation of inventory are stock automation and cold chain.

The Thai Chemical Company (TCC)

Currently, the Thai Chemical Company has two plants. The layout is still not appropriate since they are not connected to each other. However, to save time and energy for sending and receiving materials, the TCC decided to locate its warehouse as a centre for the whole facility for each plant. Moreover, because all the products share the same warehouse, the firm can save many fixed cost. For example, the company can lower number of workers. The TCC also has an information system that monitor the lifetime of materials, thereby improving warehouse utilization.

The Thai Textile Company (TTC)

The Thai Textile Company does not emphasize on ready-made for sale products or keeping stock of products. Therefore, a size of warehouse is not big and there is no keeping lot of finished goods. The TTC focuses on prompt delivery of finished goods. Management of warehouse is effective. Stocking in warehouse is classified into raw materials from customer and finished goods. They are separately kept with separate staff to take care them.

Raw materials are kept with good standard. There is a control of temperature and humidity as they have an effect on quality of raw materials. For example, without controlling of temperature and humidity, colour of clothes will be changed or fade. Those clothes have to be re-processed or replaced with new materials. This causes less profit. Finished products are kept at warehouse for short time as they will be promptly delivered to customers. Sometimes, customers collect products by themselves as they can inspect quality of products.

5.3.3 Transportation

Transportation entails moving inventory from point to point in the supply chain. Transportation can take the form of many combinations of modes and routes, each with its own performance characteristics (Chopra and Meindl, 2010). Under transportation, there are four performance measurement factors in tactical decision making level. They are capacity utilization, efficiency, flexibility and reliability.

5.3.3.1 Capacity utilization

Capacity utilization directly affects the speed of response to delivery order through its impact on flexibility and deliverability (Slack *et al.*, 1995). The details of supply chain performance for each case study company are discussed inturn.

The Thai Food Processing Company (TFPC)

For inbound, the Thai Food Processing Company hires third party logistics service provider to carry imported materials from sea port to factory. For raw materials and ingredient from domestic, suppliers carry for the TFPC. For outbound, the company uses third party logistics transportation for effective capacity utilization. The TFPC evaluates transportation performance by measuring transportation duration to see if delivery is on time or not. The breakdown of trucks is the factor hindering to use full capacity.

The Thai Chemical Company (TCC)

Not only did the Thai Chemical Company backwards integrate to make synthetic resin, the company forwards integrated to run outbound transportation by itself as well. Its fleet includes more than ten trucks. The TCC also has an own garage and hires three own mechanics to repair and service the trucks. By having everything under control, the company can deliver the products sooner than competitors. Its customers unanimously mention about the company' quick delivery capability. The transportation utilization is high also because the TCC shares the transportation with all other business units in the holding company group. On the other hand, inbound transportation is under suppliers' responsibility.

The Thai Textile Company (TTC)

There are not many trucks, only six trucks for local outbound transportation as most customers collect products by themselves. While a freight forwarder is a middleman for international outbound transportation. The Thai Textile Company has an insured

transportation to enhance confidence for customers and reduce risk in transportation. For inbound, the suppliers deliver raw materials for the company.

5.3.3.2 Efficiency

Efficiency measures how well the transportation is utilized (Lai *et al.*, 2002). The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

Small trucks are used to carry items between factories and big trucks are used between factory and outside warehouse. In the future, the Thai Food Processing Company will use conveyer to increase efficiency of transportation. In order to reduce transportation cost in normal situation and during high oil price adjustment of route is used. To keep transportation cost down, the TFPC tries to efficiently use trucks by planning to carry item both trips from and to the company and by buying energy insurance to fix energy cost.

The Thai Chemical Company (TCC)

The Thai Chemical Company obtains transportation efficiency mainly owing to economy of scale. For example, the company can deliver several products from different business units to the same customers in the same trip. The TCC also has a global positioning system (GPS) installed in each truck. When the delivery schedule is tight or something urgent happens, GPS systems enable the firm to know which trucks should be call backed. Furthermore, GPS system allows firms to assess the drivers' efficiency. Due to the increasing oil price, the TCC uses natural gas for vehicles (NGV) rather than gasoline as a fuel for company's transportation system.

Thank to its own transportation facility, the TCC can increase efficiency by loading the products at night and when the drivers arrive, they can drive off immediately in the morning. The first delivery truck sets off at 4 a.m. before any other competitors could. For example, if customers place the order today afternoon, tomorrow morning they will

get what they ordered. But for some other firms they might be a bit later in the afternoon to deliver the goods.

The Thai Textile Company (TTC)

A quick and precise management of the Thai Textile Company and convenience provided by the TTC allows customers come to collect products by themselves. Moreover, some customers are suppliers so when they carry raw materials to the TTC they also collect products. This can help the TTC saves cost and allows the company's process system to be effective. In a near future, ERP system will be fully implemented and there will be an improvement of cooperation. There is no need for checking by calling and decision can be made quickly. Maintenance of its own transportation is also a strength that supports Thai Textile Company's work system. Maintenance is made before an appointed time so this can reduce damage and supports truck to be ready for work.

5.3.3.3 Flexibility

Flexibility may be measured as the ability to change or react with little penalty in time, effort, cost, or performance (Upton, 1994). The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The use of third party logistics service provider for most of the Thai Food Processing Company's transportation system provides the flexibility to the company. The TFPC can choose a third party logistics transportation that matches with its order delivery schedule. Moreover, The TFPC owns small trucks to carry materials and finished products between factories and its warehouse. Big trucks are also used between factories and outside warehouse. These transportation systems support the company in the term of flexibility.

The Thai Chemical Company (TCC)

Due to its own transportation facility, the Thai Chemical Company is able to change the delivery schedule as desired. The new technology such as GPS systems also contributes to its flexibility. The company can monitor the real circumstances and change the delivery schedule properly and spontaneously.

By not relying on independence garages, the TCC can strictly control maintenance schedule. Consequently, its trucks are always in good condition. The company has much more usable truck available. This resource slack then enhances the firm's ability to react quickly.

The Thai Textile Company (TTC)

The Thai Textile Company carefully controls production and takes order because products are highly changeable and customer's expectation is high. Thus, production is fixed and it results in effective transportation management. However, transportation is not quite flexible because there are only two types of transportation, by the TTC and by customers. Outsource transportation is used in case of shortage of trucks. This problem hardly occurs though and it is not an obstacle for the TTC.

5.3.3.4 Reliability

Reliability refers to the trustworthiness of the transportation including its delivery schedule, environment kindly and safety. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The challenges to achieve delivery schedule are long distance delivery such as delivery to America and Europe. This can cause delay. The Thai Food Processing Company ensures that transportation systems are environment friendly by applying close transportation system and controlling with documents. Also, the TFPC prevents contamination during delivery to Thai Food Processing Company's factory. A

maintenance department has checked delivery trucks to keep them in good condition and maintain them to have complete stop burning. The criteria to measure logistic performance are the delivery is on time and products are delivered as agreement.

The Thai Chemical Company (TCC)

The Thai Chemical Company faces no problems regarding transportation reliability. The company asks its customers to evaluate transportation performance every month and found that it is improved every time in terms of both speed and dependability.

With regard to the maintenance system, the TCC has a mechanic team who is always available to check up the trucks. In addition, every driver needs to check their trucks on a daily basis.

The Thai Textile Company (TTC)

Reliability is built among customers by inspecting working process and updating status of products. Those processes also allow reliability for transportation system as timetable of transportation can be adjusted and collecting of product is effective. The Thai Textile Company and customers work together to fill up truck with goods or raw materials, do not let empty truck run. Milk run system and carrying waste from factory back to customer are also applied because some leftover materials such as leftover of clothes and colour can be sold.

5.3.4 Internal integration

Internal integration refers to a collaborative relationship within company which recognises some degree of interdependence and cooperation on a specific project (van Hoek, 2001). Under internal integration, there are four performance measurement factors in tactical decision making level. They are information integration, internal quick response, use of information technology and efficiency.

5.3.4.1 Information integration

Information integration refers to the extent to which all functions within company can pass information smoothly (Chan *et al.*, 2003). The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The Thai Food Processing Company measures information system performance from a quantity of error of sending information and delay in sending information between the TFPC and customers. There is limited capacity of mailbox in e-mail of employees. Thus in case of huge file, space is not enough to keep such file. Furthermore, the speed of internet is not stable, sometimes it is very slow.

The Thai Chemical Company (TCC)

A major strength of the Thai Chemical Company is its information system. Its IT links all business functions altogether. Orders from customers are the starting point. The system then uses this data as input in other software applications, such as account receivable, billing, purchasing, planning, and inventory control.

Data in its information system are always up-to-dated. The crucial information for the TCC is product costs. The company has to monitor material prices regularly, as it can change any time. Once the TCC anticipates that the price of some materials would go up, the company will pile up that material in advance. The company even estimates overhead so that the company can figure out the actual costs accurately. Information about product costs is very important for customized products, whose price can be changed dramatically. Knowing the actual product costs accurately, salespeople can quote the price competitively.

One intriguing function of its information system is its capability to support product customization. When research and development department develops new items, the TCC can enter the mixture formula into the system and now planning, production, and procurement departments can use it in its processes seamlessly.

The Thai Textile Company (TTC)

The Thai Textile Company has ability to integrate information within the company. The information integration is made by updating data via database which focuses on accuracy and promptness. Staffs are a key to run working system as there has not been fully automatic information technology. Main information is from various departments and can support decision of administration team. Those data are not entirely integrated with customers or suppliers as some are critical and the TTC does not want competitors have an access to its system. Head of information technology sector usually checks and updates those data on daily basis.

5.3.4.2 Internal quick response

Internal quick response refers to the sharing and availability of information between related departments in company. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The Thai Food Processing Company strengthens information sharing further by developing Thai Food Processing Company' own intranet system and linking with ERP system. Timeliness of information inbound and outbound is inacceptable degree. E-mail is used in case of sending information to organisations in Thailand or international office such as in Japan. In case of hurry, contact via telephone will be used.

The Thai Chemical Company (TCC)

Thai Chemical Company's information system has been designed to be a real-time and highly interconnected system. While this kind of information system is hard to develop in many firms, Thai Chemical Company's founders made it possible here. Specifically, they determined that the system should be the first priority, and people then have to go along with the system.

Internal quick response also results in excellent customer service. Although the TCC does not integrate their information systems with suppliers and customers, they use their systems to support the entire supply chain. For instance, either suppliers or customers can call for an inquiry which can be answered right away.

The Thai Textile Company (TTC)

When there is an order and production is run, operation will be fixed and there is a few of adjustment. If there is any change from customer, there is a specific team that will directly report to administration team for immediate decision. The contact is via calling and e-mailing.

5.3.4.3 Use of information technology

The role of information technology is shifting from a general passive management enabler through databases, to a highly advanced process controller that can monitor activities and decide upon an appropriate route for information (Gunasekaran *et al*., 2004). Modern information technology, through its power to provide timely, accurate and reliable information, has led to a greater integration of modern supply chains than possible by any other means (Benjamin and Wigand, 1995). The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The state of art information system that the Thai Food Processing Company uses for effective operation of internal communication process is ERP system and e-mail is used when contacting with outside organisations. ERP system in warehouse system is ready to be used but the linking with production department is not be used in full capacity. It is still under the process of testing and developing. The TFPC tries to improve system further by creating ERP system to cover all company's work system.

The Thai Chemical Company (TCC)

As the Thai Chemical Company realized the importance of information technology, the company began investing in the information system since twenty years ago. The company uses standard and contemporary software packages such as Lotus Notes so that the TCC can have reliable customer service and software updated. Besides, the company has its own IT team who will maintain and improve the system continuously.

The Thai Textile Company (TTC)

Faxing, e-mailing and calling are the key communications of the Thai Textile Company. Recently, the TTC has planned to upgrade its ERP system. However, it is not an urgent issue as current working system of the TTC is not complicated and there is not in a situation of frequent change of production. In addition, workers are capable of dealing with current jobs. In near future, the TTC has planned to extend and build new plant. Thus, it is necessary to link all data and complex ERP system will be a key to this process. Currently, it is not operated in every step of work and executive cannot check all details. It is in the phase of developing for more efficiently.

5.3.4.4 Efficiency

Efficiency measures how well the internal supply chain is integrated by considering the related costs. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The ways the Thai Food Processing Company can reduce operating cost by using e-mail. This can save cost of sending via fax machine. However, the cost of sending the samples via airplane is high and it tends to be higher because of the fluctuation of airfreight cost. To improve effectiveness of existing information technology, the TFPC should provide its own e-mail address. There should be an automatic information management in intranet system. Information should be distributed to all staff in time of

needed. This information can support executive operators by providing more choices for making decisions.

The Thai Chemical Company (TCC)

The efficiency of Thai Chemical Company's information system results from long period of experience. Its IT department has three employees who are in charge of computer network and computer programming. These employees have been worked with the firm for a long time. Therefore, they are so capable that problems can be solved without delay.

Information system however has some drawbacks. Like many other firms, the TCC faces a problem about information overload. There are too many e-mails distributed throughout the corporation. Now, the company tries to change the procedure. Particularly, in an earlier step problems at hand should be solved via telephones rather than via e-mails which normally need to be sent back and forth. Only then could the conclusions be sent to the company's network via e-mails.

The Thai Textile Company (TTC)

Building good relationship with customers is one key success of the Thai Textile Company. Moreover, an approach and exchange of information within the company are smoothly run. E-mailing and calling are key communication as they allow exactness and promptness. Customer can also directly contact with executive in case of emergency issue. In the future, when ERP system is fully upgraded, the company's information system will have more efficiency. Local area network (LAN) system and calling are mainly used for internal communication. Sometimes, internet is used but communication via LAN system is more quick and stable. It is because most data are picture with big size.

5.3.5 Human resources

Human resources refer to the management of employees' improvement for a better company's internal supply chain. Under human resources, there are four performance

measurement factors in tactical decision making level. They are motivation, safety, training and innovation and learning.

5.3.5.1 Motivation

Motivation refers to the method to inspire employees to improve their ability. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The Thai Food Processing Company maintains both new and existed staffs. The company motivates them with appropriate wages plus attractive over-time (OT) payment. The TFPC provides additional training in area of specific skills for staff. Also, there is a test to evaluate staff's capacity in order to plan for further trainings.

The Thai Chemical Company (TCC)

The Thai Chemical Company employs about 250 workers in its plants. The company uses rewards rather than punishment to stimulate its workers. Unlike many other firms, the TCC increases wages for blue-collar workers every year. The company also tries to not make any punishment when something go wrong. In addition, the TCC inclines to use persuasion technique if the company wants workers to cooperate with the company in some issues, such as saving the company's overhead expenses. Finally, the TCC holds the fairness of pay in high regard.

The Thai Textile Company (TTC)

Encouragements for employees are offering welfare and fringe benefits as primary labour law. Incentive is also provided for employees but different in their level of employment. In addition, there is supporting activity which helps to increase employees' connection and loyalty to organization. The Thai Textile Company also supports capacity development in order to extend employees' knowledge and develop them to be ready for the Thai Textile Company' business growth. During a high peak of order, offering over-time and bonus payment is used to motivate workers.

5.3.5.2 Safety

Safety refers to the degree to which the risks can reduce from work process. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The safety procedure the Thai Food Processing Company has in place to ensure the working environments is notifying safety regulation and applying them with restrict. Safety equipment such as belt to support back, a pair of shoes covered with metal, clothes to prevent chemical materials are provided sufficiently.

The safety regulation of Thai government is applied in all factories. There has been an evaluation of government if any factory fails to follow the safety regulation it will be closed. Thus, the TFPC has followed the safety regulation of Thai government with restrict. The company has applied ISO 18000 and this can assure the standard of safety for workers. Each year the TFPC sets goal for safety in order to improve the safety degree towards 'zero accident'.

The Thai Chemical Company (TCC)

The Thai Chemical Company has standard safety procedures as a contingency plan. The company also practices the procedures regularly. The safety issue is very important for the surrounding community since the firm uses hazardous chemical product. The TCC still has a major problem about worker safety. Workers are apathetic toward the safety issues. Ironically, though the TCC has safety training course regularly, the workers often do not wear masks. As mentioned earlier, the accidents are also the result of carelessness of workers.

The Thai Textile Company (TTC)

Administration team and engineering team have employed zero accident direction for staffs who works closely with machine. This supports safety at work, builds motivation among workers and reduces risk from damage. Safety system is used and is evaluated

with a variety of standards including S-5 activity and safety standard from government requirement.

Safety team always inspects safety gadget and safety guard and usually reports to administration team. There has been a clear plan of preventive accident and sorting out. Mock-up situation of emergency is also applied, for example fire accident, moving an injured worker, etc. This mock-up situation supports workers to have confidence to handle with those chaoses in emergency situation.

5.3.5.3 Training

Training refers to the process to provide the professional skill to the work force. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The Thai Food Processing Company compensates the skill gap when new person replaced a high skilled retired person by providing training. On job training is also provided. On job training is tested and designed by related departments such as maintenance department. Maintenance jobs need specific equipments and skills thus engineer will design appropriate process and time for those specific equipments and skills. Then, engineer will provide on job training program. When the on job training program is finished a human resource department will evaluate it and send the results to engineer in order to further develop the program.

The TFPC measures human performance by evaluating participants both pre and post training program. Then a week after the training, the department of participants will evaluate whether the previous evaluation is appropriate with that department and staff. It is because staffs are different in skill and capacity. The manager of each department is person who justifies and co-works with human resource department. Overall, there is annual test and there is co-working among departments in order to assign an appropriate key performance indicator (KPI) such as performance. In issue of hardworking, it can be measured with on time reporting to work.

The TFPC improves human skill by providing training programs every year. Each department has to revise work procedure to analyse its appropriateness and analyse which skills are needed for staff. Human resource department is responsible for evaluating in order to further design programs which suit with each department.

The Thai Chemical Company (TCC)

The Thai Chemical Company conducts training every month. Generally, the company provides in-house training. Training is also important for new employees so that they will be familiar with the company's system. Actually, because the key critical knowledge is already embedded in the information system, Thai Chemical Company's new employees require less training time in order to work effectively compared with the other firms.

The Thai Textile Company (TTC)

Novice employees are trained by senior worker before they are put in their position. Human resource department collaborates with production department to provide training for employees. Training is necessary as products are various and changeable. The Thai Textile Company continuously provides workers trainings as the pattern of clothes is always updated and the TTC needs highly skilled workforce. Thus, during an off peak production trainings are offered for workers. Initially, the TCC may face with a shortage of workers with expertise. However, after those workers are trained, they improve themselves with more skill. Thus, this can support an increase of efficiency.

Putting a right man in a right job is also employed at the TTC as human power has immense impact on jobs related to human competence. Man and machine have to work together. As a result, Training provided has to be arranged by each department. Each training is suitable with work characteristic of each department. Employees are then trained with specific skill and their skill is matched with needs of each department. However, such way of training may cause problem when those employees are transferred to other departments because of their specific skills, not general skills. Thus, they have to adjust themselves to different type of work at another department.

5.3.5.4 Innovation and learning

Innovation and learning refer to the management of increasing employee's capability in learning new knowledge. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The Thai Food Processing Company has system in place for listening to everybody, collecting their thoughts, and displaying their ideas and innovation. The TFPC encourages human resources to be innovative and keep tradition of learning by ordering direct from the executive committee.

The Thai Chemical Company (TCC)

Thai Chemical Company's workplace environment instigates creativity and innovation. However, the TCC initiated joint ventures so that the company can learn new knowledge from outside specialists in the industry. On the other hand, the company gains new knowledge from customers when the TCC is requested to develop innovative customized products.

The other factor that influences creativity in the workplace is the firm's commitment to innovation. This factor can be found in the TCC as top management always supports creative activities. Top management may start a creative process by pointing the areas that need improvement. However, the TCC empowers the staff to freely explore the means to achieve the desired ends. But when it is time to implement the innovations, top management will step in and lead the change. The latter point is important since change can get resistant from many people along the way.

The Thai Textile Company (TTC)

The Thai Textile Company has employed activity and guidance of Kaizen system in order to stimulate employees to develop their skills, be promoted towards upper position, and build pride among employees. Besides innovation development and

learning for job position, other advantages for the TCC are having highly skilled employees and low rate of job turn-over. Furthermore, each department can adapt those innovation and learning for its own department and this results in atmosphere of learning in organization.

5.3.6 Operations

Operations refer to operational performance and environmental performance of the company including company's operational improvement. Under operation, there are three performance measurement factors in tactical decision making level. They are operational performance, environmental performance and innovation.

5.3.6.1 Operational performance

Operational performance measures the quality, flexibility, and reliability of company's procedure. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The Thai Food Processing Company reacts with uncertain demand fluctuation by developing workers to be versatile and this can help substitute other positions when needed. The criteria that the TFPC considering to measure reliability are products produced with food standard assurance, including HACCP and GMP.

Materials usage cannot be reduced as products must be standard. The TFPC tries to reduce mistakes in production and mistakes from workers. For example, the process of slicing fish needs skilled workers. Otherwise, job has to be re-done. The TFPC reduces waste by adding value for some unused materials such as fish skin. Fish skin used to be thrown away but now it is fried to be crispy fish skin. Other waste such as fish oil it can be sold to customers.

The TFPC eliminates the non value adding activities by cutting some unnecessary procedure. Every department shares their ideas to help with this issue. For example,

before the materials are kept in freezer the temperature of materials will be reduced in order to save energy and the usage of nitrogen. In future, the TFPC plans for sustainable development by applying QCC or Kaizen system.

The TFPC measures process efficiency by comparing actual versus planned through put time. There has been a summary report every month in order to further improve. A summary report is also passed on to top management. The reasons have to be clarified if the goal is not fulfilled. The TFPC maximizes throughput by having heads to control in every level. Different head will be shown by different colours of hats. These heads work closely with their workers and can react immediately for sudden problems.

The Thai Chemical Company (TCC)

Thai Chemical Company's operations are both effective and efficient. To achieve economy of scale, its business units share the same fundamental business support functions, such as purchasing, transportation, and IT. One problem with this strategy in general, however, is complex cost allocation. Interestingly, the TCC seems to foresee this problem beforehand. That is why the company decided to adopt standard contemporary software packages. Consequently, the TCC can apply activity-based costing painlessly.

Thai Chemical Company's operations are so flexible that the company can satisfy each customer's unique demand. Its products also have high conformance. That is, every unit of its products always meets the specified standards.

The Thai Textile Company (TTC)

Staff is key to success for operational level as the Thai Textile Company focuses on using staff's skills to add value of works. Thus, encouraging staff is a critical concern. Trainings have usually been organised in order to extend staff's potential. Evaluation of individual staff is another focus of the TTC. Head of each sector always supervises and gives a hand to staff. In addition there has been a maintenance team to handle and maintain machine in order to keep it run without an interruption.

A special team that has expertise and is able to deal with emergency situation is a critical issue of company. The Thai Textile Company employs in order to encourage staff to take part in problem solving and to share its ideas and suggestions. This approach brings efficiency to work, both direct and indirect. For instance, the TTC can launch a product matched with customers' needs and can expand market continuously.

5.3.6.2 Environmental performance

Environmental performance relates to the environmental issues of the operational processes. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

Thai Food Processing Company' environmental policies are ISO 14000 EMS and green productivity. The TFPC has both internal and external audit process. The frequency is once a month for internal audit and once a year for external audit. However, in case of hurry individual internal audit may be needed if customers ask for. Thai Food Processing Company' plans to reduce energy consumption are: 1) Turn off electricity during lunch break, 2) Use machine appropriately with types of jobs and 3) Use substitute energy such as biogas.

An alternative source of energy for consumption is using diesel with boiler. In future, the TFPC will change from diesel to biomass. Thailand is agricultural based country so agricultural products can be easily supplied to be produced for substitute energy such as biogas. There has been an expansion of waste water treatment plant in order to increase the capacity to treat waste water effectively.

The Thai Chemical Company (TCC)

Many of Thai Chemical Company's customers, such as NIKE, adopt high standard practices regarding environmental issues. Their considerations then compel the TCC to follow the practices. The company also realizes that there are many rules and regulations about environmental issues that a firm has to follow both at present and in

the future. Therefore, it is advised for the TCC to have a proactive posture on these concerns. The company now strives to the standard for corporate social responsibility (CSR-DIW): 2009 which corresponds to ISO 26000 (social responsibility) by following seven principles: accountability, transparency, ethical behaviour, respect for stakeholder interests, respect for the rule of law, respect for international norms of behaviour, and respect for human rights.

The Thai Textile Company (TTC)

More concerns of environment friendly issue in global market competition and more legal issues related to environment affect suppliers and the Thai Textile Company to adapt its production and operation. The TTC cooperates with public sectors to let them initially assess the company's environment by using ISO 14000 standards. Green purchase is also applied. In addition, a measure of energy saving is employed as machines are controlled by staff such as sewing machine. Thus, motivation of staff' discipline is very important. A reduce of using materials is another measure of the TTC. It is used to build saving discipline among staffs and include them in developing process.

5.3.6.3 Innovation

Innovation refers to technology and the way to improve operating performance of the company. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The Thai Food Processing Company tends to substitute workers with machine in order to reduce mistakes from works and solve the problem of labour shortage. The average time for new product development is about one year, including time for testing new product. However, it takes about two or three months in case of developing existing products. Thai Food Processing Company' procurement lead time is about one year and sales cycle lead time is three or four years.

The TFPC has innovative operation process such as freezing with nitrogen. Nitrogen used to be injected into products but it is developed to be a tube for injecting nitrogen and products are run through an engine belt in tube. This can save the quantity of nitrogen and increase the efficiency of freezing.

The Thai Chemical Company (TCC)

The Thai Chemical Company learns from its errors all the time. The company realizes that it is difficult to get rid of human error which is beyond its control. The best way to cope with this problem, in its idea, is to make the system tighter. When something bad happens, the TCC first examines the system and procedure to identify the flaws and then change the procedure accordingly. By doing so, the company improves its operation processes every time the company learns a new thing. The TCC also adopts the concept of total quality management (TQM). The company wants to incessantly decrease its operational costs.

The Thai Textile Company (TTC)

Training and initiation of innovative thinking are provided for staffs in order to build dignity among them and build atmosphere of learning in company. Changing trends of fashion cause difficulty in forecasting of production as there are many external factors. Thus, the Thai Textile Company has planned to employ computer innovation to set up effective calculating models such as neural network, supporting vector machine and genetic algorithm. Moreover, computer simulation will be applied for forecasting and planning for production. However, they are planning and under developing to compare with the expected results. The cost is high and there is no staff with specific expertise in these models.

There is a summary of each performance measurement factor on internal supply chain management as shown in table 5.2.

Table 5.2: A summary of the performance measurement factors on internal supply chain management for three case study companies

Companies / Factors	The Thai Food Processing Company (TFPC)	The Thai Chemical Company (TCC)	The Thai Textile Company (TTC)
(Facility) Capacity utilization	Around 70 percent of its full capacity utilization is used, while double shifts will be operated for peak period.	Up to 80 percent for synthetic resin and only 50 percent for synthetic leather are used on capacity.	Current capacity utilization is about 70 percent and the company focuses on skilled labour.
Efficiency	Appropriate instrument for specific job is designed to increase productivity.	For efficiency, the company produces synthetic resin by itself to use for synthetic leather.	The company trains its workers to be skilled labours to support an increase of efficiency.
Flexibility	An adaptation of work process occurs during festivals and high orders.	Flexibility comes from the ability to produce both synthetic resin and leather.	Mixed old and new machines can help the company to have flexibility for a variety of customers' needs.
Quality	The management of maintenance can help increase the quality of production.	The quality policy is to continually improve quality system for serving customers' satisfaction.	A Quality Control Circle (QCC) is applied before products are ready to send out.
Reliability	The company has continuously invested in sustainable environment and energy development.	The company launches safety activity which sets the zero accident target.	The company focuses on reducing risk of work and increases reliability of working process.

Companies / Factors	The Thai Food Processing Company (TFPC)	The Thai Chemical Company (TCC)	The Thai Textile Company (TTC)
(Inventory) Optimal inventory policy	The company manages risks during inventory level optimisation by buying raw materials when their prices are low.	The company classifies inventories into different categories by their movement and determines the minimum stock requirement for each category.	The company selects suppliers that can deliver raw materials promptly with short lead time and plans the production with customers to allow economy and precise inventory.
Warehouse utilization	The outsource warehouse is rented because most finished products are not delivered immediately after produced.	Warehouse is located at the centre of each plant to save time and energy for movement.	The company focuses on prompt delivery of finished goods to reduce inventory quantity.

Companies / Factors	The Thai Food Processing Company (TFPC)	The Thai Chemical Company (TCC)	The Thai Textile Company (TTC)
(Transportation) Capacity utilization	The company uses third party logistics transportation for effective capacity utilization.	The utilization is high because the company shares the transportation with all other firms in holding group.	The company owns its trucks for outbound transportation to manage the delivery capacity.
Efficiency	The company plans to use conveyer within the plant to increase efficiency of transportation.	GPS systems are installed in each truck and NGV are used rather than gasoline to raise transportation efficiency.	Maintenance of transportation by itself is a strength that allows the company's process system to be effective.
Flexibility	The use of third party logistics service provider provides the flexibility to the company.	Due to its own transportation, the company has a flexibility of delivery schedule.	Sometimes outsource transportation is used in case of shortage of its own trucks to expand the flexibility.
Reliability	The company checks all delivery trucks and prevents contamination when they arrive at factory.	Additional from mechanic team, truck drivers check their trucks on daily basis.	The company tries to fill up truck with materials or products in every trip.

Companies / Factors	The Thai Food Processing Company (TFPC)	The Thai Chemical Company (TCC)	The Thai Textile Company (TTC)
(Internal integration) Information integration	The company has issues about employees' electronic mailbox space and the speed of internet.	The company's information system can link all business functions altogether.	The information integration is made by updating data via database which focuses on accuracy and promptness.
Internal quick response	The company strengthens information sharing further by developing its own intranet system and linking with ERP system.	The company's information system has been designed to be a real-time and highly interconnected system.	A specific team is assigned to work with any change from customer and report to administration team.
Use of information technology	ERP system is used for effective operation of internal communication process.	Contemporary software packages and its own IT team are invested for the company's information system.	An upgrade ERP system will need when the company extends to the new plant.
Efficiency	An automatic information management in intranet system can help the company to improve effectiveness of existing information technology.	Long experienced of its IT staffs makes efficiency to the company's information system.	Exchange of information within the company flows smoothly by LAN system and telephone.

Companies / Factors	The Thai Food Processing Company (TFPC)	The Thai Chemical Company (TCC)	The Thai Textile Company (TTC)
(Human resources) Motivation	The company motivates its employees with appropriate wages plus attractive OT payment.	The company uses rewards rather than punishment to motivate its workers.	Welfare and fringe benefits are offered to encourage staffs and OT payment is provided during peak orders.
Safety	The company sets 'zero accident' goal for safety in order to improve the safety degree in each year.	The company has safety training course regularly to maintain standard safety procedures.	S-5 activity and safety standard from government requirement are applied for workers' safety.
Training	The company improves human skill by providing training programs and on job training every year.	In-house training is conducted every month, especially for new employees.	The company continuously provides workers trainings as products are various and changeable by fashion trend.
Innovation and learning	The company has openness from employees' ideas and innovations.	The company gains new knowledge from its joint venture companies and customers.	Innovation and learning development are employed to all department of the company.

Companies / Factors	The Thai Food Processing Company (TFPC)	The Thai Chemical Company (TCC)	The Thai Textile Company (TTC)
(Operations) Operational performance	To maintain its operational reliability, the company produces under many food standards assurance.	To make its operations effective and efficient, the company shares the same fundamental business support functions for its business units.	Staff training and machine maintenance are the keys to success in company's operations.
Environmental performance	ISO 14000 EMS and green productivity are the company's environmental policies.	Because of its type of products, the company concerns on environmental issue seriously.	Energy saving and reduce of materials using are the initiatives in environmental concerns.
Innovation	The company tries to replace man power with machine and innovate the work process to challenge its operational efficiency.	The company continuous improves its operation process from the errors. The work system becomes strictly to reduce further error.	The company plans to employ computer innovation and simulation to improve the production process.

5.4 Customer relationship management

The customer relationship management provides the structure for how relationships with customers are developed and maintained (Croxton *et al.*, 2001). This customer relationship management process represents for all processes that focus on the interface between the company and its customers (Chopra and Meindl, 2004). Customer relationship management macro process aims to generate customer demand and facilitate the placement and tracking of orders (Croxton *et al.*, 2001). Based on the proposed framework in Chapter Four, customer relationship management has four performance measurement factors in strategic decision making level. They are customer service, customer integration, demand forecasting and market analysis. In summary, there is the brief comparison of each performance measurement factors in tactical decision making level for three case study companies as shown in Table 5.3.

5.4.1 Customer service

Customer service refers to the provision of labour and other resources, for the purpose of increasing that value that buyers receive from their purchases and from the processes leading up to the purchase (Aramyan *et al.*, 2007). Under customer service, there are four performance measurement factors in tactical decision making level. They are responsiveness, customer order processing and delivery, handling customer complaints and value added services.

5.4.1.1 Responsiveness

Responsiveness relates to the way it takes for a firm to respond to a customer query with the required information. It is not unusual for a customer to enquire about the status of order, potential problems on stock availability or delivery. A fast and accurate response to those requests is essential in keeping customers satisfied (Gunasekaran *et al*., 2004). The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The type of Thai Food Processing Company' manufacturing is made to order with 80 percent of the total products so the business strategy with respect to customer service of the TFPC is to respond the customers' needs. Also, other business strategies are delivery products at right time, a fixed price and made products as customers' demands. To measure and improve the quality of customer service, the TFPC provides a survey to customers to evaluate the customers' satisfaction. The survey is conducted by the marketing department once a year and is divided into the category of products and services. Then the marketing department will make an executive summary based on these evaluations.

The TFPC has initiated the innovative approach to enhance quality of service to next level but it is still under processing and improving. To create outstanding customer experience with optimum cost, the TFPC uses the machine to substitute the man power and to increase the manufacturing and decrease the defect (from the worker), and this can result in the standard of products. This is Thai Food Processing Company's strength. Also, the company can save on costs for labour.

The Thai Chemical Company (TCC)

Thai Chemical Company's unique selling point (USP) for polyurethane synthetic leathers is made-to-order products. The TCC holds up the premise by being receptive to customers' demand. The company also uses salespeople who have long experience within the industry. These salespeople are acquainted with market trends. Hence, these insightful salespeople understand the customer need and then have a capability to respond to it promptly.

Another Thai Chemical Company's value proposition is its quality. Interestingly, Japanese firms prefer products from the TCC over those from Chinese firms. While they often complain about the company's higher prices, they still have business deals with the company.

Based on these two foundations, the TCC always gets 95 percent of customer satisfaction.

The Thai Textile Company (TTC)

The design of product focuses primarily on customer's need such as softness, pattern, and delicacy of cloth. The flexible capacity of machine is a key to develop a design of product. The Thai Textile Company has changed a machine according to its production capacity, not its useful life. This allows the company to be able to respond a variety of orders, to maintain existing customers. Sales personnel also closely work with customers in order to help them to customize their products. Furthermore, the TTC has a diversity of clothes inventory. Thus, an ability to respond to various customers' needs makes the company be able to compete on its competitors.

However, the TTC needs more sophisticated integrated customer relationship management (CRM) system to integrate customers with its design, planning, production and procurement.

5.4.1.2 Customer order processing and delivery

Customer order processing and delivery aim to providing the requested products with a short lead-time (Persson and Olhager, 2002). The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The total order cycle time (from order entry to delivery) of the Thai Food Processing Company is about one month for regular products and about two or three months for new products. The typical order fill rate of the TFPC is classified into the quantity of products with the rate of 100 percent, the time with the rate of 90 to 95 percent. However, there might have some delay about two or three weeks during the peak period. The constraint to achieve required fill rate is the raw materials which affect on manufacturing, stocking, and delivery. The TFPC has a problem of the size of shrimp which does not meet the needs of customers. Also, there are a few quantities of squid

which is not enough for customers' order. This results in the high cost of manufacturing and also results in high price of products.

There are some bottlenecks in the process of the TFPC to achieve required fill rate that are no sufficient materials and labour. There is a high rate of staff turnover and most workers would want to work in a cool temperature sector rather than a hot temperature sector. Therefore, the TFPC manages these bottlenecks by using the machine to substitute the labour. However, some work cannot be replaced with machinery. Another thing is in order to encourage the staff there is an increase of labour fee for staff who have not been absent from work in each month.

The criteria that the TFPC considers to measure the delivery performance are time and quantity. However, sometime customers provide no sufficient time for the company to deliver products at right time. If customers provide the TFPC more time the company then can work more efficiently.

The Thai Chemical Company (TCC)

Compared with the other firms, the Thai Chemical Company may use longer time to fill the customer orders. This is because the company does not stock finished products in advance. However, this issue is not perilous for the company since its customers need flexibility rather than speed. In fact, the TCC rarely loses customer order once requested. The company fulfils customer needs marvellously.

In some cases that customers need products urgently, the TCC will assess the feasibility of altering the production schedule. This is done easily because the company has fully integrated information system. The TCC knows whether it should either combine the productions or suspend other production without disturbing the whole system.

The Thai Textile Company (TTC)

The Thai Textile Company adopts a systematic approach to process customers' requirements. A process of customer order begins when customer gives details of specification. Then, a department of production will plans and examines its competence

of production. The TTC does not concern the size of order, either small order or large order. The production system is not complex and customers mostly provide their own raw materials so the decision to take an order is quick. Customers are also allowed to make necessary change if feasible through mutual consent. Therefore, the problem of this process is there have been some changes from customer and the TTC has to deal with them.

The TTC usually delivers the products to customers, only a few of them come to get their products by themselves. Customers can call to check the stage from the start to the delivery of their products. Occasionally the TTC observes delivery failure mainly due to specification change request from Customers. Capacity constraint of some machines also sometime results meeting delivery schedule.

5.4.1.3 Handling customer complaints

Handling customer complaints refers to the process to deal with registered complaints from customers about product or service (Aramyan *et al.*, 2007). The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

To deal with customer complaint, there is a form for customers to fill out and pass it back to the Thai Food Processing Company. However, customers would rather e-mail to the company with photo of defect products as evidence. In case, there are some problems the quality assurance department will respond to those problem and sort them out immediately. It is not over eight days to dissolve a customer complaint after there are complaints from customers. The average number of complaint that the TFPC receives is about 60 complaints per year. The majority of complaints are from customers in Japan, for example hair in pizza or fish bone in food in the line of squid.

The TFPC tries to reduce the number of complaint by using a system to compare between the sale volume and the amount of complaints from customers. To decide which complaint need urgent response, the TFPC would consider if that complaint is

very serious and problem has negative impact on consumers or negative effect on laws. However, the TFPC responds to every complaint from customers.

The Thai Chemical Company (TCC)

There are two main problems that customers have been complained about: waiting time and return product. To prevent the vast damage from the former problem, the Thai Chemical Company with the help of its information system will try to notify customers in advance once the company realizes the tendency to delay.

The former however seems to be less critical than the latter. The latter is often a result of miscommunication between salespeople and customers. Once the problem arises, the TCC always investigates the cause. The company also tries to please customers by bringing back the products and recheck or modify the products, if necessary. If it is required to make the new ones, the TCC will rework on it without hesitation and sell the old ones to other customers instead. To prevent this problem, salespeople also have to confirm order specifications before they go to the production line.

The Thai Textile Company (TTC)

Most customers are existing customers and a deal of business is based on trust between the Thai Textile Company and customers. Thus, there have been very a few of complaints. However, for new customers or in some cases, complaints come directly to sale sector in marketing department and these complaints are sent directly to administration team afterwards. There is a monthly meeting in order to find a solution for problems of customers, case by case. The TTC can figure out those problems immediately because the company provides a pilot product to customers before making an entire order.

5.4.1.4 Value added services

Value added service refers to the services to satisfy customer needs in both before and after sales. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

In the process of value creation, the Thai Food Processing Company creates and delivers value to customers by informing issue concerning the consuming on package, providing some utensil to facilitate eating and/or various kinds of sauces. There is no value assessment method for this type of business because the business is wholesale, not retail. Regarding to the high competition, the TFPC has to plan and predict the customers' needs. For instance, to create further value, during the New Year festival, there is a present set (a set of 4 meal boxes kept in a bag) to be an addition option for customers to use as a New Year gift.

After sales service that the TFPC gives to customers is to provide additional information when customers require. In future, the company will ask for customers' feedback periodically and follow them in order to provide more facility. There is no charge for customers during after sales service. To ensure that customers are satisfied with after sales service they received, there is a survey. Then, the TFPC will improve work performance based on the results from a survey. A survey can reflect the degree of customers' satisfaction and the company's goal for next year can be set based on the results of survey.

The Thai Chemical Company (TCC)

Customers can request the Thai Chemical Company to make some product prototypes for them. The prototypes sometimes are brought to market tests. If customers or the customers' clients need some additional features, they can request the company to make a product adjustment. Generally, the TCC agrees to make adjustments till the products are well received.

The Thai Textile Company (TTC)

The Thai Textile Company introduces tailored offering facility for its loyal customers. In company's website, the TTC has aimed to provide information to broad spectrum of business customers on design process and technology on selecting home textile by design area, colours and patterns. Additionally, the company provides visualization

opportunities to the customers by establishing showroom at the head office. Through visualization visitors can choose to view the home textile in an existing room and they can order sample of their favourite home textile at the reception in a similar way to ordering products from the website. Moreover, Thai Textile Company's after sales service sector provides customer feedbacks on every product, which are considered for new product development.

5.4.2 Customer integration

Customer integration refers to a collaborative relationship between company and customer which recognises some degree of interdependence and cooperation on a specific project or for a specific order agreement (Ellram, 1991). Under customer integration, there are four performance measurement factors in tactical decision making level. They are extent of cooperation to improve quality, information integration, organizational relationship and use of information technology.

5.4.2.1 Extent of cooperation to improve quality

Extent of cooperation to improve quality refers to the collaboration with customers to improve products' quality and to develop new product in both normal situation and under contingency. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The customer integration is very importance to the Thai Food Processing Company. It helps the company to improve product innovation performance and quality performance. There is cooperation between the TFPC and customers by letting customers to visit the factory, sharing their opinions. This can encourage coordinated working, for example customers can share their opinion to specify the taste of products to meet their needs. Thus, the TFPC gains information from customers and utilizes that information to improve products. The current company website has only product information not an online catalogue. The TFPC updates information once there is any new information, without any setting the time frequency. Also, the company cannot

provide this product catalogue with the explanation of price and shipping cost because of the variable cost of materials and variable exchange rate. However, the TFPC is considering the probability of this operation.

The Thai Chemical Company (TCC)

The Thai Chemical Company has a great extent in terms of cooperation to improve quality. The company arranges the cooperation in two levels.

For special accounts or special orders, customers can request new product specifications. The TCC then compares the customers' specifications with its own. If its products do not meet the customers' specification, research and development department will step in. In general, while customers have to devise their own pattern or design of polyurethane synthetic leathers to keep up with fashion, the company works out the quality of synthetic leathers. The TCC exerts great efforts to develop such a high quality product that it functions perfectly with the products' application. The important attribute for polyurethane synthetic leather is generally about light in terms of weight.

For regular accounts, customers can take product samples and then test it. If the products pass the tests, the customers then place the orders.

The Thai Textile Company (TTC)

There have been two aspects of extent of cooperation. First is dealing with the changes of customers' orders. The keys to deal with those changes are an often communication, a cooperation in looking for suitable raw materials, and a continuous development of product quality. These collaborations also can help to maintain existing customers. Second is cooperation with an abroad design business to research and develop trends of fashion for the next season or next year. This allows the Thai Textile Company to work out efficiently with production process.

During ordering stage, the TTC communicates with the customers through formal channels. During production stage, both formal and informal network helps them to remain in touch. During uncertainties also both formal and informal network helps

sorting the issues. The TTC could get benefit from implementing formal knowledge management practices in order to add value to its customers.

5.4.2.2 Information integration

Information integration refers to the extent to which all functions between company and customer can pass information smoothly (Chan *et al.*, 2003). The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The Thai Food Processing Company organizes information of customers by dividing into the type of products and the country of customers because there are differences in customers' needs and the related laws have always changed. To understand customers' need and use this information to improve product, the TFPC builds a mock situation by assigning the marketing department as a customer. Thus, the company can search for customers' expectation from this mock situation. The results will then be used to improve by production department.

The TFPC maintains with customers about product quality and availability by sharing every respect of information with customers. Thus customers can gain complete information. Also, the company lets customers know whether the company can operate things they want or not. The strategy that the TFPC adopts to get to customer and for customers to get to company is to improved work quality and tried to build impression among customers. The main policy of company is keeping the existing customers because there are many risks to work with new customers such as risks concerning giving them a credit or making a contact with new customers.

To cooperate with customers for developing joint demand forecasting, the TFPC requests information from customers by planning a sufficient time to manage, particularly managing in term of manufacturing and delivery. Anyway, this can be adjusted later. Another important information is observing buying behaviour of customers. Joint demand forecasting can help the TFPC to reduce the cost of materials

and stock. It also helps to reduce cost of work. Thus, it can help to design the price which can be competed with competitors.

The major standard means of communication across function and customers is email. The TFPC tries to respond every email within a day. However, time difference because of time zone (Europe, America) is the challenge to cope with. Thus, the TFPC has to plan carefully and manage an appropriate time of communication for both parties.

The Thai Chemical Company (TCC)

Like its suppliers, Thai Chemical Company's customers cannot directly access Thai Chemical Company's information through network systems.

Although they cannot share information with each other formally, the TCC organizes informal channel to exchange information. For instance, after placing their orders, customers can call the company any time they want to know about the progression status of their orders. The TCC also sends customers questionnaires asking their plan to order in the near future. Customers can revise their plans as needed and often plan with the TCC collaboratively.

The Thai Textile Company (TTC)

The Thai Textile Company has dedicated sales team to remain in touch with customers in order to not only dynamically discovering their requirements, but also helping them to customize their products. A communication and exchange of data are made before business deal as customer wants to make sure that products are produced upon the specification. Data and other details are sent via fax machine and e-mail. Customer can inspect each stage of production any time such as ability of production upon specification and on time production.

Interviews revealed that there are a few issues that need to be addressed in order to improve information integration with the customers. These evolve mainly due to fast change in customers' requirements, and customers often change their requirements even after placing the orders. A good communication across the supply chain in order to

accommodate such changes throughout the production process is the key to customers' satisfaction. Moreover, there are evidences of order cancellation, delay in processing during production because of communication gaps. Hence, there are rooms for improvements in information integration.

5.4.2.3 Organizational relationship

Organizational relationship refers to the management of communication channels with customer including shared objective and risk. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

Thai Food Processing Company' objectives match with customer's requirements. Each year the TFPC has to adjust the company's objectives in order to make them match with the customer's requirements. A bargaining power of customers has also an impact on assigning customer's requirements. To achieve the company's objectives, the quality assurance department controls the operation under the company's objectives. The TFPC has also applied the ISO management standard with the operation of company. The results of this year working are applied and improved for the next year operation.

There is no evidence of risk sharing with customers. However, the TFPC wants to share risk with customers but customers do not want to. Thus, the company has to conclude in each order and this will result in the difficulty of operation. Actually, risks have to be shared and evaluated by both parties.

The Thai Chemical Company (TCC)

The organizational relationship between customers and the Thai Chemical Company is nourishing. Customers with special demand frequently send their staffs to stay in the company for two or three days. These staffs will train Thai Chemical Company's workers how to manufacture particular products they need. The new knowledge benefits the company greatly in the long run. In effect, the TCC leverages the

transferred knowledge for creating novel products, which is an objective commonly shared between the firm and customers.

The Thai Textile Company (TTC)

There has not been a department to take care of organization relationship with the customers because of a few numbers of current customers and a good relationship between the Thai Textile Company and its customers. Also, there has no plan to emphasize on extending a number of customers. An extension of customers may cause a problem of production as there is a variety of needs per individual customer.

However, the TTC maintains common objective and team work across the supply chain through continuous collaboration, cooperation and coordination with its existing customers. Work with customers through their interior designer and help customizing their requirements. There is no evidence of risk sharing.

5.4.2.4 Use of information technology

Use of information technology refers to the capability of the current company's information technology system. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The Thai Food Processing Company has physical communication mechanism (e.g. telephone, fax and e-mail) to remain in touch with the customers. There is no any state of art electronic business (e-Business) in place. The current company website has only primary information of company and product information. The TFPC intends to apply EDI and e-Business to its system. There is a plan in the future to use ERP system to create e-Business via internet. There is also no any state of art online direct sale arrangement. It is because Thai Food Processing Company' products are wholesale. The products are sold as a container, not retail selling.

However, the present information technology system is still okay but there is some confusion when many customers want to change many orders in the same time. The TFPC plans to develop the paperless system by working on computer and link the order process via internet. Thus, the use of information technology between the TFPC and customers is the issue that has to be improved.

The Thai Chemical Company (TCC)

Information system used to service customers is fully integrated within the company's all departments. As discussed earlier, the system is contemporary and effective for the internal use within company only. Mostly traditional communication systems such as telephone, fax and e-mail are used for keeping contact between the company and its customers. The Thai Chemical Company however has not offered online direct sale arrangement yet.

The Thai Textile Company (TTC)

The Thai Textile Company has both web-based and physical communication mechanism to remain in touch with the prospective customers. However, it seems the TTC can get considerable benefit through appropriate ERP system. Thus, there has been a designing and setting process of ERP system. This system allows Thai Textile Company's staff and customers an access to inspect real time data. However, an access to all data is classified and limited as some data cannot be distributed to competitors.

5.4.3 Demand forecasting

Generally, supply chain planning relies on forecast data, which becomes the basis for its production, material sourcing, inventory management and all other activities in supply chain (Chae, 2009). Demand forecasting usually takes demand data from salespeople who receive sales and demand information from customers. Under demand forecasting, there are three performance measurement factors in tactical decision making level. They are forecasting system in place, decision making, and reliability of demand data.

5.4.3.1 Forecasting system in place

Forecasting system in place refers to the current forecasting system of the company including its technology and process. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The Thai Food Processing Company uses historic demand and seasonality for demand forecasting. The existing information is used for the next year selling plan. Information of selling during festival can help in planning and forecasting effective. The demand forecasting has been carried out in each line of products every year. This can help to plan the order and the stock of materials. However, it could be complicated because of the forecasting in each line of products. Actually, some different products use same materials. The TFPC has to design the bill of material system to be related with products and this system can help to reduce the cost of material order. The company brings uncertainty factors due to global economic crunch, political instability, environment or other factors for forecasting but there is no statistical analysis. Furthermore, some factors cannot be predicted ahead thus the TFPC has regularly reviewed factors that may be come up.

The Thai Chemical Company (TCC)

The Thai Chemical Company uses a simple forecast model utilizing historical data to predict the future. In other words, the company predicts levels of demand and sales for a particular period, based on past records over the same period. To increase accuracy, the TCC also modifies the prediction based on further information gathered from its joint venture parties. As discussed next, the TCC still has a problem about prediction errors.

The Thai Textile Company (TTC)

Forecasting system is a challenge task for the Thai Textile Company as company's products are fashionable and vary on customers' needs. The analysis of market trend is

also necessary. An analysis team from overseas is hired to analyze trend of fashion for the next season or next year as marketing research may take too much time. Analyzed data can be used for the TTC to support its forecasting system. The TTC uses historic demand and seasonality for demand forecasting. The quantity of production is predicted from a sale volume of previous year. Then raw materials are stocked after an analysis the trend of mainstream fashion. This can save cost and reduce a risk of stock out for the TTC.

5.4.3.2 Decision making

Decision making refers to the degree of transparency and speed of decision. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

As the role of governance in the Thai Food Processing Company on decision making process, it is a policy of company that the executive committee has to share their decision. The TFPC measures its effectiveness on direction and control during the process of decision making and considering related factors. Then, the company measures its effectiveness again after the decision has been made. This can help to compare the results before and after the decision process. The challenges for any fast decision making process in the TFPC are various risk factors related in system because there is no evaluation and planning for the results that would be occurred from the fast decision making.

The Thai Chemical Company (TCC)

Typically, the Thai Chemical Company will inform customers its decision before the company works on it. This approach may cause some delay but it reduces conflict significantly. For example, the company will ask customers how much they need the product during this time and if they are going to order it continuously in the future. If so, the TCC might decide to produce it more and carry it in its stock for later order. But if not, the company is making just only for this order. This will reduce the chance that the firm cannot make it in case the customers urgently need it in the future.

The Thai Textile Company (TTC)

There are many decision points and variables within Thai Textile Company's CRM processes. They are complex and need consideration of multiple factors and involvement of various stakeholders. Although the decisions are currently being made with the involvement of administration team that establishes by and works with the managing director, appropriate support system could help to standardized decision making processes and to make right decision quicker. There is a data gathering sector from marketing department and production department to provide necessary information to administration team for making decision. In an emergency case but still under authority of the relevant department, the decision can make immediately. Sometimes, customer can communicate directly with a managing director in order to make a mutual decision. However, there is no software to support a decision making process as man power is still efficient enough to work out on this process.

5.4.3.3 Reliability of demand data

Reliability of demand data refers to the trustworthiness of the demand data including its accuracy of forecast and decreasing of errors and volatility. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The accuracy in demand forecasting process is about 90 percent. Besides working based on the existing information of customers, the Thai Food Processing Company keeps communication with them in order to gain additional information for reducing prediction error. However, there is still no appropriate prediction error for the company. Also, the TFPC has still needed more demand from customers for its capacity utilization.

The Thai Chemical Company (TCC)

The domestic market is usually more complicated to predict than the international market. The difference between these two markets contributes to the problem. While

the international market composes of only big accounts, the domestic market has much more diversity.

Market test by customers, such as Nike, is helpful in decreasing prediction errors. Market test however causes time lag. At the outset, the Thai Chemical Company has to make some product samples for customers to use in their market test. If the end product is well received, customers then place an order which will be essentially produced next year.

The Thai Textile Company (TTC)

The quantity of demand data is a few so an inspection is easy. Demand forecasting accuracy is quite good (95 to 98 percent). As a result, the reliability is high and there is no room for errors. There is a repeat inspection on daily basis by a head of relevant department. Also, it is reported directly to administration team right on time.

5.4.4 Market analysis

Market analysis refers to the degree of company's market share and total number of customers including the government policy that affects the policy of company. Under market analysis, there are four performance measurement factors in tactical decision making level. They are market equity, customer acquisition, customer retention and government policy over market equity.

5.4.4.1 Market equity

Market equity refers to the number and the movement of market share. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

There is no information for the percentage of market share that the Thai Food Processing Company holds in the overall market with respect to competitors because there are too many other frozen food companies from both domestic and international

firms. The frozen food companies from China, Vietnam and Indonesia have more comparative advantage in the cost of production. However, the TFPC is better off in the sense of quality and food safety. Domestically, within Thailand, there are some firms which imitate Thai Food Processing Company' products and they could produce cheaper in the southern part of Thailand because the labour cost is lower than in that of Bangkok.

The customers that the TFPC targeted are both domestic and international markets. However, the proportion of international market is the majority, contributing to 97 percent. Market share of domestic market is only 3 percent. Therefore, the critical market focuses mainly on the international markets that are Japan, U.S., Taiwan, Europe and Australia. To make product differentiation for getting competitive advantage over competitors, the TFPC adds value in its products and creates innovative products. However, this operation must be under the cover of cost and there is no reduction in quality.

The Thai Chemical Company (TCC)

The Thai Chemical Company is a market leader in terms of polyurethane synthetic leathers, while the company ranks third in synthetic resin sales. 60 percent of its polyurethane synthetic leathers sell to global customers and 40 percent serve local customers. In contrast, only 10 percent of its synthetic resin sells to a global market and 90 percent sell to local customers.

The Thai Textile Company (TTC)

Both domestic and international markets share equal proportion. However, the Thai Textile Company has a competitive advantage for domestic markets as the company has sufficient budget and an effectiveness of machine is over its competitors. In addition, the assignment of market price is fair and there is no competition over price. The TTC can create and capture new demand by strategically placing the product where profits and growth are there but no competition (blue ocean strategy). As the manager of marketing department stated:

> "We try to apply blue ocean strategy by getting the order that our competitors cannot produce for the customer."

Blue ocean strategy is a business strategy book first published in 2005 and written by W. Chan Kim and Renée Mauborgne of The Blue Ocean Strategy Institute at INSEAD (Wekipedia, 2011b). The book illustrates what the authors believe is the high growth and profits an organization can generate by creating new demand in an uncontested market space, or a 'Blue Ocean', than by competing head-to-head with other suppliers for known customers in an existing industry (Wekipedia, 2011b).

5.4.4.2 Customer acquisition

Customer acquisition refers to the number of customer increase and its source. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

There is about one or two new customers expected to increase with new brand launch. The Thai Food Processing Company has focused on maintaining existing customers rather than seeking new customers. The company has customer data base in ERP system. The data base has been updated once there are some changes in information. The communication via telephone is also the main means. Europe's market is the target for new customers. To build relationship with targeted customer, the TFPC entertains and provides presents at the special festival each year. Thai Food Processing Company' strategy for creating new customers is keeping a promise and making to order as the agreement between the company and new customers. Another thing is the TFPC must adjust the manufacturing to be matched with new customers' demand. From the past, the TFPC gained new customers from the recommendation of existing customers. There is word of mouth. Thus, it is important to maintain existing customers as they could contribute to new customers.

The Thai Chemical Company (TCC)

Basically, customers of polyurethane synthetic leathers are companies that make shoes, stationery, packaging, luggage and so on. Because there are now so many low cost competitors from China, the competition in the industry are very intense. Consequently, the Thai Chemical Company has to acquire more new customers.

Thai Chemical Company's strategy is market development. That is, the company tries to find new ways or new customers who can use its polyurethane synthetic leathers for different purpose or applications such as bins and bed heads. The TCC sends its salespeople to survey in department stores to see how polyurethane synthetic leather can be used in a different way.

The Thai Textile Company (TTC)

There has been a good relationship between the Thai Textile Company and its existing customers. Good relationship is built on reliability in dealing business, prioritization of customers, and providing a long credit period. Development of informal virtual network with customers could help develop strong customer base. On the other hand, for new customers, there is a sales team assigned from marketing department to look for new ones. The TTC uses dedicated sales team to liaise with customer and offer package deal to acquire new customer. However, this team has to work under the limitation of company's production capacity and machine flexibility.

5.4.4.3 Customer retention

Customer retention refers to the number of customer remain and its base. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

The percentage of customer shift per year is very low because the Thai Food Processing Company maintains long term relationship with its customer that helps to retain customers. For retaining existing customers, The TFPC makes an order and keeps a

promise as the agreement between the company and customers. This can reduce the argument between both parties and can retain existing customers. The TFPC feels confident that current customers will purchase from it again. It is because the company tries to respond the customers' need and build good relationship with them. The TFPC and its customers have a trust in each other and have a long relationship. The way to reward customers to be loyal is the company offers them to be a partnership in company. The TFPC expects that the company will get the continuous orders from customers and customers should help the company even in the crisis situation such as low season. The TFPC tries to retain the existing customers. If the company loses these customers the reputation of company may be decreased and it may be hard to expand the business.

The Thai Chemical Company (TCC)

In business-to-business context, it is not unusual to find enduring customer loyalty. Above all, it is somewhat risky to change suppliers. Companies that change their suppliers too often may have to risk not having materials on time. This will cause delay in their production schedule, thus getting their products to markets later than other firms. This is also true for Thai Chemical Company's customers. To service customers better, the TCC also prioritizes its customers. The TCC then services customers who have the highest priority first. For instance, when there is material shortage, these customers will get their order first.

To make thing worse, the TCC products require a great deal of experience. Therefore, customers who send orders to suppliers who are not familiar with their need will get themselves into trouble. With these two cited factors, most customers usually stick with the TCC.

The TCC also increases customer commitment to do business with the company by initiating joint investment. For instance, the company agrees to installs synthetic resin tanks for its customers, while its customers have to pay for maintenance costs.

The Thai Textile Company (TTC)

The maintenance of existing customers focuses on their satisfaction. The Thai Textile Company responds to individual customers with primary concern on quality and prompt delivery. This cause satisfaction among customers and majority of Thai Textile Company's customers is existing customers. However, there is always room for improvement.

5.4.4.4 Government policy over market equity

Government policy over market equity refers to the support from government and equal opportunity in the market. The details of supply chain performance for each case study company are discussed in turn.

The Thai Food Processing Company (TFPC)

There is no subsidy on raw material from government but initially, government by Board of Investment (BOI) provides support by reducing tax for machinery. However, this support is not been provided anymore. However, there are some support and update on new information and regulation from government organization such as Department of Fisheries, Ministry of Agriculture and Cooperatives. The Thai Food Processing Company shares its knowledge in legislation with public sector. This can help to reflect the experiences of businesses that are directly affected from laws implementation. For sharing knowledge with private sector, there is an education visits to the TFPC from various associations such as academics. This can help to build good image of company by showing its caring to community. This means matches with the concept of corporate social responsibility (CSR) because this is an innovative trend for Thai companies and industries.

The Thai Chemical Company (TCC)

The Thai Chemical Company gets little help from government. The company cannot access to low cost materials. The TCC always complains about having higher cost than Chinese firm and thus less competitiveness.

The TCC shares some knowledge with public. When requested by government bodies, the company always provides good cooperation. The TCC trains many small and medium enterprises (SMEs) about how to use polyurethane synthetic leathers as their raw materials.

The Thai Textile Company (TTC)

Public sector by Ministry of Industry provides support as the policy makers to help textile industry in Thailand. Moreover, there is a support from private sector by Thailand Textile Institute (THTI), a non-profit organization with the main duty to support and develop Thai textile and garment industries (Thailand Textile Institute, 2010). This support helps business to be able to compete with foreign competitors. The potential of the Thai Textile Company can effectively respond to domestic customers. However, there are political problems in country and worldwide economic crisis recently. Thus, the TTC cannot compete with foreign competitors who have advantage over cost.

Government policy having an impact on business is the control of minimum labour cost. This causes a competition among business to look for skilled labours. Sometimes the production is pending because of a shortage of skilled labours. Another policy relates with tax measure. It helps reduce cost of products. Various measures are continuously enacted according to current situation and necessary issue.

There is a summary of each performance measurement factor on customer relationship management as shown in table 5.3.

Table 5.3: A summary of the performance measurement factors on customer relationship management for three case study companies

Companies / Factors	The Thai Food Processing Company (TFPC)	The Thai Chemical Company (TCC)	The Thai Textile Company (TTC)
(Customer service) Responsiveness	The company provides a survey to customers to evaluate the satisfaction. Then the marketing department will make an executive summary based on these evaluations.	The company has long experience salespeople who understand the customer's need and then have a capability to respond to it promptly.	The flexible capacity of machine helps the company to respond to various customers' needs and to compete on its competitors.
Customer order processing and delivery	One month is the time from order entry to delivery for regular products but a few week delays may happen during the peak period.	The company spends longer time to fill customer order because of no finished product stock. However, customers prefer flexibility more than speed.	The decision to take an order from customer is quick because the production system is not complex and customers sometimes supply their own materials.
Handling customer complaints	There is a complaint form for customers but they usually send e-mail with photo to the company instead.	The customers complain on the long period of received the products and wrong specification product.	Most complaints are from new customers. A monthly meeting is setting up to solve each problem.
Value added services	The special product such as a gift set is created for the festival.	Product prototype is made for loyal customers for market test and it is adjusted until satisfaction.	The showroom is established to help customers before making an order.

Companies / Factors	The Thai Food Processing Company (TFPC)	The Thai Chemical Company (TCC)	The Thai Textile Company (TTC)
(Customer integration) Extent of cooperation to improve quality	Customers are invited to visit the company's factories and share their opinions to help the company to improve the quality.	The company develops the quality of synthetic leathers to meet the customers' specification in special orders.	The company deals with the changes of customers' orders before the production stage in order to develop the product quality.
Information integration	The company shares every respect of information with customers to maintain about product quality and availability.	The company organizes informal channel to exchange information with customers by allowing customers to call to check about the progression status of their orders.	A dedicated sales team is assigned to connect with customers in order to fulfil their requirements and to customize their products.
Organizational relationship	The company adjusts the objectives to match with customers' requirements every year.	For special order, customers send their staffs to train the company's workers how to produce particular products.	The company works with customers' interior designer to maintain organizational relationship.
Use of information technology	Physical communication mechanisms (e.g. telephone, fax and e-mail) are used to remain in touch with customers.	Mostly traditional communication systems such as telephone, fax and e-mail are used for keeping contact between the company and its customers.	The company has both web-based and physical communication means to remain in touch with the prospective customers.

Companies / Factors	The Thai Food Processing Company (TFPC)	The Thai Chemical Company (TCC)	The Thai Textile Company (TTC)
(Demand forecasting) Forecasting system in place	The demand forecasting has been carried out in each line of products every year by using historic demand and seasonality.	The company forecasts demand and sales for a particular period, based on past records over the same period.	The analysis of market trend is used to support the company's forecasting system.
Decision making	The executive committee is used for the governance of decision making process. The results before and after the decision process are compared.	To reduce the conflict, the company will confirm the decision to customers before started the production process. This can help the company to decide the amount to produce.	A data gathering sector from marketing department and production department is set up to provide necessary information to administration team for making decision.
Reliability of demand data	Based on the existing information from customers and continuous communication with customers, demand forecasting is reliable.	Pilot product for market test by customer is helpful to decrease the error in prediction.	A repeat inspection on daily basis by a head of relevant department is made and reported directly to administration team.

Companies / Factors	The Thai Food Processing Company (TFPC)	The Thai Chemical Company (TCC)	The Thai Textile Company (TTC)
(Market analysis) Market equity	The critical market focuses mainly on the international market as it contributes to 97 percent.	The company ranks third in synthetic resin sales but a market leader in terms of polyurethane synthetic leathers. Customers are both local and foreign markets.	There is an equal market share on both domestic and international markets.
Customer acquisition	Europe's market is the target for new customers. However, the company gains new customers from the recommendation of existing customers.	The company tries to expand the usage of its product in different applications to gain new orders or new customers.	There is a sales team assigned from marketing department to look for new customers by offering package deal.
Customer retention	A partnership is offered to loyal customer for maintaining long term relationship.	A joint investment is created to retain customers. Synthetic resin tanks are installed at customers' factory to reduce their insufficient supply.	The company responds to individual customers with primary concern on quality and prompt delivery to keep existing customers.
Government policy over market equity	Only new information and regulation are supported from government organizations, no subsidy or tax reduction.	There is no raw material subsidy but knowledge sharing to government bodies is requested.	There are supports from both public and private sectors to help textile industry to complete with foreign competitors.

5.5 Conclusion

This chapter has provided a detailed investigation of three case studies of Thai manufacturing sector companies in order to understand their supply chain performance. These companies are the Thai Food Processing Company (TFPC), the Thai Chemical Company (TCC) and the Thai Textile Company (TTC). The detailed analysis of the supply chain performance was based on the performance measurement factors that were presented in the study's conceptual framework as explained in Chapter Four. The performance measurement factors were indentified on the three supply chain macro processes along with three decision making levels. Therefore, this chapter contained of three main parts. Part one was the supplier relationship management. The internal supply chain management was part two and part three was customer relationship management.

The information from this result chapter was reviewed by the respondents to validate the conceptual framework and the research. The respondents had the opportunity to further comment on the issues identified by the researcher. They were asked to confirm if it was a true representation of the discussion. They were also asked to suggest amendments and, if necessary, add any important issue they thought should have in this result chapter.

The next chapter provides a detailed analysis of the performance measurement in order to understand the supply chain performance of three case study companies by using the analytic hierarchy process (AHP). The detailed analysis of the supply chain performance measurement was based on the performance measurement factors that were presented in the study's conceptual framework as explained in Chapter Four and AHP that was introduced in Chapter Three.

Chapter 6 Supply Chain Performance Measurement

6.1 Introduction

This chapter applies the proposed conceptual framework concerning performance measurement factors to measure supply chain performance of the case study companies so as to indicate how well these companies perform their supply chain performance by using the analytic hierarchy process (AHP). These performance measurement factors were identified in the study's conceptual framework as explained in Chapter Four and the analytic hierarchy process was introduced in Chapter Three (section 3.8.2 quantitative data analysis). The chapter discusses details of supply chain performance measurement grounded on two main concepts: supply chain macro processes and decision making levels that emerged from quantitative analysis of Thai manufacturers. The results are mainly drawn from interviews with three different types of departments to represent three supply chain macro processes of each participating company. There are the respondents from purchasing department to represent relationship with supplier, the respondents from marketing department to represent relationship with customer, and the respondents from production department to represent internal supply chain of the company. Additional, interviews of the managing director were conducted to cover for the whole supply chain system. In summary, the analysis of data relates to question themes in Appendix 1 part 2 (interview questions for measuring the performance of supply chain on supply chain macro process), Appendix 3 (interview questions for measuring the performance of supply chain on supplier relationship management), Appendix 5 (interview questions for measuring the performance of supply chain on internal supply chain management) and Appendix 7 (interview questions for measuring the performance of supply chain on customer relationship management). Therefore, this chapter analyzes performance measurement factors that contain in three themes: supplier relationship management, internal supply chain management and customer relationship management. However, to provide an entire view of supply chain system, overall supply chain performance for these three supply chain macro processes is

analyzed first. The insights from the cases help to identify and compare the important of the performance measurement factors on the case studies.

6.2 The application of the analytic hierarchy process (AHP) to this study

As mentioned in previous chapter (Chapter Three), the analytic hierarchy process (AHP) is a systematic procedure for representing the elements of any problem, hierarchically (Saaty, 1980). According to Jagdev *et al*. (2004), AHP provides a theory and a corresponding methodology, which support the modelling of unstructured problems. A hierarchy is structured from the top (objectives from a managerial standpoint), through intermediate levels (criteria or sub-criteria on which subsequent levels depend) to the lowest level (which is usually a list of alternatives) (Bhagwat and Sharma, 2007b). It organizes the basic rationality by breaking down a problem into smaller and smaller constituent parts and then guides decision makers through a series of pair-wise comparison judgments (which are documented and can be re-examined) to express the relative strength or intensity of impact of the elements in the hierarchy (Saaty, 1980). These judgments are then translated to numbers. AHP uses pair-wise comparison of the same hierarchy elements in each level (criteria or alternatives) using a scale indicating the importance of one element over another with respect to a higher-level element (Saaty, 1980).

This research presents the use of AHP to measure the supply chain performance because it provides a flexible and easily understood way of analyzing complicated problems. The AHP is a multiple criteria decision making technique that allows subjective as well as objective factors to be considered in the decision making process (Dey, 2002). The AHP allows the active participation of decision makers in reaching agreement, and gives managers a rational basis on which to make decisions. The AHP is a theory of measurement for dealing with quantifiable and intangible criteria that has been applied to numerous areas, such as decision theory and conflict resolution (Vargas, 1990).

It should be pointed out that there is a debate on the rigor of using AHP for decision making. While the researcher believes that the use of AHP with this proposed

framework is valid, it is necessary to examine the issue raised by AHP opponents to justify his belief. Belton and Gear (1984) argued that AHP lacked a firm theoretical basis and an axiomatic approach compared to multi-attribute utility theory (MAUT), hence it was a flawed theory in analyzing decisions. Saaty (1986) then provided theorems to prove that AHP was based on an axiomatic theory. Dyer (1990) questioned the validity of Saaty's axioms. Saaty (1990), together with Harker and Vargas (1990), defended their standpoints that the axioms of AHP are different from that of traditional utility theory, and they are valid.

Bhutta (2003) selected and reviewed 154 journal articles on supplier selection and evaluation for the period 1986-2002. The methods used were individual, including total cost approach, multiple attribute utility theory, total cost of ownership (TCO), AHP, data envelopment analysis, and mathematical programming techniques. Among them, TCO was the most prevalent approach, followed by AHP. Because of this finding, Bhutta and Huq (2002) compared TCO and AHP comprehensively. They revealed that AHP can provide a more robust tool for decision makers to select and evaluate suppliers with respect to qualitative and quantitative criteria, instead of cost data only considered in TCO (Ho *et al*., 2011).

Ho *et al.* (2010) selected and reviewed 70 journal articles on supplier selection and evaluation for the period 2000-2008. Several approaches have been proposed for supplier selection, such as using AHP, analytic network process (ANP), case-based reasoning (CBR), data envelopment analysis (DEA), fuzzy set theory, genetic algorithm (GA), mathematical programming, simple multi-attribute rating technique (SMART), and their integrations. According to Ho *et al.* (2010), the most popular individual approach is DEA. DEA has attracted more attention mainly because of its robustness. In the past, it was used to measure the relative efficiencies of homogeneous decision making units (DMUs) based on numerical data only. As the supplier selection problem involves both qualitative and quantitative criteria, DEA has been modified to handle qualitative data (Ho *et al*., 2010).

There are three limitations or drawbacks of DEA (Ho *et al*., 2011). First, the practitioners may be confused with input and output criteria. The second problem is due to the subjective assignment of ratings to qualitative criteria. The third concern is due to

the nature of DEA. DEA is a linear programming to measure the relative efficiencies of homogenous DMUs. In the other words, those suppliers generating more outputs while requiring fewer inputs are regarded as the more efficient suppliers (Ho *et al*., 2011).

The second most popular individual approach is AHP, which is a popular multi-criteria decision making technique nowadays (Ho *et al*., 2010). It has been applied to various application areas, including education, engineering, finance, government, industry, management, manufacturing, personal, political, social, and sports in the last 20 years (Ho, 2008). The wide applicability is due to its simplicity, ease of use, and great flexibility. Furthermore, AHP can be used to make a consistent decision with respect to multiple qualitative and quantitative criteria. This is achieved by one of its operations called consistency verification. The operation can help to avoid making inconsistent decisions due to personal or subjective judgments (Ho *et al*., 2011).

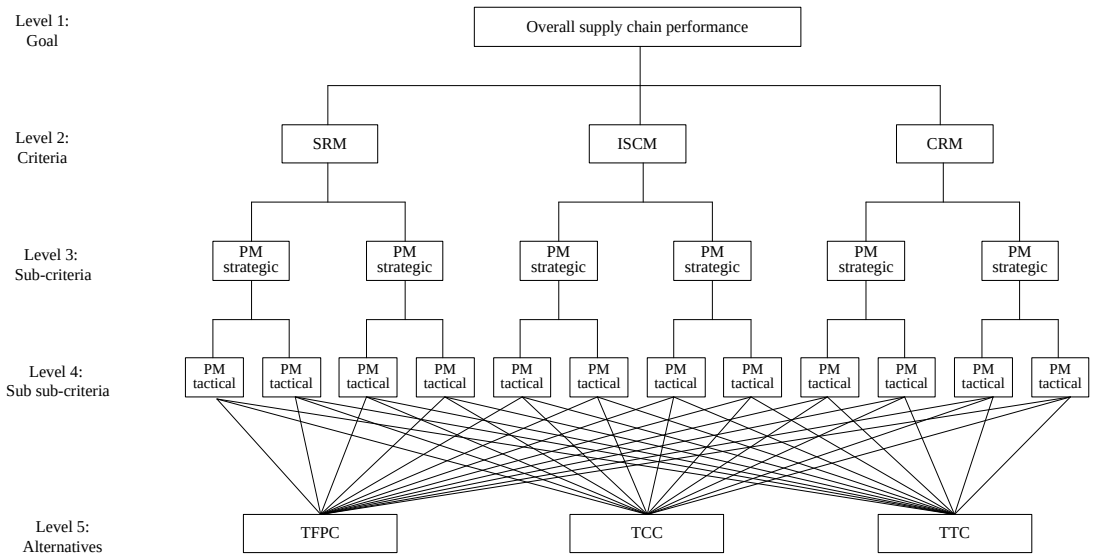
Therefore, the AHP can be the best tool for prioritizing and choosing the best performance measurement factors for day-to-day business operations. Moreover, the AHP approach provides a quantitative hierarchical framework for performance measurement. The study divides the measurement in to three parts based on the supply chain macro processes: supplier relationship management, internal supply chain management and customer relationship management.

The performance measurement of each supply chain macro process is decided by performance measurement factors in the hierarchy: strategic, tactical and operational level. These performance measurement factors are divided into intermediate levels of performance measurement factors for different decision levels in the hierarchy. The problem is to decide which of the three case study companies' supply chain performance is most critical from the supply chain performance evaluation point of view. However, due to the different type of business on these case study companies, the performance measurement factors in operational decision making level are not measured. The participating companies have different aspects of performance measurement factors in operational decision making level from the proposed framework. Some performance measurement factors are not attributed to be key performance indicators (KPIs) in one company but they can be KPIs for other companies. In addition, the detailed analysis of the supply chain performance on

performance measurement factors in tactical decision making level from previous chapter (Chapter Five) and in this chapter will provide sufficient information to measure the supply chain performance for the case study companies.

The hierarchic portrayal of a problem is as follows: The first step is the decomposition or structuring of the problem as a hierarchy. In the first (or top) level is the overall supply chain performance. In the second level are the factors or criteria of supply chain macro processes, which contribute to the goal (overall performance measurement system), in the third level are the sub-criteria of performance measurement factors in strategic decision making level, then in the fourth level are the sub sub-criteria of performance measurement factors in tactical decision making level and in the fifth (bottom) level are the three case study companies, which are to be evaluated in terms of the criteria, sub-criteria, and sub sub-criteria in the second, third and fourth levels. Figure 6.1 shows the hierarchy for measuring the supply chain performance.

Figure 6.1: Pictorial representation of the problem hierarchy



In the AHP, elements of a problem are compared in pairs with respect to their relative impact (‘weight’ or ‘intensity’) on a property they share in common (Bhagwat and Sharma, 2007b). Pair-wise comparisons are reduced to a matrix form. When sets of elements are compared with each other a square matrix is produced. The square matrix has an equal number of rows and columns together with eigenvectors and eigenvalues (Bhagwat and Sharma, 2007b). The reason for this computation is that it gives a way to

determine quantitatively the relative importance of factors. The factors with the highest values are the ones that should be concentrated on for developing a plan of action.

For this study, AHP structures the problem hierarchically and a matrix is arranged to compare the relative importance of criteria in the second level with respect to the overall objective or focus of the first level. Similar matrices are further constructed for pair-wise comparisons of each sub-criterion in the third level with respect to the criteria in the second level. Then, similar matrices are constructed for pair-wise comparisons of each sub sub-criterion in the fourth level with respect to the sub-criteria in the third level. Finally, similarly matrices are also constructed for pair-wise comparisons of each alternative in the fifth level with respect to the criteria, sub-criteria and sub sub-criteria of the second, third and fourth levels respectively.

Priorities are synthesized from the second level down by multiplying local priorities by the priority of their corresponding criterion in the level above and adding them for each element in a level according to the criteria it affects. This gives the global or composite priority of that element which is then used to weight the local priorities of elements in the level below compared by it as criterion and so on to the bottom level.

The tables of pair-wise comparison and weight calculation are shown for performance measurement factors in supplier relationship management, internal supply chain management and customer relationship management of each case study company respectively. Moreover, all results are discussed in the next sections starting from overall supply chain performance for these three supply chain macro processes.

6.3 Supply chain macro process

The processes to measure supply chain performance of each case study company are shown in pair-wise comparison and weight calculation tables below. Then, to compare their supply chain performance, a summary of priorities with respect to supply chain macro processes is showed in Table 6.1.

Tables of pair-wise comparison and weight calculation for the TFPC

	SRM	ISCM	CRM
SRM	**1**	1/5	1/4
ISCM	5	**1**	2
CRM	4	1/2	**1**

→→→

	SRM	ISCM	CRM	**Weights**
SRM	0.100	0.118	0.077	**0.098**
ISCM	0.500	0.588	0.615	**0.568**
CRM	0.400	0.294	0.308	**0.334**
				1.000

Maximum eigenvalue (λ_{max}) = 3.0326,

Consistency index (CI) = 0.0163, Consistency ratio (CR) = 2.80 %

Tables of pair-wise comparison and weight calculation for the TCC

	SRM	ISCM	CRM
SRM	**1**	1/4	1/4
ISCM	4	**1**	1
CRM	4	1	**1**

→→→

	SRM	ISCM	CRM	**Weights**
SRM	0.111	0.111	0.111	**0.111**
ISCM	0.444	0.444	0.444	**0.444**
CRM	0.444	0.444	0.444	**0.444**
				1.000

λ_{max} = 3.0000, CI = 0.0000, CR = 0.00 %

Tables of pair-wise comparison and weight calculation for the TTC

	SRM	ISCM	CRM
SRM	**1**	1/2	1/4
ISCM	2	**1**	1/3
CRM	4	3	**1**

→→→

	SRM	ISCM	CRM	**Weights**
SRM	0.143	0.111	0.158	**0.138**
ISCM	0.286	0.222	0.211	**0.239**
CRM	0.571	0.667	0.632	**0.623**
				1.000

λ_{max} = 3.0255, CI = 0.0127, CR = 2.19 %

Table 6.1: A summary of priorities with respect to supply chain macro processes

Supply chain macro processes	**Priority for TFPC**	**Priority for TCC**	**Priority for TTC**
Supplier relationship management (SRM)	0.098	0.111	0.138
Internal supply chain management (ISCM)	0.568	0.444	0.239
Customer relationship management (CRM)	0.334	0.444	0.623

A sample of how this study arrived to the rating in the AHP is illustrated below. Then, the rating results are discussed in turn. In Table of pair-wise comparison for the TFPC, the cells of the matrix have been filled in with the subjective judgments using 1 to 9 pair-wise comparison scales from interview questions in Appendix 1 part 2 and based on the preference and perception of the criteria for the overall performance measurement. For example, when asked the managing director of the Thai Food Processing Company (TFPC), "With respect to all three supply chain macro processes, what is the importance of performance measure at supplier relationship management (SRM) to performance measure at internal supply chain management (ISCM)?" If the ISCM was more strongly preferred than the SRM, then the integer 5 was entered in the corresponding cell; its reciprocal or 1/5 was automatically entered for the reverse comparison. In the same way other cells of the matrix were also filled in such as "With respect to all three supply chain macro processes, what is the importance of performance measure at supplier relationship management (SRM) to performance measure at customer relationship management (CRM)?" If the CRM was moderately to strongly to the SRM, then the integer 4 was entered in the corresponding cell; its reciprocal or 1/4 was automatically entered for the reverse comparison; and "With respect to all three supply chain macro processes, what is the importance of performance measure at internal supply chain management (ISCM) to performance measure at customer relationship management (CRM)?" If the ISCM was equally to moderately to the SRM, then the integer 2 was entered in the corresponding cell; its reciprocal or 1/2 was automatically entered for the reverse comparison. According to the respondent's feedback in the interview question, different ranks are entered in the table.

Next, the weight calculation is reckoned. In Table of weight calculation for the TFPC, the value in each cell from pair-wise comparison table was divided by the sum of value from all cells in the same column. For example, in cell SRM (row) and SRM (column), 0.100 came from 1 divided by 10 (the sum of SRM's column that came from 1+5+4). In the same way other cells of the matrix were also filled in such as in cell SRM (row) and ISCM (column), 0.118 came from 1/5 divided by 1.7 (the sum of ISCM's column that came from 1/5+1+1/2); and in cell SRM (row) and CRM (column), 0.077 came from 1/4 divided by 3.25 (the sum of SRM's column that came from 1/4+2+1).

Then, the result of the priorities with respect to supply chain macro processes was calculated. For SRM, the priority weight was 0.098 that calculated from the average value of row SRM in column SRM, ISCM and CRM (value in column SRM plus value in column SRM plus value in column SRM then divided by the number of column) (0.100+0.118+0.077/3).

Finally, In addition, the consistency is checked. If the consistency ratio (CR) is greater than 10 percent, then the pair-wise is not consistent in making the comparison. The pair-wise comparison should review and make adjustment. In this case, the CR was 2.80%. It means the pair-wise is comparable.

For the Thai Food Processing Company (TFPC), clearly from Table 6.1, internal supply chain management (0.568) is perceived to be the most important criterion followed by customer relationship management (0.334) and supplier relationship management (0.098). It reveals that performance measurement at the internal supply chain management process is the most important whereas the measurement at supplier relationship management process rated least important. It also suggests that performance measurement factors that reflect the internal supply chain management process are preferred. Moreover, it is interesting to note that performance measurement at the customer relationship management process has been preferred over performance measurement at the supplier relationship management process. It shows that performance measurement factors that reflect the customer relationship management play more significantly than performance measurement factors for the supplier relationship management.

Then, for the Thai Chemical Company (TCC), both internal supply chain management and customer relationship management are equally (0.444) desirable to be the most important criteria followed by supplier relationship management (0.111). It discloses that performance measurement at the supplier relationship management process is the least important. By contrast, it proposes that performance measurement factors that reflect the internal supply chain management process and the customer relationship management are preferred.

Finally, for the Thai Textile Company (TTC), customer relationship management (0.623) is indicated to be the most important criterion followed by internal supply chain management (0.239) and supplier relationship management (0.138). It exposes that performance measurement at the customer relationship management process is the most important while the measurement at supplier relationship management process is the least important. It also advises that performance measurement factors that reflect the customer relationship management process are preferred. Furthermore, it is interesting to mention that performance measurement at the internal supply chain management process has been favoured over performance measurement at the supplier relationship management process. It presents that performance measurement factors that respect to the internal supply chain management perform more significantly than performance measurement factors for the supplier relationship management.

6.4 Supplier relationship management

In strategic level, there are three performance measurement factors: quality supplier selection (QSS), supplier integration (SI) and effective procurement processes (EPP).

Tables of pair-wise comparison and weight calculation for the TFPC

	QSS	SI	EPP
QSS	**1**	3	2
SI	1/3	**1**	1/2
EPP	1/2	2	**1**

→→→

	QSS	SI	EPP	**Weights**
QSS	0.545	0.500	0.571	**0.539**
SI	0.182	0.167	0.143	**0.164**
EPP	0.273	0.333	0.286	**0.297**
				1.000

Maximum eigenvalue (λ_{max}) = 3.0112,

Consistency index (CI) = 0.0056,

Consistency ratio (CR) = 0.96 %

Tables of pair-wise comparison and weight calculation for the TCC

	QSS	SI	EPP
QSS	**1**	4	3
SI	1/4	**1**	1/3
EPP	1/3	3	**1**

→→→

	QSS	SI	EPP	**Weights**
QSS	0.632	0.500	0.692	**0.608**
SI	0.158	0.125	0.077	**0.120**
EPP	0.211	0.375	0.231	**0.272**
				1.000

λ_{max} = 3.1012, CI = 0.0506, CR = 8.73 %

Tables of pair-wise comparison and weight calculation for the TTC

	QSS	SI	EPP
QSS	**1**	3	2
SI	1/3	**1**	1/2
EPP	1/2	2	**1**

→→→

	QSS	SI	EPP	**Weights**
QSS	0.545	0.500	0.571	**0.539**
SI	0.182	0.167	0.143	**0.164**
EPP	1.273	0.333	0.286	**0.297**
				1.000

λ_{max} = 3.0112, CI = 0.0056, CR = 0.96 %

In tactical level, from quality supplier selection, there are three performance measurement factors: supplier performance (SuP), selection process (SeP) and green supplier (GS).

Tables of pair-wise comparison and weight calculation for the TFPC

	SuP	SeP	GS
SuP	**1**	2	3
SeP	1/2	**1**	2
GS	1/3	1/2	**1**

→→→

	SuP	SeP	GS	**Weights**
SuP	0.545	0.571	0.500	**0.539**
SuP	0.273	0.286	0.333	**0.297**
SuP	0.182	0.143	0.167	**0.164**
				1.000

$\lambda_{max} = 3.0112$

CI = 0.0056, CR = 0.96 %

Tables of pair-wise comparison and weight calculation for the TCC

	SuP	SeP	GS
SuP	**1**	1	3
SeP	1	**1**	1
GS	1/3	1/3	**1**

→→→

	SuP	SeP	GS	**Weights**
SuP	0.429	0.429	0.429	**0.429**
SuP	0.429	0.429	0.429	**0.429**
SuP	0.143	0.143	0.143	**0.143**
				1.000

$\lambda_{max} = 3.0000$

CI = 0.0000, CR = 0.00 %

Tables of pair-wise comparison and weight calculation for the TTC

	SuP	SeP	GS
SuP	**1**	2	4
SeP	1/2	**1**	3
GS	1/4	1/3	**1**

→→→

	SuP	SeP	GS	**Weights**
SuP	0.571	0.600	0.500	**0.557**
SuP	0.286	0.300	0.375	**0.320**
SuP	0.143	0.100	0.125	**0.123**
				1.000

$\lambda_{max} = 3.0234$

CI = 0.0117, CR = 2.02 %

In tactical level, from supplier integration, there are four performance measurement factors: coordination and resource sharing (CRS), information integration (II), organizational relationship (OR) and use of information technology (UIT).

Tables of pair-wise comparison and weight calculation for the TFPC

	CRS	II	OR	UIT
CRS	**1**	2	3	4
II	1/2	**1**	2	3
OR	1/3	1/2	**1**	2
UIT	1/4	1/3	1/2	**1**

→→→

	CRS	II	OR	UIT	**Weights**
CRS	0.480	0.522	0.462	0.400	**0.466**
II	0.240	0.261	0.308	0.300	**0.277**
OR	0.160	0.130	0.154	0.200	**0.161**
UIT	0.120	0.087	0.077	0.100	**0.096**
					1.000

$\lambda_{max} = 4.0395$

CI = 0.0132, CR = 1.46 %

Tables of pair-wise comparison and weight calculation for the TCC

	CRS	II	OR	UIT
CRS	**1**	3	1	3
II	1/3	**1**	1/3	2
OR	1	3	**1**	1
UIT	1/3	1/2	1/3	**1**

→→→

	CRS	II	OR	UIT	**Weights**
CRS	0.375	0.400	0.375	0.333	**0.371**
II	0.125	0.133	0.125	0.222	**0.151**
OR	0.375	0.400	0.375	0.333	**0.371**
UIT	0.125	0.067	0.125	0.111	**0.107**
					1.000

$\lambda_{max} = 4.0757$

CI = 0.0252, CR = 2.80 %

Tables of pair-wise comparison and weight calculation for the TTC

	CRS	II	OR	UIT
CRS	**1**	2	3	3
II	1/2	**1**	2	2
OR	1/3	1/2	**1**	1
UIT	1/3	1/2	1	**1**

→→→

	CRS	II	OR	UIT	**Weights**
CRS	0.462	0.500	0.429	0.429	**0.455**
II	0.231	0.250	0.286	0.286	**0.263**
OR	0.154	0.125	0.143	0.143	**0.141**
UIT	0.154	0.125	0.143	0.143	**0.141**
					1.000

$\lambda_{max} = 4.0133$

CI = 0.0044, CR = 0.49 %

In tactical level, from effective procurement processes, there are three performance measurement factors: effective communication with production (ECP), effective management of purchase portfolio (EMPP) and effective contract administration (ECA).

Tables of pair-wise comparison and weight calculation for the TFPC

	ECP	EMPP	ECA
ECP	**1**	3	2
EMPP	1/3	**1**	1/2
ECA	1/2	2	**1**

→→→

	ECP	EMPP	ECA	**Weights**
ECP	0.545	0.500	0.571	**0.539**
EMPP	0.182	0.167	0.143	**0.164**
ECA	0.273	0.333	0.286	**0.297**
				1.000

$\lambda_{max} = 3.0112$

CI = 0.0056, CR = 0.96 %

Tables of pair-wise comparison and weight calculation for the TCC

	ECP	EMPP	ECA
ECP	**1**	1	3
EMPP	1	**1**	3
ECA	1/3	1/3	**1**

→→→

	ECP	EMPP	ECA	**Weights**
ECP	0.429	0.429	0.429	**0.429**
EMPP	0.429	0.429	0.429	**0.429**
ECA	0.143	0.143	0.143	**0.143**
				1.000

$\lambda_{max} = 3.0000$

CI = 0.0000, CR = 0.00 %

Tables of pair-wise comparison and weight calculation for the TTC

	ECP	EMPP	ECA
ECP	**1**	3	2
EMPP	1/3	**1**	1/2
ECA	1/2	2	**1**

→→→

	ECP	EMPP	ECA	**Weights**
ECP	0.545	0.500	0.571	**0.539**
EMPP	0.182	0.167	0.143	**0.164**
ECA	0.273	0.333	0.286	**0.297**
				1.000

$\lambda_{max} = 3.0112$

CI = 0.0056, CR = 0.96 %

Table 6.2: A summary of local and global priorities with respect to performance measurement factors in supplier relationship management

Decision making level	**Performance measurement factors**	**Priority for TFPC**		**Priority for TCC**		**Priority for TTC**	
		Local	**Global**	**Local**	**Global**	**Local**	**Global**
Strategic	Quality supplier selection (QSS)	0.539	-	0.608	-	0.539	-
Tactical	- Supplier performance (SuP)	0.539	0.290	0.429	0.261	0.557	0.300
	- Selection process (SeP)	0.297	0.160	0.429	0.261	0.320	0.173
	- Green supplier (GS)	0.164	0.088	0.143	0.087	0.123	0.066
Strategic	Supplier integration (SI)	0.164	-	0.120	-	0.164	-
Tactical	- Coordination and resource sharing (CRS)	0.466	0.076	0.371	0.044	0.455	0.074
	- Information integration (II)	0.277	0.045	0.151	0.018	0.263	0.043
	- Organizational relationship (OR)	0.161	0.026	0.371	0.044	0.141	0.023
	- Use of information technology (UIT)	0.096	0.016	0.107	0.013	0.141	0.023
Strategic	Effective procurement processes (EPP)	0.297	-	0.272	-	0.297	-
Tactical	- Effective communication with production (ECP)	0.539	0.160	0.429	0.117	0.539	0.160
	- Effective management of purchase portfolio (EMPP)	0.164	0.049	0.429	0.117	0.164	0.049
	- Effective contract administration (ECA)	0.297	0.088	0.143	0.039	0.297	0.088
			1.000		**1.000**		**1.000**

The processes to measure supply chain performance of each case study company are shown in pair-wise comparison and weight calculation tables above. Then, to compare their supply chain performance, a summary of local and global priorities with respect to performance measurement factors in supplier relationship management is showed in Table 6.2.

The Thai Food Processing Company (TFPC)

At strategic decision making level, it is observed that quality supplier selection factor (0.539) is found to be the most preferred followed by effective procurement processes factor (0.297) and supplier integration factor (0.164). It reveals that the TFPC considers the selection of quality supplier is the most important in its supplier relationship management.

At tactical decision making level, from quality supplier selection, supplier performance (0.539) is perceived to be the most preferred factor followed by selection process (0.297) and green supplier (0.164). It discloses that supplier performance factor is the most important while green supplier facto is the least important. Then, from effective procurement processes, effective communication with production (0.539) is known to be the most preferred factor followed by effective contract administration (0.297) and effective management of purchase portfolio (0.164). It exposes that effective communication with production factor is the most important whereas effective management of purchase portfolio factor is the least important. Finally, from supplier integration, coordination and resource sharing (0.466) is indicated to be the most preferred factor followed by information integration (0.277), organizational relationship (0.161) and use of information technology (0.096). It founds that coordination and resource sharing factor is the most important while use of information technology factor is the least important.

For overall performance measurement factors in tactical level with respect to supplier relationship management (global priority), supplier performance (0.290) followed by both selection process (0.160) and effective communication with production (0.160) are preferred as the desirable factors compared with others. This result shows the

importance of these factors in supplier relationship management macro process of a supply chain system for The Thai Food Processing Company.

The Thai Chemical Company (TCC)

At strategic decision making level, it is evident that quality supplier selection factor (0.608) is suggested to be the most preferred followed by effective procurement processes factor (0.272) and supplier integration factor (0.120). It proposes that the TCC defines the quality supplier selection is the most important in its supplier relationship management.

At tactical decision making level, from quality supplier selection, both supplier performance and selection process are equally (0.429) perceived to be the most preferred factors followed by green supplier (0.143). It advises that green supplier factor is the least important. Next, from effective procurement processes, both effective communications with production and effective management of purchase portfolio are equally (0.429) desirable to be the most preferred factors followed by effective contract administration (0.143). It mentions that effective contract administration factor is the least important. Finally, from supplier integration, both coordination and resource sharing and organizational relationship are equally (0.371) concerned to be the most preferred factors followed by information integration (0.151) and use of information technology (0.107). It claims that both information integration factor and use of information technology factors are the least important.

For overall performance measurement factors in tactical level with respect to supplier relationship management (global priority), both supplier performance (0.261) and selection process (0.261) followed by both effective communications with production (0.117) and effective management of purchase portfolio (0.117) are preferred as the desirable factors compared with others. This result explains the importance of these factors in supplier relationship management macro process of a supply chain system for The Thai Chemical Company.

The Thai Textile Company (TTC)

At strategic decision making level, it is described that quality supplier selection factor (0.539) is found to be the most preferred followed by effective procurement processes factor (0.297) and supplier integration factor (0.164). It expresses that the TTC determines the selection of quality supplier is the most important in its supplier relationship management.

At tactical decision making level, from quality supplier selection, supplier performance (0.557) is identified to be the most preferred factor followed by selection process (0.320) and green supplier (0.123). It displays that supplier performance factor is the most important while green supplier factor is the least important. Then, from effective procurement processes, effective communication with production (0.539) is perceived to be the most preferred factor followed by effective contract administration (0.297) and effective management of purchase portfolio (0.164). It reveals that effective communication with production factor is the most important whereas effective management of purchase portfolio factor is the least important. Finally, from supplier integration, coordination and resource sharing (0.455) is known to be the most preferred factor followed by information integration (0.263), organizational relationship (0.141) and use of information technology (0.141). It indicates that coordination and resource sharing factor is the most important while both organizational relationship and use of information technology factors are the least important.

For overall performance measurement factors in tactical level with respect to supplier relationship management (global priority), supplier performance (0.300) followed by selection process (0.173) and effective communication with production (0.160) are preferred as the desirable factors compared with others. This result proposes the importance of these factors in supplier relationship management macro process of a supply chain system for The Thai Textile Company.

6.5 Internal supply chain management

In strategic level, there are six performance measurement factors: facility (F), inventory (I), transportation (T), internal integration (II), human resources (HR) and operations (O).

Table of pair-wise comparison for the TFPC

	F	I	T	II	HR	O
F	**1**	2	6	5	3	4
I	1/2	**1**	3	3	2	2
T	1/6	1/3	**1**	1/2	1/3	1/2
II	1/5	1/3	2	**1**	1/3	1/2
HR	1/3	1/2	3	3	**1**	2
O	1/4	1/2	2	2	1/2	**1**

Table of weight calculation for the TFPC

	F	I	T	II	HR	O	**Weights**
F	0.408	0.429	0.353	0.345	0.419	0.400	**0.392**
I	0.204	0.214	0.176	0.207	0.279	0.200	**0.213**
T	0.068	0.071	0.059	0.034	0.047	0.050	**0.055**
II	0.082	0.071	0.118	0.069	0.047	0.050	**0.073**
HR	0.136	0.107	0.176	0.207	0.140	0.200	**0.161**
O	0.102	0.107	0.118	0.138	0.070	0.100	**0.106**
							1.000

Maximum eigenvalue (λ_{max}) = 6.1556

Consistency index (CI) = 0.0311

Consistency ratio (CR) = 2.51 %

Table of pair-wise comparison for the TCC

	F	I	T	II	HR	O
F	**1**	1/2	3	3	2	1/3
I	2	**1**	4	4	3	1/2
T	1/3	1/4	**1**	2	1/2	1/5
II	1/3	1/4	1/2	**1**	1/2	1/6
HR	1/2	1/3	2	2	**1**	1/4
O	3	2	5	6	4	**1**

Table of weight calculation for the TCC

	F	I	T	II	HR	O	**Weights**
F	0.140	0.115	0.194	0.167	0.182	0.136	**0.156**
I	0.279	0.231	0.258	0.222	0.273	0.204	**0.244**
T	0.047	0.058	0.065	0.111	0.045	0.082	**0.068**
II	0.047	0.058	0.032	0.056	0.045	0.068	**0.051**
HR	0.070	0.077	0.129	0.111	0.091	0.102	**0.097**
O	0.419	0.462	0.323	0.333	0.364	0.408	**0.385**
							1.000

$\lambda_{max} = 6.1469$

CI = 0.0294

CR = 2.37 %

Table of pair-wise comparison for the TTC

	F	I	T	II	HR	O
F	**1**	3	2	4	1/3	1/2
I	1/3	**1**	1/2	2	1/5	1/4
T	1/2	2	**1**	3	1/4	1/3
II	1/4	1/2	1/3	**1**	1/6	1/5
HR	3	5	4	6	**1**	2
O	2	4	3	5	1/2	**1**

Table of weight calculation for the TTC

	F	I	T	II	HR	O	**Weights**
F	0.141	0.194	0.185	0.190	0.136	0.117	**0.160**
I	0.047	0.065	0.046	0.095	0.082	0.058	**0.065**
T	0.071	0.129	0.092	0.143	0.102	0.078	**0.102**
II	0.035	0.032	0.031	0.048	0.068	0.047	**0.043**
HR	0.424	0.323	0.369	0.286	0.408	0.467	**0.379**
O	0.282	0.258	0.277	0.238	0.204	0.233	**0.249**
							1.000

$\lambda_{max} = 6.1689$

CI = 0.0338

CR = 2.72 %

In tactical level, from facility, there are five performance measurement factors: capacity utilization (CU), efficiency (E), flexibility (F), quality (Q) and reliability (R).

Table of pair-wise comparison for the TFPC

	CU	E	F	Q	R
CU	**1**	1/2	3	2	3
E	2	**1**	3	2	4
F	1/3	1/3	**1**	1/2	2
Q	1/2	1/2	2	**1**	3
R	1/3	1/4	1/2	1/3	**1**

Table of weight calculation for the TFPC

	CU	E	F	Q	R	**Weights**
CU	0.240	0.194	0.316	0.343	0.231	**0.265**
E	0.480	0.387	0.316	0.343	0.308	**0.367**
F	0.080	0.129	0.105	0.086	0.154	**0.111**
Q	0.120	0.194	0.211	0.171	0.231	**0.185**
R	0.080	0.097	0.053	0.057	0.077	**0.073**
						1.000

$\lambda_{max} = 5.1278$

CI = 0.0319

CR = 2.85 %

Table of pair-wise comparison for the TCC

	CU	E	F	Q	R
CU	**1**	1/2	3	2	3
E	2	**1**	3	2	4
F	1/3	1/3	**1**	1/2	2
Q	1/2	1/2	2	**1**	3
R	1/3	1/4	1/2	1/3	**1**

Table of weight calculation for the TCC

	CU	E	F	Q	R	**Weights**
CU	0.240	0.194	0.316	0.343	0.231	**0.265**
E	0.480	0.387	0.316	0.343	0.308	**0.367**
F	0.080	0.129	0.105	0.086	0.154	**0.111**
Q	0.120	0.194	0.211	0.171	0.231	**0.185**
R	0.080	0.097	0.053	0.057	0.077	**0.073**
						1.000

$\lambda_{max} = 5.1278$

CI = 0.0319

CR = 2.85 %

Table of pair-wise comparison for the TTC

	CU	E	F	Q	R
CU	**1**	1/2	1/5	1/4	1/3
E	2	**1**	1/4	1/3	1/2
F	5	4	**1**	2	3
Q	4	3	1/2	**1**	2
R	3	2	1/3	1/2	**1**

Table of weight calculation for the TTC

	CU	E	F	Q	R	**Weights**
CU	0.067	0.048	0.088	0.061	0.049	**0.062**
E	0.133	0.095	0.109	0.082	0.073	**0.099**
F	0.333	0.381	0.438	0.490	0.439	**0.416**
Q	0.267	0.286	0.219	0.245	0.293	**0.262**
R	0.200	0.190	0.146	0.122	0.146	**0.161**
						1.000

$\lambda_{max} = 5.0905$

CI = 0.0226

CR = 2.02 %

In tactical level, from inventory, there are two performance measurement factors: optimal inventory policy (OIP) and warehouse utilization (WU).

Tables of pair-wise comparison and weight calculation for the TFPC

	OIP	WU
OIP	**1**	1/2
WU	2	**1**

→→→

	OIP	WU	**Weights**
OIP	0.333	0.333	**0.333**
WU	0.667	0.667	**0.667**
			1.000

$\lambda_{max} = 2.0000$

CI = 0.0000

CR = N/A

Tables of pair-wise comparison and weight calculation for the TCC

	OIP	WU
OIP	**1**	2
WU	1/2	**1**

→→→

	OIP	WU	**Weights**
OIP	0.667	0.667	**0.667**
WU	0.333	0.333	**0.333**
			1.000

$\lambda_{max} = 2.0000$

CI = 0.0000

CR = N/A

Tables of pair-wise comparison and weight calculation for the TTC

	OIP	WU
OIP	**1**	2
WU	1/2	**1**

→→→

	OIP	WU	**Weights**
OIP	0.667	0.667	**0.667**
WU	0.333	0.333	**0.333**
			1.000

$\lambda_{max} = 2.0000$

CI = 0.0000

CR = N/A

In tactical level, from transportation, there are four performance measurement factors: capacity utilization (CU), efficiency (E), flexibility (F) and reliability (R).

Tables of pair-wise comparison and weight calculation for the TFPC

	CU	E	F	R
CU	**1**	1/2	3	3
E	2	**1**	3	3
F	1/3	1/3	**1**	2
R	1/3	1/3	1/2	**1**

→→→

	CU	E	F	R	**Weights**
CU	0.273	0.231	0.400	0.333	**0.309**
E	0.545	0.462	0.400	0.333	**0.435**
F	0.091	0.154	0.133	0.222	**0.150**
R	0.091	0.154	0.067	0.111	**0.106**
					1.000

$\lambda_{max} = 4.1527$

CI = 0.0509, CR = 5.66 %

Tables of pair-wise comparison and weight calculation for the TCC

	CU	E	F	R
CU	**1**	2	3	3
E	1/2	**1**	2	2
F	1/3	1/2	**1**	2
R	1/3	1/2	1/2	**1**

→→→

	CU	E	F	R	**Weights**
CU	0.462	0.500	0.462	0.375	**0.450**
E	0.231	0.250	0.308	0.250	**0.260**
F	0.154	0.125	0.154	0.250	**0.171**
R	0.154	0.125	0.077	0.125	**0.120**
					1.000

$\lambda_{max} = 4.0833$

CI = 0.0278, CR = 3.09%

Tables of pair-wise comparison and weight calculation for the TTC

	CU	E	F	R
CU	**1**	1/2	1/3	2
E	2	**1**	1/2	3
F	3	2	**1**	4
R	1/2	1/3	1/4	**1**

→→→

	CU	E	F	R	**Weights**
CU	0.154	0.130	0.160	0.200	**0.161**
E	0.308	0.261	0.240	0.300	**0.277**
F	0.462	0.522	0.480	0.400	**0.466**
R	0.077	0.087	0.120	0.100	**0.096**
					1.000

$\lambda_{max} = 4.0395$

CI = 0.0132, CR = 1.46 %

In tactical level, from internal integration, there are four performance measurement factors: information integration (II), internal quick response (IQR), use of information technology (UIT) and efficiency (E).

Tables of pair-wise comparison and weight calculation for the TFPC

	II	IQR	UIT	E
II	**1**	1/2	3	2
IQR	2	**1**	4	2
UIT	1/3	1/4	**1**	1/2
E	1/2	1/2	2	**1**

→→→

	II	IQR	UIT	E	**Weights**
II	0.261	0.222	0.300	0.364	**0.287**
IQR	0.522	0.444	0.400	0.364	**0.432**
UIT	0.087	0.111	0.100	0.091	**0.097**
E	0.130	0.222	0.200	0.182	**0.184**
					1.000

$\lambda_{max} = 4.0543$

CI = 0.0181, CR = 2.01%

Tables of pair-wise comparison and weight calculation for the TCC

	II	IQR	UIT	E
II	**1**	2	4	3
IQR	1/2	**1**	3	2
UIT	1/4	1/3	**1**	1/2
E	1/3	1/2	2	**1**

→→→

	II	IQR	UIT	E	**Weights**
II	0.480	0.522	0.400	0.462	**0.466**
IQR	0.240	0.261	0.300	0.308	**0.277**
UIT	0.120	0.087	0.100	0.077	**0.096**
E	0.160	0.130	0.200	0.154	**0.161**
					1.000

$\lambda_{max} = 4.0395$

CI = 0.0132, CR = 1.46 %

Tables of pair-wise comparison and weight calculation for the TTC

	II	IQR	UIT	E
II	**1**	2	3	4
IQR	1/2	**1**	2	3
UIT	1/3	1/2	**1**	2
E	1/4	1/3	1/2	**1**

→→→

	II	IQR	UIT	E	**Weights**
II	0.480	0.522	0.462	0.400	**0.466**
IQR	0.240	0.261	0.308	0.300	**0.277**
UIT	0.160	0.130	0.154	0.200	**0.161**
E	0.120	0.087	0.077	0.100	**0.096**
					1.000

$\lambda_{max} = 4.0395$

CI = 0.0132, CR = 1.46 %

In tactical level, from human resources, there are four performance measurement factors: motivation (M), safety (S), training (T) and innovation and learning (IL).

Tables of pair-wise comparison and weight calculation for the TFPC

	M	S	T	IL
M	**1**	2	3	4
S	1/2	**1**	2	4
T	1/3	1/2	**1**	3
IL	1/4	1/4	1/3	**1**

→→→

	M	S	T	IL	**Weights**
M	0.480	0.533	0.474	0.333	**0.455**
S	0.240	0.267	0.316	0.333	**0.289**
T	0.160	0.133	0.158	0.250	**0.175**
IL	0.120	0.067	0.053	0.083	**0.081**
					1.000

$\lambda_{max} = 4.1098$

CI = 0.0366, CR = 4.07 %

Tables of pair-wise comparison and weight calculation for the TCC

	M	S	T	IL
M	**1**	1/2	1/2	2
S	2	**1**	2	3
T	2	1/2	**1**	3
IL	1/2	1/3	1/3	**1**

→→→

	M	S	T	IL	**Weights**
M	0.182	0.214	0.130	0.222	**0.187**
S	0.364	0.429	0.522	0.333	**0.412**
T	0.364	0.214	0.261	0.333	**0.293**
IL	0.091	0.143	0.087	0.111	**0.108**
					1.000

$\lambda_{max} = 4.0854$

CI = 0.0285, CR = 3.16 %

Tables of pair-wise comparison and weight calculation for the TTC

	M	S	T	IL
M	**1**	3	2	4
S	1/3	**1**	1/2	2
T	1/2	2	**1**	3
IL	1/4	1/2	1/3	**1**

→→→

	M	S	T	IL	**Weights**
M	0.480	0.462	0.522	0.400	**0.466**
S	0.160	0.154	0.130	0.200	**0.161**
T	0.240	0.308	0.261	0.300	**0.277**
IL	0.120	0.077	0.087	0.100	**0.096**
					1.000

$\lambda_{max} = 4.0395$

CI = 0.0132, CR = 1.46 %

In tactical level, from operations, there are three performance measurement factors: operational performance (OP), environmental performance (EP) and innovation (I).

Tables of pair-wise comparison and weight calculation for the TFPC

	OP	EP	I
OP	**1**	2	4
EP	1/2	**1**	3
I	1/4	1/3	**1**

→→→

	OP	EP	I	**Weights**
OP	0.571	0.600	0.500	**0.557**
EP	0.286	0.300	0.375	**0.320**
I	0.143	0.100	0.125	**0.123**
				1.000

$\lambda_{max} = 3.0234$

CI = 0.0117, CR = 2.02 %

Tables of pair-wise comparison and weight calculation for the TCC

	OP	EP	I
OP	**1**	2	2
EP	1/2	**1**	2
I	1/2	1/2	**1**

→→→

	OP	EP	I	**Weights**
OP	0.500	0.571	0.400	**0.490**
EP	0.250	0.286	0.400	**0.312**
I	0.250	0.143	0.200	**0.198**
				1.000

$\lambda_{max} = 3.0607$

CI = 0.0304, CR = 5.23 %

Tables of pair-wise comparison and weight calculation for the TTC

	OP	EP	I
OP	**1**	2	3
EP	1/2	**1**	2
I	1/3	1/2	**1**

→→→

	OP	EP	I	**Weights**
OP	0.545	0.571	0.500	**0.539**
EP	0.273	0.286	0.333	**0.297**
I	0.182	0.143	0.167	**0.164**
				1.000

$\lambda_{max} = 3.0112$

CI = 0.0056, CR = 0.96 %

Table 6.3: A summary of local and global priorities with respect to performance measurement factors in internal supply chain management

Decision making level	**Performance measurement factors**	**Priority for TFPC**		**Priority for TCC**		**Priority for TTC**	
		Local	**Global**	**Local**	**Global**	**Local**	**Global**
Strategic	Facility (F)	0.392	-	0.156	-	0.160	-
Tactical	- Capacity utilization (CU)	0.265	0.104	0.265	0.041	0.062	0.010
	- Efficiency (E)	0.367	0.144	0.367	0.057	0.099	0.016
	- Flexibility (F)	0.111	0.043	0.111	0.017	0.416	0.067
	- Quality (Q)	0.185	0.073	0.185	0.029	0.262	0.042
	- Reliability (R)	0.073	0.029	0.073	0.011	0.161	0.026
Strategic	Inventory (I)	0.213	-	0.244	-	0.065	-
Tactical	- Optimal inventory policy (OIP)	0.333	0.071	0.667	0.163	0.667	0.044
	- Warehouse utilization (WU)	0.667	0.142	0.333	0.081	0.333	0.022
Strategic	Transportation (T)	0.055	-	0.068	-	0.102	-
Tactical	- Capacity utilization (CU)	0.309	0.017	0.450	0.030	0.161	0.017
	- Efficiency (E)	0.435	0.024	0.260	0.018	0.277	0.028
	- Flexibility (F)	0.150	0.008	0.171	0.012	0.466	0.048
	- Reliability (R)	0.106	0.006	0.120	0.008	0.096	0.010

Decision making level	Performance measurement factors	Priority for TFPC		Priority for TCC		Priority for TTC	
		Local	**Global**	**Local**	**Global**	**Local**	**Global**
Strategic	Internal integration (II)	0.073	-	0.051	-	0.043	-
Tactical	- Information integration (II)	0.287	0.021	0.466	0.024	0.466	0.020
	- Internal quick response (IQR)	0.432	0.031	0.277	0.014	0.277	0.012
	- Use of information technology (UIT)	0.097	0.007	0.096	0.005	0.161	0.007
	- Efficiency (E)	0.184	0.013	0.161	0.008	0.096	0.004
Strategic	Human resources (HR)	0.161	-	0.097	-	0.379	-
Tactical	- Motivation (M)	0.455	0.073	0.187	0.018	0.466	0.177
	- Safety (S)	0.289	0.047	0.412	0.040	0.161	0.061
	- Training (T)	0.175	0.028	0.293	0.028	0.277	0.105
	- Innovation and learning (IL)	0.081	0.013	0.108	0.010	0.096	0.036
Strategic	Operations (O)	0.106	-	0.385	-	0.249	-
Tactical	- Operational performance (OP)	0.557	0.059	0.490	0.189	0.539	0.134
	- Environmental performance (EP)	0.320	0.034	0.312	0.120	0.297	0.074
	- Innovation (I)	0.123	0.013	0.198	0.076	0.164	0.041
			1.000		**1.000**		**1.000**

The processes to measure supply chain performance of each case study company are shown in pair-wise comparison and weight calculation tables below. Then, to compare their supply chain performance, a summary of local and global priorities with respect to performance measurement factors in internal supply chain management is showed in Table 6.3.

The Thai Food Processing Company (TFPC)

At strategic decision making level, it is observed that facility factor (0.392) is found to be the most preferred followed by inventory factor (0.213), human resources factor (0.161), operations factor (0.106), internal integration factor (0.073) and transportation factor (0.055). It reveals that the TFPC considers facility is the most important in its internal supply chain management.

At tactical decision making level, from facility, efficiency (0.367) is perceived to be the most preferred factor followed by capacity utilization (0.265), quality (0.185), flexibility (0.111) and reliability (0.073). It discloses that efficiency factor is the most important while reliability factor is the least important. Next, from inventory, warehouse utilization (0.667) is known to be the most preferred factor and optimal inventory policy (0.333) is the least preferred factor. From transportation, efficiency (0.435) is shown to be the most preferred factor followed by capacity utilization (0.309), flexibility (0.150) and reliability (0.106). It exposes that efficiency factor is the most important whereas reliability factor is the least important. Then, from internal integration, internal quick response (0.432) is indicated to be the most preferred factor followed by information integration (0.287), efficiency (0.184) and use of information technology (0.097). It founds that internal quick response factor is the most important while use of information technology factor is the least important. From human resources, motivation (0.455) is concerned to be the most preferred factor followed by safety (0.289), training (0.175) and innovation and learning (0.081). It claims that motivation factor is the most important whereas innovation and learning factor is the least important. Finally, from operations, operational performance (0.557) is displayed to be the most preferred factor followed by environmental performance (0.320) and innovation (0.123). It founds that operational performance factor is the most important while innovation factor is the least important.

For overall performance measurement factors in tactical level with respect to internal supply chain management (global priority), efficiency of facility (0.144) followed by warehouse utilization (0.142) and capacity utilization of facility (0.104) are preferred as the desirable factors compared with others. This result shows the importance of these factors in internal supply chain management macro process of a supply chain system for The Thai Food Processing Company.

The Thai Chemical Company (TCC)

At strategic decision making level, it is evident that operations factor (0.385) is suggested to be the most preferred followed by inventory factor (0.244), facility factor (0.156), human resources factor (0.097), transportation factor (0.068) and internal integration factor (0.051). It proposes that the TCC defines the operations is the most important in its internal supply chain management.

At tactical decision making level, from facility, efficiency (0.367) is perceived to be the most preferred factor followed by capacity utilization (0.265), quality (0.185), flexibility (0.111) and reliability (0.073). It advises that efficiency factor is the most important while reliability factor is the least important. Next, from inventory, optimal inventory policy (0.667) is known to be the most preferred factor and warehouse utilization (0.333) is the least preferred factor. From transportation, capacity utilization (0.450) is desirable to be the most preferred factor followed by efficiency (0.260), flexibility (0.171) and reliability (0.120). It mentions that capacity utilization factor is the most important whereas reliability factor is the least important. Then, from internal integration, information integration (0.466) is indicated to be the most preferred factor followed by internal quick response (0.277), efficiency (0.161) and use of information technology (0.096). It founds that information integration factor is the most important while use of information technology factor is the least important. From human resources, safety (0.412) is found to be the most preferred factor followed by training (0.293), motivation (0.187) and innovation and learning (0.108). It proposes that safety factor is the most important whereas innovation and learning factor is the least important. Finally, from operations, operational performance (0.490) is concerned to be the most preferred factor followed by environmental performance (0.312) and

innovation (0.198). It claims that operational performance factor is the most important while innovation factor is the least important.

For overall performance measurement factors in tactical level with respect to internal supply chain management (global priority), operational performance (0.189) followed by optimal inventory policy (0.163) and environmental performance (0.120) are preferred as the desirable factors compared with others. This result explains the importance of these factors in internal supply chain management macro process of a supply chain system for The Thai Chemical Company.

The Thai Textile Company (TTC)

At strategic decision making level, it is described that human resources factor (0.379) is found to be the most preferred followed by operations factor (0.249), facility factor (0.160), transportation factor (0.102), inventory factor (0.065) and internal integration factor (0.043). It expresses that the TTC determines the human resources is the most important in its internal supply chain management.

At tactical decision making level, from facility, flexibility (0.416) is identified to be the most preferred factor followed by quality (0.262), reliability (0.161), efficiency (0.099) and capacity utilization (0.062). It displays that flexibility factor is the most important while capacity utilization factor is the least important. Next, from inventory, optimal inventory policy (0.667) is known to be the most preferred factor and warehouse utilization (0.333) is the least preferred factor. From transportation, flexibility (0.466) is perceived to be the most preferred factor followed by efficiency (0.277), capacity utilization (0.161) and reliability (0.096). It reveals that flexibility factor is the most important whereas reliability factor is the least important. Then, from internal integration, information integration (0.466) is desirable to be the most preferred factor followed by internal quick response (0.277), use of information technology (0.161) and efficiency (0.096). It realizes that information integration factor is the most important while efficiency factor is the least important. From human resources, motivation (0.466) is concerned to be the most preferred factor followed by training (0.277), safety (0.161) and innovation and learning (0.096). It expresses that motivation factor is the most important whereas innovation and learning factor is the least important. Finally, from

operations, operational performance (0.539) is known to be the most preferred factor followed by environmental performance (0.297) and innovation (0.164). It indicates that operational performance factor is the most important while innovation factor is the least important.

For overall performance measurement factors in tactical level with respect to internal supply chain management (global priority), motivation (0.177) followed by operational performance (0.134) and training (0.105) are preferred as the desirable factors compared with others. This result proposes the importance of these factors in internal supply chain management macro process of a supply chain system for The Thai Textile Company.

6.6 Customer relationship management

In strategic level, there are four performance measurement factors: customer service (CS), customer integration (CI), demand forecasting (DF) and market analysis (MA).

Tables of pair-wise comparison and weight calculation for the TFPC

	CS	CI	DF	MA
CS	**1**	1/2	2	2
CI	2	**1**	3	3
DF	1/2	1/3	**1**	2
MA	1/2	1/3	1/2	**1**

→→→

	CS	CI	DF	MA	**Weights**
CS	0.250	0.231	0.308	0.250	**0.260**
CI	0.500	0.462	0.462	0.375	**0.450**
DF	0.125	0.154	0.154	0.250	**0.171**
MA	0.125	0.154	0.077	0.125	**0.120**
					1.000

Maximum eigenvalue (λ_{max}) = 4.0833

Consistency index (CI) = 0.0278

Consistency ratio (CR) = 3.09 %

Tables of pair-wise comparison and weight calculation for the TCC

	CS	CI	DF	MA
CS	**1**	2	3	4
CI	1/2	**1**	2	3
DF	1/3	1/2	**1**	2
MA	1/4	1/3	1/2	**1**

→→→

	CS	CI	DF	MA	**Weights**
CS	0.480	0.522	0.462	0.400	**0.466**
CI	0.240	0.261	0.308	0.300	**0.277**
DF	0.160	0.130	0.154	0.200	**0.161**
MA	0.120	0.087	0.077	0.100	**0.096**
					1.000

λ_{max} = 4.0395, CI = 0.0132, CR = 1.46 %

Tables of pair-wise comparison and weight calculation for the TTC

	CS	CI	DF	MA
CS	**1**	2	3	4
CI	1/2	**1**	2	3
DF	1/3	1/2	**1**	2
MA	1/4	1/3	1/2	**1**

→→→

	CS	CI	DF	MA	**Weights**
CS	0.480	0.522	0.462	0.400	**0.466**
CI	0.240	0.261	0.308	0.300	**0.277**
DF	0.160	0.130	0.154	0.200	**0.161**
MA	0.120	0.087	0.077	0.100	**0.096**
					1.000

λ_{max} = 4.0395, CI = 0.0132, CR = 1.46 %

In tactical level, from customer service, there are four performance measurement factors: responsiveness (R), customer order processing and delivery (COP), handling customer complaints (HCC) and value added service (VAS).

Tables of pair-wise comparison and weight calculation for the TFPC

	R	COP	HCC	VAS
R	**1**	1/2	2	2
COP	2	**1**	3	3
HCC	1/2	1/3	**1**	1/2
VAS	1/2	1/3	2	**1**

→→→

	R	COP	HCC	VAS	**Weights**
R	0.250	0.231	0.250	0.308	**0.260**
COP	0.500	0.462	0.375	0.462	**0.450**
HCC	0.125	0.154	0.125	0.077	**0.120**
VAS	0.125	0.154	0.250	0.154	**0.171**
					1.000

$\lambda_{max} = 4.0833$

CI = 0.0278, CR = 3.09 %

Tables of pair-wise comparison and weight calculation for the TCC

	R	COP	HCC	VAS
R	**1**	2	3	3
COP	1/2	**1**	2	2
HCC	1/3	1/2	**1**	2
VAS	1/3	1/2	1/2	**1**

→→→

	R	COP	HCC	VAS	**Weights**
R	0.462	0.500	0.462	0.375	**0.450**
COP	0.231	0.250	0.308	0.250	**0.260**
HCC	0.154	0.125	0.154	0.250	**0.171**
VAS	0.154	0.125	0.077	0.125	**0.120**
					1.000

$\lambda_{max} = 4.0833$

CI = 0.0278, CR = 3.09 %

Tables of pair-wise comparison and weight calculation for the TTC

	R	COP	HCC	VAS
R	**1**	1/2	2	2
COP	2	**1**	3	3
HCC	1/2	1/3	**1**	1/2
VAS	1/2	1/3	2	**1**

→→→

	R	COP	HCC	VAS	**Weights**
R	0.250	0.231	0.250	0.308	**0.260**
COP	0.500	0.462	0.375	0.462	**0.450**
HCC	0.125	0.154	0.125	0.077	**0.120**
VAS	0.125	0.154	0.250	0.154	**0.171**
					1.000

$\lambda_{max} = 4.0833$

CI = 0.0278, CR = 3.09 %

In tactical level, from customer integration, there are four performance measurement factors: extent of cooperation to improve quality (ECI), information integration (II), organizational relationship (OR) and use of information technology (UIT).

Tables of pair-wise comparison and weight calculation for the TFPC

	ECI	II	OR	UIT
ECI	**1**	3	2	4
II	1/3	**1**	1/2	2
OR	1/2	2	**1**	3
UIT	1/4	1/2	1/3	**1**

→→→

	ECI	II	OR	UIT	**Weights**
ECI	0.480	0.462	0.522	0.400	**0.466**
II	0.160	0.154	0.130	0.200	**0.161**
OR	0.240	0.308	0.261	0.300	**0.277**
UIT	0.120	0.077	0.087	0.100	**0.096**
					1.000

$\lambda_{max} = 4.0395$

CI = 0.0132, CR = 1.46 %

Tables of pair-wise comparison and weight calculation for the TCC

	ECI	II	OR	UIT
ECI	**1**	2	2	3
II	1/2	**1**	2	3
OR	1/2	1/2	**1**	2
UIT	1/3	1/3	1/2	**1**

→→→

	ECI	II	OR	UIT	**Weights**
ECI	0.429	0.522	0.364	0.333	**0.412**
II	0.214	0.261	0.364	0.333	**0.293**
OR	0.214	0.130	0.182	0.222	**0.187**
UIT	0.143	0.087	0.091	0.111	**0.108**
					1.000

$\lambda_{max} = 4.0854$

CI = 0.0285, CR = 3.16 %

Tables of pair-wise comparison and weight calculation for the TTC

	ECI	II	OR	UIT
ECI	**1**	3	2	4
II	1/3	**1**	1/2	2
OR	1/2	2	**1**	3
UIT	1/4	1/2	1/3	**1**

→→→

	ECI	II	OR	UIT	**Weights**
ECI	0.480	0.462	0.522	0.400	**0.466**
II	0.160	0.154	0.130	0.200	**0.161**
OR	0.240	0.308	0.261	0.300	**0.277**
UIT	0.120	0.077	0.087	0.100	**0.096**
					1.000

$\lambda_{max} = 4.0395$

CI = 0.0132, CR = 1.46 %

In tactical level, from demand forecasting, there are three performance measurement factors: forecasting system in place (FSP), decision making (DM) and reliability of demand data (RDD).

Tables of pair-wise comparison and weight calculation for the TFPC

	FSP	DM	RDD
FSP	**1**	2	1/2
DM	1/2	**1**	1/2
RDD	2	2	**1**

→→→

	FSP	DM	RDD	**Weights**
FSP	0.286	0.400	0.250	**0.312**
DM	0.143	0.200	0.250	**0.198**
RDD	0.571	0.400	0.500	**0.490**
				1.000

$\lambda_{max} = 3.0607$

CI = 0.0304, CR = 5.23 %

Tables of pair-wise comparison and weight calculation for the TCC

	FSP	DM	RDD
FSP	**1**	2	2
DM	1/2	**1**	2
RDD	1/2	1/2	**1**

→→→

	FSP	DM	RDD	**Weights**
FSP	0.500	0.571	0.400	**0.490**
DM	0.250	0.286	0.400	**0.312**
RDD	0.250	0.143	0.200	**0.198**
				1.000

$\lambda_{max} = 3.0607$

CI = 0.0304, CR = 5.23 %

Tables of pair-wise comparison and weight calculation for the TTC

	FSP	DM	RDD
FSP	**1**	1/2	1/3
DM	2	**1**	1/2
RDD	3	2	**1**

→→→

	FSP	DM	RDD	**Weights**
FSP	0.167	0.143	0.182	**0.164**
DM	0.333	0.286	0.273	**0.297**
RDD	0.500	0.571	0.545	**0.539**
				1.000

$\lambda_{max} = 3.0112$

CI = 0.0056, CR = 0.96 %

In tactical level, from market analysis, there are four performance measurement factors: market equity (ME), customer acquisition (CA), customer retention (CR) and government policy over market equity (GP).

Tables of pair-wise comparison and weight calculation for the TFPC

	ME	CA	CR	GP
ME	**1**	1/2	1/3	1/2
CA	2	**1**	1/2	2
CR	3	2	**1**	3
GP	2	1/2	1/3	**1**

→→→

	ME	CA	CR	GP	**Weights**
ME	0.125	0.125	0.154	0.077	**0.120**
CA	0.250	0.250	0.231	0.308	**0.260**
CR	0.375	0.500	0.462	0.462	**0.450**
GP	0.250	0.125	0.154	0.154	**0.171**
					1.000

$\lambda_{max} = 4.0833$

CI = 0.0278, CR = 3.09 %

Tables of pair-wise comparison and weight calculation for the TCC

	ME	CA	CR	GP
ME	**1**	1/3	1/2	2
CA	3	**1**	2	4
CR	2	1/2	**1**	3
GP	1/2	1/4	1/3	**1**

→→→

	ME	CA	CR	GP	**Weights**
ME	0.154	0.160	0.130	0.200	**0.161**
CA	0.462	0.480	0.522	0.400	**0.466**
CR	0.308	0.240	0.261	0.300	**0.277**
GP	0.077	0.120	0.087	0.100	**0.096**
					1.000

$\lambda_{max} = 4.0395$

CI = 0.0132, CR = 1.46 %

Tables of pair-wise comparison and weight calculation for the TTC

	ME	CA	CR	GP
ME	**1**	1/3	1/4	3
CA	3	**1**	1/2	4
CR	4	2	**1**	6
GP	1/3	1/4	1/6	**1**

→→→

	ME	CA	CR	GP	**Weights**
ME	0.120	0.093	0.130	0.214	**0.139**
CA	0.360	0.279	0.261	0.286	**0.296**
CR	0.480	0.558	0.522	0.429	**0.497**
GP	0.040	0.070	0.087	0.071	**0.067**
					1.000

$\lambda_{max} = 4.1154$

CI = 0.0385, CR = 4.28 %

Table 6.4: A summary of local and global priorities with respect to performance measurement factors in customer relationship management

Decision making level	**Performance measurement factors**	**Priority for TFPC**		**Priority for TCC**		**Priority for TTC**	
		Local	**Global**	**Local**	**Global**	**Local**	**Global**
Strategic	Customer service (CS)	0.260	-	0.466	-	0.466	-
Tactical	- Responsiveness (R)	0.260	0.067	0.450	0.209	0.260	0.121
	- Customer order processing and delivery (COP)	0.450	0.117	0.260	0.121	0.450	0.209
	- Handling customer complaints (HCC)	0.120	0.031	0.171	0.080	0.120	0.056
	- Value added service (VAS)	0.171	0.044	0.120	0.056	0.171	0.080
Strategic	Customer integration (CI)	0.450	-	0.277	-	0.277	-
Tactical	- Extent of cooperation to improve quality (ECI)	0.466	0.209	0.412	0.114	0.466	0.129
	- Information integration (II)	0.161	0.072	0.293	0.081	0.161	0.045
	- Organizational relationship (OR)	0.277	0.125	0.187	0.052	0.277	0.077
	- Use of information technology (UIT)	0.096	0.043	0.108	0.030	0.096	0.027

Decision making level	Performance measurement factors	Priority for TFPC		Priority for TCC		Priority for TTC	
		Local	**Global**	**Local**	**Global**	**Local**	**Global**
Strategic	Demand forecasting (DF)	0.171	-	0.161	-	0.161	-
Tactical	- Forecasting system in place (FSP)	0.312	0.053	0.490	0.079	0.164	0.026
	- Decision making (DM)	0.198	0.034	0.312	0.050	0.297	0.048
	- Reliability of demand data (RDD)	0.490	0.084	0.198	0.032	0.539	0.087
Strategic	Market analysis (MA)	0.120	-	0.096	-	0.096	-
Tactical	- Market equity (ME)	0.120	0.014	0.161	0.015	0.139	0.013
	- Customer acquisition (CA)	0.260	0.031	0.466	0.045	0.296	0.028
	- Customer retention (CR)	0.450	0.054	0.277	0.027	0.497	0.048
	- Government policy over market equity (GP)	0.171	0.021	0.096	0.009	0.067	0.006
			1.000		**1.000**		**1.000**

The processes to measure supply chain performance of each case study company are shown in pair-wise comparison and weight calculation tables above. Then, to compare their supply chain performance, a summary of local and global priorities with respect to performance measurement factors in customer relationship management is showed in Table 6.4.

The Thai Food Processing Company (TFPC)

At strategic decision making level, it is observed that customer integration factor (0.450) is found to be the most preferred followed by customer service factor (0.260), demand forecasting factor (0.171) and market analysis factor (0.120). It reveals that the TFPC considers the integration with customer is the most important in its customer relationship management.

At tactical decision making level, from customer service, customer order processing and delivery (0.450) is perceived to be the most preferred factor followed by responsiveness (0.260), value added service (0.171) and handling customer complaints (0.120). It discloses that customer order processing and delivery factor is the most important while handling customer complaints factor is the least important. Next, from customer integration, extent of cooperation to improve quality (0.466) is known to be the most preferred factor followed by organizational relationship (0.277), information integration (0.161) and use of information technology (0.096). It exposes that extent of cooperation to improve quality factor is the most important whereas use of information technology factor is the least important. Then, from demand forecasting, reliability of demand data (0.490) is indicated to be the most preferred factor followed by forecasting system in place (0.312) and decision making (0.198). It founds that reliability of demand data factor is the most important while decision making factor is the least important. Finally, from market analysis, customer retention (0.450) is shown to be the most preferred factor followed by customer acquisition (0.260), government policy over market equity (0.171) and market equity (0.120). It displays that customer retention factor is the most important whereas market equity factor is the least important.

For overall performance measurement factors in tactical level with respect to customer relationship management (global priority), extent of cooperation to improve quality

(0.209) followed by organizational relationship (0.125) and customer order processing and delivery (0.117) are preferred as the desirable factors compared with others. This result shows the importance of these factors in customer relationship management macro process of a supply chain system for The Thai Food Processing Company.

The Thai Chemical Company (TCC)

At strategic decision making level, it is evident that customer service factor (0.466) is suggested to be the most preferred followed by customer integration factor (0.277), demand forecasting factor (0.161) and market analysis factor (0.096). It proposes that the TCC defines customer service is the most important in its customer relationship management.

At tactical decision making level, from customer service, responsiveness (0.450) is perceived to be the most preferred factor followed by customer order processing and delivery (0.260), handling customer complaints (0.171) and value added service (0.120). It advises that responsiveness factor is the most important while value added service factor is the least important. Next, from customer integration, extent of cooperation to improve quality (0.412) is desirable to be the most preferred factor followed by information integration (0.293), organizational relationship (0.187) and use of information technology (0.108). It mentions that extent of cooperation to improve quality factor is the most important whereas use of information technology factor is the least important. Then, from demand forecasting, forecasting system in place (0.490) is concerned to be the most preferred factor followed by decision making (0.312) and reliability of demand data (0.198). It claims that forecasting system in place factor is the most important while reliability of demand data factor is the least important. Finally, from market analysis, customer acquisition (0.466) is shown to be the most preferred factor followed by customer retention (0.277), market equity (0.161) and government policy over market equity (0.096). It explains that customer acquisition factor is the most important whereas government policy over market equity factor is the least important.

For overall performance measurement factors in tactical level with respect to customer relationship management (global priority), responsiveness (0.209) followed by

customer order processing and delivery (0.121) and extent of cooperation to improve quality (0.114) are preferred as the desirable factors compared with others. This result displays the importance of these factors in customer relationship management macro process of a supply chain system for The Thai Chemical Company.

The Thai Textile Company (TTC)

At strategic decision making level, it is described that customer service factor (0.466) is found to be the most preferred followed by customer integration factor (0.277), demand forecasting factor (0.161) and market analysis factor (0.096). It expresses that the TTC determines the service for customer is the most important in its customer relationship management.

At tactical decision making level, from customer service, customer order processing and delivery (0.450) is identified to be the most preferred factor followed by responsiveness (0.260), value added service (0.171) and handling customer complaints (0.120). It displays that customer order processing and delivery factor is the most important while handling customer complaints factor is the least important. Next, from customer integration, extent of cooperation to improve quality (0.466) is perceived to be the most preferred factor followed by organizational relationship (0.277), information integration (0.161) and use of information technology (0.096). It reveals that extent of cooperation to improve quality factor is the most important whereas use of information technology factor is the least important. Then, from demand forecasting, reliability of demand data (0.539) is known to be the most preferred factor followed by decision making (0.297) and forecasting system in place (0.164). It indicates that reliability of demand data factor is the most important while forecasting system in place factor is the least important. Finally, from market analysis, customer retention (0.497) is shown to be the most preferred factor followed by customer acquisition (0.296), market equity (0.139) and government policy over market equity (0.067). It displays that customer retention factor is the most important whereas government policy over market equity factor is the least important.

For overall performance measurement factors in tactical level with respect to customer relationship management (global priority), customer order processing and delivery

(0.209) followed by extent of cooperation to improve quality (0.129) and responsiveness (0.121) are preferred as the desirable factors compared with others. This result proposes the importance of these factors in customer relationship management macro process of a supply chain system for The Thai Textile Company.

6.7 Conclusion

This chapter provides a detailed analysis of performance measurement in order to understand supply chain performance of three case study companies by using the analytic hierarchy process (AHP). These companies are the Thai Food Processing Company (TFPC), the Thai Chemical Company (TCC) and the Thai Textile Company (TTC). The detailed analysis of supply chain performance measurement was based on performance measurement factors that were presented in the study's conceptual framework as explained in Chapter Four and the analytic hierarchy process was introduced in Chapter Three. The performance measurement factors were indentified on the three supply chain macro processes along with decision making levels. Therefore, this chapter analyzes performance measurement factors that contain in three themes: supplier relationship management, internal supply chain management and customer relationship management. However, a comparison of performance measurement for these three supply chain macro processes is presented at the beginning to provide an entire view of supply chain system.

The next chapter presents the overall research conclusions and the final remarks. It reviews the theoretical purpose and implications of the conceptual framework, and the contribution of the conceptual framework.

Chapter 7 Conclusion

7.1 Introduction

This study has examined performance of supply chain management in three case study companies in the Thai manufacturing sector: the Thai Food Processing Company (TFPC), the Thai Chemical Company (TCC) and the Thai Textile Company (TTC). The study uses the concept of decision making levels and supply chain macro processes as its approach to the study of the supply chain performance measurement. The concept of decision making levels and supply chain macro processes is related to the various performance measurement factors through their interactions. By combining both decision making levels and supply chain macro processes, the study explored the holistic performance of supply chain management. Importantly, it was argued that there is very little existing research in the supply chain performance measurement field using this combined approach.

A key aim of this research was to develop a conceptual framework to understand supply chain performance measurement as a form of the holistic performance of supply chain management by combining both supply chain macro processes and decision making levels. This framework will provide a balanced horizontal (cross-process) and vertical (hierarchical decision) view in the developing world context, in this case, Thailand. In order to achieve these broad research aims, three more specific research objectives were set. They were:

1. To identify performance measurement factors with respect to supplier relationship management, internal supply chain management and customer relationship management against strategic, tactical and operational levels for a supply chain performance measurement framework.
2. To develop a conceptual framework based on proposed performance measurement factors.

3. To validate the proposed framework by applying it to the case study companies in the Thai manufacturing sector for the following purposes:

3.1 To evaluate supply chain performance in relation to performance measurement factors

3.2 To determine the importance of the performance measurement factors by using the analytic hierarchy process (AHP).

The researcher examined three manufacturers in Thailand as case study companies: the Thai Food Processing Company (stands for the case study company that represented for food processing industrial group), the Thai Chemical Company (stands for the case study company that represented for chemical industrial group) and the Thai Textile Company (stands for the case study company that represented for textile industrial group). They were selected on the basis of the representative of the main industrial groups and the practical feasibility of access to the case study companies. One key type of data collection used in the study was in-depth interviews, with these being used to understand the views of manufacturers related to supply chain performance measurement factors in Thailand. In this study, semi-structured interviews were used to collect both qualitative data (words) and quantitative data (numbers). Qualitative data were used for studying supply chain characteristics of each case study company, and identifying their supply chain performance. By contrast, quantitative data were used for measuring performance of case study companies. The interviews were conducted from January to April 2009 and two additional visits to the case study companies in Thailand. Many of the results were drawn from fifty seven interviews. The respondents included manager, deputy manager, assistant manager and officers from purchasing, marketing and production departments. Additional, the managing director (MD) of the companies were the respondents for collecting the overall company's information.

This chapter presents the final conclusions of the research and other remarks. It comprises six sections. It starts by reviewing the theoretical purpose and implications of the conceptual framework, which relates to Objectives One and Two. Then it focuses on the study's main findings from the application of the conceptual framework, which is relevant to Objectives Three. The next part concerns the contribution of the conceptual framework. Then the strengths of this research are discussed, followed by a

description of limitations of the research. After that, recommendations for future research are given, and finally, the thesis ends with some concluding comments.

7.2 Theoretical purpose and application of the conceptual framework to this study

This section relates to Objectives One and Two. It examines the conceptual framework in relation to performance measurement factors for measuring supply chain performance, including the purpose of the conceptual framework and its application. They are explained in turn.

To achieve Objective One, literature was critically reviewed on supply chain performance measurement frameworks and performance measurement factors for supply chain performance measurement. The details of the literature review were presented in Chapter Two. Then, the conceptual framework was developed based on key concepts from this literature review, this being undertaken to meet Objective Two.

A review of previous research in relation to supply chain management has highlighted a lack of consideration of performance measurement for supply chain, particularly in developing countries. By exploring the themes relating to supply chain performance as a form of performance measurement, it is anticipated that the research will lead to a more comprehensive understanding of supply chain performance measurement in developing countries, in this case Thailand.

The attention of many researchers has often focused on single area of performance measurement, while they have relatively neglected research on the whole performance of supply chain management. Concerning these gaps, the framework developed for this study was used the concept of decision making levels and supply chain macro processes as its approach to the study of the holistic supply chain performance measurement.

The framework was fundamentally underpinned by the perspective of decision making levels and supply chain macro processes. Decision making levels were applied here to look at the performance in vertical view. These decisions fall into three categories or levels: strategic, tactical and operational; depending on the authority decision level, the

frequency of each decision and the time frame which a decision level has an impact. This framework also employed supply chain macro processes to explore the performance in horizontal view. All supply chain processes can be classified into the following three macro processes: supplier relationship management which represents for all processes that focus on the interface between the company and its suppliers; internal supply chain management which represents for all processes that are internal to the company; and customer relationship management which represents for all processes that focus on the interface between the company and its customers.

Concerning Objective Two to develop a new conceptual framework based on decision making levels and supply chain macro processes approaches, here the researcher intended this framework to be a more integrative, comprehensive, and relational framework than others developed by other researchers. It looks at a more holistic perspective of the supply chain performance measurement. The framework helped to guide the fieldwork, notably in developing the topics in the questions to obtain data from respondents. The questions reflected the detailed elements of each theme in the framework. The framework helped to organize the presentation of the results, helping to outline the themes in the results chapters and to inform recommendations resulting from the research. Also, the conceptual framework helped in understanding supply chain performance in the three manufacturer case studies in Thailand, and thus it has potential value for application to other business sectors in Thailand and potentially elsewhere in other developing countries as well as in developed countries.

7.3 Key findings from the application of the conceptual framework

This section links to Objective Three part one (findings based on the supply chain performance) and Objective Three part two (findings related to the supply chain performance measurement). The conceptual framework and the research findings reported in Chapters Five and Six are closely related, with the framework guiding the data analysis and helping to identify the themes in the results chapters. The following details are key findings from the application of the conceptual framework to the three case studies.

7.3.1 Supply chain performance

This section relates to Objective Three part one, and thus this summary focuses on the supply chain performance in relation to performance measurement factors in the three case study companies. These performance measurement factors were identified in the study's conceptual framework based on the two main concepts: the supply chain macro processes and the decision making levels. The insights from the cases help to understand the current performance of supply chain on the Thai manufacturing sector companies.

A first finding concerns the performance of supply chain of three case study companies in relation to supplier relationship management. All three companies shared the same main criterion for selecting their suppliers that was the quality of raw materials. However, delivery performance, competitive price and reliability of suppliers also played the important roles when these companies determined their suppliers.

Because of the Thai culture and the business values in Thailand, these companies did not want to share their information to other stakeholders in the supply chain system, even their strategic supplier. The companies concerned if they had to reveal their business secret. The only information that the companies supported to suppliers was the related information that help suppliers to prepare appropriate raw materials for their products. Furthermore, there was no risk sharing between these companies and their suppliers. Mostly traditional communication means such as telephone, fax and e-mail were used to remain in touch between the companies and the suppliers.

The Thai Chemical Company tried to have more than one supplier in all required raw materials to reduce supplier power. Moreover, this multiple suppliers' policy can reduce the risks that will occur when the company depend on just one supplier. While the Thai Textile Company had a few total number of its supplier. There were only 7 to 8 suppliers. However, the company was finding for new suppliers from overseas that can provide high quality with low price.

A second finding involves the supply chain performance of the case study companies related to internal supply chain management. All of these three companies applied the

flexibility of production for their facility strategy. This strategy can help the companies to support a variety of specification order from their customers. Raw materials were the main items of inventory for these companies because the companies produce mostly make-to-order products. Therefore, they attempted to keep a good relationship with suppliers in order to reduce the safety stock cost.

For transportation, inbound transportation was under responsibility of their suppliers. However, the TFPC used third party logistics service provider for outbound because its finished products need a specific transportation that has frozen container to control the temperature. While the TCC and the TTC had their own trucks for delivering to domestic customers and hired third party logistics transportation for international customers. The reason behind that was the flexibility and reliability of their transportation system.

The TCC and the TTC invested an ERP system to link all business functions together and share the information within the company. A contemporary software package such as Lotus Notes was used in the TCC to support its IT system. While ERP system in the TFPC did not link to all departments yet. However, it was under the testing and developing process to improve its IT system.

For human resources, in addition from regular training, as the nature of their business that required a large amount of workers, both the TFPC and the TTC used over-time (OT) payment to motivate their workers to stay with the companies for long period while the TCC attempted to apply reward policy rather than punishment to encourage its employees. However, the safety of work process and staffs is the main concern issue for all of these companies.

For environmental operations, both the TFPC and the TCC were certified ISO 14001 EMS because this environmental management standard is necessary for their production and products. Moreover, the TCC attempted to move to the next step by applying ISO 26000 (the standard for corporate social responsibility) while the TTC was certified ISO 9001:2000 only. As the current location of the company problem, the TTC did not have ISO 14001 certification yet. Furthermore, there was a low environmental pressure to the company to get ISO 14001 EMS.

A final finding relates to the performance of supply chain of three case study companies in relation to customer relationship management. Customer satisfaction was the main concern for all these three companies because they manufactured made-to-order products. Therefore, the companies tried to response to all customers' demands by using long experienced salespeople to work closely with customers in order to help them to fulfil their needs. Moreover, the companies deal with customer complaint seriously to satisfy the customers.

Like dealing with their suppliers, the companies did not want to share their information to customers because they considered most of information was their business secret. On the other hand, the companies wanted to get as much as information from their customers in order to improve their products and forecast correct demand. In addition, there was no risk sharing between these companies and their customers, even they wanted to share risk with customers. Physical communication mechanism such as telephone, fax and e-mail were used for keeping contact between the companies and customers.

For demand forecasting, these companies used a common forecast method from historic data and seasonality to predict for the next year production plan. While the Thai Textile Company hired a professional team from overseas to analyze trend of fashion for the next season or next year for further support data. Currently, the reliability of demand forecasting data was an acceptable result for all three companies.

The customers of these three companies came from both domestic and international markets but different in proportion of market share. Major contribution of Thai Food Processing Company's customers was international market while the Thai Chemical Company served mostly to local customers for synthetic resin products. For the Thai Textile Company, both domestic and international markets shared equal proportion. However, there were also many competitors from both domestic and international markets, especially for food processing and textile industries. Thus, both the Thai Food Processing Company and the Thai Textile Company worked hard to maintain long term relationship with their customers that can help to retain royal customers. By contrast, the Thai Chemical Company still focused on satisfying its customers, even though the

company was in a group of big three leader of the synthetic resin industry and a market leader for polyurethane synthetic leather.

7.3.2 Supply chain performance measurement

This section relates to Objective Three part two. The summary here reviews the analysis of the performance measurement of supply chain. This study applied the proposed conceptual framework concerning performance measurement factors to measure supply chain performance of the case study companies so as to indicate how well these companies perform their supply chain performance by using the analytic hierarchy process (AHP). The insights from the cases help to identify and compare the important of the performance measurement factors on the Thai manufacturer case studies.

A first finding involves the analysis of an overall supply chain performance from three supply chain macro processes. It was evident that internal supply chain management was the most preferred supply chain macro process for the Thai Food Processing Company while customer relationship management was the most preferred supply chain macro process for the Thai Textile Company. For the Thai Chemical Company, both internal supply chain management and customer relationship management were equally desirable to be the most preferred supply chain macro processes. These results showed that the Thai Food Processing Company intended to concentrate on its internal supply chain as it is the most important for the company. On other hand, the Thai Textile Company provided its interest to customer as the company considered that its customers are the most important. However, the Thai Chemical Company concerned both internal supply chain and customer equally. The results also suggested that supplier relationship management was the least important to these companies compared with others.

A second finding concerns the measurement of supply chain performance by analyzing performance measurement factors in supplier relationship management. At strategic decision making level, all three companies agreed that quality supplier selection was the most important factor whereas supplier integration was the least important factor. This result revealed that the companies gave a significant role on the selection of supplier while they did not attempt to share the information with suppliers.

Then, at tactical level, both supplier performance and selection process factors from quality supplier selection in strategic level were among the front-runners for all three companies. This result was not surprising as the companies concerned on their upper level factor, quality supplier selection.

A third finding is about the analysis of performance measurement factors in internal supply chain management. At strategic decision making level, all three companies had different aspects for the importance of performance measurement factor. From its nature of business, the Thai Food Processing Company had five factories and variety of products. The TFPC also used third party logistics service providers for most of the company's transportation system. Therefore, these were the reasons why the TFPC considered facility to be the most important factor while transportation was the least important factor. On the other side, the Thai Chemical Company selected operations to be the most important factor whereas internal integration was the least important factor. The reasons behind that were the TCC had complicated production process for its both main products and the company believed in its strength of information system. While the Thai Textile Company concerned on the ability of its employees and felt satisfied with its information system. Thus, the TTC chose human resources to be the most important factor whereas internal integration was the least important factor.

In tactical level, as a consequence from upper level, efficiency factor from facility and warehouse utilization factor from inventory in strategic level were the front-runners for the TFPC. Operational performance factor from operations and optimal inventory policy factor from inventory in strategic level were the favourites for the TCC. Motivation factor from human resources and operation performance factor from operations in strategic level were the preferences for the TTC.

A final finding relates to the measurement of supply chain performance by analyzing performance measurement factors in customer relationship management. At strategic decision making level, customer service was the most important factor for both the Thai Chemical Company and the Thai Textile Company while customer integration was the most important factor for the Thai Food Processing Company. This result explained that the TCC and the TTC focused on improving a better service to their customers while

the TFPC attempted to cooperate and integrate information with its customers. On other hand, market analysis was the least important factor for all three companies.

For tactical level, both customer order processing and delivery factor from customer service in strategic level and extent of cooperation to improve quality factor from customer integration in strategic level were among the front-runners for all three companies but in different order. This was a result from the importance of their higher level factor. This result illustrated that the companies concerned on the processing of order and delivery for customers and strived to improve their quality of product and service by cooperating with customers.

7.4 Contribution of the conceptual framework and strengths of the study

The section evaluates the contributions of the conceptual framework, which also relate to the study's key strengths. It discusses the framework's potential contribution for other business sectors in Thailand, in other developing countries, as well as in developed countries. Initially, some key contributions of the conceptual framework are discussed.

First, the conceptual framework provided an integrated conceptual contribution through its use of decision making levels and supply chain macro processes approaches on supply chain performance measurement. These perspectives are used in supply chain management research in general, but they have not been applied together before to supply chain performance measurement or even in part to supply chain performance framework. Researchers have also often focused on single area of performance measurement, while there has been relative neglect of research on a combined approach for measuring the whole performance of supply chain management. In response to these research gaps, the framework developed for this study used decision making levels and supply chain macro processes as its approach to study supply chain performance measurement. This approach helped to understand the holistic perspective on supply chain performance. The framework provided a balanced horizontal (cross-process) and vertical (hierarchical decision) view on supply chain performance. Importantly, there is

very little existing research in the supply chain performance measurement field using this combined approach of decision making levels and supply chain macro processes.

Second, the conceptual framework provided new insights about supply chain performance and supply chain performance measurement in a developing country, specifically, Thailand. Most research on supply chain performance measurement concerns developed countries (Gunasekaran *et al*., 2004; Huang *et al.*, 2005; Aramyan *et al.*, 2007; Jammernegg and Reiner, 2007; Chia *et al.*, 2009; Rodriguez *et al.*, 2009; Bigliardi and Bottani, 2010), with relatively little research on this topic for developing countries. This study looked at supply chain performance measurement factors and framework in one developing country context which is somewhat different in terms of the stage of supply chain management development, stage of capitalism and the chronology or sequence of change are probably different too compared with the developed world. The study also identified new directions for research on supply chain management for developing country. Not only did the study contribute new insights on this topic for developing country, it also added to research on performance measurement for supply chain management as an integrated supply chain performance measurement framework, which are also areas where there is scant previous research.

Finally, the researcher intended that the framework would be a broad framework that potentially could be applied to other contexts. Thus, this study uses very broad concepts from the decision making levels and from the supply chain macro processes approaches, concepts which were mainly developed and used in the developed world. More rigid and context-specific theories and concepts were avoided in this study. Thus, the framework taken in the present study is broad, loose, as well as quite flexible, so that it can be applied to other business sectors in Thailand, and also to other developing countries where there are different cultures, society, and economy. Furthermore, it is felt that the framework used in this study probably is sufficiently broad and adaptive also to be valuable for the study of supply chain performance measurement in the developed world.

On the other hand, for practical contribution, this research provided a more holistic approach to the measurement of supply chain performance by combining both supply chain macro process and decision making levels for improving performance of supply

chain for manufacturers in Thailand. The objective of a collaborative supply chain is to gain a competitive advantage by improving overall performance through measuring a holistic perspective of the supply chain. Therefore, the proposed framework can provide a balanced horizontal (cross-process) and vertical (hierarchical decision) view and measure the performance of the entire supply chain for manufacturing companies. The research also effects organisations by preparing decision makers to make strategic, tactical and operational levels decisions with respect to supply chain macro processes. Thai manufacturing companies can apply the conceptual framework to identify performance measurement factors against each supply chain macro processes; enables companies to make enhanced supply chain management decisions at strategic, tactical and operational levels and measures the performance of case study organizations against each performance measurement factor.

The above contributions of the framework were considered as key strengths of the study. The study also has other strengths in respect to its research method. While many research on supply chain performance measurement employs quantitative research methods (Chan and Qi, 2003; Gunasekaran *et al*., 2004; Yeh *et al.*, 2007; Hwang *et al.*, 2008; Robb *et al.*, 2008; Zhu *et al.*, 2008; Chia *et al.*, 2009; Flynn *et al.*, 2010; Lin *et al.*, 2010), this study employed a multi-method qualitative research approach. This was because the present study was concerned with the views of manufacturers about supply chain activities and performance. These were all issues where there was a need to understand in some depth personal views about complex issues. Therefore, a multi-methods approach, including interviews, non-participant observation, and secondary data analysis, was used to collect the data for this study. Moreover, this study used both qualitative and quantitative data analysis. The data that were collected from case study companies had both qualitative (words) and quantitative (numbers). Qualitative data were used for studying supply chain characteristics of each case study company, and identifying their supply chain performance. These data were analyzed by thematic analytical approach. By contrast, quantitative data were used for measuring performance of case study companies, and analyzed by the analytic hierarchy process (AHP). Importantly, this research method has rarely been used in other studies.

7.5 Limitations of the research

The research followed a well-prepared research process, with care taken at every stage. However, inevitably there were some limitations affecting the study. First, the fact that the researcher lived in the UK when the empirical work was conducted meant that only a fairly short period of time could be devoted to fieldwork. However, care and effort were put into each interview in order to ensure that there was the best use of the time available for each interview and that all relevant topics were covered. Despite the time constraints, the visit and interview time at each respondent was at the average of two and a half hours and everything was scheduled according to a carefully planned timeframe. Furthermore, the researcher had a chance to visit the case study companies for next round of interviews. This provided additional data and observation opportunities, and it helped to compensate for the limited time during the first fieldwork visit.

Second, the researcher's lack of prior experience in conducting qualitative research work was also an obstacle to overcome. Much work had to be devoted to developing the methodology and methods in order to compensate for previously deficient knowledge on this issue. However, the difficulty prompted extra effort, which was a positive thing. In addition, the researcher's characteristics of being a good listener and of having an enquiring mind helped his to achieve the task. Also, the pilot interviews assisted the researcher in developing his skills.

A final limitation involved difficulties in asking respondents about the effectiveness of their own companies' performance in relation to supply chain management. In Thai society there is much emphasis on avoiding conflict and maintaining face, and this is seen in the avoidance of overt criticism, conflicts, disagreement and controversy (Boyle, 1998). Some respondents were thus quite reserved about offering critiques in relation to these issues. This meant that care had to be taken when asking about these topics and this entailed taking a long time to get to discuss a certain issue. However, the researcher tried to build a good rapport with the participants and this seemed to encourage openness and to build a level of trust between the respondents and the researcher. Also, the researcher assured the respondents that all information gained

from them would be used only for research study and would remain confidential. These assurances helped to encourage them to talk more openly.

7.6 Recommendations for future research

Future research on supply chain performance measurement factors and framework could benefit from the following ideas, which are based on practical experience in the field. First, future research might focus on a comparative study of this topic by applying the conceptual framework to different business sectors in Thailand, to other developing countries, or to developed countries. Thus, the differences which may exist from region to region and country to country could be identified, and there could be an assessment of the value of the framework in different cultures and contexts. Another recommendation is that future research might include more respondents who are the suppliers and customers of the case study company in order to gather more information on their interest in, or lack of interest in, diversifying into participating company's supply chain performance. Furthermore, future research might include respondents who are the next tier or initial suppliers (supplier of supplier) and next tier or ultimate customers (client of customer) of the case study company. During the fieldwork, the respondents from purchasing department declined to appoint their suppliers to attend the interviews because they did not want their suppliers to get involve with their information. The respondents from marketing department also rejected to invite their customers to join the interviews too. If the interviews can cover to the suppliers and customers of the case study company, it might be interesting to explore the barriers they may have confronted in their supply chain system.

7.7 Final remarks

This chapter has provided a final critical analysis of the research. The main objectives and the key findings were revisited as well as the main contributions of the conceptual framework, and the strengths of the study were discussed. Limitations and suggestions for future research were also identified. The research on supply chain performance measurement factors and framework provided new insights on approaches and concepts

that are undeveloped in the supply chain performance measurement literature and in the Thai literature. The decision making levels and supply chain macro processes approach were critically reviewed after they had been combined to provide the basis for the empirical work. The results offered new perspectives and insights for the study of supply chain performance measurement in relation to performance measurement factors and framework in Thailand and elsewhere.

References

Abdul-Hamid, Y.T. (1999). The analytical hierarchy process approach to the choice of manufacturing plant layout. *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture,* 213 (B4), p.397-406.

Akintoye, A., McIntosh, G. and Fitzgerald, E. (2000). A survey of supply chain collaboration and management in the UK construction industry. *European Journal of Purchasing and Supply Management, Supply Chain Management in Construction – special issue,* 6, p.159-168.

Ali, F., Smith, G. and Saker, J. (1997). Developing buyer-supplier relationships in the automobile industry, a study of Jaguar and Nippon Denson. *European Journal of Purchasing and Supply Management,* 3 (1), p.33-42.

Angerhofer, B.J. and Angelides, M.C. (2006). A model and a performance measurement system for collaborative supply chains. *Decision Support System,* 42 (1), p.283-301.

Aramyan, L.H., Lansink, A.O., Vorst, J. and Kooten, O. (2007). Performance measurement in agri-food supply chains: a case study. *Supply Chain Management: An International Journal,* 12 (4), p.304-315.

Asian Development Bank (ADB) (1995). *Local and Technical Assistance Grant to the Bank for Agriculture and Agricultural Cooperatives for the Small Farmer Credit Project in the Kingdom of Thailand.* Bangkok: ADB.

Babbie, E. (1998). *The Practice of Social Research.* CA: Wadsworth.

Bank of Thailand (2002). *The Economics Report.* Bangkok: Bank of Thailand. January-March, p.65-80.

Bank of Thailand (2004). *The Economics Report.* Bangkok: Bank of Thailand. July-September, p.17-80.

Bank of Thailand (2011). *Thailand's Macro Economic Indicators [online]*. Available from: http://www2.bot.or.th/statistics/BOTWEBSTAT.aspx?reportID=409&language=ENG [Accessed 22 Mar 2011].

Banks, R.L. and Wheelright, S.C. (1979). Operations versus strategy – trading tomorrow for today. *Harvard Business Review,* 57, p.112-120.

Basnet, C., Corner, J., Wisner, J. and Tan, K.C. (2003). Benchmarking supply chain management practice in New Zealand. *Supply Chain Management: An International Journal,* 8 (1), p.57-64.

Beamon, B.M. (1998). Supply chain design and analysis: models and methods. *International Journal of Production Economics,* 55 (3), p. 281-294.

Beamon, B.M. (1999). Measuring supply chain performance. *International Journal of Operations & Production Management,* 19 93-40, p.275-292.

Beamon, B.M. and Chen, V.C.P. (2001). Performance analysis of conjoined supply chains. *International Journal of Production Research,* 39 914), p.3195-3218.

Belton, V. and Gear, T. (1984). On the short-coming of Saaty's method of analytic hierarchies. *Omega,* 11 (3), p.228-230.

Benjamin R. and Wigand, R. (1995). Electronic markets and virtual value chains on the information superhighway. *Sloan Management Review,* 36 (2), p. 62-72.

Bergquist, K. and Abesysekera, J. (1996). QFD – a means for developing usable products. *International Journal Industrial Ergonomics,* 18, p.269-275.

Berrah, L. and Cliville, V. (2007). Towards an aggregation performance measurement system model in a supply chain context. *Computers in Industry,* 58, p.709-719.

Bhagwat, R. and Sharma, M.K. (2007a). Performance measurement of supply chain management: A balanced scorecard approach. *Computers & Industrial Engineering,* 53, p.43-62.

Bhagwat, R. and Sharma, M.K. (2007b). Performance measurement of supply chain management using the analytical hierarchy process. *Productions Planning & Control,* 18 (8), p.666-680.

Bhutta, K. (2003). Supplier selection problem: methodology literature review. *Journal of International Technology and Information Management,* 12 (2), p.53-71.

Bhutta, K. and Huq, F. (2002). Supplier selection problem: a comparison of the total cost of ownership and analytic hierarchy process approaches. *Supply Chain Management: An International Journal,* 7 (3), p.126-135.

Bigliardi, B. and Bottani, E. (2010). Performance measurement in the food supply chain: a balanced scorecard approach. *Facilities,* 28 (5/6), p.249-260.

Boyle, J (1998). Cultural influences on implementing environmental impact assessment: insight from Thailand, Indonesia and Malaysia. *Environmental Impact Assessment Review,* 18 (2), p.95-116.

Braun, V. and Clarke, V. (2006). Using Thematic Analysis in Psychology. *Qualitative Research in Psychology*, 3, p.77-101.

Bremser, W.G. and Barsky, N.P. (2004). Utilizing the balanced scorecard for R&D performance measurement. *R&D Management,* 34 (3), p.229-238.

Browne, J., Devlin, J., Rolstadas, A. and Andersen, B. (1998). Performance Measurement: The ENAPS Approach. *International Journal of Business Transform,* 1 (2), p.73-84.

Bryman, A. (2004). *Social Research Methods.* 2nd ed. Oxford: Oxford press.

Burr, V. (2003). *Social Constructionism.* 2nd ed. London: Routledge.

Burt, D.N. and Soukup, W.R. (1985). Purchasing's role in new product development. *Harvard Business Review,* 64 (5), p.90-97.

Busi, M. and Bititci, U. (2006). Collaborative performance management: present gaps and future research. *International Journal of Productivity and Performance Management,* 55 (1), p.7-25.

Cai, J., Liu, X., Xiao, Z. and Liu, J. (2009). Improving supply chain performance management: A systematic approach to analyzing iterative KPI accomplishment. *Decision Support Systems,* 46, p.512-521.

Calantone, R.J. (1999). Using analytical hierarchy process in new product screening. *International Journal of Production & Innovation Management,* 16, p.65-76.

Carter, J.R. and Ferrin, B.G. (1995). The impact of transportation costs on supply chain management. *Journal of Business Logistics,* 16 (1), p.189-212.

Chae, B. (2009). Developing key performance indicators for supply chain: an industry perspective. *Supply Chain Management: An International Journal,* 14 (6), p.422-428.

Chan, F.T.S. (2003). Performance measurement in a supply chain. *International Journal of Advanced Manufacturing Technology,* 21, p.534-548.

Chan, F.T.S. and Qi, H.J. (2003). An innovative performance measurement method for supply chain management. *Supply Chain Management: An International Journal,* 8 (3-4), p.209-223.

Chan, F.T.S., Qi, H.J., Chan, H.K., Lau, H.C.W. and Ip, R.W.L. (2003). A conceptual model of performance measurement for supply chains. *Management Decision,* 41 (7), 635-642.

Chia, A., Goh, M. and Hum, S.H. (2009). Performance measurement in supply chain entities: balanced scorecard perspective. *Benchmarking: An International Journal,* 16 (5), p.605-620.

Chopra, S. and Meindl, P. (2004). *Supply Chain Management: Strategy, Planning, and Operation.* 2rd ed. Upper Saddle River, NJ: Prentice Hall.

Chopra, S. and Meindl, P. (2007). *Supply Chain Management: Strategy, Planning, and Operation.* 3rd ed. Upper Saddle River, NJ: Pearson Education.

Chopra, S. and Meindl, P. (2010). *Supply Chain Management: Strategy, Planning, and Operation.* 4rd ed. Boston, MA: Pearson Education.

Christians, C.G. (2005). Ethical theory in communications research. *Journalism Studies,* 6 (1), p.3-14.

Christopher, M. and Juttner, U. (2000). Developing strategic partnerships in the supply chain: a practitioner perspective. *European Journal of Purchasing & Supply Chain Management*, 2 (6), p.117-127.

Christopher, M.L. (1992). *Logistics and Supply Chain Management.* London: Pitman Publishing.

Churchill, G.A. (1997). A paradigm for developing better measures of marketing constructs. *Journal of marketing research,* 16.

Cook, T.D. and Reichardt, C.S. (1979). *Qualitative and Quantitative Methods in Evaluation Research*. Thousand Oaks: Sage Publication.

Creswell, J.W. (1994). *Research Design: Qualitative and Quantitative Approaches.* Thousand Oaks: Sage Publication.

Creswell, J.W. (2003). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches.* 2nd ed. Thousand Oaks: Sage Publication.

Cross, K.F. and Lynch, R.L. (1988-1989). The SMART way to define and sustain success. *National Production Review,* 9 (1), p.23-33.

Crotty, M. (1998). *The Foundations of Social Research: Meaning and Perspective in the Research Process.* London: Sage Publication.

Croxton, K.L., García-Dastugue, S.J., Lambert, D.M. and Rogers, D.S. (2001). The Supply Chain Management Processes. *International Journal of Logistics Management,* 12 (2), p.13-36.

Dangayach, G.S. and Deshmukh, S.G. (2003). Evidence of manufacturing strategies in Indian industry: a survey. *International Journal of Production Economics,* 83(3), p. 279-298.

Decrop, A. (1999). Triangulation in Qualitative Tourism Research. *Tourism Management,* 20 (2), p.157-161.

Decrop, A. (2004). Trustworthiness in Qualitative Research. IN: Phillimore, J. and Goodson, L. (eds.) *Ontologies, Epistemologies and Methodologies.* London: Routledge, p. 156-167.

Denscombe, M. (1998). *The Good Research Guide: For Small-scale Social Research project*. Buckingham: Open University Press.

Denzin, N.K. and Lincoln, Y.S. (2005). Introduction: The Discipline and Practice of Qualitative Research. IN: Denzin, N.K. and Lincoln, Y.S. (eds.) *Handbook of qualitative research.* 3rd ed. Thousand Oaks: Sage Publication, p.1-32.

Dey, P.K. (2002). Benchmarking project management practices of Caribbean organizations using analytic hierarchy process. *Benchmarking International Journal*, 9 (4), p.326-356.

Dey, P.K. (2004). Analytic hierarchy process helps evaluate projects in Indian oil pipeline industry. *International Journal of Operations & Production Management*, 24 (6), p.588-604.

Dey, P.K. (2006). Integrated approach to project selection using multiple attribute decision-making technique. *International Journal of Production Economics,* 103 (1), p.90-103.

Dey, P.K. and Ramcharan, E.K. (2008). Analytic hierarchy process helps select site for limestone quarry expansion in Barbados. *Journal of Environmental Management,* 88 (4), p.1384-1395.

Dey, P.K., Hariharan, S. and Clegg, B. (2006). Measuring the Operational Performance of Intensive Care Units using the Analytical Hierarchy Process Approach. *International Journal of Operations and Production Management,* 26 (8), p.849-865.

Dey, P.K., Tabucanon, M.T. and Ogunlana, S.O. (1994). Planning for project control through risk analysis: A case of petroleum pipeline laying project. *International Journal of Project Management,* 12 (1), p.23-33.

Dixon, J.R., Nanni, A.J. and Vollman, T.E. (1990). *The New Performance Challenge: Measuring Operations for World Calls Competition.* Homewood, IL: Dow-Jones Irwin.

Dubois, A. and Gadde, L. (2000). Supply strategy and network effects – purchasing behaviour in the construction industry. *European Journal of Purchasing & Supply Chain Management, Supply Chain Management in Construction – special issue,* 6, p.207-215.

Dweiri, F. and Al-oqla, F.M. (2006). Material selection using analytical hierarchy process. *International Journal of Computer Application in Technology*, 26 (4), p.182-189.

Dweiri, F. and Meirer, .F.A. (1996). Application of Fuzzy decision-making in facility lay out planning. *International Journal of Production Research*, 34 (11), p.3201-3225.

Dyer, J.S. (1990). Remarks on the analytic hierarchy process. *Management Science,* 36 (3), p.249-258.

Edum-Fotwe, F.T., Thorpe, A. and McCaffer, R. (2001). Information procurement practices of key actors in construction supply chains. *European Journal of Purchasing & Supply Management,* 7 (3), p.155-164.

Eisner, E.W. (1991). *The enlightened eye: Qualitative inquiry and the enhancement of educational practice.* New York: Macmillan Publishing.

Ellram, L.M. (1991) A managerial guide for the development and implementation of purchasing partnerships. *International Journal of Purchasing and Materials Management*, 27 (3), p. 2-8.

Farley, G.A. (1997). Discovering supply chain management: a roundtable discussion. *APICS – The Performance Advantage*, 7 (1), p.38-39.

Federation of Thai Industries (2003). *Report on the Thai Automotive Industry: Working Group on Automotive Industry.* Bangkok: Federation of Thai Industries.

Fernie, J. (1995). International comparisons of supply chain management in grocery retailing. *Service Industries Journal*, 815 (4), p.134-147.

Fisher, M.L. (1997). What is the right supply chain for your product? *Harvard Business Review*, 75 (2), p.105-116.

Fitzgerald, L., Johnston, R., Brignall, T.J., Silvestro, R. and Voss, C. (1991). *Performance Measurement in Service Businesses.* London: Chartered Institute of Management Accountants.

Flynn, B.B., Huo, B. and Zhao, X. (2010). The impact of supply chain integration on performance: A contingency and configuration approach. *Journal of Operations Management*, 28 (1), p.58-71.

Folan, P. and Browne, J. (2005). A review of performance measurement: Towards performance management. *Computers in Industry,* 56, p.663-680.

Fontana, A. and Frey, J.H. (2005). The Interview: from Neutral Stance to Political Involvement. 3rd ed. IN: Denzin, N.K. and Lincoln, Y.S. (eds.) *The SAGE Handbook of Qualitative Research.* Thousand Oaks: Sage Publication, p.695-727.

Franzosi, R. (2004). *From World to numbers: Narrative Data, and Social Science*. Cambridge: Cambridge University Press.

Fry, T.D. and Cox, J.F. (1989). Manufacturing performance; local versus global measures. *Production & Inventory Management Journal*, 30, p.52-56.

Galt, J.D.A. and Dale, B.G. (1991). Supplier development: a British case study. *International Journal of Purchasing & Materials Management,* 27 (1), p.16-22.

Gammelgaard, B. and Vesth, H. (2004). The SCOR model – a critical review. *Proceedings of Operations Management as a Change Agent Conferences. INSEAD,* p.233-241.

Goh, M. and Pinaikul, P. (1998). Logistics management practices and development in Thailand. *Logistics Information Management,* 11 (6), p.359-369.

Guba, E.G. (1990).*The Paradigm Dialog.* Beverly Hills, CA: Sage Publication.

Guba, E.G. and Lincoln, Y.S. (1994). Competing Paradigm in Qualitative Research. IN: Denzin, N.K. and Lincoln, Y.S. (eds.) *Handbook of Qualitative Research.* 2nd ed. Thousand Oaks: Sage Publication, p.105-117.

Gunasekaran, A. and Kobu, B. (2007). Performance measures and metrics in logistics and supply chain management: a review of recent literature (1995-2004) for research and applications. *International Journal of Production Research*, 45 (12), p.2819-2840.

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

Gunasekaran, A., Patel, C. and Tirtiroglu, E. (2001). Performance measures and metrics in a supply chain environment. *International Journal of Operations & Production Management*, 21 (1-2), p.71-87.

Handfield, R.B. (1994). US global sourcing: patterns of development. *International Journal of Operations & Production Management*, 14 (6), p.40-51.

Harker, P.T. and Vargas, L.G. (1990). Reply to 'Remarks on the analytic hierarchy process' by J.S. Dyer. *Management Science,* 36 (3), p.269-273.

Harland, C.M., Lamming, R.C. and Cousins, P.D. (1999). Developing the concept of supply strategy. *International Journal of Operations & Production Management,* 19 (7), p.650-673.

Hartley, J. (1994). Case Studies in Organizational Research. IN: Cassell, C. and Symon, G. (eds). *Qualitative Methods in Organizational Research: A Practical Guide.* London: Sage Publication, p.208-229.

Harwick, T. (1997). Optimal decision-making for the supply chain. *APICS – The Performance Advantage,* 7 (1), p.42-44.

Hayes, R.H. and Garvin, D.A. (1982). Managing as if tomorrow mattered. *Harvard Business Review,* 60, p.70-79.

Healy, M. and Perry, C. (2000). Comprehensive criteria to judge validity and reliability of qualitative research within the realism paradigm. *Qualitative Market Research,* 3(3), p.118-126.

Heron, J. and Reason, P. (1997). A Participatory Inquiry Paradigm. *Qualitative Inquiry,* 3 (3), p.274-294.

Hervani, A.A., Helms, M.M. and Sarkis, J. (2005). Performance measurement for green supply chain management. *Benchmarking: An International Journal,* 12 (4), p.330-353.

Ho, W. (2008). Integrated analytic hierarchy process and its applications – a literature review. *European Journal of Operational Research,* 186, p.211-228.

Ho, W., Dey, P.K. and Lockstrom, M. (2011). Strategic sourcing: a combined QFD and AHP approach in manufacturing. *Supply Chain Management: An International Journal*, 16 (6), p.446-461.

Ho, W., Xu, X. and Dey, P.K. (2010). Multi-criteria decision making approaches for supplier evaluation and selection: a literature review. *European Journal of Operational Research,* 202 (1), p.16-24.

Holmberg, S. (2000). A system perspective in supply chain measurement. *International Journal of Physical Distribution & Logistics Management,* 30 (10), p.847-868.

Holti, R. (1997). Adapting supply chain for construction. *Workshop Report CPN727.*

Huan, S.H., Sheoran, S.K. and Wang, G. (2004). A review and analysis of supply chain operations reference (SCOR) model. *Supply Chain Management: An International Journal*, 9 (1), p.23-29.

Huang, S.H., Sheoran, S.K. and Keskar, H. (2005). Computer-assisted supply chain configuration based on supply chain operations reference (SCOR) model. *Computers & Industrial Engineering*, 48, p.377-394.

Hudson, M., Lean, J. and Smart, P.A. (2001). Improving control through effective performance measurement in SMEs. *Production Planning & Control,* 12 (8), p.804-813.

Hwang, Y.D., Lin, Y.C. and Lyu Jr., J (2008). The performance evaluation of SCOR sourcing process – The case study of Taiwan's TFT-LCD industry. *International Journal of Production Economics*, 115, p.411-423.

Israel, M. and Hay, I. (2006). *Research Ethics for Social Scientists: Between Ethical Conduct and Regulatory Compliance.* London: Sage Publication.

Jagdev, H., Brennan, A. and Browne, J. (2004). *Strategic Decision Making in Modern Manufacturing.* Massachusetts, MA: Kluwer Academic Publishers.

Jammernegg, W. and Reiner, G. (2007). Performance improvement of supply chain processes by coordinated inventory and capacity management. *International Journal of Production Economics,* 108, p.83-190.

Jorgensen, D.L. (1989). *Participant Observation: A Methodology for Human Studies.* London: Sage Publication.

Kaosa-ard, M. (1998). Economic Development and Institutional Failures in Thailand. *Thailand Development Research Institute (TDRI) Quarterly Review,* 13 (1), p.3-11.

Kaplan, R.S. and Norton, D.P. (1992). The balanced scorecard: Measures that drive performance. *Harvard Business Review,* 70 (1), p.71-99.

Kaplan, R.S. and Norton, D.P. (1996). Using the balanced scorecard as a strategic management system. *Harvard Business Review,* 74 (1), p.75-85.

Kaplan, R.S. and Norton, D.P. (1997). *Translating Strategy Into Action, The Balanced Score Card.* Boston, MA: HBS Press.

Keegan, D.P., Eiler, R.G. and Jones, C.R. (1989). Are your performance measures obsolete? *Management Account Research,* p.45-50.

Kennerley, M. and Neely, A. (2002). A framework of the factors affecting the evolution of performance measurement systems. *International Journal of Operations & Production Management,* 22 (11), p.1222-1245.

Kimmel, A.J. (1988). *Ethics and values in Applied Social Research.* London: Sage Publication.

Kincheloe, J. and McLaren, P. (2005). Rethinking Critical Theroy and Qualitative Research. IN: Denzin, N.K. and Lincoln, Y.S. (eds.) *Handbook of qualitative research* 3rd ed. Thousand Oaks: Sage Publication, p.303-342.

King, N. (1994). The Qualitative Research Interview. IN: Cassell, C. and Symon, G. (eds.) *Qualitative Methods in Organizational Research: A Practical Guide.* London: Sage Publication, p.14-36.

Kosela, L. (1999). Management of production construction: a theoretical view. *Proceedings of the 7th Annual Conference of the International Group for Lean Construction IGLC-7,* Berkeley, p.241-252.

Krause, D.R. (1997). Supplier development: current practices and outcomes. *International Journal of Purchasing & Materials Management,* 33 (2), p.12-19.

Kumar, A. And Sharman, G. (1992). We love your product, but where is it? *Sloan Management Review,* 33 (2), p.93-99.

Kvale, S. (1996). *Interviews: An Introduction to Qualitative Research Interviewing.* London: Sage Publication.

Kwan, A.T.W. (1999). The use of information technology to enhance supply chain management in the electronics and chemical industries. *Production & Inventory Management Journal,* 40 (3), p.7-15.

La Londe, B.J. and Masters, J.M. (1994). Emerging logistics strategies: blue prints for the next century. *International Journal of Physical Distribution and Logistics Management,* 24 (7), p.35-47.

Lai, K.H., Ngai, E.W.T. and Cheng, T.C.E. (2002). Measures for evaluating supply chain performance in transport logistics. *Transportation Research, Part E: Logistics and Transportation Review,* 33 (6), p.439-456.

Lambert, D.M. and Pohlen, T.L. (2001). Supply chain metrics. *International Journal of Logistics Management,* 12, p.1-19.

Lambert, D.M., Garcia-Dastugue, S.J. and Croxton, K.L. (2005). An evaluation of process-oriented supply chain management frameworks. *Journal of Business Logistics,* 26 (1), p.25-51.

Lambert, D.M., Stock, J.R. and Ellram, L.M. (1998). *Fundamentals of Logistics Management.* Boston, MA: Irwin/McGraw-Hill.

Laosirihongthong, T. and Dangayach, G.S. (2005). New manufacturing technology implementation: a study of the Thai automotive industry. *Production Planning & Control,* 16 (3), p.263-272.

Lapide, L. (2000). What about measuring supply chain performance? *ASCET,* 2 (15), p.287-297.

Lee, H.L. and Billington, C. (1992). Managing supply chain inventory: pitfalls and opportunities. *Sloan Management Review*, 33 (3), p.65-73.

Legard, R., Keegan, J. and Ward, K. (2003). In-Depth Interviews. IN: Ritchie, J. and Lewis, J. (eds.) *Qualitative Research Practice: A Guide for Social Science Students and Researchers.* London: Sage Publication, p.138-169.

Lin, Y., Wang, Y. and Yu, C. (2010). Investigating the drivers of the innovation in channel integration and supply chain performance: A strategy orientated perspective. *International Journal of Production Economics,* 127 (2), p.320-332.

Lincoln, Y.S. and Guba, E.G. (1985). *Naturalistic inquiry*. Beverly Hills: Sage Publication.

Lincoln, Y.S. and Guba, E.G. (2000). Paradigmatic controversies, contradiction, and emerging confluences. IN: Denzin, N.K. and Lincoln, Y.S. (eds.) *Handbook of qualitative research.* 2nd ed. Thousand Oaks: Sage Publication, p.163-188.

Lynch, R.L. and Cross, K.F. (1991). *Measure Up – The Essential Guide to Measuring Business Performance.* London: Mandarin.

Madu, C.N. (1997). Quality management in developing economies. *International Journal of Quality Science,* 2 (4), p.272-291.

Marshall, C. and Rossman, G. (2006). *Designing Qualitative Research.* 4th ed. London: Sage Publication.

Mason, J. (2002). *Qualitative Researching.* 2nd ed. London: Sage Publication.

Maxwell, J. (1996). *Qualitative Research Design: an Interactive Approach*. London: Sage Publication.

May, T. (2001). *Social Research: Issues, Methods, and Process.* 3rd ed. Buckingham and Philadelphia: Open University Press.

McMullan, A. (1996). Supply chain management practices in Asia Pacific today. *International Journal of Physical Distribution & Logistics Management,* 26 (10), p.79-95.

McQueen, R.A. and Knussen, C. (2002). *Research Methods for Social Science: A Practical Introduction*. Harlow: Prentice Hall.

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

Merriam, S. B. (1998). *Qualitative Research and Case Studies Applications in Education.* San Francisco: Jossey-Bass Publications.

Miles, M.B. and Humberman, A.M. (1994). *Qualitative data Analysis: An Expanded Sourcebook.* Thousand Oaks: Sage Publication.

Morgan, J. and Monczka, R.M. (1995). Alliances for new products. *Purchasing,* 118 (1), p.103-109.

Morgan, J. and Monczka, R.M. (1996). Supplier integration: a new level of supply chain management. *Purchasing,* 120 (1), p.110-113.

Morse, J.M. (1991). Approaches to Qualitative-Quantitative Methodological Triangulation. *Nursing Research,* 40 (1), p.120-123.

Mowery, D.C. (1988). *International Collaborative Ventures in US Manufacturing.* Cambridge, MA: Ballinger.

Neely, A. (1998). *Measuring Business Performance – Why, What and How*. London: Economist Books.

Neely, A., Gregory, M. and Platts, K. (1995). Performance measurement systems design: a literature review and research agenda. *International Journal of Operations & Production Management,* 15 (4), p.80-116.

Neuman, W.L. (1997). *Social Research Methods: Qualitative and Quantitative Approaches.* MA: Allyn and Bacon Needham Heights.

New, S. and Ramsay, J. (1997). A critical appraisal of aspects of the lean approach. *European Journal of Purchasing & Supply Management,* 3 (2), p.93-102.

Novich, N. (1990). Distribution strategy: Are you thinking small enough? *Sloan Management Review,* 32 (1), p.71-77.

Otto, A. and Kotza, H. (2003). Does supply chain management really pay? Six perspectives to measure the performance of managing a supply chain. *European Journal of Operational Research,* 144, p.306-320.

Partovi, F.Y., Burton, J. and Banerjee, A. (1990). Application of analytical hierarchy process in operation management. *International Journal of Operations & Production Management,* 10 (3), p.5-19.

Patton, M.Q. (1990). *Qualitative Evaluation and Research Methods.* Newbury Park, CA: Sage Publication.

Patton, M.Q. (2002). *Qualitative Research and Evaluation Methods.* Thousand Oaks and London: Sage Publication.

Persson, F. and Olhager, J. (2002). Performance simulation of supply chain designs. *International Journal of Production Economics,* 77 (3), p.231-245.

Poapongsaorn, N. and Tangkitvanich, S. (2000). Industrial Restructuring in Thailand: What Went Wrong? *Tokyo Club Foundation for Global Studies, Industrial Restructuring in East Asia Towards the 21st Century Seminars & Conferences 2000,* p.1-26.

Quayle, M. (2003). A study of supply chain management practice in UK industrial SMEs. *Supply Chain Management: An International Journal,* 8 (1), p.79-86.

Ritchie, J., Lewis, J. and Elam, G. (2003a). Designing and Selecting Samples. IN: Ritchie, J. and Lewis, J. (eds.) *Qualitative Research Practice: A Guide for Social Science Students and Researchers.* London: Sage Publication, p.77-108.

Ritchie, J., Spencer, L. and O'Connor, W. (2003b). Carrying Out Qualitative Analysis. IN: Ritchie, J. and Lewis, J. (eds.) *Qualitative Research Practice: A Guide for Social Science Students and Researchers.* London: Sage Publication, p.219-262.

Robb , D.J., Xie, B. and Arthanari, T. (2008). Supply chain and operations practice and performance in Chinese furniture manufacturing. *International Journal of Production Economics,* 112, p.683-699.

Robson, C. (1993). *Real World Research.* Oxford: Blackwell.

Rockart, J. and Bullen, C. (1981). A primer on critical success factors. *Center for Information Systems Research Working Paper No 69*. Cambridge, Massachusetts: Sloan School of Management, MIT.

Rodriguez, R.R., Saiz, J.J.A. and Bas, A.O. (2009). Quantitative relationships between key performance indicators for supporting decision-making processes. *Computers in Industry,* 60, p.104-113.

Ross, D.F. (1998). *Competing Through supply Chain Management.* New York, NY: Chapman & Hall.

Rouse, P. and Putterill, M. (2003). An Integral framework for Performance measurement. *Management Decision,* 41 (8), p.791-805.

Rubin, H. and Rubin, I. (1995). *Qualitative Interviewing: The Art of Hearing Data.* London: Sage Publication.

Ryan, G.W. and Bernard, H.R. (2000). Data Management and Analysis Methods. IN: Denzin, N.K. and Lincoln, Y.S. (eds.) *Handbook of qualitative research.* London: Sage Publication.

Saad, M., Jones, M. and James, P. (2002). A review of the progress towards the adoption of supply chain management (SCM) relationships in construction. *European Journal of Purchasing & Supply Management,* 8, p.173-183.

Saaty, T.L. (1980). *The Analytical Hierarchy Process.* New York: McGraw-Hill.

Saaty, T.L. (1986). Axiomatic foundation of the analytic hierarchy process. *Management Science,* 32 (7).

Saaty, T.L. (1990). An exposition of the AHP in reply to the paper 'Remarks on the analytic hierarchy process'. *Management Science,* 36 (3), p.259-268.

Sahay, B.S. and Mohan R. (2003). Supply chain management practices in Indian industry. *International Journal of Physical Distribution & Logistics Management,* 33 (7), p.582-606.

Sarantakos, S. (2001). *Social Research.* 2nd ed. Basingstoke: Palgrave.

Scott, C. and Westbrook, R. (1991). New strategic tools for supply chain management. *International Journal of Physical Distribution & Logistics Management,* 21 (1), p.23-33.

Seale, C. (1999). Quality in qualitative research. *Qualitative Inquiry,* 5 (4), p.465-478.

Shepherd, C. and Gunter, H. (2006). Measuring supply chain performance: current research and future directions. *International journal of Productivity and Performance Management,* 55 (3/4), p.242-258.

Silverman, D. (1993). *Interpreting Qualitative Data. Methods for Analysing Talk, Text and Interaction.* London: Sage Publication.

Silverman, D. (2000). *Doing Qualitative Research: A Practical Hand Book.* London: Sage Publication.

Silverman, D. (2005). *Doing Qualitative Research: A Practical Hand Book.* ed. London: Sage Publication.

Simatupang, T.M. and Sridharan, R. (2005). The collaboration index: a measure for supply chain collaboration. *International Journal of Physical Distribution and Logistics Management,* 35 (1), p.44-62.

Sink, D.S. and Tuttle, T.C. (1989). *Planning and measurement in your organization of the future.* Norcross, GA: Industrial Engineering and Management Press.

Slack, N., Chambers, S. and Johnston, R. (2001). *Operations Management.* 3rd ed. Eaglewood cliff, NJ: Prentice Hall.

Slack, N., Chambers, S., Harland, C., Harrison, A. and Johnston, R. (1995). *Operations Management.* London: Pitman Publishing.

Spekman, R.E., Kamauff, J.W. Jr. and Myhr, N. (1998). An empirical investigation into supply chain management: a perspective on partnerships. *International Journal of Physical Distribution & Logistics Management,* 28 (8), p.630-650.

Stake, R.E. (1995). *The Art of Case Study Research.* London: Sage Publication.

Stake, R.E. (2008). Qualitative Case Studies. IN: Denzin, N.K. and Lincoln, Y.S. (eds.) *Strategies of Qualitative Inquiry.* 3rd ed. London: Sage Publications, pp.119-150.

Stenbacka, C. (2001). Qualitative research requires quality concepts of its own. *Management Decision,* 39 (7), p.551-555.

Stewart, G. (1995). Supply chain performance benchmarking study reveals keys to supply chain excellence. *Logistics Information Management,* 8 (2), p.38-44.

Tan, K.C., Handfield, R.B. and Krause, D.R. (1998a). Enhancing firm's performance through quality and supply base management: an empirical study. *International Journal of Production Research,* 36 (10), p.13-37.

Tan, K.C., Kannan, V.R. and Handfield, R.B. (1998b). Supply chain management: supplier performance and firm performance. *International Journal of Purchasing & Materials Management,* 34 (3), p.2-9.

Tan, K.C., Lyman, S.B. and Wisner, J.D. (2002). Supply chain management: a strategic perspective. *International Journal of Operations & Production Management,* 22 (6), p.614-631.

Thai Logistics and Production Society (2010). *National Logistics Master Plan [online]*. Available from: http://www.tlaps.or.th/doc/2005-ScheduleforGTTConference-16.pdf [Accessed 6 Jul 2010].

Thailand Textile Institute (2010) *THTI Information [online]*. Available from: http://www.thaitextile.org/eng/General/aboutus.asp [Accessed 10 Nov 2010].

Thakkar, J., Kanda, A. and Deshmukh, S.G. (2009). Supply chain performance measurement framework for small and medium scale enterprises. *Benchmarking: An International Journal,* 16 (5), p.702-723.

The Council of Supply chain Management Professionals (2009). *CSCMP's Definition of Supply Chain Management [online]*. Available from: http://cscmp.org/aboutcscmp/definitions.asp [Accessed 22 Apr 2009].

The Department of Export Promotion (2008). *Thailand: Golden Trade Opportunities,* Bangkok: Ministry of Commerce.

The European Foundation for Quality Management (2009). *The EFQM Excellence Model [online]*. Available from: http://www.efqm.org/en/tabid/132/default.aspx [Accessed 7 Jun 2009].

The Federation of Thai Industries (2008). *Industrail Groups [online]*. Available from: http://www.fti.or.th/2008/eng/ftiindustryclub.aspx [Accessed 7 Dec 2008].

The Office of the National Economic and Social Development Board (2008a). *Gross Domestic Product [online]*. Available from: http://www.nesdb.go.th/econSocial/macro/NAD/1_qgdp/data4_05/12%20Table-press%20-%20Eng.pdf [Accessed 4 Jul 2008].

The Supply Chain Council (2009a). *About Supply Chain Council [online]*. Available from: http://supply-chain.org/about [Accessed 12 May 2009].

The Supply Chain Council (2009b). *What is SCOR? [online]*. Available from: http://supply-chain.org/scor [Accessed 15 May 2009].

The World Bank (2008). *Thailand Country Brief [online]*. Available from: http://www.worldbank.or.th [Accessed 18 Jul 2008].

Theeranuphattana, A. and Tang, J.C.S. (2008). A conceptual model of performance measurement for supply chains Alternative considerations. *Journal of Manufacturing Technology Management,* 19 (1), p.125-148.

Thompson, P. (2000). *The Voice of the Past: Oral History.* 2nd ed. Oxford: Oxford University Press.

Turner, T.J., Bititci, U.S. and Nudurupati, S.S. (2005). Implementation and impact of performance measures in two SMEs in Central Scotland. *Production Planning & Control,* 16 (2), p.135-151.

Upton, D.M. (1994). The management of manufacturing flexibility. *California Management Review,* 36 (2), p.93-103.

van Hoek, R.I. (2001). The contribution of performance measurement to the expansion of third party logistics alliances in the supply chain. *International Journal of Operations & Production Management*, 21 (1/2), p.15-29.

van Hoek, R.I., Harrison, A. and Christopher, M. (2001). Measuring agile capabilities in the supply chain. *International Journal of Operations & Production Management,* 21 (1/2), p.126-147.

Vargas, L.G. (1990). An overview of the analytic hierarchy process and its applications. *Europe Journal Operation Research,* 48 (1), p.2-8.

Veal, A.J. (1997). *Research Methods for Leisure and Tourism: a Practical Guide*. 2nd ed. Essex: Prentice Hall.

Vollmann, T.E., Berry, W.L. and Whybark, D.C. (1997). *Manufacturing Planning and Control Systems.* New York, NY: Irwin/McGraw-Hill.

Von Hipple, E. (1986). Co-operation between rivals: informal know how trading. *Research Policy,* 16 (5), p.21-28.

Vrijhoef, R. and Koskela, L. (2000). The four roles of supply chain management in construction. *European Journal of Purchasing & Supply Management, Supply Chain Management in Construction – special issue,* 6, p.169-178.

Waller, D. (2003). *Operations Management: A Supply Chain Approach.* 2nd ed. London: Thomson Learning.

Watts, C.A. and Hahn, C.K. (1993). Supplier development programs: an empirical analysis. *International Journal of Purchasing & Materials Management,* 29 (2), p.10-17.

Wengraf, T. (2001). *Qualitative Research Interviewing*. London: Sage Publication.

Whipple, J.M. and Frankel, R. (2000). Strategic alliance success factors. *The Journal of Supply Chain Management,* 36 (3), p.21-28.

Wight, O. (1993). *The Oliver Wight ABCD Check List.* 4th ed. New York, NY: John Wiley.

Wong, A. and Fung, P. (1999). Total quality management in the construction industry in Hong Kong: a supply chain management perspective. *Total Quality Management,* 10 (2) p.199-208.

Yeh, D.Y., Cheng, C.H. and Chi, M.L. (2007). A modified two-tuple FLC model for evaluating the performance of SCM: By the Six Sigma DMAIC process. *Applied Soft Computing,* 7, p.1027-1034.

Yin, R.K. (1994). *Case Study Research Design and Methods.* 2nd ed. London: Sage Publication.

Zhu, Q., Sarkis, J. and Lai, K. (2008). Confirmation of a measurement model for green supply chain management practices implementation. *International Journal of Production Economics,* 111, p.261-273.

Ziilal, G. and Arikan, F. (2000). Application of fuzzy decision-making in part-machining grouping. *International Journal of Production Economics,* 63, p.181-193.

Appendix 1: Interview questions for studying the overall supply chain performance and measuring the performance of supply chain on supply chain macro process

Interviewee group: Top management

Interviewee actor: Managing director

Interview data: Company's overall supply chain performance

PART 1: To study overall supply chain performance

Background information

1. Please describe what do you do in your job?
2. How many years have you involved in company?
3. What role of supply chain initiatives has your company involved in?
4. Do you have any responsibilities in supply chain activities?

Company information

5. What is your company profile?
   Please explain briefly and provide support documents.

Supplier relationship

6. How many major suppliers do you have in your operations system?
7. Do you have any supplier related issues and challenges?
   If yes, please explain.
8. Do you measure your supplier performance?
   If yes, what criteria do you consider for supplier performance measurement?
   If no, please give reason.

Internal supply chain

Facility

9. What is your current percentage capacity utilization?
10. What are your facility strategies?
11. Do you have any facility related issues and challenges?

    If yes, please explain.
12. Do you measure your facility performance?

    If yes, what criteria do you consider for facility performance measurement?

    If no, please give reason.

Inventory

13. What are your inventory policies (in general)?
14. Do you have any inventory related issues and challenges?

    If yes, please explain.
15. Do you measure your inventory performance?

    If yes, what criteria do you consider for inventory performance measurement?

    If no, please give reason.

Transportation

16. Do you own your transportation?

    Or is it the third party logistics (both inbound and outbound)?
17. What criteria do you consider while making the above decision?
18. What are your logistics strategies?
19. Do you have any transportation related issues and challenges?

    If yes, please explain.
20. Do you measure your transportation performance?

    If yes, what criteria do you consider for transportation performance measurement?

    If no, please give reason.

Information

21. What technology do you use for managing information across the supply chain?
22. What are the obstacles to coordinate in your supply chain?
23. What criteria do you consider while selecting a specific IT system for managing your supply chain?

24. Do you have any information related issues and challenges?
    If yes, please explain.
25. Do you measure your information system performance?
    If yes, what criteria do you consider for information system performance measurement?
    If no, please give reason.

Customer relationship

Customer

26. Who are your customers? (General customer characteristics)
27. Do you have any customer related issues and challenges?
    If yes, please explain.
28. Do you measure your customer performance?
    If yes, what criteria do you consider for customers performance measurement?
    If no, please give reason.

Competitor

29. Who are your competitors?
30. What are your competitive advantages over your competitors?
31. What are your competitive strategies?

Demand forecasting

32. In what way demand forecasting is carried out in your company?
33. Is there any specific forecasting model for short term and long term forecasting for your products?
34. What criteria do you consider to select a specific model for forecasting?

Supply chain integration

35. Do you have any information or risk sharing, or any integration related issues with your supplier?
    If yes, please explain.
36. Do you have any information sharing or any integration related issues within your company?
    If yes, please explain.
37. Do you have any information or risk sharing, or any integration related issues with your customer?
    If yes, please explain.

Environmental or green supply chain

38. What is your company's environmental policy?
39. What role of environmental initiatives has your company involved in?
40. What are the reasons and main drivers behind these initiatives?
41. What criteria do you consider when making environmental decisions?
42. Do you think your company needs any help in taking environmental decisions?

    If yes, what kind of help do you reckon your company need?
43. What are the environmental concerns with your supplier?
44. What are the environmental concerns for your operations system?
45. What are the environmental concerns with your customer?
46. Do you measure your environmental or green supply chain performance?

    If yes, what criteria do you consider for environmental or green supply chain performance measurement?

    If no, please give reason.

PART 2: To measure the performance of supply chain on supply chain macro process

According to the figure, the supply chain processes are divided into three macro processes.

1. In your opinion, do you agree whether the following supply chain processes are the measures of performance for your company's supply chain management?
   If no, please indicate as: **N/A** – Not applicable
   If yes, please indicate the degree of importance of these supply chain processes in 1 to 9 rating scale as:
   1 – The least important
   3 – Less important
   5 – Moderately important
   7 – More important
   9 – The most important

2. Could you compare the importance between each supply chain process, in 1 to 9 pair-wise comparison scales?
   1 – Equally preferred
   2 – Equally to moderately
   3 – Moderately preferred
   4 – Moderately to strongly
   5 – Strongly preferred
   6 – Strongly to very strongly
   7 – Very strongly preferred
   8 – Very strongly to extremely
   9 – Extremely preferred

Overall supply chain performance

Supply chain macro processes		**Question 1**	**Question 2**
1	Supplier relationship management		
2	Internal supply chain management		
3	Customer relationship management		

Appendix 2: Interview questions for studying supply chain performance on supplier relationship management

Interviewee group: Purchasing department
Interviewee actors: Manager, Deputy manager, Assistant manager, and Officers
Interview data: Company's supply chain performance

PART 1: To study supply chain performance on supplier relationship management

Background information

1. Please describe what do you do in your job?
2. How many years have you involved in current department and in company?
3. What role of supply chain initiatives has your department involved in?
4. Do you have any responsibilities in supply chain activities?

Quality supplier selection (Strategic level)

Supplier performance (Tactical level)

5. As a customer, what do you expect from your supplier?
6. How do you ensure that you are receiving 'quality' material from your supplier?
7. Do you have any established performance measurement procedure in place?
8. In case your supplier can not satisfy your delivery criteria (except very unusual situation), what preventive procedure do you take to avoid reoccurrence?
9. Do you have any arrangement with your supplier to keep stock ready for your routine and urgent requirement in their warehouse?
10. What is the percentage of the total suppliers having similar arrangements?

Selection process (Tactical level)

11. What selection criteria do you follow during choosing a supplier?
12. Do you have any standard procedure in place?
13. Do you have any feedback system to identify the area of improvement?

14. Do you have any standard procedure for effective negotiation?
    Or does it depend on individual skill?
15. Can you give an example when due to lack of proper negotiation and the company cannot take any advantage over supplier?
16. In what way do you tender during a process of procurement?
17. Do you have standard contract for all suppliers?
    Or is it customized contract?
18. Can you give one example of typical contract?

Green supplier (Tactical level)

19. What is your company environmental policy?
20. How do you ensure that your supplier is following the same line of environmental policy?
21. How do you keep track of your supplier being maintain its procedure on environmental issue?
22. How do you ensure that your supplier is following environmental friendly manufacturing process, by following national and international regulation?
23. Is there any third party certification and survey system existed?
24. What arrangement do you have to take back your product for reengineering or for proper disposal?
25. What action do you take to insure all ethical issues taken in for consideration during procurement process?

Supplier integration (Strategic level)

Coordination and resource sharing (Tactical level)

26. How does your company cooperate with supplier to improve operation process?
27. How can you further improve this collaboration process?
28. During any unforeseen situation, does your company help supplier to take any critical decision?
29. Can you place one typical example that you have helped your supplier to take a right decision for a better supply chain process?
30. Does your company inform supplier in advance for an extra requirement of material due to sudden or planned requirements?

31. Is there any coordination and understanding to facilitate urgent requirement between the company and supplier?

Information integration (Tactical level)

32. How do you share your information with supplier?
33. Can you give an example for effective information sharing with your supplier?
34. Do you have any collaborating planning in use?
35. Can you give an example of good collaborating effort made between you and your supplier?
36. Do you make forecasting along with your supplier?

    If yes, please give an example.
37. What is the means of communication between you and your supplier?
38. Do you think your present communication process effective enough?

    Or do you have any plan to further improve it?

    How?

Organizational relationship (Tactical level)

39. What do you do to keep good communication with your supplier?
40. Do you share risk with your supplier?
41. During an unforeseen situation, are you strict enough not to share risk with your supplier or cooperate each other?
42. Do your business objective and that of your supplier have something in common?

    Or are they different?

    What is your objective?
43. How do you achieve your common objective?

Use of information technology (Tactical level)

44. What kind of information system do you use during procurement process?
45. Is there any state of art e-Business (electronic business) in place with your supplier?

    If yes, how does e-Business help to build stronger supply chain?

    If no, do you have any intention to introduce in near future?
46. How effective is the present system?
47. Do you find any gap or think of any further improvement?

Effective procurement processes (Strategic level)

Effective communication with production (Tactical level)

48. Do you have material specification list in place to guide your supplier?
49. Is that specification match to end customer required specification?
50. How do you decide right specification and right quantity required for purchase?
51. How do you match with required specification with right supplier?
52. How many suppliers do you keep ready for getting required material to reduce supplier power?

Effective management of purchase portfolio (Tactical level)

53. Do you have any critical item list?
54. What action do you take to keep safety inventory level of that critical item?
55. Do you have any supplier designated for supply critical item?
56. Do you have any alternative supplier to supply the critical item in emergency?
57. How often do you update your supplier database?
58. What criteria do you follow to update your supplier database?

Effective contract administration (Tactical level)

59. How do you inspect and verify your supplied material with required specification?
60. Is it starting from the supplier's place or from your place?
61. What is the payment procedure?
62. Is the payment procedure agreed with supplier?
63. How often do you evaluate your effective purchasing process?
64. Do you have any standard evaluation process existed?

Appendix 3: Interview questions for measuring the performance of supply chain on supplier relationship management

Interviewee group: Purchasing department
Interviewee actors: Manager, Deputy manager, Assistant manager, and Officers
Interview data: Company's supply chain performance

PART 2: To measure supply chain performance on supplier relationship management

According to the figure, the performance measurement factors are divided into three main decision making level at strategic, tactical, and operational levels.

1. In your opinion, do you agree whether the following performance measurement factors are the measures of performance for your company's supply chain management on supplier relationship management sector?
   If no, please indicate as: **N/A** – Not applicable
   If yes, please indicate the degree of importance of these performance measurement factors in 1 to 9 rating scale as:
   - **1** – The least important
   - **3** – Less important
   - **5** – Moderately important
   - **7** – More important
   - **9** – The most important

2. Could you compare the importance between each performance measurement factor in the same decision making level, in 1 to 9 pair-wise comparison scales?
   - **1** – Equally preferred
   - **2** – Equally to moderately
   - **3** – Moderately preferred
   - **4** – Moderately to strongly
   - **5** – Strongly preferred
   - **6** – Strongly to very strongly
   - **7** – Very strongly preferred
   - **8** – Very strongly to extremely
   - **9** – Extremely preferred

Supplier relationship management

Factors in **strategic** level		**Question 1**	**Question 2**
1	Quality supplier selection		
2	Supplier integration		
3	Effective procurement processes		

1 Quality supplier selection (Strategic level)

Factors in **tactical** level		**Question 1**	**Question 2**
1.1	Supplier performance		
1.2	Selection process		
1.3	Green supplier		

1.1 Supplier performance (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
1.1.1	Quality of products		
1.1.2	Delivery performance		
1.1.3	Overall reliability		

1.2 Selection process (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
1.2.1	Robust selection criteria		
1.2.2	Clear scope, specification and criteria for selection		
1.2.3	Effective negotiation		
1.2.4	Right contract		

1.3 Green supplier (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
1.3.1	Environmental policy		
1.3.2	Design		
1.3.3	Manufacturing		
1.3.4	Reverse logistics		

2 Supplier integration (Strategic level)

Factors in **tactical** level		**Question 1**	**Question 2**
2.1	Coordination and resource sharing		
2.2	Information integration		
2.3	Organizational relationship		
2.4	Use of information technology		

2.1 Coordination and resource sharing (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
2.1.1	Operations		
2.1.2	Decision-making		
2.1.3	Production planning		

2.2 Information integration (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
2.2.1	Information sharing		
2.2.2	Collaborative planning		
2.2.3	Joint demand forecasting		
2.2.4	Standardized means of communication across functions and suppliers		

2.3 Organizational relationship (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
2.3.1	Designing and maintaining of communication channels		
2.3.2	Risk sharing		
2.3.3	Common objective and teamwork		

2.4 Use of information technology (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
2.4.1	State of art system in place		
2.4.2	System's effectiveness		
2.4.3	System improvement		

3 Effective procurement processes (Strategic level)

Factors in **tactical** level		**Question 1**	**Question 2**
3.1	Effective communication with production		
3.2	Effective management of purchase portfolio		
3.3	Effective contract administration		

3.1 Effective communication with production (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
3.1.1	Developing right material specification		
3.1.2	Identifying right suppliers for specific materials		

3.2 Effective management of purchase portfolio (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
3.2.1	Segregation of materials as per value and criticality		
3.2.2	Maintaining up-to-date supplier database		
3.2.3	Making purchase decision accordingly		

3.3 Effective contract administration (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
3.3.1	Contract selection		
3.3.2	Inspection and verification		
3.3.3	Payment		
3.3.4	Evaluation		

Appendix 4: Interview questions for studying supply chain performance on internal supply chain management

Interviewee group: Production department

Interviewee actors: Manager, Deputy manager, Assistant manager, and Officers

Interview data: Company's supply chain performance

PART 1: To study supply chain performance on internal supply chain management

Background information

1. Please describe what do you do in your job?
2. How many years have you involved in current department and in company?
3. What role of supply chain initiatives has your department involved in?
4. Do you have any responsibilities in supply chain activities?

Facility (Strategic level)

Capacity utilization (Tactical level)

5. What are the constraints in your optimum capacity utilization?
6. How do you optimize your idle time caused by non scheduled work or end of shift?

Efficiency (Tactical level)

7. What are the challenges of efficient use of your facility?
8. What plans do you have to reduce fixed cost?

Flexibility (Tactical level)

9. How flexible is your facility to accommodate market uncertainties?

Quality (Tactical level)

10. What is the percentage of an increasing of production regarding to automation?
11. What is the percentage of response time you can expect to reduce by introducing of automation?
12. What are the factors driving you to further improve?

Reliability (Tactical level)

13. How reliable is your facility to address market needs?
14. Is your facility environment friendly?
    How do you control your waste?
15. Do you have any documented safety or pollution control procedure for your company?
16. Is there any instruction for operation posted near each machine?
17. Do you have any planned maintenance system in place?
18. Do you maintain minimum stock level for critical spares?

Inventory (Strategic level)

Optimal inventory policy (Tactical level)

19. How do you reduce your inventory cost?
20. How do you manage your risks during inventory level optimization?
21. Where is the bottleneck in your internal supply chain process?
22. How do you manage your inventory level during sudden fluctuation in customer demand?
23. Do you have vendor managed inventory (VMI) arrangement with your supplier?

Warehouse utilization (Tactical level)

24. How do you select suitable channel, scheduling, and location of warehouses?
25. How do you deal with your obsolete raw material in your stock?
26. How do you improve space utilization?
27. What is the percentage of finished product being not delivered immediately after finished?
28. What is the percentage of material being always in 'work in progress' condition?

Transportation (Strategic level)

Capacity utilization (Tactical level)

29. What is the percentage of your full capacity being utilized?
30. What are the factors hindering to use your full capacity?

31. Do you have your own transportation system or depend on third party logistics?
32. Do you have any system for gradual improvement?

Efficiency (Tactical level)

33. What are the means of transportation that you use inbound and outbound?
34. What are the ways you follow to reduce transportation cost in normal situation and during high oil price?
35. What challenges do you face to keep transportation cost down?

Flexibility (Tactical level)

36. How flexible is your logistics to accommodate market uncertainties?
37. How do you react during sudden demand fluctuation?

Reliability (Tactical level)

38. How reliable is your logistics to address market needs?
39. What are the challenges to achieve delivery schedule?
40. How do you mark your present performance in terms of meeting delivery schedule?
41. How do you ensure that your transportation systems are environment friendly?

Internal integration (Strategic level)

Information integration (Tactical level)

42. Do you agree that a flexibility of your information system being accordance with your business needs?
43. Do you have any real time monitoring system in use?

Internal quick response (Tactical level)

44. What do you do to further strengthen information sharing?
45. What are your general comments about timeliness of information?
46. How effectively can your system collect information and distribute to concerned place?

Use of information technology (Tactical level)

47. Do you have any state of art information system for effective operation of internal communication process?
48. How effective your system is?
49. What do you do to further improve your system?

Efficiency (Tactical level)

50. Is any investment required to improve effectiveness of existing information technology?
51. What are the ways you can reduce your operating cost?

Human resources (Strategic level)

Motivation (Tactical level)

52. How do you motivate your staff and worker to get best out of them?
53. Do you have any continuous development process?

Safety (Tactical level)

54. What safety procedure do you have in place to ensure that the working environments are safe and follow all safety regulation?
55. Do you have your own system in place?
    Or do you follow the safety regulation of local government?

Training (Tactical level)

56. How do you compensate the skill gap when a retire worker with high skills has been replaced with novice?
57. How do you improve your human skill?

Innovation and learning (Tactical level)

58. How do you encourage your human resources to be innovative and keep tradition of learning?
59. Do you have system in place?

Operations (Strategic level)

Operational performance (Tactical level)

60. How does your operation react with the fluctuation of uncertain demand?
61. How do you reduce material usage and waste?
62. How do you eliminate the non value adding activities between order and start of processing it?
63. How you maximize your throughput?
64. What are the challenges you face to maximize your throughput?

Environmental performance (Tactical level)

65. What is your environment policy?

66. Do you have any internal or external audit process?
67. What is your plan to reduce energy consumption?
68. Do you have any alternative source of energy for consumption?
69. How do you manage your emission related issue?

Innovation (Tactical level)

70. How often do you introduce any innovative operation process?
71. What is the average time for new product development?
72. What is your procurement lead time?
73. What is your sales cycle lead time?
74. Do you have any innovative operation process?

Appendix 5: Interview questions for measuring the performance of supply chain on internal supply chain management

Interviewee group: Production department
Interviewee actors: Manager, Deputy manager, Assistant manager, and Officers
Interview data: Company's supply chain performance

PART 2: To measure supply chain performance on internal supply chain management

According to the figure, the performance measurement factors are divided into three main decision making level at strategic, tactical, and operational levels.

1. In your opinion, do you agree whether the following performance measurement factors are the measures of performance for your company's supply chain management on internal supply chain management sector?
   If no, please indicate as: **N/A** – Not applicable
   If yes, please indicate the degree of importance of these performance measurement factors in 1 to 9 rating scale as:
   - **1** – The least important
   - **3** – Less important
   - **5** – Moderately important
   - **7** – More important
   - **9** – The most important

2. Could you compare the importance between each performance measurement factor in the same decision making level, in 1 to 9 pair-wise comparison scales?
   - **1** – Equally preferred
   - **2** – Equally to moderately
   - **3** – Moderately preferred
   - **4** – Moderately to strongly
   - **5** – Strongly preferred
   - **6** – Strongly to very strongly
   - **7** – Very strongly preferred
   - **8** – Very strongly to extremely
   - **9** – Extremely preferred

Internal supply chain management

Factors in **strategic** level		**Question 1**	**Question 2**
1	Facility		
2	Inventory		
3	Transportation		
4	Internal integration		
5	Human Resources		
6	Operations		

1 Facility (Strategic level)

Factors in **tactical** level		**Question 1**	**Question 2**
1.1	Capacity utilization		
1.2	Efficiency		
1.3	Flexibility		
1.4	Quality		
1.5	Reliability		

1.1 Capacity utilization (Tactical level)

Factor in **operational** level		**Question 1**
1.1.1	Percentage of capacity utilization	

1.2 Efficiency (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
1.2.1	Capital cost		
1.2.2	Operating cost		

1.3 Flexibility (Tactical level)

Factor in **operational** level		**Question 1**
1.3.1	Ability to change product produced	

1.4 Quality (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
1.4.1	State of art technology		
1.4.2	Continuous improvement possibility		

1.5 Reliability (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
1.5.1	Environment friendly		
1.5.2	Safety		
1.5.3	Availability or effective maintenance		

2 Inventory (Strategic level)

Factors in **tactical** level		**Question 1**	**Question 2**
2.1	Optimal inventory policy		
2.2	Warehouse utilization		

2.1 Optimal inventory policy (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
2.1.1	Decrease inventory levels		
2.1.2	Decrease inventory costs		
2.1.3	Shared inventory with supplier		
2.1.4	Shared inventory with customer		

2.2 Warehouse utilization (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
2.2.1	Raw materials		
2.2.2	Finished products		
2.2.3	Spares and maintenance materials		

3 Transportation (Strategic level)

Factors in **tactical** level		**Question 1**	**Question 2**
3.1	Capacity utilization		
3.2	Efficiency		
3.3	Flexibility		
3.4	Reliability		

3.1 Capacity utilization (Tactical level)

Factors in **operational** level		**Question 1**
3.1.1	Percentage capacity utilization	

3.2 Efficiency (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
3.2.1	Capital cost		
3.2.2	Operating cost		

3.3 Flexibility (Tactical level)

Factor in **operational** level		**Question 1**
3.3.1	Ability to change delivery modes	

3.4 Reliability (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
3.4.1	Adhering to delivery schedule		
3.4.2	Environment friendly		
3.4.3	Safety		
3.4.4	Availability or effective maintenance		

4 Internal integration (Strategic level)

Factors in **tactical** level		**Question 1**	**Question 2**
4.1	Information integration		
4.2	Internal quick response		
4.3	Use of information technology		
4.4	Efficiency		

4.1 Information integration (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
4.1.1	Improve data validity		
4.1.2	Information system flexibility		
4.1.3	Information accuracy		
4.1.4	Enterprise application integration		
4.1.5	Real-time monitor		
4.1.6	Information sharing		

4.2 Internal quick response (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
4.2.1	Strengthen information sharing		
4.2.2	Information timeliness		
4.2.3	Information availability		

4.3 Use of information technology (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
4.3.1	State of art system in place		
4.3.2	System's effectiveness		
4.3.3	System improvement		

4.4 Efficiency (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
4.4.1	Capital cost		
4.4.2	Operating cost		

5 Human resources (Strategic level)

Factors in **tactical** level		**Question 1**	**Question 2**
5.1	Motivation		
5.2	Safety		
5.3	Training		
5.4	Innovation and learning		

6 Operations (Strategic level)

Factors in **tactical** level		**Question 1**	**Question 2**
6.1	Operational performance		
6.2	Environmental performance		
6.3	Innovation		

6.1 Operational performance (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
6.1.1	Flexibility		
6.1.2	Customer services		
6.1.3	Consistence quality		
6.1.4	Reliability		
6.1.5	Waste reduction		

6.2 Environmental performance (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
6.2.1	Environmental policy		
6.2.2	Environmental audit		
6.2.3	Energy consumption		
6.2.4	Emission		
6.2.5	Reverse logistics		

6.3 Innovation (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
6.3.1	State of art technology		
6.3.2	Continuous improvement		

Appendix 6: Interview questions for studying supply chain performance on customer relationship management

Interviewee group: Marketing department

Interviewee actors: Manager, Deputy manager, Assistant manager, and Officers

Interview data: Company's supply chain performance

PART 1: To study supply chain performance on customer relationship management

Background information

1. Please describe what do you do in your job?
2. How many years have you involved in current department and in company?
3. What role of supply chain initiatives has your department involved in?
4. Do you have any responsibilities in supply chain activities?

Customer service (Strategic level)

Responsiveness (Tactical level)

5. What is your business strategy with respect to customer service?
6. How do you improve your quality of customer service?
7. What kind of innovative approach do you take to enhance quality of service to next level?
8. How do you get feedback from customer about its effectiveness?
9. What is the cost of return ratio for an innovation?
10. How do you create an outstanding customer experience with optimum cost?

Customer order processing and delivery (Tactical level)

11. What is the total order cycle time?
12. What is your typical order 'fill rate'?
13. What are the factors or constraints to achieve required fill rate?
14. Do you feel any bottleneck somewhere in your process to achieve required fill rate?
15. How do you manage your bottleneck?
16. Do you have any web-based supply chain and inventory management system?

Handling customer complaints (Tactical level)

17. Do you have any documented procedure to deal with customer complaint?
18. Do you give any opportunity to your customer to lodge a complaint?
19. How fast do you dissolve a customer complaint?
20. What is the average number of complaint you receive per year?
21. Do you have any system in place to reduce the number of complaint?
22. How many responses do you do for every ten complaint being lodged?
23. What are the criteria to decide which complaint needs urgent response?

Value added service (Tactical level)

24. In the process of value creation, how do you create and deliver value to your customer?
25. Do you have any value assessment method in place?
26. What is your understanding of where opportunities lie to create further value?
27. What kind of after sales service do you give to your customer?
28. How do you know that customers are satisfied with after sales service they received?
29. Do you charge them during after sales service?

Customer integration (Strategic level)

Extent of cooperation to improve quality (Tactical level)

30. In what way can customer integration help to improve your product innovation performance and quality performance?
31. How do you interact with your customer to leverage advantage?
32. How often do you update your online catalogue?
33. Does your online catalogue readily explain the price and shipping cost?
34. What is your contingency approach regarding customer integration?

Information integration (Tactical level)

35. How do you organize information on your customer?
36. How do you 'replicate' the mind of customers and use this information to improve your customer relationship management activities?
37. How much transparency do you maintain with your customer about product quality and availability?
38. What strategy do you adopt to get to customer and for customer to get to you?

39. How do you cooperate with your customer to develop joint demand forecasting?
40. How does joint demand forecasting help you for new product offerings, pricing changes, new technologies, and competitive activities?
41. How do you identify, understand, and anticipate your customer's needs?
42. What are the standard means of communication across functions and customers?

Organizational relationship (Tactical level)

43. What kind of customer contact facility do you use?
44. Do you share your risk with your customer?
    If not, do you think it is required for better coordination?
45. Does your objective match with your customer's requirements?
46. How do you achieve your objective?

Use of information technology (Tactical level)

47. Do you have any state of art arrangement for online direct sale?
    If yes, how much revenue do you earn per year from online direct sale?
48. What state of art information technology do you use for customer service?

Demand forecasting (Strategic level)

Forecasting system in place (Tactical level)

49. How is demand forecasting carried out in your company?
50. Is there any specific forecasting model for short term and long term forecasting for your products?
51. What criteria do you consider to select a specific model for forecasting?
52. How do you consider uncertainty factor due to global economic crunch, political instability, environment, or other factor for forecasting?
53. What is the percentage of errors you take in to consideration for your forecasting?

Decision making (Tactical level)

54. What is the role of governance on decision making process in your company?
55. How do you measure its effectiveness on direction and control?
56. What are the challenges for any fast decision making process in your company?

Reliability of demand data (Tactical level)

57. What is the percentage of accuracy in your forecasting process?
58. How do you satisfy your customer demand?
59. What do you do to reduce prediction error?

Market analysis (Strategic level)

Market equity (Tactical level)

60. Who are your main competitors?
61. What is the percentage of market share you hold in the overall market with respect to your competitors?
62. What is your targeting market?
63. How do you differentiate product in order to get competitive advantage?
64. What is the percentage of market equity change regarding to economic crunch?

Customer acquisition (Tactical level)

65. What is the percentage of new customer expected to increase with the launch of new brand?
66. What is the expected attrition rate of visitors in your website?
67. Who are the customers you target?
    How do you segment them?
68. Do you have any customer database?
69. How often do you update the database?
70. How do you build relationship with your targeted customer?

Customer retention (Tactical level)

71. What is the average percentage of customer shift per year?
72. What is your strategy in the respect of retaining existing customer and creating new customer?
73. How much likely will your current customer purchase from you again?
74. How do you build customer's loyalty?
    How do you reward them for being loyal customers?
75. How do you expect to get return from your loyal customer?
76. What is your customer satisfaction index?
77. Do you have any matrix to identify old product with new customer?

Government policy over market equity (Tactical level)

78. Does your government give subsidy on raw material?
79. How do you follow equal opportunity by ethics?
80. How do you share your knowledge among public and private sectors?

Appendix 7: Interview questions for measuring the performance of supply chain on customer relationship management

Interviewee group: Marketing department
Interviewee actors: Manager, Deputy manager, Assistant manager, and Officers
Interview data: Company's supply chain performance

PART 2: To measure supply chain performance on customer relationship management

According to the figure, the performance measurement factors are divided into three main decision making level at strategic, tactical, and operational levels.

1. In your opinion, do you agree whether the following performance measurement factors are the measures of performance for your company's supply chain management on customer relationship management sector?
   If no, please indicate as: **N/A** – Not applicable
   If yes, please indicate the degree of importance of these performance measurement factors in 1 to 9 rating scale as:
   - **1** – The least important
   - **3** – Less important
   - **5** – Moderately important
   - **7** – More important
   - **9** – The most important

2. Could you compare the importance between each performance measurement factor in the same decision making level, in 1 to 9 pair-wise comparison scales?
   - **1** – Equally preferred
   - **2** – Equally to moderately
   - **3** – Moderately preferred
   - **4** – Moderately to strongly
   - **5** – Strongly preferred
   - **6** – Strongly to very strongly
   - **7** – Very strongly preferred
   - **8** – Very strongly to extremely
   - **9** – Extremely preferred

Customer relationship management

Factors in **strategic** level		**Question 1**	**Question 2**
1	Customer service		
2	Customer integration		
3	Demand forecasting		
4	Market analysis		

1 Customer service (Strategic level)

Factors in **tactical** level		**Question 1**	**Question 2**
1.1	Responsiveness		
1.2	Customer order processing and delivery		
1.3	Handling customer complaints		
1.4	Value added service		

1.1 Responsiveness (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
1.1.1	Quality		
1.1.2	Innovation		
1.1.3	Customer satisfaction		

1.2 Customer order processing and delivery (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
1.2.1	Response time		
1.2.2	Order fill rate		
1.2.3	Order flexibility		
1.2.4	Delivery performance		

1.3 Handling customer complaints (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
1.3.1	System in place		
1.3.2	Number of complaints received		
1.3..3	Number of response made		

1.4 Value added service (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
1.4.1	Flexibility of services to meet particular customer needs		
1.4.2	After sales services		

2 Customer integration (Strategic level)

Factors in **tactical** level		**Question 1**	**Question 2**
2.1	Extent of cooperation to improve quality		
2.2	Information integration		
2.3	Organizational relationship		
2.4	Use of information technology		

2.1 Extent of cooperation to improve quality (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
2.1.1	New product and service development		
2.1.2	Regular operations		
2.1.3	Under contingency		

2.2 Information integration (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
2.2.1	Information sharing		
2.2.2	Collaborative planning		
2.2.3	Joint demand forecasting		
2.2.4	Standardized means of communication across functions and customers		

2.3 Organizational relationship (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
2.3.1	Designing and maintaining of communication channels		
2.3.2	Risk sharing		
2.3.3	Common objective and teamwork		

2.4 Use of information technology (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
2.4.1	State of art system in place		
2.4.2	System's effectiveness		
2.4.3	System improvement		

3 Demand forecasting (Strategic level)

Factors in **tactical** level		**Question 1**	**Question 2**
3.1	Forecasting system in place		
3.2	Decision making		
3.3	Reliability of demand data		

3.1 Forecasting system in place (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
3.1.1	State of art technology		
3.1.2	Forecasting model		
3.1.3	Forecasting process		

3.2 Decision making (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
3.2.1	Governance		
3.2.2	Fast decision making		

3.3 Reliability of demand data (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
3.3.1	Accuracy of forecasting techniques		
3.3.2	Improve response to customer demands		
3.3.3	Decrease prediction errors		
3.3.4	Forecast volatility		
3.3.5	Increase employee's adaptation for changes		

4 Market analysis (Strategic level)

Factors in **tactical** level		**Question 1**	**Question 2**
4.1	Market equity		
4.2	Customer acquisition		
4.3	Customer retention		
4.4	Government policy over market equity		

4.1 Market equity (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
4.1.1	Percentage of market share		
4.1.2	Percentage of change		
4.1.3	Trend		

4.2 Customer acquisition (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
4.2.1	Percentage of increase		
4.2.2	Critical zone		

4.3 Customer retention (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
4.3.1	Percentage of shift		
4.3.2	Critical zone		

4.4 Government policy over market equity (Tactical level)

Factors in **operational** level		**Question 1**	**Question 2**
4.4.1	Subsidy of raw materials		
4.4.2	Equal trade opportunity		
4.4.3	Knowledge sharing among public and private sectors		

Appendix 8: The coding scheme for the interview questions of Appendix 2

Interviewee group: Purchasing department

Interviewee actors: Manager, Deputy manager, Assistant manager, and Officers

Interview data: Company's supply chain performance

PART 1: To study supply chain performance on supplier relationship management

There are 64 questions for this interviewee group.

Question 1 to 4 represent for **background information**

Question 5 to 25 are under **quality supplier selection** in strategic level

- Question 5 to 10 represent for **supplier performance** in tactical level
- Question 11 to 18 represent for **selection process** in tactical level
- Question 19 to 25 represent for **green supplier** in tactical level

Question 26 to 47 are under **supplier integration** in strategic level

- Question 26 to 31 represent for **coordination and resource sharing** in tactical level
- Question 32 to 38 represent for **information integration** in tactical level
- Question 39 to 43 represent for **organizational relationship** in tactical level
- Question 44 to 47 represent for **use of information technology** in tactical level

Question 48 to 64 are under **effective procurement processes** in strategic level

- Question 48 to 52 represent for **effective communication with production** in tactical level
- Question 53 to 58 represent for **effective management of purchase portfolio** in tactical level
- Question 59 to 64 represent for **effective contract administration** in tactical level

Appendix 9: The coding scheme for the interview questions of Appendix 4

Interviewee group: Production department

Interviewee actors: Manager, Deputy manager, Assistant manager, and Officers

Interview data: Company's supply chain performance

PART 1: To study supply chain performance on internal supply chain management

There are 74 questions for this interviewee group.

Question 1 to 4 represent for **background information**

Question 5 to 18 are under **facility** in strategic level

- Question 5 to 6 represent for **capacity utilization** in tactical level
- Question 7 to 8 represent for **efficiency** in tactical level
- Question 9 represents for **flexibility** in tactical level
- Question 10 to 12 represent for **quality** in tactical level
- Question 13 to 18 represent for **reliability** in tactical level

Question 19 to 28 are under **inventory** in strategic level

- Question 19 to 23 represent for **optimal inventory policy** in tactical level
- Question 24 to 28 represent for **warehouse utilization** in tactical level

Question 29 to 41 are under **transportation** in strategic level

- Question 29 to 32 represent for **capacity utilization** in tactical level
- Question 33 to 35 represent for **efficiency** in tactical level
- Question 36 to 37 represent for **flexibility** in tactical level
- Question 38 to 41 represent for **reliability** in tactical level

Question 42 to 51 are under **internal integration** in strategic level

- Question 42 to 43 represent for **information integration** in tactical level
- Question 44 to 46 represent for **internal quick response** in tactical level
- Question 47 to 49 represent for **use of information technology** in tactical level
- Question 50 to 51 represent for **efficiency** in tactical level

Question 52 to 59 are under **human resources** in strategic level

- Question 52 to 53 represent for **motivation** in tactical level
- Question 54 to 55 represent for **safety** in tactical level
- Question 56 to 57 represent for **training** in tactical level
- Question 58 to 59 represent for **innovation and learning** in tactical level

Question 60 to 74 are under **operations** in strategic level

- Question 60 to 64 represent for **operational performance** in tactical level
- Question 65 to 69 represent for **environmental performance** in tactical level
- Question 70 to 74 represent for **innovation** in tactical level

Appendix 10: The coding scheme for the interview questions of Appendix 6

Interviewee group: Marketing department

Interviewee actors: Manager, Deputy manager, Assistant manager, and Officers

Interview data: Company's supply chain performance

PART 1: To study supply chain performance on customer relationship management

There are 80 questions for this interviewee group.

Question 1 to 4 represent for **background information**

Question 5 to 29 are under **customer service** in strategic level

- Question 5 to 10 represent for **responsiveness** in tactical level
- Question 11 to 16 represent for **customer order processing and delivery** in tactical level
- Question 17 to 23 represent for **handling customer complaints** in tactical level
- Question 24 to 29 represent for **value added service** in tactical level

Question 30 to 48 are under **customer integration** in strategic level

- Question 30 to 34 represent for **extent of cooperation to improve quality** in tactical level
- Question 35 to 42 represent for **information integration** in tactical level
- Question 43 to 46 represent for **organizational relationship** in tactical level
- Question 47 to 48 represent for **use of information technology** in tactical level

Question 49 to 59 are under **demand forecasting** in strategic level

- Question 49 to 53 represent for **forecasting system in place** in tactical level
- Question 54 to 56 represent for **decision making** in tactical level
- Question 57 to 59 represent for **reliability of demand data** in tactical level

Question 60 to 80 are under **market analysis** in strategic level

- Question 60 to 64 represent for **market equity** in tactical level
- Question 65 to 70 represent for **customer acquisition** in tactical level
- Question 71 to 77 represent for **customer retention** in tactical level
- Question 78 to 80 represent for **government policy over market equity** in tactical level