REVERSE LOGISTICS PERFORMANCE IN THE THAI AUTOMOTIVE INDUSTRY

By

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ABSTRACT

Reverse logistics has been of interest by both researchers and practitioners due to its potential to help firms provide better customer service, improve customer satisfaction, increase control of inventory, reduce costs, gain higher profitability, and enhance corporate image (Daugherty et al., 2001). However, the study specifically related to reverse logistics performance is still at an early stage with only few publications available.

This research attempts to explore the factors that influence the reverse logistics performance. Based on previous literature and in-depth interviews, a reverse logistics performance model was developed. Supply chain orientation, information system support, resource commitment, external integration, and internal integration were identified as factors that can directly and/or indirectly influence the reverse logistics performance of a firm. The relationships among these constructs and reverse logistics performance were hypothesized and investigated under the context of the Thai automotive industry.

By using both data triangulation and "between" method triangulation techniques, both qualitative and quantitative data were collected in this study. While qualitative data was used to gain better understanding on the constructs of interest and the context of this study, quantitative data was used to empirically test the proposed hypotheses. Structural equation modeling analysis was used to provide empirical assessment of the framework and to examine the proposed relationships in this study.

The result of the structural equation modeling analysis indicated that the proposed model of reverse logistics performance fit well with the data in this study. External integration and internal integration were found to be important factors that directly influence reverse logistics performance. For supply chain orientation, information system support, and resource commitment, the direct relationships between these factors and reverse logistics performance were not statistically significant. However, these factors can indirectly influence reverse logistics performance through external integration and

internal integration. Supply chain orientation, information system support, and resource commitment in logistics operations lead a firm to initiate and develop external integration and internal integration. With external integration and internal integration, a reverse logistics performance would be enhanced.

The findings suggested that supply chain orientation, information system support, resource commitment, external integration, and internal integration are crucial factors that lead to superior performance of a reverse logistics process. All of these factors must be considered simultaneously to ensure that reverse logistics operation can be a source of competitive advantage of a firm.

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CHAPTER 1

INTRODUCTION

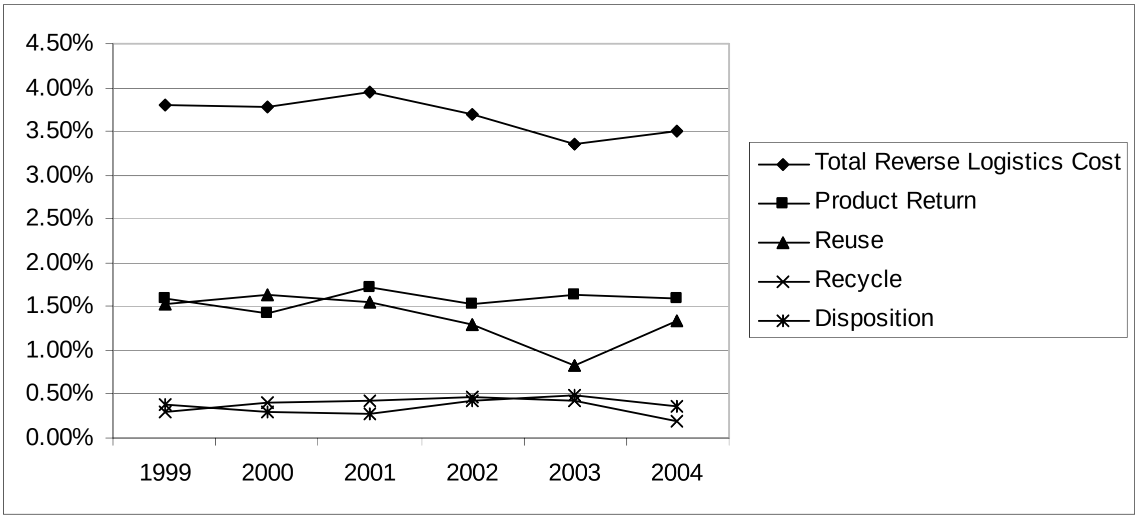
The first chapter aims to provide an introduction of this dissertation. This chapter can be divided into 7 sections. The first section starts with the rationale of study. Section 2 to 4 discuss proposes of research, research objectives, and research questions respectively. Section 5 provides a brief description on research design. Section 6 explains the expected outcome of the study. Finally, the organization of this dissertation is presented in the last section.

1.1 RATIONALE OF STUDY

Reverse logistics may have been the most neglected part of supply chain management (Norek, 2002). However, many firms have begun to realize that reverse logistics is an important and often strategic part of their business mission (Rogers and Tibben-Lembke, 2001). A well managed reverse logistics program can result in savings in inventory carrying, transportation, and waste disposal costs as well as improving customer service (Daugherty et al, 2001). With a good return handling system, reverse logistics can even evolve into profit center (Andel, 1997). While the efficient handling and disposition of returned product is unlikely to be the primary basis upon which a firm competes, it can make a competitive difference among firms.

Delaney (2000) mentioned that the exact amount of reverse logistics activity is difficult to determine because most companies do not carefully track reverse logistics costs. Rogers and Tibben-Lembke (2001) found that reverse logistics accounted, on average, for approximately 4% of total logistics costs. Based on the research done by Japan Institute of Logistics Systems (2005), it was found that reverse logistics costs in Thailand accounted for approximately 3.5% of total logistics costs in 2004. This number is consistent with that proposed by Roger and Tibben-Lembke (2001). The details can be seen in figure 1.1.

Figure 1.1: Thailand Reverse Logistics Costs as a Percentage of Total Logistics Costs



Source: Japan Institute of Logistics Systems (2005)

In Thailand, the logistics costs are currently estimated at 16.8% of the country's GDP (Banomyong et al., 2005). If these percentages are applied to the GDP of Thailand in 2005 which is 7,103 billion baht, the total reverse logistics cost in Thailand is estimated to be approximately at 42 billion baht in 2005. This number suggests that the amount of reverse logistics is significant and can not be ignored.

While reverse logistics has received more attention in recent years, the number of studies related to reverse logistics performance is still very limited. The first research on reverse logistics performance was done in year 2000 (Autry et al., 2000). Until recently, only five articles specifically related to reverse logistics performance have been published (Autry et al., 2000; Daugherty et al., 2001; Daugherty et al., 2002; Richey et al., 2004; Richey and Daugherty, 2005). With the limited number of studies related to reverse logistics performance, researchers have investigated only a small set of constructs related to reverse logistics performance. The examples of the constructs are industry, firm size, and assignment of responsibility (Autry et al., 2000); resource commitment (Daugherty et al., 2001); information system support and relationship commitment (Daugherty et al., 2002); timing and resource (Richey et al., 2004); resource commitment and innovation (Richey and Daugherty, 2005). It can be seen that the study of factors that influence a performance of reverse logistics is still at an early stage with mixed results. There is a need to explore more factors that are related to reverse logistics performance as well as to investigate some of the previously studied factors that still have inconclusive relationships with reverse logistics performance.

Reverse logistics processes normally involve with interactions and cooperation among several parties in the supply chain (Autry et al., 2000). Thus, the boundary of reverse logistics has expanded beyond a single firm to cover the whole reverse-logistics channel consisting of several members in the supply chain (Dowlatshahi, 2000). Pohlen and Farris (1992)'s study on reverse-logistics channel suggested that greater coordination and better communication between supply chain members are needed to improve the flexibility of reverse logistics systems. These studies illustrated that, in addition to the factors that lie inside a single firm as proposed by several authors, supply chain integration, divided into external integration and internal integration, also has a potential to affect a performance of reverse logistics program by improving cooperation and information sharing between supply chain members. Although supply chain integration is considered an important construct in the logistics and supply chain area, it has been ignored in the study of reverse logistics performance. Thus, this research represents an attempt to expand the body of knowledge by investigate the relationship between supply chain integration and reverse logistics performance in addition to the previously studied constructs.

1.2 PURPOSE OF RESEARCH

The main purpose of this research is to explore the factors that influence the reverse logistics performance. The focus is on two of the previously studied factors, information system support and resource commitment, that were considered major barriers to reverse logistics as proposed by Tibben-Lembke and Rogers (2002). In addition, since supply chain integration can be divided into external integration and internal integration, this research also investigates both external integration and internal integration as new factors that influence reverse logistics performance. Finally supply chain orientation is also included in the reverse logistics performance model since several authors suggested that firms that implement external integration must first realize supply chain orientation inside their firms (Lambert, 2004, Min and Mentzer, 2004, Stank et al., 2005).

In addition to explore the above mentioned factors, this research aims to investigate how these factors affect reverse logistics performance. While previous studies mostly proposed direct relationships between these factors and reverse logistics performance, this research investigates both direct and indirect relationships among these factors based on the literature review.

1.3 RESEARCH OBJECTIVES

This study seeks to develop a better understanding of reverse logistics process and to investigate the relationships between information system support, resource commitment, supply chain orientation, external integration, internal integration, and reverse logistics performance. The primary objectives of the research are as follows:

1. To provide comprehensive theoretical and practical perspectives of reverse logistics including several aspects of reverse logistics such as the development of its definitions, reverse logistics activities, related costs and benefits of reverse logistics, differences between logistics and reverse logistics, and difference between reverse logistics and green logistic.
2. To explore the factors that influence the reverse logistics performance.
3. To investigate how the proposed factors affect reverse logistics performance.
4. To develop a model that examines the relationships between supply chain orientation, information system support, resource commitment, external integration, internal integration, and reverse logistic performance.
5. To examine the fit of the proposed model in the context of the Thai Automotive Industry.

1.4 RESEARCH QUESTIONS

Based on the research objectives, the main research question of this research is:

> "What are the important factors that influence reverse logistics performance and how do these factors affect the performance of reverse logistics process?"

Five specifying research questions are proposed as follows:

1. What is reverse logistics and how can reverse logistics contribute to the competitive advantage of a firm?
2. What are the factors that influence the performance of reverse logistics processes?
3. How does information system support directly and indirectly influence the reverse logistic performance?
4. How does resource commitment directly and indirectly influence the reverse logistic performance?
5. How do external integration and internal integration influence the reverse logistic performance?
6. Is supply chain orientation an antecedent of external integration?

1.5 RESEARCH DESIGN

In order to answer the proposed research questions, the study was designed to consist of two main parts which were exploratory research and survey research. The exploratory research aimed to provide a better understanding of the nature of the research problems. The literature review and expert interviews could help answering research questions 1-2 while providing a foundation to answer the rest of the research questions. The second part was a survey used to examine the proposed research model and answer research questions 3-6.

1.6 EXPECTED OUTCOME OF THE STUDY

There are four main expected outcomes of the current research.

1. The research will identify important factors that influence the reverse logistics performance and explain how these factors affect the performance of reverse logistics process.
2. The research will illustrate significant direct relationship between external integration and internal integration, and the reverse logistics performance.
3. The research will confirm the direct relationship between resource commitment and reverse logistics performance that was previously studied as well as illustrate the significant indirect relationship between resource commitment and reverse logistics performance that is mediated by external integration and internal integration.
4. This research will illustrate a significant direct relationship between information system support and reverse logistics performance that was inconclusive in the previous study. In addition, the indirect relationship between information system support and reverse logistics performance that is mediated by external integration and internal integration is also expected.

1.7 ORGANIZATION OF THIS DISSERTATION

The content of this dissertation is organized as follows:

Chapter 1 is an introduction of this dissertation. The discussion begins with the rationale of study. Then the proposes of this research, research objectives, and research questions are presented respectively. In addition, a brief description on research design and the expected outcome of the study are provided. Finally, the organization of this dissertation is presented in the last section.

Chapter 2 is a literature review describing a theoretical perspective that provides the foundation of this research. This chapter initially provides a literature review on the concepts of logistics and supply chain management as well as reverse logistics. In addition, the constructs proposed in this research and reverse logistics performance will also be reviewed.

Chapter 3 aims to provide information on the Thai automotive industry which was chosen as the context for this research. It includes an overview of the industry, its supply chain structure, and the reverse logistics process and supply chain integration in the Thai automotive industry.

Chapter 4 discusses a conceptual framework and proposes hypotheses that are developed in order to answer the proposed research questions. In addition, the research methodology of the current study will also be presented. The chapter explains the research framework, research design, population and sampling method, the development of measurement items and the questionnaire, data collection method, pilot study, and the data analysis methods used in this study.

Chapter 5 describes the process of data analysis and the results. The details include data preparation which explains the process of data coding and entry, treatment of missing data, and checks for nonresponse bias. In addition, the result of descriptive data analysis on the respondent profiles is illustrated. The chapter also presents the evaluation of reliability and validity of the measurement items used. Finally, structural equation modeling analysis is illustrated in this chapter to explain the structural relationship of the model and to test the proposed hypotheses.

Chapter 6 starts with the presentation of the alternative model and the result of structural equation modeling analysis for the alternative model. Then a discussion of the findings is provided based on the results of both quantitative data analysis and in-depth interview.

Chapter 7 aims to provide a conclusion for this dissertation. The chapter starts with the summary of this dissertation. Then the explanation of how this dissertation achieves proposed research objectives and answers the main research question as well as subsequent research questions is presented. Finally, the chapter concludes this dissertation with theoretical contribution, managerial implication, research limitations, and suggestions for future research.

CHAPTER 2

LITERARURE REVIEW

This Chapter presents a theoretical perspective that provides the foundation of this research. It can be divided into three main parts. The first part provides a detailed literature review on the concepts of logistics and supply chain management as well as reverse logistics. The second part reviews the constructs that are interested in this research including supply chain orientation, information system support, and resource commitment. Finally, the third part discusses about supply chain integration, especially the stages and types of supply chain integration.

Logistics and supply chain management have been studied by researchers for more than a decade and have also been adopted by managers in business sectors. In the 1980s and 1990s, companies began to view logistics as more than simply a source of cost savings and recognize it as a source of enhancing product or service offerings as part of the broader supply chain process to create competitive advantage (Novack et al., 1995). Although logistics and supply chain management are closely related, their scopes and activities are different from each other. In order to have a clear understanding, logistics and supply chain shall be carefully investigated**.**

2.1 LOGISTICS

2.1.1 Definitions of Logistics

There are a number of commonly accepted definitions of logistics. In the past, logistics had mostly been related to physical distribution (Lummus et al., 2001). Shapiro and James (1985) provided a simple logistics definition which defines it as ensuring the availability of the right product, in the right quantity and the right condition, at the right place, at the right time, for the right customer, at the right cost and called it the "Seven Rs of Logistics". Delaney (1996) stated that logistics is the management of inventory in motion and the goal of the logistics manager is to achieve the lowest level of investment in inventory consistent with ensuring customer service and maintaining efficient production. Fawcett and Clinton (1997) defined logistics as the "process of planning, implementing, and controlling the efficient, effective flow and storage of materials, finished goods, services, and related information from origin to the location where they are used or consumed." Christopher (1998)'s definition of logistics is very close to that of Fawcett and Clinton (1997), except that an objective of logistics to satisfy demand was added into the definition. However, the most accepted definition of logistics was offered by the Council of Supply Chain Management Professionals[1] (2003). Logistics is defined as that part of the supply chain process that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services, and related information between the point of origin and the point of consumption in order to meet customer requirements. Mentzer et al. (2004) adopted the CLM definition of logistics and defined logistics management as a within-firm function that has cross-function and cross-firm (i.e. boundary-spanning) aspects to it. Regardless of the differences in all these definitions, most of the authors agree that logistics is an internal process of a firm with a smaller scope than supply chain management. The definitions of logistics are summarized in table 2.1.

Table 2.1: Definitions of Logistics

Author	Definitions
Shapiro and James (1985)	"Seven Rs of Logistics": Ensuring the availability of the right product, in the right quantity and the right condition, at the right place, at the right time, for the right customer, at the right cost.
Delaney (1996)	The management of inventory in motion and the goal of the logistics manager is to achieve the lowest level of investment in inventory consistent with ensuring customer service and maintaining efficient production.
Fawcett and Clinton (1997)	The process of planning, implementing, and controlling the efficient, effective flow and storage of materials, finished goods, services, and related information from origin to the location where they are used or consumed.
Christopher (1998)	The detailed process of planning, implementing and controlling the efficient, cost-effective flow and storage of material and products, and related information within a supply chain to satisfy demand.
Council of Supply Chain Management Professionals (2003)	That part of the supply chain process that plans, implements, and controls the efficient, effective forward and reverses flow and storage of goods, services, and related information between the point of origin and the point of consumption in order to meet customer requirements.

Source: The Author

[1] Council of Supply Chain Management Professionals (CSCMP) is previously known as Council of Logistics Management (CLM) until 2004 when CLM's Executive Committee voted to become CSCMP, effective in 2005.

2.1.2 Role of Logistics

Logistics plays an important role in providing the boundary-spanning, demand and supply coordinating, and capabilities the firm needs to create customer value to satisfy customers. Efficient management of logistics process can reduce costs such as transportation, inventory holding, and warehousing costs, as well as providing superior customer value through faster and better quality services. Christopher (1998) noted that logistics creates a competitive advantage for firms by providing superior competencies that are leveraged to create customer value and achieve cost and differentiation advantages. Mentzer et al. (2004) also confirmed that logistics significantly contributes to a firm's competitive advantage in both efficiency (cost leadership) and effectiveness (customer service). Many firms, especially those operating in commodity or convenience goods markets, succeed as a result of their logistics systems, rather than their marketing strategies (Christopher, 1998; Bowersox et al., 1995; Mentzer and Williams, 2001).

2.2 SUPPLY CHAIN MANAGEMENT

Although a good logistics system is one of the success factors for a company, Christopher (1998) proposed that the real competition is not company against company, but rather supply chain against supply chain. While Ganeshan (1999) defined supply chain as a network of facilities and distribution operations to perform the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers, Mentzer et al. (2001) described a supply chain as "a set of three or more organizations directly linked by one or more of the upstream and downstream flows of products, services, finances, and information from a source to a customer." Thus, the nature of a supply chain is comprehensive so that membership is not limited to a supplier, a manufacturer, and a distributor, but opens to any firm that performs various flow-related services (Mentzer et al., 2001).

2.2.1 Definitions of Supply Chain Management

The expansion of scope from a single company to a supply chain consisting of several members raises a new concept called supply chain management (SCM). To date, numerous definitions of supply chain management have been offered. The definition of supply chain in this study is based on the one provided by The Council of Supply Chain Management Professionals (CSCMP) which defined supply chain management as the "planning and management of all activities involved in sourcing and procurement, conversion, and logistics management activities, including coordination and collaboration with suppliers, intermediaries, third-party service providers, and customers to facilitate integration of supply and demand management within and across companies" (Council of Supply Chain Management Professionals, 2004).

Many definitions of supply chain management are closely related by focusing on the integration and management of business process and the chain's resources from end user through original suppliers to provide superior value to customers (Cooper and Ellram, 1993; Cooper et al., 1997; Lambert et al., 1998; Stein and Voehl, 1998). Christopher (1998), on the other hand, looked at the relationship aspect of supply chain and defined it as the management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole.

Other definitions of supply chain management focus on coordination, collaboration, and integration among supply chain partners. Several authors perceived supply chain management as an effort to efficiently coordinate, collaborate, and integrates interorganizational business activities among suppliers, manufacturers, warehouses, and retailers to satisfy customer at the lowest costs or to achieve a shared market opportunity (Larson and Rogers, 1998; Bowersox et al., 1999; Simchi-Levi et al., 2000; Stank et al., 2001b).

Mentzer et al. (2001) defined supply chain management as the "systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole." Mentzer et al. (2001) further defined supply chain management as encompassing all "upstream and downstream flows of products, services, finances, and/or information from a source to a customer."

Thus, supply chain management encompasses all logistics flows and functions, as well as additional (e.g. financial) flows and functions (e.g. all the business functions) not explicitly included in the CLM (2004) definition of logistics management (Mentzer et al., 2004). Table 2.2 exhibits a summary of reviewed definitions of supply chain management in this study.

Table 2.2: Definitions of Supply Chain Management

Author	Definitions
Cooper and Ellram (1993)	An integrative philosophy to manage the total flow of a distribution channel from the supplier to the ultimate user
Cooper, Lambert, and Pagh (1997)	The integration of business processes from end user through original suppliers that provides products, services, and information that add value for customers. Supply chain management is not just another name for logistics. It includes elements that are not typically included in a definition of logistics, such as information systems integration and coordination of planning and control activities.
Lambert, Cooper, and Pagh (1998)	A philosophy that views a business as an interrelated entity with many parts that seeks to integrate all aspects of the chain's resources to provide superior value to customers
Stein and Voehl (1998)	A systematic effort to provide integrated management to the Supply Value Chain in order to meet customer needs and expectations, from suppliers of raw materials through manufacturing and on to end customers
Christopher (1998)	The management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole
Larson and Rogers (1998)	The coordination of activities, within and between vertically linked firms, for the purpose of serving end customers at a profit.
Bowersox, Closs, and Stank (1999)	A collaborative-based strategy to link interorganizational business operations to achieve a shared market opportunity
Simchi-Levi et al. (2000)	A set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses, and retailers, so that merchandise is produced and distributed in the right quantities, to the right locations, and at the right times, in order to minimize system-wide costs while satisfying service level requirements
Mentzer et al. (2001)	The systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole. It encompasses all upstream and downstream flows of products, services, finances, and/or information from a source to a customer.
Council of Supply Chain Management Professionals (2004)	The planning and management of all activities involved in sourcing and procurement, conversion, and logistics management activities, including coordination and collaboration with suppliers, intermediaries, third-party service providers, and customers to facilitate integration of supply and demand management within and across companies

Source: The Author

Supply chain management involves with various types of activities. Murphy and Wood (2004) identified the following business activities and functional areas that comprise supply chain management operations:

- Customer service
- Demand management (forecasting, pricing, customer segmentation)
- Procurement (purchasing, supplier selection, supplier base rationalization)
- Inventory management (raw materials, finished goods, maintenance, repair and operating goods)
- Warehousing and material handling
- Production planning and control (aggregate planning, workforce scheduling, factory operations, etc.)
- Packaging (industrial and consumer)
- Transportation management
- Order management
- Distribution network design (facility location, distribution strategy, etc.)
- Product return management

The list of activities above includes several activities related to reverse logistics process such as customer service, demand forecasting, raw material and spare part inventory management, and product return management. These interrelated activities clearly indicate the reverse logistics is also a part of supply chain management. A well-managed supply chain will influence a reverse logistics process of supply chain members, which requires not only expertise within each firm, but also collaboration among members in the supply chain.

2.2.2 Role of Supply Chain Management

In a traditional supply chain, each member is concerned with decisions that directly affect their bottom line. Many manufacturing operations were designed to maximize throughput and lower costs with little consideration for the impact on inventory levels and distribution capabilities. There was not a single, integrated plan for the entire supply chain, but rather several independent plans made by each member to achieve individual goals. Therefore, there exists a need to integrate these different functions (Sundaram and Mehta, 2002). Supply chain management is a strategy through which such integration can be achieved. Supply chain management extends the concept of functional integration (i.e., the integration of traditional business functions, departments, and processes) beyond a firm to all the firms in the supply chain (Cooper et al., 1997; Greene, 1991). Individual members of a supply chain help each other improving the competitiveness of the supply chain, which enhance competitiveness of all supply chain members (Bowersox and Closs, 1996; Cooper and Ellram, 1993). The main premise of supply chain management is that the sharing of information and the coordination of strategies among firms in a supply chain can both reduce total logistics costs and enhance value delivered to the customer (Brewer and Speh, 2000; Cooper et al., 1997), which lead to improvement in supply chain efficiency (Sundaram, and Mehta, 2002) and sustainable competitive advantage for the firm (Mentzer et al., 2001).

Supply chain management philosophy stress that maximizing service to customers of choice at the lowest total cost requires a strong commitment to close relationships among trading partners. The philosophy requires a movement away from arms-length interactions toward longer term, partnership-type arrangements to create highly competitive supply chains. Ideally, collaboration begins with customers and extends back through the firm from finished goods distribution to manufacturing and raw material procurement, as well as to material and service suppliers. Thus, integration is needed both internally and externally (Stank et al., 2001b).

While the tenets of supply chain management appear sound, there are issues that make it difficult to implement. Barriers to implementation include a lack of managerial comfort with the sharing of information with other firms, an unwillingness to subordinate one firm's goals for the good of the supply chain, employee resistance to change, technological inadequacies, weak relationships among trading partners, and not having human and financial resources to invest in supply chain initiatives (Mentzer et al., 2000).

2.3 REVERSE LOGISTICS

Historically, reverse logistics has been most closely associated with recycling and the environment (Barry et al., 1993; Kopicki et al., 1993; Kroon and Vrijens, 1995; Murphy et al., 1994; Stock, 1992; Wu and Dunn, 1995). However, asset recovery is another aspect of reverse logistics that is equally as important as environmental issues. In the past, defective products may be detected after they have entered the supply chain resulting in a pull back of products through the chain known as product recalls. At present, there are more actors in the chain involved with the reverse flows on the basis of commercial agreements such as returning and taking back obsolete stocks of short-life products (B2B commercial returns). In addition, in the business-to-consumer context, products may be sent back due to mismatches in demand and supply in terms of timing or product quality (B2C commercial returns). During use and in the presence of warranty or service possibilities, products may also be returned to be substituted by others, or to be repaired (warranty and service returns). Ultimately, even after use or product life, products are collected to be e.g. remanufactured, recycled or incinerated (end-of-use and end-of-life returns).

At this point both material's hazard and environmental impact have to be taken into account. From the above reasons, the chain does not deal with only the supply side anymore, but also with recovery-related activities. Managers increasingly face the necessity of dealing with product that has been returned, recalled, or needs to be repaired. The reclamation and further handling of assets has become a priority issue for businesses because of the potential for simultaneously enhancing profitability and customer satisfaction (Minahan, 1998).

2.3.1 Definitions of Reverse Logistics

One of the earliest descriptions of reverse logistics was given by Lambert and Stock (1981). They described reverse logistics as "going the wrong way on a one-way street because the great majority of product shipments flow in one direction" (Lambert and Stock, 1981). This definition is quite close to those provided by Murphy (1986) and Murphy and Poist (1989) where reverse logistics was defined as the "movement of goods from a consumer towards a producer in a channel of distribution." Throughout the 1980s, the scope of reverse logistics was limited to the movement of material against the primary flow, from the customer toward the producer.

Stock (1998) provides one of the most comprehensive definitions of reverse logistics. He noted that "from a business logistics perspective, the term refers to the role of logistics in product returns, source reduction, recycling, materials substitution, reuse of materials, waste disposal, and refurbishing, repair, and remanufacturing; from an engineering logistics perspective, it is referred to as reverse logistics management (RLM) and is a systematic business model that applies best logistics engineering and management methodologies across the enterprise in order to profitably close the loop on the supply chain." Carter and Ellram (1998) adopted a similar definition, calling it "the process whereby companies can become more environmentally efficient through recycling, reusing, and reducing the amount of materials used".

Ross (1998) explained that reverse logistics encompasses the total "process of moving goods from their typical destination to another point for the purpose of capturing value that would be otherwise unavailable, or for the proper disposal of product". Companies are finding it necessary to pull products back into the supply chain for a variety of reasons extending beyond traditional recycling activities. These include product recalls, unsellable items, and redistribution for resale, reuse, repair/refurbishing, and scrap or salvage potential (Higginson and Libby, 1997). Daugherty et al. (2001) defined reverse logistics as “the process of planning, implementing and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from point of consumption to the point of origin for the purpose of recapturing value or for proper disposal."

The Council of Supply Chain Management Professionals noted that if the focus of logistics is the movement of material from the point of origin toward the point of consumption, then the focus of reverse logistics should be the movement of material from the point of consumption toward the point of origin. By drawing on the Council of Supply Chain Management Professionals' definition of logistics, Rogers and Tibben-Lembke (2001) defined reverse logistics as "The process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods, and related information from the point of consumption to the point of origin for the purpose of recapturing or creating value or proper disposal." Table 2.3 exhibits a summary of reviewed definitions of reverse logistics in this study.

Table 2.3: Definitions of Reverse Logistics

Author	Definitions
Lambert and Stock (1981)	Going the wrong way on a one-way street because the great majority of product shipments flow in one direction
Murphy (1986)	Movement of goods from a consumer towards a producer in a channel of distribution
Stock (1998)	From a business logistics perspective, the term refers to the role of logistics in product returns, source reduction, recycling, materials substitution, reuse of materials, waste disposal, and refurbishing, repair, and remanufacturing From an engineering logistics perspective, it is referred to as reverse logistics management (RLM) and is a systematic business model that applies best logistics engineering and management methodologies across the enterprise in order to profitably close the loop on the supply chain
Carter and Ellram (1998)	The process whereby companies can become more environmentally efficient through recycling, reusing, and reducing the amount of materials used
Ross (1998)	The process of moving goods from their typical destination to another point for the purpose of capturing value that would be otherwise unavailable, or for the proper disposal of product
Daugherty, Autry, and Ellinger (2001)	The process of planning, implementing and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from point of consumption to the point of origin for the purpose of recapturing value or for proper disposal
Rogers and Tibben-Lembke (2001)	The process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods, and related information from the point of consumption to the point of origin for the purpose of recapturing or creating value or proper disposal

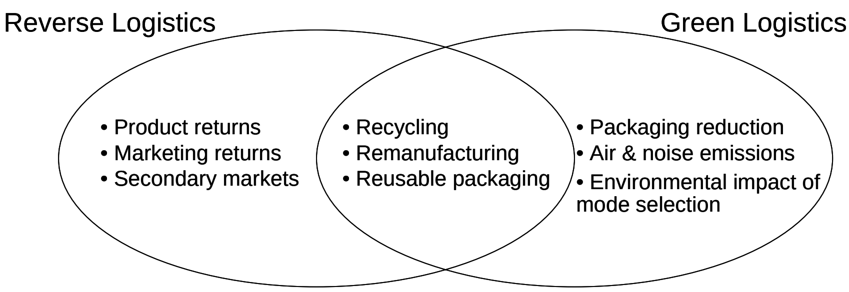
Source: The Author

The above definitions of reverse logistics are how the term reverse logistics was originally used. The term reverse logistics has also been referred as efforts to reduce the environmental impact of the supply chain. Although activities such as source reduction and material substitution do have a significant impact on logistics, these and other activities primarily motivated by environmental considerations might better be labeled "green logistics" or "environmental logistics" Rogers and Tibben-Lembke (2001). In order to avoid confusion between these two terms and to clearly distinguish between reverse logistics and green logistics, the next section explains the differences between them.

2.3.2 Differences between Reverse Logistics and Green Logistics

Many people are still confused with the terms reverse logistics and green logistics. Rogers and Tibben-Lembke (2001) mentioned that while the terms "green logistics" or "environmental logistics" are defined as "efforts to measure and minimize the environmental impact of logistics activities", the term "reverse logistics" should be reserved for the flow of products and materials going "the wrong way on a one-way street." Under these definitions, it can be seen that the focus of each process is different from each other. While green logistics concerns more on the environmental impact, reverse logistics concern with the returned product entering into the supply chain. Figure 2.1 illustrates the differences and the overlap between the two terms.

Figure 2.1: Comparison of Reverse Logistics and Green Logistics



Source: Rogers and Tibben-Lembke (2001)

However, there are many activities to which both reverse logistics and green logistics can be equally applied. For example, utilizing reusable containers that avoid the use of one-way cartons made of corrugated paper could be classified as both reverse and green logistics. The use of reusable containers involves reverse logistics in a sense that a firm need to bring the containers from the customers back to the firm. At the same time, the use of reusable containers to reduce waste caused by the paper containers concerns with environmental aspect of green logistics.

2.3.3 Reverse Logistics Activities

Rogers and Tibben-Lembke (2001) broke down reverse logistics activities into two general areas, depending on whether the reverse flow consists primarily of product or packaging. The return of product and packaging may originate from either supply chain partners or end users for different purposes. Table 2.4 summarizes the most common reasons why product or packaging may be sent backwards.

Table 2.4: Characterization of Items in Reverse Flow by Type and Origin

	Supply Chain Partners	End Users
Products	Stock balancing returns End of life/seasons Faulty order processing	Defective/unwanted products Warranty returns Recalls Environmental disposal issues
Packaging	Reusable totes Multi-trip packaging Disposal requirements	Reuse Recycling Disposal restrictions

Source: Adapted from Rogers and Tibben-Lembke (2001)

For packaging, the main objectives of reverse flow are to reuse (e.g., pallets or plastic totes) and to comply with regulations that restrict its disposal (e.g., corrugated). For product, reverse flows that are originated by supply chain partners may cause by several reasons. The most popular reasons are stock balancing returns, marketing returns, end of life/seasons, and faulty order processing.

- **Stock balancing return:** Manufacturers can provide resellers with the luxury of returning unsold stock. This offer is a common practice in some industries such as publishing industry. Retailers that need to make their accounting figures look good for the end of quarter or month will sometimes send significant amounts of unsold stock back for credits, only to reorder it again after the end of a financial period.
- **End of life/seasons:** Once a product has reached the end of its lifecycle, many manufacturers want to get it out of the retailers' shelves as soon as possible to prevent sales cannibalization of the new version. This means that the old products have to be disposed. Manufacturers either have to take the stock back, based upon the conditions agreed with the retailers, or the latter need to dump the old version quickly.
- **Faulty order processing:** Both end consumers and retailers can experience shipping problems. Products need to be delivered in full and on time or customers can make claims against manufacturers and return (part of) their shipment. Examples of delivery problems are incomplete shipments or missing parts, wrong quantities, wrong products, duplicate shipments and untimely delivery, which can cause the customer to miss out on the intended use of the product.

In addition, products may also be returned by end users for different reasons. The most common reasons for products returns by end customers are defective/unwanted products, warranty returns, recalls, and environmental disposal issues.

- **Defective/unwanted products:** Many manufacturers and retailers allow customers to return products if they do not meet their demands within a predefined period or if the product is defective. Money back guarantees are standard practice for most direct sales channels. However, the policy sometimes causes a problem to manufacturer as consumers and retailers may abuse the return policies of manufacturers.
- **Warranty returns:** Defective products or parts can be sent back to retailers or the manufacturers for repair. Products might either be dead on arrival, not working according to specifications or cosmetically damaged. This could happen either to

the retailer or the end consumer. Alternatively, products might break down during the course of their life cycle. If the product is still within the warranty period extended by the manufacturer, customers might return their product to the manufacturer or if that period has expired, customers could take up other options such as taking the product to a specialist repair center.

- **Recalls:** Serious flaws in a product can lead to a recall, instigated either by the manufacturer or a government agency. Common recalls appear in the automotive, pharmaceutical, and the toy industry. Aside from the safety issues in such situations, getting the discredited product out of circulation and into designated storage centers as soon as possible is a crucial part of damage limitation strategies.
- **Environmental disposal issues:** New environmental laws are being enacted worldwide and more stringent compliance to these laws is required. In the past once a product left the manufacturer's factory doors the responsibility to dispose of the product also disappeared. However, legislation in Europe and in the US is changing, sometimes even making manufacturers responsible for disposal of the product at the end of its life cycle. These environmental reasons cause a growing number of manufacturers to take their products back at the end of their lifetime.

Both product and packaging that re-enter into the supply chain on a reverse flow may face with different activities and processes in order to recapture their value again. Table 2.5 indicates a list of common reverse logistics activities that may occur to product and packaging.

Table 2.5: Common Reverse Logistics Activities

Common Reverse Logistics Activities			
Material	Reverse Logistics Activities	Material	Reverse Logistics Activities
Product	Return to suppliers Resell/Sell via outlet Salvage/Landfill Recondition/ Refurbish Remanufacture/ Recycle Reclaim material/Donate	Packaging	Reuse Refurbish Reclaim material Recycle Salvage/Landfill

Source: Rogers and Tibben-Lembke (2001)

2.3.4 Difference between Logistics and Reverse Logistics

Fleischmann et al. (1997) argued that reverse logistics is not necessary a symmetric picture of forward distribution. In fact, the differences are considerable and cover a wide variety of aspects of logistics. Tibben-Lembke and Rogers (2002) investigated the different between forward logistics and reverse logistics and summarized the differences between forward and reverse logistics as shown in table 2.6.

Table 2.6: Differences in Forward and Reverse Logistics

Forward	Reverse
Forecasting relatively straightforward	Forecasting more difficult
One to many transportation	Many to one transportation
Product quality uniform	Product quality not uniform
Product packaging uniform	Product packaging often damaged
Destination/routing clear	Destination/routing unclear
Standardized channel	Exception driven
Disposition options clear	Disposition not clear
Pricing relatively uniform	Pricing dependent on many factors
Importance of speed recognized	Speed often not considered a priority
Forward distribution costs closely monitored by accounting system	Reverse costs less directly visible
Inventory management consistent	Inventory management not consistent
Product lifecycle manageable	Product lifecycle issues more complex
Negotiation between parties straightforward	Negotiation complicated by additional considerations
Marketing methods well-known	Marketing complicated by several factors
Real-time information readily available to track product	Visibility of process less transparent

Source: Tibben-Lembke and Rogers (2002)

While there are many differences between forward and reverse logistics, this section explains only some important aspects of the differences (for complete details, please see Tibben-Lembke and Rogers (2002). The first difference deals with the greater uncertainty involved with reverse logistics which makes it more difficult to do planning for reverse logistics than planning for forward distribution (Guide et al., 2000). Unlike the forward flow, individual customers are the one who initiate reverse logistics activities which makes future planning and forecasting for reverse logistics more difficult. The difference in the number of origin and destination points between forward flow and reverse flow was identified by Fleischmann et al. (1997) as the largest difference between forward and reverse logistics. Whereas forward logistics is generally the movement of products from one origin to many destinations, the reverse logistics involved with the movement of products from many origins to one destination. In term of product and packaging quality, forward logistics usually involved with a completed and uniform packaging which makes it easy to transport and store. On the other hand, most products in the reverse logistics channel may not have complete packaging. The product may not be properly packaged by customers or packaging may become damaged during handling which make it more susceptible to damage in transit.

When the returned product re-enter the distribution system, it frequently involves movement along the distribution chain back to a factory for after sales supports such as repairs, or reconfiguration (Giuntini and Andel, 1995). This may present significant problem due to very small quantities normally involved with the return (Daugherty et al., 2002) compared with the normal forward flow. The challenge is to handle the returned products as timely and cost-efficiently as possible. Traditional delivery-oriented logistics systems often do not provide comparable quality on product returns due to the different natures of reverse logistics flow and forward flow of products especially when a reverse logistics flow is much more reactive, with much less visibility (Tibben-Lembke and Rogers, 2002).

Another difference lies in the cost structures of forward and reverse logistics. In forward logistics, costs are well defined and well-known. In reverse logistics, however, the costs are not necessary the same as the costs in forward logistics. Table 2.7 lists some of the ways in which reverse logistics costs differ from the costs of forward logistics.

Table 2.7: Reverse Logistics Costs

Cost	Comparison with Forward Logistics
Transportation	Greater
Inventory holding cost	Lower
Shrinkage (theft)	Much lower
Obsolescence	May be higher
Collection	Much higher-less Standardized
Sorting, quality diagnosis	Much greater
Handling	Much higher
Refurbishment/packaging	Significant for RL, non-existent for forward logistics
Change from book value	Significant for RL, non-existent for forward logistics

Source: Tibben-Lembke and Rogers (2002)

In reverse logistics, transportation cost is one of the major costs involved with the collection of returned product. Transportation costs per item for reverse logistics are generally higher than forward logistics because reverse shipments tend to be smaller and less standardized. These conditions make it more difficult to maximize cube utilization of trucks the way forward logistics can. When inventory holding cost is calculated as a percentage of the product’s value, the holding costs for reverse logistics are lower than forward logistics since reverse logistics product is generally worth a small percentage of the value of new product. The costs involved with shrinkage or theft are also lower than forward logistics because returned product is less desirable than new product which makes it less desirable to steal. The cost of obsolescence is also important in reverse logistics. By the time a product is purchased, returned, and arrives at a return center, several weeks may have passed. This period of time can make seasonal or technology products less desirable and significantly reducing their resale values.

Inventory management is another important issue for reverse logistics. Unlike forward logistics, the arrival of product in the reverse channel tends to be random which make traditional models of inventory management inapplicable to the situations. Finally, there is lower visibility of entire process in the case of reverse logistics. This lack of visibility of product coming into a returns center makes short-term operational planning more difficult.

The above mentioned differences between the natures of forward logistics and reverse logistics intensify the need to conduct researches in reverse logistics separately from forward logistics. While some of the knowledge in forward logistics may be applicable to reverse logistics, the others may not. More researches in reverse logistics area are needed in order to clearly understand the nature of reverse logistics and how to manage it effectively and efficiently. The final goal is to use reverse logistics as a competitive weapon for firms to differentiate themselves from their competitors and to create value to their customers.

2.3.5 Benefits of Reverse Logistics

Reverse logistics has received more attention in recent years because of its strategic implications. Daugherty et al. (2001) noted that better customer service, improved customer satisfaction, increased control of inventory, reduced costs, higher profitability, and enhancement of corporate image have all been identified as potential benefits that may accrue to firms with effective reverse logistics programs. A well managed reverse logistics program can result in savings in inventory carrying, transportation, and waste disposal costs as well as improving customer service. It has been estimated that efficient management of the reverse process can cut as much as 10% from companies' total annual logistics costs (Minahan, 1998).

In addition to the logistics costs, Toffel (2004) proposed that reverse logistics also provide a firm with opportunities to reduce production costs. Some companies have discovered that components and materials from end-of-life durable products can often be refurbished to substitute for virgin parts to be used as spares or in remanufacturing. Daugherty et al. (2002) noted that reverse logistics offers an opportunity for companies to differentiate or distinguish themselves with customers. Companies may enact product recovery programs to enhance the environmental image of their brand. Increasing the use of recyclable materials and becoming an industry leader in developing environmentally sustainable business practices were perceived as having the greatest positive influence in consumers' intention to invest in, work for, or use a company's products and services (Toffel, 2004).

The handling of the reverse movement becomes part of the corporate image and is often an important evaluative criterion used in vendor selection and subsequent purchase decisions. High quality reverse logistics can promote longer-term relationships since buyers are more likely to repurchase from vendors who do a good job at handling returns. In addition, reverse logistics programs can improve overall customer service and customer relations by helping to ensure that returns are processed quickly. Customer satisfaction ratings can soar with good reverse handling and corporate profitability can be directly impacted as well. Reverse logistics support also plays a critical role in overall corporate strategy. Some companies have adopted very liberal returns policies and will accept returned merchandise without question (Dawe, 1995).

Reverse logistics programs also offer firms the opportunity to collect valuable information. Data may facilitate the identification of patterns of defects or problem areas, and thus, can be used to reduce the volume of returns (Daugherty et al., 2001). In order to reduce their reverse supply chain costs, companies need to look beyond the processing of returns. The real benefit comes from sharing information with design, production, packaging and other departments on such things as what products are coming back and why they are coming back. By doing this, reverse logistics systems can solve return problems at the root causes. Companies that concentrate solely on improving returns processes will miss significant cost saving opportunities. Thus, a good reverse logistics system shall include proper data collection and effective reporting. To understand a consumer's reason for returning a good, companies must collect structured and consistent data concerning the reason for the return and the product and its condition. With this information, trends should be analyzed in individual products and consumer segments to determine root causes.

In some industries, reverse logistics may even provide a firm with an opportunity to protect its aftermarket. Aftermarket refers to the market for parts and accessories to maintain or enhance a previous purchase, and they are often quite profitable for manufacturers. While independent remanufacturers can attract new buyers into a market by providing "like-new" products at prices that typically range from 45% to 65% of comparable new products, they can also pose a threat to this market for original manufacturers. Original manufacturers may recover their end-of-life products to deter independent firms from remanufacturing and selling them, thus preventing potential losses of both market share and brand image.

Even with the potential for such substantive savings, most reverse logistics programs have been reactive, i.e., resulting from government regulation or pressures from environmental groups, rather than proactive attempts to gain economic benefits (Doherty, 1996). Firms generally do not initiate reverse logistics activity as a result of planning and decision making on the part of the firm, but in response to actions by consumers or downstream channel members (Tibben-Lembke and Rogers, 2002). Many firms have devoted too few resources and too little effort to effectively forecast for and handle reverse logistics (Andel, 1997). Therefore, the current research was undertaken to empirically examine involvement in reverse logistics activities. The research specifically addresses the relationship between firm's resource, logistics integration, and performance of reverse logistics.

2.3.6 Reverse Logistics and Competitive Advantage of a Firm

Day (1994) mentioned that competitive advantage traditionally involved how a firm would compete and defend its marker share by using price and product performance attributes. However, price and product attributes are not the only factors of competition in the current market that depends on anticipating market trends and quick response to changes in customer needs (Stalk et al., 1992). Competitive advantage emerges from the creation of superior competencies that are leveraged to create customer value and achieve cost and/or differentiation advantages, resulting in market share and profitability performance (Barney, 1991; Coyne, 1986; Day and Wensley, 1988; Prahalad and Hamel, 1990; Christopher, 1998). Sustaining competitive advantage requires that firms set up barriers that make imitation difficult through continual investment to improve the advantage, making this a long-run cyclical process (Day and Wensley 1988).

It is widely accepted that supply chain management can help firms become more competitive in their particular industry (Bowersox and Closs, 1996; Cooper and Ellram, 1993; Mentzer et al., 2001). Reverse logistics, as a part of supply chain, should also partially influences competitiveness of a firm. In order to validate this claim, it becomes relevant to examine how reverse logistics create customer value and achieve cost and differentiation advantages through each of the four common bases of competition which are cost, quality, flexibility, and response time (Handfield and Nichols, 1999).

In order to increase net income, a firm can either try to earn more revenue or lower its operating costs. On the revenue side, reverse logistics program can recapture the value of returned products that would otherwise be lost if there is no reverse logistics program. When the returned product enters the reverse logistics process, it will be reconditioned, refurbished, remanufactured and resold again in the secondary market to generate more revenue for a firm. On the cost side, effective reverse logistics program can result in savings in inventory carrying, transportation, and waste disposal costs. Better relations and information sharing with suppliers and customers allows a company to reduce the required levels of inventory that flow through the channel, thus improving the turnover ratios and decreasing the amount of capital that must be invested in risky inventory. While inventory carrying and transportation costs can be considered an important portion of logistics costs, a well-managed reverse logistics program, which provide opportunities to lower costs and increase a revenue, would positively enhance a competitive position of a firm.

Very few firms are entirely vertically integrated that is, able to perform every act necessary from manufacturing raw material and spare parts until transporting products from/to customers. Firms, therefore, must rely on suppliers, service providers, and distribution channel partners to perform many of the functions required to deliver a quality product and service that meets the customers' increasingly demanding needs. The current trend indicates that more and more customers are increasing their demands of vendors for better and faster service for product returns. Reverse logistics programs offer firms an opportunity to collect valuable information which may facilitate the identification of patterns of defects or problem areas, and thus, can be used to reduce the volume of returns (Daugherty et al., 2001) as well as improve the quality of product. High quality of products and services that arises from effective reverse logistics program will develop a long-term relationship with customers and promote competitiveness of a firm in an industry.

In many cases, the customers are large enough that their requests must be honored. In reverse logistics context, the question arises when a company tries to meet the individual demands of thousands of customers which tend to be random in terms of products, quantities, and requirements. Firms can utilize various techniques such as agile or leagile supply chain strategies to improve their flexibility in responding to specific customers demand. The added demand visibility that effective supply chain management provides enables firms to see this data almost in real time and react to any changes. The customer receives a higher degree of service without the need for additional inventory investment within the supply chain. The flexibility of reverse logistics process will also directly impact the responsiveness of the system, which is another area of competition among firms. As buyers are more likely to repurchase from vendors who provide good and flexible services in handling product returns, a flexible reverse logistics can also promote a long-term relationship with customers and secure a competitive position of a firm in an industry (Daugherty et al., 2002).

Technological advancements have recently shortened product life cycles which make product obsolescence a significant factor in reducing a product value if it sits in a return center for a long time. A responsive reverse logistics program can shorten the time between product return and the time that such product can be resold or sent back to customers. Responsiveness usually involves with cooperation and collaboration among the members in the chain to help reducing the delays that often result in lower levels of customer satisfaction. By being more responsive, a reverse logistics program can help firms enhancing competitiveness by recovering more value from the products as well as improving customer satisfaction.

2.3.7 Barrier to Reverse Logistics Implementation

Although reverse logistics has been perceived as one of the factors that contribute to the success of a firm, the study of Rogers and Tibben-Lembke (2001), found that many respondents reported significant difficulties in attempting to implement reverse logistics. The reasons and percentage of respondents facing the issues are listed in table 2.8.

Table 2.8: Barriers to Reverse Logistics

Barrier	Percentage of Respondents
Importance of reverse logistics relative to other issues	39.9%
Companies policies	35.4%
Lack of systems	35.1%
Competitive issues	32.1%
Management inattention	27.3%
Personnel resources	19.3%
Financial resources	18.9%
Legal issues	14.1%

Source: Tibben-Lembke and Rogers (2002)

It was found that the importance of reverse logistics relative to other issues is the most important barrier to implementation of reverse logistics. Nearly 40% of the respondents said that reverse logistics was not a priority for their firms. Approximately 35% of the respondents cited lack of reverse logistics information system as a problem for reverse logistics implementation. Another important issue is the lack of resources. The research indicated that 19.3% and 18.9% of respondents stated that lack of personnel resources and financial resources are their problems for implementation of reverse logistics. These barriers can be classified into tangible and intangible barriers to reverse logistics implementation. The tangible barriers include the lack of physical resources such as information system, personnel resources, and financial resources. However, Tibben-Lembke and Rogers (2002) argued that the real cause for lacking personnel and financial resource is not the firm's access to these resources itself, but the lack of resource commitment due to the management inattention and policies. The intangible barriers include company policies, competitive issues, management inattention, and relative importance of reverse logistics to firm. While these barriers prohibit a successful implementation of a reverse logistics program, it is expected that solving these problems will enable a firm to enhance its reverse logistics performance.

2.4 REVERSE LOGISTICS PERFORMANCE

2.4.1 Logistics and Supply Chain Performance

Rodrigues et al. (2004) conceptualized logistics performance as the ability of the firm to deliver specified value levels in a timely manner and to do so consistently. Logistics performance focuses on the creation of customer value through cost reduction and/or differential advantage (Stank et al., 2005). Such customer value would not only attract new customers, but also provide superior relationship to existing ones. Stainer (1997) believed that a performance measure should be used to determine the efficiency and/or effectiveness of an existing logistics system, or to compare competing alternative logistics systems. Thor (1994) claimed that there should be multiple indicators to measure logistics performance. In general, performance measures can be classified as qualitative and quantitative in nature.

2.4.1.1 Qualitative Performance Measures

Qualitative performance measures are measures for which there is no direct numerical measurement, although some aspects of them may be quantified (Chan et al., 2003). The frequently used qualitative performance measures are summarized in table 2.9.

Table 2.9: Qualitative Performance Measures

Qualitative Measurement	Description
Customer Satisfaction	The degree to which customers are satisfied with the product and/or service received, and can be applied to internal customers or external customers.
Flexibility	The degree to which the supply chain can respond to random fluctuation in the demand pattern
Information and material flow integration	The extent to which all functions within the supply chain can pass information and transport materials smoothly
Effective risk management	All of the relationships within the supply chain contain inherent risk. Effective risk management describes the degree to which the effect of these risks is minimized
Supplier performance	A measurement to describe how good a supplier can deliver raw materials to production facilities on time and in good conditions
Overall competitive position	A competitive position of a firm in relative to its competitors in the same industry

Source: Chan et al. (2003)

2.4.1.2 Quantitative Performance Measures

Quantitative performance measures are those measures that may be directly described numerically. Quantitative supply chain performance measures may be categorized by objectives that are based on cost or profit, measures of customer responsiveness, and productivity (Chan et al., 2003). Since quantitative measures are something that can be described and handled easily, qualitative measures should be translated into quantitative measures whenever possible. The frequently used quantitative performance measures can be classified as cost-based measures, customer responsiveness-based measures, and productivity-based measures. These measures are summarized in table 2.10.

Table 2.10: Quantitative Performance Measures

Quantitative Measurement	Description
Cost-Based Measures	
Cost	The most widely used objective. Cost is typically minimized for an entire supply chain. One example is to minimize transportation cost
Sales maximization	Maximize the amount of sales dollars or units sold
Profit maximization	Maximize revenues less costs
Inventory investment minimization	Minimize the amount of inventory costs so reduction of the inventory level is required
Return on investment maximization	Maximize the ratio of net profit to capital that was employed to produce that profit
Customer responsiveness-based measures	
Fill rate maximization	Maximize the fraction of customer orders filled on time
Product lateness minimization	Minimize the amount of time between the promised product delivery date and the actual product delivery date
Customer response time minimization	Minimize the amount of time required from the time an order is placed until the time the order is received by the customer, such as order lead time
Lead time minimization	Minimize the time that is required from the time an order has begun its production until the time the order is read for shipment
Function duplication minimization	Minimize the number of business functions that are provided by more than one business entity
Productivity-based measures	
Capacity utilization maximization	Maximize the capacity utilization
Resources utilization maximization	Maximize the resources utilization

Source: Chan et al. 2003

2.4.2 Existing Measures for Reverse Logistics Performance

Based on the literature review, only five studies relating to reverse logistics performance have been done so far. The first three studies in reverse logistics performance were done in catalog retailing industry. The first study was done by Autry et al. (2001) to investigate relationships between industry, firm size/sales volume, and internal or external assignment of responsibility for disposition and a performance of reverse logistics. The authors identified six performance measures to evaluate a reverse logistics program; environmental regulatory compliance, improved customer relations, recovery of assets (products), cost containment, improved profitability, and reduced inventory investment. The findings of this study indicated that the relationships between industry, assignment of disposition responsibility, and reverse logistics performance were not statistically significant. Only a relationship between sales volume and reverse logistics performance was found to be statistically significant at a marginal level.

In the second study (Daugherty et al., 2001), the authors investigated the relationship between resource commitment and reverse logistics program performance. The same set of reverse logistics performance measures was used again. However, an additional measure, overall effectiveness of reverse logistics program, was introduced in this study. The result of this study was inconclusive. While the relationship between managerial resource commitment and reverse logistics performance was found to be significant, the relationship between financial resource commitment and reverse logistics performance was relatively weak.

In the third study that examined the relationship among information system support, relationship commitment, and reverse logistics performance (Daugherty et al., 2002), the authors categorized performance measures into two groups; operating/financial performance measures and satisfaction. The measures in the first group are identical to the set of measures used in first study. However, the authors identified three measures in the second group to evaluate satisfaction which are satisfaction with returns, desire for similar supplier, and satisfaction with supplier. The result of this study was mixed. No direct relationship was found between information system support and operating/financial performance. The relationship between information system support and satisfaction was also not statistically significant. However, the result indicated that resource commitment is a critical moderator for the relationship between information system support and reverse logistics program performance, suggesting that whereas information system support is a necessary component of reverse logistics program, it is not enough on its own. Technological capabilities must be used in conjunction with the more personal aspect of transaction exchange, i.e. relationship commitment.

The fourth and fifth studies were done in the automotive aftermarket industry. The different industrial environment and characteristics of products encouraged the authors to use different sets of measures. The fourth study that investigated the impact of timing and resources on reverse logistics performance (Richey et al., 2004) evaluated a performance outcome of a reverse logistics program based on responsiveness, quality, and economic performance. The result indicated that while the relationship between program timing and reverse logistics performance was inconclusive, resource commitment was found to influence reverse logistics performance.

In the fifth study, a role of resource commitment and innovation in reverse logistics performance was investigated. Richey et al. (2005) used to same set of questions to evaluate reverse logistics performance, but rather called part of it a strategic performance instead of economic performance. The result provided inconclusive relationship between resource commitment, reverse logistics innovation, and reverse logistics performance. Innovation was found to be a moderator of the relationship between resource commitment and reverse logistics performance. However, innovation can influence reverse logistics performance in terms of strategic performance and operational service quality while relationship between innovation and operational responsiveness was not found. Table 2.11 illustrates these five previous studies, their independent variables for reverse logistics performance, and the reverse logistics performance measurement.

Thus, it can be summarized that two set of measurements has been used so far to evaluate the reverse logistics performance of a firm. The differences between the two set of measurements are based on the context of industry which contributes to the differences in characteristics of products, supply chains structure, and business norms. These studies mainly focused on three main aspects of reverse logistics performance which were costs, customer satisfaction, and responsiveness.

Table 2.11 Previous Studies on Reverse Logistics Performance

Authors	Title	Independent/ Moderating Variables	Dependent Variables
Autry et al. (2001)	The Challenge of Reverse Logistics in Catalog Retailing	Industry Firm Size/Sales Volume Assignment of Responsibility	Environmental regulatory compliance Improved customer relations Recovery of assets (products) Cost containment Improved profitability Reduced inventory investment
Daugherty et al. (2001)	Reverse Logistics: The Relationship between Resource Commitment and Program Performance	Management Resource Commitment Financial Resource Commitment	Environmental regulatory compliance Improved customer relations Recovery of assets (products) Cost containment Improved profitability Reduced inventory investment Overall effectiveness of reverse logistics program
Daugherty et al. (2002)	Information Support for Reverse Logistics: The Influence of Relationship Commitment	Information System Support Relationship Commitment	Environmental regulatory compliance Improved customer relations Recovery of assets (products) Cost containment Improved profitability Reduced inventory investment Overall effectiveness of reverse logistics Satisfaction with returns Desire for similar supplier Satisfaction with supplier
Richey et al. (2004)	Reverse Logistics: The Impact of Timing and Resources	Reverse Logistics Program Timing Resource Commitment	Responsiveness Quality Economic performance
Richey and Daugherty (2005)	The Role of Resource commitment and Innovation in Reverse Logistics Performance	Resource Commitment Innovation	Responsiveness Quality Strategic (economic) performance

Source: Author

In Porter (1991)'s framework, competitive advantage of the firm is caused by a firm's ability to perform interrelated economic activities at a collectively lower cost than rivals, or to perform some activities in unique ways that create end-customer value. Cost advantage and customer value are seen as the keys to competitive advantage of a firm. Thus, performance of reverse logistics program shall be measured in term of cost and value that the program can provide to customer in order to distinguish itself from the competitor in the eyes of customers.

The cost performance aspect of reverse logistics program is evaluated based on the overall costs of reverse logistics process including ordering, transportation, handling, and inventory holding costs as well as other costs occurred when the product is returned from the customers and delivered back to the customers.

The value aspect of performance is evaluated by responsiveness and customer satisfaction. These two measurements, based on measurements used in previous studies of reverse logistics performance as well as other studies related to supply chain management, have been widely used to evaluate reverse logistics and supply chain performance.

2.5 ANTECEDENTS OF SUPPLY CHAIN INTEGRATION AND REVERSE LOGISTICS PERFORMANCE

It can be seen from table 2.11 that the factors that had been studied as antecedents to reverse logistics performance are still limited. The antecedents that were identified in these studies are Industry, Firm Size, Sales Volume, Assignment of Responsibility, Resource Commitment, Information System Support, Reverse Logistic Program Timing, Innovation, and Relationship Commitment (Autry et al., 2001; Daugherty et al., 2001; Daugherty et al., 2002; Richey et al., 2004; Richey and Daugherty, 2005). Based on Tibben-Lembke and Rogers (2002)'s barriers to reverse logistics, it can be concluded that the most important factors in this group are information system support and resource commitment. The lack of resource commitment and information system support is caused by the relative importance of reverse logistics, management inattention, and companies policies. Thus, these two factors are included in the current study.

However, reverse logistics involves with multiple parties in the supply chain (Autry et al., 2000). Reverse logistics consists of product and information flows in both upward and downward directions in the supply chain. This situation requires cooperation and information sharing among supply chain partners in order to achieve efficient and effective operation (Pohlen and Farris, 1992). Therefore, the current study proposes that, supply chain integration should be investigated if it affects the reverse logistics performance. Since firms must first realize supply chain orientation inside their firms before implementing supply chain integration (Lambert, 2004, Min and Mentzer, 2004, Stank et al., 2005), supply chain orientation is also included in this study. The literature review of these factors can be seen in the next parts.

2.5.1 Supply Chain Orientation

By definition, a Supply Chain Orientation (SCO) is the implementation by an organization of the systemic, strategic implications of the tactical activities involved in managing the various flows in a supply chain (Min and Mentzer, 2004). A supply chain orientation differs from other orientations, such as customer orientation, product orientation, and competitor orientation (Gatignon and Xuereb, 1997) in that it stresses a systemic view stretching beyond the focal firm to include coordination of business processes and flows with those of other members of the supply chain for the purpose of creating a strategic advantage based on end-customer value delivery. Supply chain orientation adopts a systems approach to viewing the supply chain as a whole, and to managing the total flow of goods inventory from the supplier to the ultimate customer. It also predicates a perspective that favors cooperative efforts to synchronize and converge intrafirm and interfirm operational and strategic capabilities into a unified whole (Mentzer et al., 2001). A business unit with a supply chain orientation would assess customer, product, and competitor inputs to coordinate and organize internal functions and processes with those provided by external supply chain entities to best deliver value to customers as well as to members of the supply chain (Bowersox et al. 1999).

Mentzer et al. (2001) summarized three things that are normally demonstrated by firms adopting supply chain orientation. The first thing is a systems approach to viewing the supply chain as a whole, and to managing the total flow of goods inventory from the supplier to the ultimate customer. The second is a strategic perspective focused on cooperative efforts to synchronize and converge intrafirm and interfirm operational and strategic capabilities into a unified whole. Finally, firms with supply chain orientation shall demonstrate a customer focus to create unique and individualized sources of customer value, leading to customer satisfaction. It is proposed that a supply chain oriented firm should build and maintain the following cultural elements of relations with its supply chain partners:

- **Trust** is recognized as an important factor developing and managing business relationships. It is a substantial dimension in the interaction and network approach (Hakansson and Snehota, 1995), and a basic feature in relationship marketing (e.g. Morgan and Hunt, 1994). The importance of trust can be explained by the fact that it is seen as a phenomenon which contributes to the strength of interpersonal relationships, intra-organizational relationships and inter-organizational relationships (Svensson, 2001). Trust is frequently defined as a willingness to take risk (Kwon and Su, 2005; Mayer et al., 1995). Trust exists when one party has confidence in an exchange partner’s reliability and integrity (Morgan and Hunt, 1994). Trust, which determines cooperation as well as relationship commitment (Achrol, 1991; Morgan and Hunt, 1994) consists of credibility and benevolence.
    - **Credibility** is a firm's belief that its partner stands by its word (Anderson and Narus, 1990), fulfills promised role obligations, and is sincere (Dwyer and Oh, 1987; Scheer and Stern, 1992).
    - **Benevolence** is a firm's belief that its partner is interested in the firm's welfare (Deutsch, 1958; Larzelere and Huston, 1980; Rempel et al., 1985), is willing to accept short-term dislocations (Anderson et al., 1987), and will not take unexpected actions that would have a negative impact on the firm (Anderson and Narus, 1990).
- **Commitment** is defined as an implicit or explicit pledge of relational continuity between exchange partners (Dwyer et al., 1987). Morgan and Hunt (1994) defined commitment as “an exchange partner believing that an ongoing relationship with another is so important as to warrant maximum efforts at maintaining it; that is, the committed party believes the relationship endures indefinitely. Moorman et al. (1992) defined commitment to a relationship as "an enduring desire to maintain a valued relationship." Implied in this definition is that firms that are committed to

relationships with valued partners in the supply chain will work hard to maintain the relationship.

- **Cooperative norm** is defined as "the perception of the joint efforts of both the supplier and distributor to achieve mutual and individual goals successfully while refraining from opportunistic actions." (Siguaw et al., 1998).
- **Organizational Compatibility** is defined as a compatible corporate culture and management techniques of each firm in a supply chain. Organizational compatibility is necessary for successful SCM (Cooper et al., 1997; Lambert et al., 1998).
- **Top management support**, which includes leadership and commitment to change, is an important antecedent to SCM (Lambert et al., 1998), and the absence of it is a barrier to SCM (Loforte, 1993).

It is suggested that a supply chain oriented firm should incubate, retain, and even improve these five elements inside the firm with respect to its supply chain relationships (Stank et al., 2005). Stank et al. (2005) concluded that adopting a supply chain orientation leads a business unit to practice supply chain management and supply chain integration.

2.5.2 Information System Support

The introduction of information systems in supply chain management was originally limited to the automation of critical functions (Williams et al., 1997). However, information technology usage is increasingly becoming a source of sustained competitiveness and an opportunity for improvement by providing infrastructural support to the supply chain and having an indirect impact on the competitiveness of a product. In fact, key drivers for information technology adoption have included growing interactivity in supply chains, financial opportunity, efficiency and cost savings, enhanced customer and market penetration, and increased competition (Sood et al., 1999). Information system enable firms to integrate similar functions spread over different areas which enhance firms' capability to cope with sophisticated needs of customers and meet product quality standards (Bardi et al., 1994).

It has been accepted that logistics has a unique role in dealing with both upstream (i.e. materials management) and downstream (i.e. physical distribution) flows of "goods, services, and related information" (Council of Supply Chain Management Professionals, 2003). In reverse logistics, the importance of information system is even enhanced. Daugherty et al. (2002) noted that reverse logistics is frequently characterized by uncertainty and a need for rapid timing/processing. In some industries, returns are difficult to predict so that a firm cannot rely only on the historical information to project the type and amount of return. However, despite the lack of such information on returns, a firm must be prepared to quickly process and handle the products on demand. Thus, prompt and accurate exchange and access to information should be considered a top priority. Efficient and effective management of information system helps supply chain members reducing transaction costs, increasing confidence levels among firms and, thus, decreasing uncertainty. Reverse logistics, in particular, requires extensive exchange of information to cope with complexities that arise when a firm involves with multiple parties in the supply chain. Information system support acts as a technological platform to reduce barriers to collaboration, compressing lead-time, eliminate physical movement and enriching decision-making by providing firms with a visibility of product flows, improving service planning, inventory management, and distribution (Balakrishnan et al., 1999).

So far, most researches have examined the concept of information systems support in a single dimensional perspective of information. For example, studies have examined EDI, systems independence, systems development, information technology, and information exchange (Angeles-Hendon et al., 1998; Clarke, 1998; Lewis and Talalayevsky, 1997; Min, 1998; Stank et al., 1996). Daugherty et al. (2002) argued that the diverse nature of these studies suggests information systems should be viewed in a more holistic manner in order to capture the multiple dimensions and more fully understand the value of information accumulation and dissemination within and across firms. In their study, by integrating the distribution and information systems literatures, information systems support (IS support) is viewed as consisting of three distinct dimensions: capability, compatibility, and technologies.

2.5.2.1 IS Support Capability

Capability is defined as a bundle of skills and knowledge that help providing competitive differentiation (Day, 1994). In order to gain a true competitive advantage, a firm would develop capabilities that are distinct, defensible, and difficult to imitate (Day, 2000). Information system networks must be responsive in order to anticipate and accommodate operational changes and customer demands. The networks must deliver information that is readily useable, i.e., information capability must match business needs. This means information must be continuously accessible and shared across organizations (Drucker, 1993; Daugherty et al., 1995). In the case of reverse logistics, this requirement is particularly critical. Readily available and accurate information provides necessary support for accommodating non-routine events such as product returns (Ellram and Cooper, 1990). Information support can help a firm to improve buyer-seller relationships through improved customer service/satisfaction as well as to increase operation efficiency. Prompt response to customer requests on product returns, supported by effective information system network, would improve customer satisfaction while lowering related costs such as order processing costs and inventory holding costs.

2.5.2.2 IS Support Compatibility

The need for integrated supply chain makes information system support compatibility becomes as equally important as information system support capability. Information system support compatibility is defined as "the extent to which the firm is able to design and invest hardware and software that are compatible with those of its trading partners to facilitate information exchange process" (Global Logistics Research Team at Michigan State University, 1995). Whereas information system support capability indicates a practical ability, or what the system can do, information system support compatibility refers to how easy it is to use and how compatible it is with other systems in the supply chain. Information system support compatibility implies the existence of congruent systems that facilitate exchange between separate organizations. In the context of reverse logistics, increased complexity and changing channel relationships have dramatically increased the need for information exchange compatibility across organizations (Williams et al., 1997). Information exchange among supply chain partners shall be readily available and accurate. This effective, fast cross-organizational sharing of information is possible only when the information systems of firms in the supply chain are compatible. However, most firms have communication arrangements with multiple suppliers and customers with various types of systems which make it difficult to arrange system compatibility among all the channel members.

2.5.2.3 IS Support Technologies

In addition to information system support capability and compatibility, information system support technologies has long been accepted that it has a potential to serve as competitive weapons to support overall strategic initiative of a firm (Porter, 1985). In the research done by The Global Logistics Research Team at Michigan State University (1995), it was found that one of ten differentiators between leading edge logistics organizations and average firms is the leading edge performer's ability and willingness to invest in state-of-the-art information technologies. The complexity and fast-paced nature of logistics operations make information support a top priority at world-class firms. World-class firms have significantly increased the range of technologies employed within their operations. In the context of reverse logistics, a number of specialized companies have developed packages to deal with returns. While integration with back office functions remains an issue, the widespread use of Internet technology has substantially improved the way different supply chain partners can communicate with each other. Online return capabilities and electronic processing of returns drastically increase the speed with which returns can be handled, increase customer satisfaction and can significantly reduce costs.

2.5.3 Resource Commitment

Resource commitment involves the allocation of “tangible and intangible entities available to the firm that enable it to produce efficiently and/or effectively a market offering that has value for some market segment(s)” (Hunt, 2000). The resource-based theory suggested that differences in reverse logistics program performance may be explained by the level of resource commitment to the development of reverse logistics program (Richey et al., 2005). Reverse logistics, like most business operations, requires a wide range of resources, ranging from information to location-related resources. Thus, three types of resource commitment; managerial, financial, and technological resource commitment; must be taken into consideration (Daugherty et al., 2001). The development of supply chain integration relies partly upon a combination of intangible (managerial) and tangible (financial and technological) resource commitment. High level of resource commitment to the reverse logistics program is expected to provide a superior reverse logistic performance (Daugherty et al., 2001; Richey et al., 2004; Richey and Daugherty, 2005). While resource commitment to reverse logistics should be a priority because of the potential for enhancing performance and because development of reverse logistics offers a strategic way of developing lasting linkages with customers (Tan et al., 2003), the allocation of sufficient financial and personal resource has been identified as one of the principle barriers to development of a good reverse logistics program (Richey et al., 2005).

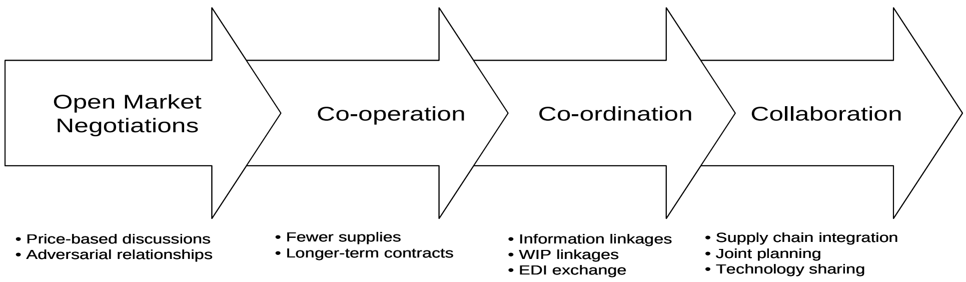
2.6 SUPPLY CHAIN INTEGRATION

The integration of supply chain has been the subject of significant debate and discussion over the recent years. While the concept of supply chain integration is not totally new, its significance has been gaining over the past decade (Stevens, 1988; Bowersox et al., 1989; Freeman and Cavinato, 1990; Morris and Calantone, 1991; Christopher, 1998; Frohlich and Westbrook, 2001; Stank et al. 2001a; Simatupang et al., 2002; Narasimhan and Kim, 2001; Fawcett and Magnan, 2002; Rodrigues et al., 2004; Power, 2005). Mentzer et al. (2001) even claimed that supply chain integration is at the heart of supply chain management.

Before the supply chain management concept was developed, the most basic form of interaction among firms in the markets is open market negotiation.

Spekman et al. (1998) proposed a concept of transition in the level of relational intensity among trading partners from open-market negotiations to collaboration. The concept suggested that firms move beyond market negotiation to cooperation and coordination with key segments of their suppliers and customers. Cooperation is where the supply chain management is initiated with low intensity of information exchange between firms and few long-term contracts among suppliers and customers. From cooperation, firms may move forward to coordination where there is an exchange in workflow and information to make seamless linkages between and among trading parties. At the final step, collaboration among firms engages partners in joint planning, future design, product performance, long-term strategic intentions and processes. By this definition, it can be seen that the concept of collaboration and supply chain integration are closely related which allows several authors to use the two terms interchangeably. The diagram illustrating Transition from open market negotiations to collaboration proposed by Spekman et al. (1998) can be seen in figure 2.2.

Figure 2.2: Transition from Open Market Negotiations to Collaboration



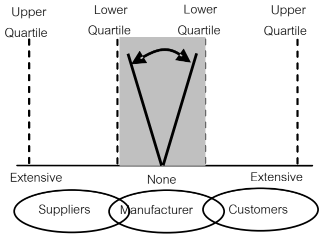
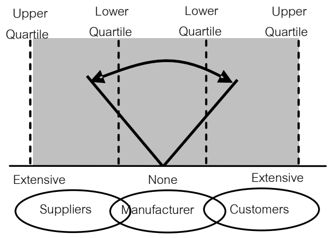
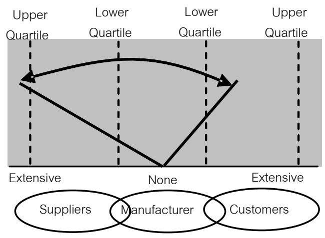
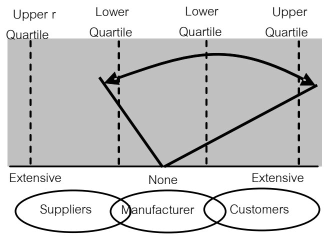
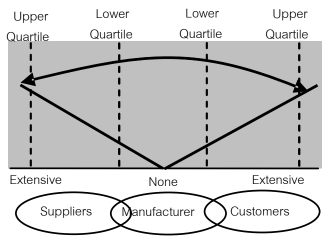
Source: Spekman et al. (1998)

Christopher (1998) and Lummus et al. (1998) proposed that creating and coordinating manufacturing processes seamlessly across the supply chain pipeline to create customer value in the manner the most competitors cannot easily match are the main objectives of supply chain integration. Lummus et al. (2001) agreed that the higher the level of integration with suppliers and customers in the supply chain, the greater the potential benefits. Lee (2000) also noted that a truly integrated supply chain creates value for the company, its supply chain partners and its shareholder as well as reduce costs. In Ragatz et al. (1997)'s study of supply chain integration in new product development, it was found that supplier integration has led to significant performance improvements and competitive advantage for the firms. Tan et al. (1998) noted that when companies integrate and act as a single entity, performance is enhanced throughout the chain.

Frohlich and Westbrook (2001) investigated the relationship between the degree of supply chain integration and operational performance. In the study, the need of integration focuses on two strategic decisions of the firm including direction and degree of integration. While direction of integration is defined as "a decision the firm needs to develop to share operational activities towards customers and/or towards suppliers", the degree of integration is defined as "the extent to which the firm develops shared operational activities with customers and suppliers." These pairs of decisions are key dimensions representing a strategic position of the firm, which can be demonstrated graphically as an arc, with the direction of the segment exhibiting whether the firm is supplier or customer leaning, and the degree of arc indicating the extent of the integration. Frohlich and Westbrook (2001) defined five degrees of supply chain integration ranging from an "inward-facing internal" focus, a "periphery-facing" focus, a "supplier-facing" focus, a "customer-facing" focus to an "outward-facing supply chain" focus. The five arcs of integration can be seen in figure 2.3.

In a study of Fawcett and Magnan (2002) to obtain an accurate view of supply chain management as it is currently practiced, the authors suggested that while definitions of supply chain integration vary, supply chain management are often referred to four primary types of supply chain integration, i.e. internal, backward, forward, and complete forward and backward integration. Internal or cross-functional process integration is identified as the crux of supply chain initiatives. Backward integration with valued first-tier supplier is identified as the most common form of supply chain integration. Forward integration with valued first-tier customers is identified as supply chain integration.

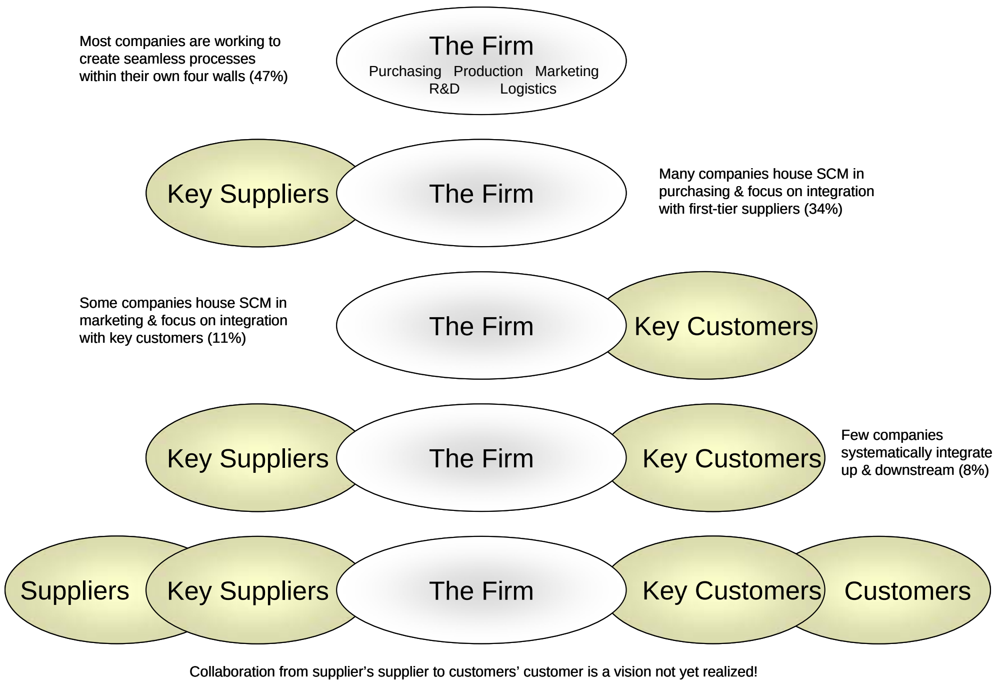
Figure 2.3: Five Arcs of Integration

To what extent do you organizationally integrate activities with your customers and suppliers	Arc of Integration
Inward-facing arc of integration (internal focus) Classified as inward-facing if response is: In lower quartile for suppliers, and In lower quartile for customer	
Periphery-facing arc of integration Classified as Periphery-facing if response is: Above lower quartile for suppliers or customers, but Below upper quartile for suppliers and customers	
Supplier-facing arc of integration (supplier leaning focus) Classified as Supplier-facing if response is: In upper quartile for suppliers, and Below upper quartile for customers	
Customer-facing arc of integration (customer leaning focus) Classified as Customer-facing if response is: In upper quartile for customers, and Below upper quartile for suppliers	
Outward-facing arc of integration (supply chain integration focus) Classified as Outward-facing if response is: In upper quartile for suppliers, and In upper quartile for customers	

Source: Frohlich and Westbrook (2001)

Lastly, complete forward and backward integration is associated with supply chain management. However, the authors commented that very few firms were managing the entire supply chain from suppliers' supplier to customers' customer. The different views of supply chain integration are illustrated in figure 2.4.

Figure 2.4: Different Views of Supply Chain Integration



Source: Fawcett and Magnan (2002)

2.6.1 Stages of Supply Chain Integration

Bowersox (1989) proposed that the process of supply chain integration should progress from the integration of internal logistics processes to external integration with suppliers and customers. Internal and external integration can be accomplished by the continuous automation and standardization of each internal logistics function, and by efficient information sharing and strategic linkage with supplier and customers. Stevens (1989) presented the integration process of supply chain management comprehensively starting with the integration of related functions to internal integration and on to external integration. The stages of integration are summarized in table 2.12.

Table 2.12: Four Integration Stages of Supply Chain Management

Stage	Definition
Stage 1: Independent Operation of Each Function	Business functions such as sales, manufacturing, planning, material control and purchasing are operated on an almost separate basis. This stage is characterized by organizational boundaries, whereby purchasing might control the incoming material flow of raw material stocks, manufacturing and production control then cover raw material through the processes which convert it into finished goods, and further along the chain, sales and distribution divide the responsibility for outbound supply chain and inventories.
State 2: Functional Integration	Limited integration between functions such as shipping and inventory or purchasing and raw material management is accomplished. This stage is characterized by emphasis on cost reduction rather than performance improvement; discrete business functions, each of which is buffered by inventory; elements of internal trade-off between, for example, purchase discount and the level of inventory investment; high plant-utilization and batch sizing; and reactive customer service.
Stage 3: Internal Integration	All internal functions from raw material management through production, shipping, and sales are connected and integrated real time. This stage is characterized by full system-visibility from distribution through to purchasing medium-term planning; a focus on tactical rather than strategic issues; an emphasis on efficiency rather than effectiveness; and reaction to customer demand rather than managing the customer.
Stage 4: External Integration	Full supply chain integration extending the scope of integration outside the company encompassing suppliers and customers is accomplished. This stage is characterized by the supply of high quality products shipped direct to the line on time; completely shared information on products, processes and specification changes; technology exchange and design support; a focus on strategic rather than tactical issues; and above all long-term commitment, which usually means the elimination of multiple-sourcing.

Source: Stevens (1989)

According to Stevens (1989), there are four integration stages of supply chain management. In the first stage, the supply chain is a function of fragmented operations within the individual firm and is characterized by staged inventories, independent and incompatible control systems and procedures, and functional segregation. The supply chain in second stage begins to focus internal integration, characterized by an emphasis on cost reduction rather than performance improvement, buffer inventory, initial evaluations of internal trade-offs and reactive customer service. Moving toward the third stage, the supply chain moves toward internal corporate integration and characterized by full visibility of purchasing through distribution, medium-term planning, tactical rather than strategic focus, emphasis on efficiency, extended use of electronics support for linkages and a continued reactive approach to customers. In the last stage that is defined as external integration, the supply chain achieves integration outside the firm to embrace suppliers and customers.

Although the stage of integration proposed by Stevens (1989) suggested that firms must achieve a relatively high degree of collaboration among internal processes before initiating external integration, Gimenez and Ventura (2005) believed that internal and external integration influence one another. Internal integration influences external collaboration and vice versa. Internal integration has a positive effect on external integration because coordination among internal functions facilitates coordination among different companies. On the other hand, the influence of external collaboration on internal collaboration has to be understood as an incentive to internal integration. In many cases, supply chain integration was not initiated from the internal of the firm, but rather from another firm which act as a focal firm in a supply chain. Even with a low level of internal integration, a firm may be forced to integrate with other supply chain members. If firms want to collaborate with their supplier chain members, they need to enhance internal integration. Companies have realized that collaboration and integration among different functional areas enhances the success of an externally integrated relationship. In this study, instead of looking at supply chain integration as a stage of development, each type of supply chain integration will be considered simultaneously.

2.6.2 Type of Supply Chain Integration

Supply chain integration can be divided into two broad categories of integration. The first involved with internal integration by integrating functions within a single firm. Another type of integration deals with the integration beyond the scope of the firm to encompass other parties in the supply chain. Such external integration can occur between a focal firm and its supplier or between a focal firm and its customer.

2.6.2.1 Internal Integration

Integration is another key logistics capability. By definition, internal integration is the core competence derived from linking internal activities to best support customer requirements at the lowest total system cost (Stank et al., 2001a). This can be achieved by linking operations into a seamless, coordinated, and synchronized operational flow across internal function areas such as marketing and sales, procurement, manufacturing and assembly, and finished goods distribution, as well as encouraging front-line managers and employees to use their own discretion, within policy guidelines, to make timely decisions (Bowersox et al., 2002; Stank et al., 2001b). To facilitate synergistic and synchronous operations, all functional areas can implement company-wide standardization (i.e. cross-functional policies and procedures), simplification (i.e. continuous improvement through benchmarking), compliance (i.e. adherence to established operational and administrative policies and procedures), and structural adaptation (i.e. the network structure and the deployment of necessary resources to its activities) (Bowersox et al., 1999). A coordination and integration of a number of interdependent activities simultaneously across major functional areas to provide various additional dimensions and ways in which logistics can create incremental customer value is also called a strategic logistics (Langley and Holcomb, 1992). This concept calls for the components of logistics to be managed holistically, as parts of an interconnected system, in order to achieve synergies that lead to better performance in meeting customer requirements (Rodrigues et al., 2004). When an internal integration is in place, it will create internally interwoven processes that cannot be easily replicated by other firms (Daugherty et al., 1998).

It has been suggested that integration is comprised of two fundamental components, i.e. interaction and collaboration (Kahn and Mentzer, 1996). Interaction represents the communication aspects associated with interdepartmental activities. Collaboration represents the willingness of departments to work together. It is characterized as the attitudinal aspect of interdepartmental relationships, representing an affective, volitional, mutual/shared process. Bowersox et al. (2003) discussed several elements of integration, including cross-functional unification, structural adaptation, and process standardization, simplification, and compliance.

Bowersox et al. (1999) mentioned that successful supply chain integration requires each organization to effectively coordinate its internal activities first. Marriotti (1999) stated that before a potential supply chain partners make decision on the supply chain collaboration, they normally need to sense trust and information sharing among the firm's functional units first. Consequently, it is crucial that people at all levels of the organization share information, learn collaboratively across departmental boundaries, and think in terms of entire processes in becoming more adaptive and creative (Tracey et al., 2004). Such internal integration will influence the level of collaboration among firms in the supply chain.

2.6.2.2 External Integration

The need to reduce redundancies, achieve greater economies of scale, and leverage differentiated core competencies in logistics operations is not limited to internal activities alone (Rodrigues et al., 2004). Recent work emphasizes the importance of achieving integration not only across internal operations but also with customers and material and service suppliers. Both intra- and inter-organizational coordination are needed (Bowersox et al., 1999). In this study, external integration is divided into supplier integration and customer integration. Mentzer et al. (2004) noted in their unified theory of logistics that, in order to create a competitive advantage, a firm needs not only collaboration between each function inside the firm, but also collaboration between each firm in the supply chain. Day (1994) proposed that a close buyer-seller relationship that is beyond arm's length, called channel linking, becomes a distinctive capability.

Stank et al. (2001a) noted that linking internal work processes with those of external material and service providers is the focus of supplier integration. External integration with suppliers synchronizes the core competencies of selected supply chain participants to jointly achieve improved service capabilities at lower total supply chain cost (Bowersox et al., 2002; Stank et al., 2001b). Rodrigues et al. (2004) stated that external integration ensures that operational interfaces between firms are synchronized by ensuring that all activities are conducted by the supply chain entity that best creates the service and cost configuration to meet customer requirements. In addition to the willingness to work together, Stank et al. (2001b) noted that external integration also requires an investment in the relationship and/or resource sharing. It has been suggested that effective integration involves mutual understanding, a common vision, shared resources, and achievement of collective goal.

Another aspect of external integration is the customer integration which is referred to as the extent to which the firm is able to deploy collaborative processing with its valued customers. In order to achieve customer integration, a firm must seek to build a long-term relationship with the customer making an integral part of the entire value network in which the firm participates. Based on the study of Stank et al. (2001a), customer integration is the competence firms use to create lasting distinctiveness with customers of choice. Customer integration enables managers to pursue business based on the fit between firm strengths and customer needs to gain mutual benefits between the two parties. Successful integration depends upon thorough knowledge of the firm and its supply chain partners' capabilities as well as customer requirements and expectations. Frohlich and Westbrook (2001) found that by integrating only the inbound side or outbound side of the supply chain, firm gain only little more benefits compared with focusing only in internal integration. Thus, in addition to perform integration with suppliers, firms also need to integrate with customers to achieve significant performance improvement.

2.7 CONCLUSION

This chapter reviewed the literature related to logistics, supply chain management, reverse logistics, supply chain integration, as well as factors that are relevant to the level of supply chain integration and a performance of reverse logistics process. The literature review suggests three main weak points of the existing studies related to reverse logistics. The first weak point indicates that reverse logistics is a relatively new concept for both researchers and practitioners compared with logistics and supply chain management. Although there are a number of reverse logistics researches in the past decade, the literature review suggests that the study of reverse logistics performance is still at an early stage with a limited number of research publications related to this issue. The second weak point is that most of the researches on reverse logistics performance focus only on factors that lie within a single firm (e.g. innovation and information system support) and ignore the importance of supply chain integration regardless of the fact that reverse logistics involved with multiple parties in the supply chain. Finally, very few studies related to reverse logistics have been done empirically. This study attempts to fill these gaps by proposing supply chain integration as a factor that influence reverse logistics performance, in addition to information system support and resource commitment. Supply chain orientation is also proposed as an antecedent of supply chain integration. This study aims to empirically investigate the effect of these factors on the reverse logistics performance of a firm.

CHAPTER 3

INDUSTRY REVIEW

This chapter aims to provide information on the Thai automotive industry which is chosen as the context for this research. The chapter starts with an overview of the Thai automotive industry by going through automobile production, sales, and export. Next, the structure of supply chain in the Thai automotive industry is presented. The final section discusses the reverse logistics process and supply chain integration in the Thai automotive industry.

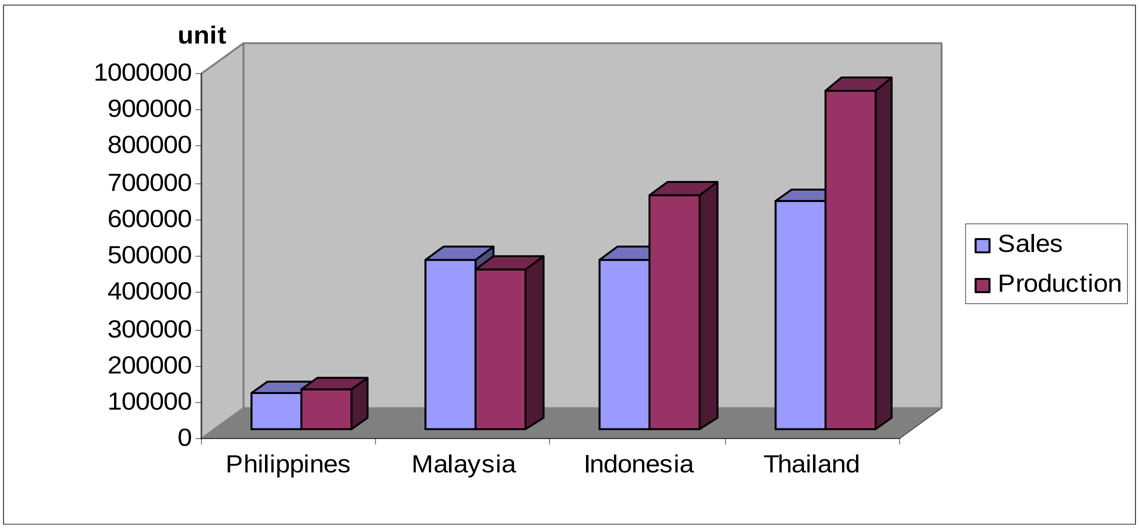
3.1 THAI AUTOMOTIVE INDUSTRY OVERVIEW

The South East Asian automotive industry has seen phenomenal growth in vehicle sales and production, especially in the four leading automotive markets; Thailand, Indonesia, Malaysia, and Philippines. These countries account for almost 85% of the region's sales volumes. The vehicle sales and production volume of these four leading markets in 2004 are shown in figure 3.1. Among ASEAN[1], Thailand has one of the largest automotive assembling capacity, and possibly the highest quality parts manufacturing capability. The capacity and manufacturing quality, combined with the good domestic market size, market growth potential, stable political atmosphere, liberal trade and investment policy, absence of ethnic conflicts, and the lack of "national car program", have made Thailand one of the most attractive countries for automotive investments (TAPMA, 2003). Thailand's automotive industry is well on the way to

[1] ASEAN is a political, economic, and cultural organization of countries located in Southeast Asia. The current member countries of ASEAN are Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam.

solidifying its status as the Detroit of Asia, which means the main hub for cars and trucks production in Asia, with the total capacity of more than one million cars and trucks per year. Thailand is already the world's second largest pick-up truck market after the U.S. and ASEAN's largest automotive market and assembler. In Asia, Thailand currently ranks fifth and third in term of production and export respectively. At a global level, Thailand ranks fourteenth regarding to production capacity and seventh for export. In 2005, Thailand achieved exceptional results in both vehicle sales and production, which further moved it ahead of its neighbors and gained international attention.

Figure 3.1: Vehicle Sales and Production of the Leading ASEAN Markets in 2004

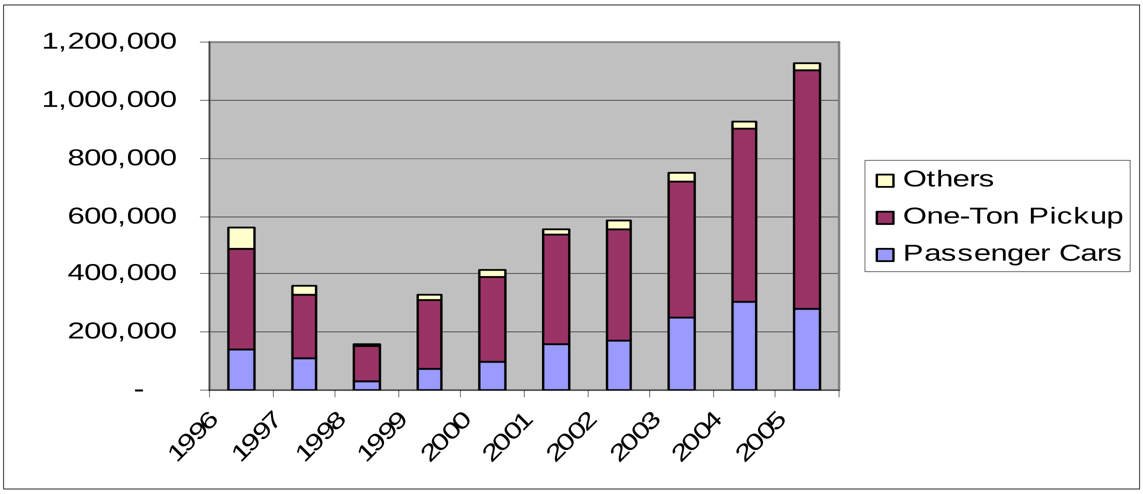


Source: Frost & Sullivan (2005)

3.1.1 Automobile Production

The total number of automobile production in Thailand has gradually increased since 1999. In 2005, Thailand produced a total of 1,125,316 vehicles. This number includes 277,603 passenger cars, 822,867 one-ton pickups, and 24,846 commercial trucks. This figure shows an increase of 21.25% over 2004. The production of one-ton pick up has soared 39.71% while the production of passenger cars has declined by 8.79%. The production of one-ton pick up has increased significantly to over 800,000 units in 2005 because Thailand is now a main hub of one-ton pickup manufactures. The production of one-ton pickup serves both domestic and exported markets in several countries. The details information on the automobile production in Thailand can be seen in figure 3.2.

Figure 3.2: Automobile Production in Thailand during 1996-2005



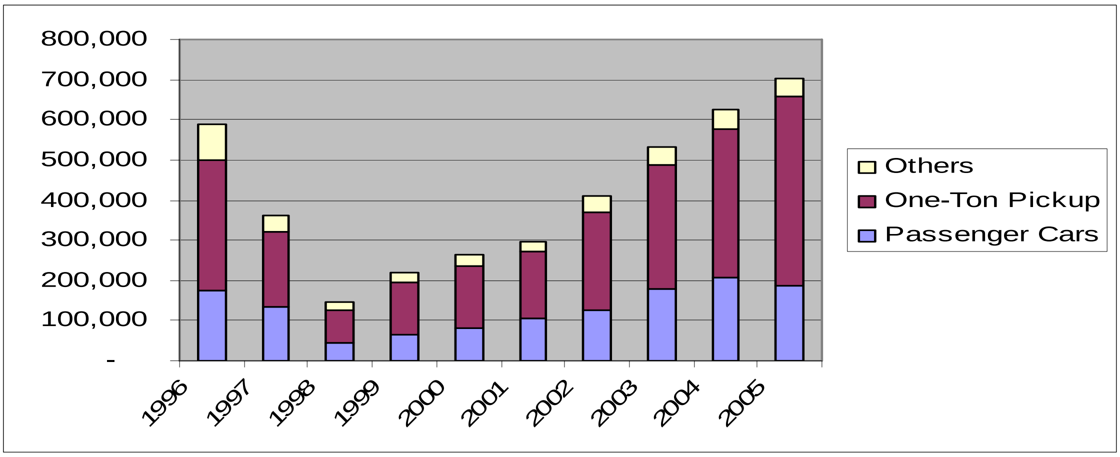
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2004/2005 Change (%)
Passenger Cars	138,579	112,041	32,008	72,716	97,129	156,066	169,321	251,684	304,349	277,603	-8.79%
One-Ton Pickup	350,857	218,336	119,986	240,369	294,834	382,297	382,297	468,938	597,914	822,867	37.62%
Others	68,929	29,926	6,136	14,148	19,758	14,003	33,333	29,890	25,818	24,846	-3.76%
Total	558,365	360,303	158,130	327,233	411,721	552,366	584,951	750,512	928,081	1,125,316	21.25%
Change (%)	6.22%	-35.47%	-56.11%	106.94%	25.82%	34.16%	5.90%	28.30%	23.66%		

Source: Thailand Automotive Institute (2006)

3.1.2 Domestic Automobile Sales

In 2005, domestic demand grew by 12.36% to reach 703,405 units. Toyota and Isuzu still dominate the overall vehicle market with a combined 65% market share. For one-ton pickup segment, Isuzu and Toyota also dominate it with a market share of 37% and 35 percent respectively. The rest is divided up between Mitsubishi, Nissan, Chevrolet, Ford and Mazda. The sales of passenger cars, which are increasingly becoming diesel powered because of petrol price increases, are dominated by Toyota, which accounts for 48% of the segment in 2005. Honda ranked second in this segment with a 30.35% market share. More details can be seen in figure 3.3 and figure 3.4.

Figure 3.3: Domestic Automobile Sales during 1996-2005

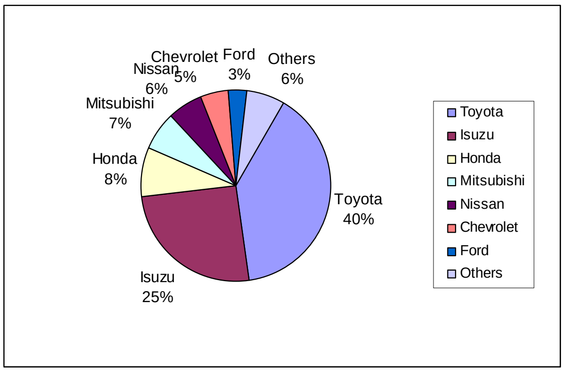


	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2004/2005 Change (%)
Passenger Cars	172,730	132,060	46,300	66,858	83,106	104,502	126,353	179,005	209,110	188,211	-9.99%
One-Ton Pickup	327,663	188,324	81,263	129,904	151,703	168,639	241,266	309,114	368,911	469,657	27.31%
Others	88,733	42,772	18,644	21,568	27,380	23,911	41,743	45,057	48,005	45,537	-5.14%
Total	589,126	363,156	146,207	218,330	262,189	297,052	409,362	533,176	626,026	703,405	12.36%
Change (%)	3.07%	-38.36%	-59.74%	49.33%	20.09%	13.30%	37.81%	30.25%	17.41%		

Source: Thailand Automotive Institute (2006)

Figure 3.4: Domestic Market Share in 2005

Rank	Manufacturer	Number of Vehicles Sold	Market Share
1	Toyota	277,955	39.52%
2	Isuzu	176,718	25.12%
3	Honda	58,515	8.32%
4	Mitsubishi	47,419	6.74%
5	Nissan	40,602	5.77%
6	Chevrolet	33,939	4.82%
7	Ford	23,449	3.33%
8	Others	44,808	6.37%
	Total	**703,405**	100.00%



Rank	One-Ton Pick Up	Number of Vehicles Sold	Market Share
1	Toyota	177,627	37.82%
2	Isuzu	165,582	35.26%
3	Mitsubishi	37,024	7.88%
4	Nissan	31,517	6.71%
5	Chevrolet	25,592	5.45%
6	Ford	19,572	4.17%
7	Mazda	12,743	2.71%
	Total	**469,657**	100.00%

Rank	Passenger Cars	Number of Vehicles Sold	Market Share
1	Toyota	90,298	47.98%
2	Honda	57,121	30.35%
3	Chevrolet	8,347	4.43%
4	Mitsubishi	8,136	4.32%
5	Nissan	6,684	3.55%
6	Mazda	5,085	2.70%
7	Others	12,540	6.66%
	Total	**188,211**	100.00%

Source: Thailand Automotive Institute (2006)

Locally assembled vehicles currently account for 95% of the domestic market since imported vehicles are normally more expensive due to high import tariffs. One-ton pickup truck is the most popular type of automobile in the Thai market which accounts for approximately 67% of the vehicles sold in Thai market in 2005. A total of 469,657 one-ton pickups had been sold in the market compared with 188,211 passenger cars in 2005. Japanese automobiles have dominated the local auto market, with nearly 90% market share.

Many of the existing vehicle manufacturers have increased their investments to fortify their business positions in the Thai market. In recent years, Daimler Chrysler (Mercedes-Benz) and BMW have also increased their investment to gain complete control on local manufacturing and marketing operations. Moreover, some vehicle brand owners that have no local assembling operations are expected to officially introduce their assembling plan in Thailand to take advantage of the CKD[2] duty. In addition, numbers of new global parts manufacturers are expected to establish their operations in Thailand (TAPMA, 2003).

3.1.3 Automobile Export

The number of exported vehicles has been continuously increasing in the last decade. In 2005, the number of exported vehicles in Thailand has increased by 32.72% over 2004 to reach 440,715 vehicles. This figure suggests that approximately one-third of total production in Thailand was exported to foreign markets. The total value of vehicle exported in 2005 is 203,025.36 Million Baht. This figure reflects a 36.05% increase over the previous year. Majority of the exported vehicles are one-ton pick ups and passenger cars. The main export markets are Indonesia, Singapore, Philippine, Australia, and Japan. The details can be seen in figure 3.5.

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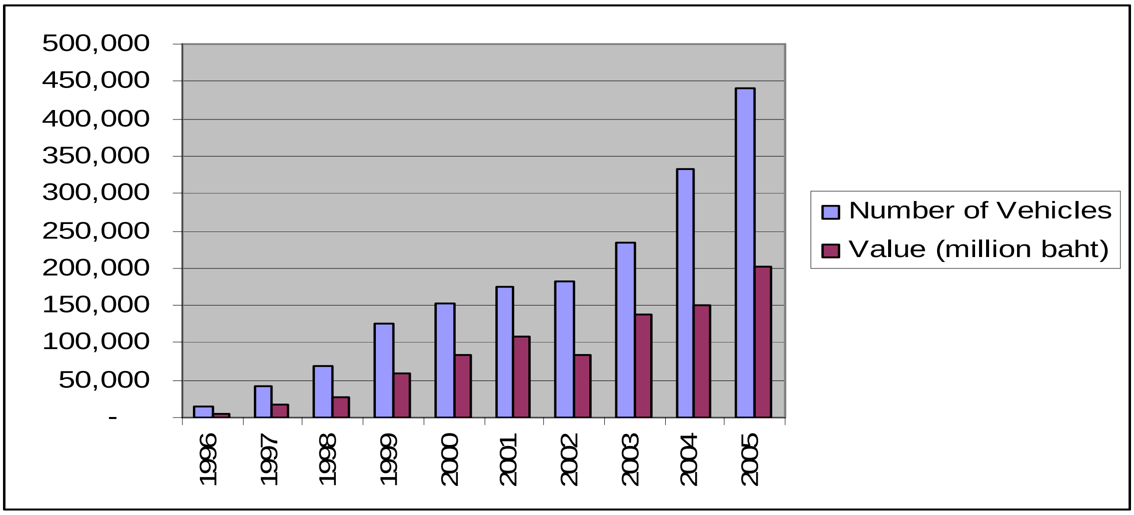
[2] CKD stands for Complete, Knocked Down, which is a type of car kit including all parts. To avoid import taxes and duties, the manufacturer normally increases the share of parts produced by local manufacturers, such as tires, wheels, seats, headlights, windscreens and glass, batteries, interior plastics, etc. down to the engine and transmission.

Figure 3.5: Automobile Export during 1996-2005



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Number of Vehicles	14,020	42,218	67,857	125,702	152,836	175,293	181,471	235,042	332,053	440,715
Value (million baht)	4,253	16,227	28,126	60,103	83,044	107,918	82,826	138,161	149,233	203,025
Change in Vehicles (%)	59.23%	201.13%	60.73%	85.25%	21.59%	14.69%	3.52%	29.52%	41.27%	32.72%
Change in Vlaue (%)	104.27%	281.51%	73.33%	113.69%	38.17%	29.95%	-23.25%	66.81%	8.01%	36.05%

Source: Thailand Automotive Institute (2006)

3.1.4 Automotive Parts Export

According to statistics from the Thai Automotive Industry Association, the country's auto parts exports were valued at 226 billion baht in 2005. The list of major exported automotive parts and their export values are illustrated in table 3.1. The main customers of these automotive parts are Japan, USA, Malaysia, South Africa, and Indonesia.

Table 3.1: Exports Components and Values in 2005

Component	Export Value (Billion Baht)
Auto Parts and Accessories	91
Engines	55
Vehicle Tires	35
Motorcycle Components	14
Wires and Cables	11
Batteries and components	5
Safety Glass	4

Source: Thai Automotive Industry Association (2006)

3.1.5 Domestic Production and Joint Venture

The Thai auto part industry currently incorporates 709 Original Equipment Manufacturers (OEMs). These local part manufacturers supply approximately 80% of all the parts used for the assembly of pickup trucks, approximately 55% for passenger cars and nearly 100% for motorcycles. Locally produced or assembled parts include engines, suspension control and spring, axles, hubs, propeller shaft, brakes, clutches, steering systems, body parts, electronic parts, air conditioning, tires, wheels, internal and external trim components and glass.

Approximately 80% of the country's overall auto assembling capacity belongs to Japanese makers. Most of these OEMs are mainly members of Japanese keiretsu groups supplying their own customer base. Keiretsu is a Japanese term describing a loose conglomeration of companies sharing one or more common denominators. In this case, Japanese car assemblers dominate a group of companies which are categorized into three groups: a member in Japanese family companies, a joint venture with Japanese technology owners, and a company having technical assistance or licensing agreements with Japanese firms. There are also companies that are wholly owned by Thai investors. However these companies are mostly second-tier, third-tier suppliers, or REMs.

In recent years, the number of parts manufacturers for non-Japanese assemblers has increased considerably as a result of Auto Alliance (Ford) and General Motors establishment in the Thai automotive industry. The American assemblers have brought a number of their own first-tier suppliers to Thailand. Although European assemblers entered the market earlier, they tend to have fewer local part suppliers due to their small assembling volume. Thus, they usually have a much higher imported content and in-house part manufacturing compared with the Japanese assemblers.

3.1.6 Industry Summary

Double digit export growth over the past few years illustrates Thailand's rising significance as a regional automotive manufacturer and supplier. Thailand gains several benefits derived from trade agreements such as Free Trade Agreements signed with Australia, New Zealand, China and India and the market opening opportunities in Southeast Asia created by the ASEAN Free Trade Agreement. These agreements allow lower tariffs for Thai vehicles imported to those countries compared with vehicles imported from other countries that do not have such agreement. Several major automobile manufacturers rely on their Thai operations to serve both domestic and regional demand. Toyota, Honda, and Ford have or are in the process of establishing Research and Development Centers in Thailand in order to support their global operations. Nissan currently plans to establish a production base with the aim to export automobiles from Thailand to 100 countries within 3 years. Thailand will be Nissan's third strategic export base after Japan and Mexico in the near future. Nissan will gradually increase the number of exported vehicles starting from 70,000 vehicles a year compared with approximately 40,000 vehicles in the past.

Thailand's extensive supporting network of auto parts manufacturers is a crucial advantage contributing to the industry's strength while giving Thailand an edge over competitors. With over 700 OEM auto parts suppliers and 1,000 in supporting industry together employing more than 217,000 workers, Thailand enjoys a reputation for having a strong supply base. Thailand Automotive Institute (TAI) has developed an 8.7 billion baht plan to further cement the "Detroit of Asia" title that includes five key projects illustrated in table 3.2.

Table 3.2: Five Key Projects Developed by Thailand Automotive Institute

No.	Project Description	Project Value (Baht)
1	Human resources development program	1.5 billion
2	Automotive experts dispatching program to establish clusters and upgrade auto parts manufacturing technology	500 million
3	Establishment of research and development centers	6 billion
3.1	Auto parts testing centers	1.5 billion
3.2	Car-testing tracks	4.5 billion
4	Information technology center to analyze industry trends	500 million
5	Automobile export promotion center	200 million

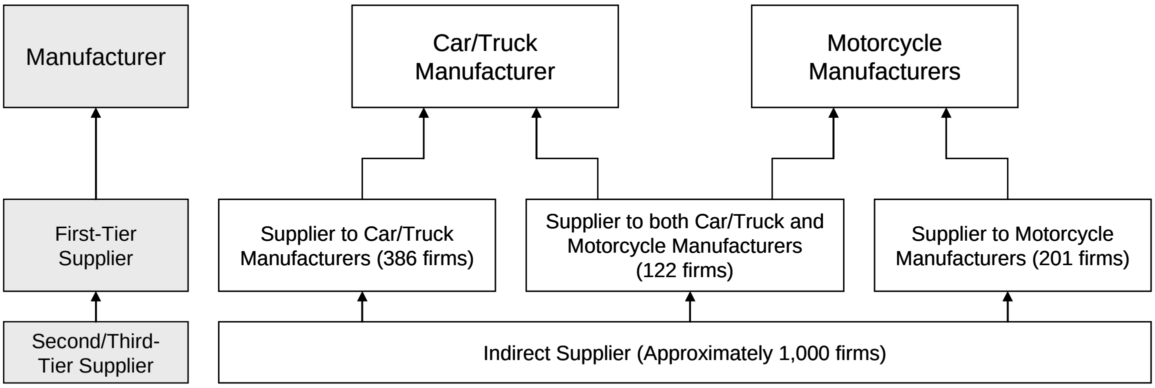
Source: Thailand Automotive Institute (2004)

Thailand Automotive Institute (TAI) believes that the implementation of these projects would help expanding the value of automotive and auto parts industry to 1.3 trillion baht (US$ 32.5 billion) by 2010. However, Thai government has recognized that in order to achieve the stated goal, a second product champion will be required in addition to the one-ton pickup. The master plan for the automotive industry has proposed the so called "Ecocar" as that second product champion. It is expected that the government will apply a significantly lower excise rate to the Ecocar to make commercial manufacturing of Ecocar viable and to position the Ecocar as a low cost alternative within the Thai new car market. For many reasons stated above, Thailand has the edge in being a regional automobile production base and will compete strongly in the years ahead to reinforce its status as the Detroit of Asia.

3.2 AUTOMOTIVE INDUSTRY SUPPLY CHAIN

The automotive supply chain can be divided into downstream and upstream supply chains. The downstream automotive supply chain comprises car distributors and dealers. The upstream automotive supply chain, on the other hand, consists of supply chain members situated in the supply side of the automotive industry, i.e. first-tier, second-tier and third-tier suppliers as well as raw materials suppliers. According to the Department of Export Promotion, upstream automotive industry consists of approximately 1,709 auto-parts suppliers, which can be divided into 709 OEM and direct supplier firms and approximately 1,000 indirect supplier firms. Among these 709 OEM suppliers, it can be divided into three groups (TAI, 2002). The first group consists of 386 OEM supplier firms that supply products directly to car industry. The second group, including 201 OEM supplier firms, is direct suppliers of motorcycle industry. The last group, consisting of 122 OEM supplier firms, is direct suppliers of both car and motorcycle industries. These three groups are referred to as first-tier suppliers in the automotive industry. The structure of upstream automotive supply chain can be seen in figure 3.6.

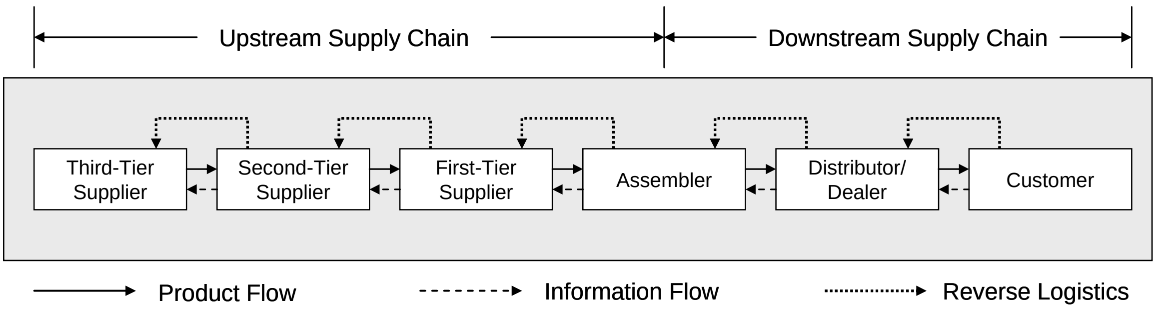
Figure 3.6: Structure of Upstream Automotive Supply Chain



Source: The Author

The second-tier and third tier suppliers, encompassing the rest of approximately 1,000 firms, are considered as supporting industry. These firms are the suppliers that support component and raw materials to the first-tier suppliers. However, it has been known that some of theses indirect suppliers also act as direct suppliers. The firms in second-tier and third-tier can also be classified into two groups. The first group is a group of SMEs that supplies raw materials and auto-parts to the first-tier suppliers. Industries such as, leather, plastic, rubber, steel, electrical and electronic, glass, color and coating and petrochemical industries are included in this group. The second group is a group of SMEs that supplies equipments, such as, mould and die, jig and fixture, casting, tooling, cutting, surface treatment, heat treatment, precision, electronic connector, engineering plastic, etc. to the first-tier suppliers. The generic supply chain of the Thai automotive industry can be seen in figure 3.7.

Figure 3.7: Generic Supply Chain of the Thai Automotive Industry



Source: The Author

3.3 REVERSE LOGISTICS AND SUPPLY CHAIN INTEGRATION IN THE THAI AUTOMOTIVE INDUSTRY

This section explains the nature of reverse logistics and supply chain integration in the Thai automotive industry based on the information gained during interviews with experts working in automobile manufacturers and suppliers.

In general, automobile assemblers normally act as focal firms in automotive supply chain. These manufacturers have more negotiation power than suppliers. When a manufacturer is sourcing for a spare part, it will specify product specifications, requirements, and related instructions in the "supplier manual" which requires a supplier to follow strictly. The supplier manual also includes the requirements and instructions on reverse logistics procedure that a supplier must perform when a manufacturer inform any problem with delivered products. There are normally two kinds of problems with the product delivered to a manufacturer; defective product and incorrect shipment. Defective product is caused by the discrepancy between actual product and what is specified as specification in the supplier manual. When the delivered product is found to be defective, a manufacturer will instantly inform the supplier and request for action. This process is normally done by phone to avoid a delay. A supplier will send a quality assurance (QA) officer, along with replacement parts, to the customer's site and perform inspection on the defective product. If the inspection shows that the product is really defective, the QA officer will replace the defective product with the new one. If the product is large and cannot be carried along with the QA officer, it will be arranged for delivery again by truck as soon as possible. After the replacement is made, a manufacturer will create an official claim document on its computer system so that a supplier could download the document and keep as a record. A supplier shall also respond to this document by reporting a reason that causes the defect and how to avoid this problem in the future. Reverse logistics may also cause by incorrect shipment. If the actual product shipment is not consistent with the order in terms of item or quantity, a manufacturer may ask for a replacement of some items or return the whole shipment to a supplier. The action depends on the negotiation between a manufacturer and a supplier. In either case, a supplier is required to take action instantly.

Reverse logistics is mandatory in the automotive industry. A manufacturer is involved with thousands of parts in the assembly line. Normally, a manufacturer will keep an inventory of each spare part, especially for large ones, only for few hours to minimize their inventory investment and warehouse space and to ensure just-in-time manufacturing. Every part must arrive on schedule to make sure that production operations are synchronized and uninterrupted. When there is a defective part, reverse logistics process must be done quickly. A manufacturer has the information on the inventory quantity of the spare part that they currently have on hand and the length of time before this inventory will be used up. The time before an inventory is used up is normally within a few hours for large parts and maybe a little longer for small parts. A supplier must take the returned product and provide a replacement within this time period. A supplier is usually required to keep 5%-30% extra inventory in order to provide a prompt service when the product is returned or when a manufacturer places an emergency order. The amount of extra inventory depends on the defect rate as well as the size of a part.

Parts can also be returned after the car left the assembly line. End customers may bring a car to service center to replace any broken parts during the warranty period. The dealer normally replaces the part with a new one for its customer and then contacts the manufacturer to make a claim for the part. The reverse logistics in this situation is not as urgent as the case when a product replacement is required for assembly line. A dealer normally holds enough spare part inventory to serve its customer and it can also order a new part to serve its customer before making a claim on the replacement. The claim is done by contacting the manufacturer with phone, fax, or e-mail to provide information of the defective part. A photo or other information will be sent to the manufacturer to get a return authorization code. The manufacturer has the right to request the failed part to be shipped back for examination. When the claim is approved, the manufacturer may send a replacement to its dealer or to credit the money back to the dealer's account depending on the agreement made between them. The returned part that arrives at the manufacturer will be initially examined. If the problem is due to the quality of the spare part, the manufacturer will contact the supplier of that part and make a claim. However, these processes do not require instant action that is taken when the defective product is found in the assembly line. This whole process may take weeks to complete.

There are several options to process returned products depending on the nature and characteristic of the products. If a defect is caused by manufacturing operation of a first-tier supplier, a supplier may re-use the returned product as a raw material, remanufacture the part, or destroy it. If the defect is caused by a part supplied by a second-tier supplier, the second-tier supplier will be informed and requested to send its QA officer to inspect the defective part. The processes of inspection, part replacement, and claim will be very similar to the cases between manufacturer and first-tier supplier. These processes illustrate that reverse logistics is not only crucial for automotive industry, but also a mandatory. All manufacturers require their suppliers to perform reverse logistics process in an effective and efficient manner. Suppliers that do not conform to these requirements will not be accepted and will not be able to operate in the industry.

The result of expert interviews also suggested that supply chain integration does exist in the automotive industry. Several kinds of information are shared among supply chain members. For example, a manufacturer normally shares a three-month demand forecast and production planning with its suppliers. Many suppliers even request for a monthly demand forecast. The information will be put on a manufacturer's information system server and can be downloaded by related suppliers. If a supplier cannot deliver as the plan, it must inform a manufacturer so that an alternative sourcing can be considered. A supplier also provides a manufacturer with a "flow chart" with details on the components that are included in its products. For each component, a supplier shall provide details on the component parts, drawing, features and functions of the parts, supplier information of these parts, lot numbers, their arrival schedules, and emergency plan if these parts do not arrive on schedule. A manufacturer, as a focal firm, will track down the root cause of each problem together with its first-tier supplier as well as second/third-tier suppliers. Cooperation among supply chain partner will be made to solve a problem.

Internal integration is also found in the automotive industry. The QA officer needs to inform a department responsible for inventory in order to get a replacement for defective product before going to customer site. The QA officer also discuss with a production department on the defective products to find a cause of problem. A production department also discuss with production engineer to find a way to improve a process. The order information will also be shared across a company. A manufacturer provides a real-time order on an hourly basis, with several orders within one day. A sales department must share this information with production department, inventory department, and logistics department in order to serve the requirement of a manufacturer on time. In addition, a work plan is made together by these departments.
A manufacturer normally communicates with its supplier by several means. In the case of emergency, such as defective product, a communication is initially made by phone. A required written document can be made later and sent to a supplier by e-mail or post on a manufacture's server. It was found during the interviews that e-mail is the most popular means of communication among supply chain members. There are several reasons for the popularity of e-mail. E-mail provides a means of communication at a relatively low cost and more flexibility compared with other means such as EDI. E-mail also provides a written document that can be kept as a record which is not feasible in the case of telephone. In addition, there is no problem of system incompatibility among firms since e-mail becomes a global standard that most people use.

A supplier of a large manufacturer normally has a log-in access to a manufacturer's server to download information such as orders, forecasts, newsletters, and other documents on a daily basis. A large-scale supplier may also have its own system. From the interview with a small, project-based car manufacturer, a large manufacturer such as Ford Operation (Thailand) provides its customer with a user name and password to log on to its server and place and track orders online. Electronic Data Interchange (EDI) is also used among large-scale suppliers and some manufacturers while small suppliers may communicate with a manufacturer via e-mail, phone, or fax. The absent of EDI among small suppliers is due to its implementation costs.

There are comments regarding to the resource commitment and information system support in reverse logistics process during the interviews with car assemblers. Both of the car assemblers that were interviewed noted that there is no information system support or resource commitment that is solely dedicated to the reverse logistics process in the Thai automotive industry. Reverse logistics process is seen as a part of overall logistics process. Both forward and reverse logistics usually share the same pool of resources and information system support. For example, the web-site that used to communicate between an assembler and a supplier provides information regarding to both forward and reverse logistics. They further commented that there is no need for specific equipment or system to handle reverse logistics process in the Thai automotive industry. Reverse logistics processes are handled by the same equipment and system used for forward logistics. Management, therefore, normally do not commit any resource specifically to the reverse logistics program, but rather to the logistics program in general. This information illustrates discrepancies between what is said in the literature and what is really done in the Thai automotive industry.

3.4 CONCLUSION

The Thai automotive industry is continuously growing in the last five years and is very crucial for the growth of Thai economy. Manufacturers and suppliers in this industry have been striving to improve the efficiency and effective of their operations to enhance their competitiveness. Thus, logistics and supply chain management has become more popular in this industry especially in the last decade. However, many firms still ignore the importance of reverse logistics. Reverse logistics should be considered another important aspect of logistics in this industry since its operations is heavily involved with the return process. Product returned are commonly seen in this industry for several purposes such as replacement, repair, remanufacture, or even recycle. These processes incur several logistics costs including handling costs, transportation costs, and inventory holding costs that involved with the returns. Although costs involved with reverse logistics may not represent the major portion of logistics costs of a firm, but it cannot be ignored in the industry with a lot of reverse logistics activities.

CHAPTER 4

HYPOTHESES DEVELOPMENT AND RESEARCH METHODOLOGY

The previous chapters discussed on the literature related to the constructs of interest in this study and a review of the Thai automotive industry to provide insight to the context of this study. In this chapter, it can be divided into two main parts. The first part discusses a conceptual framework and proposes hypotheses developed to answer the main and subsequent research questions proposed in Chapter 1 which are:

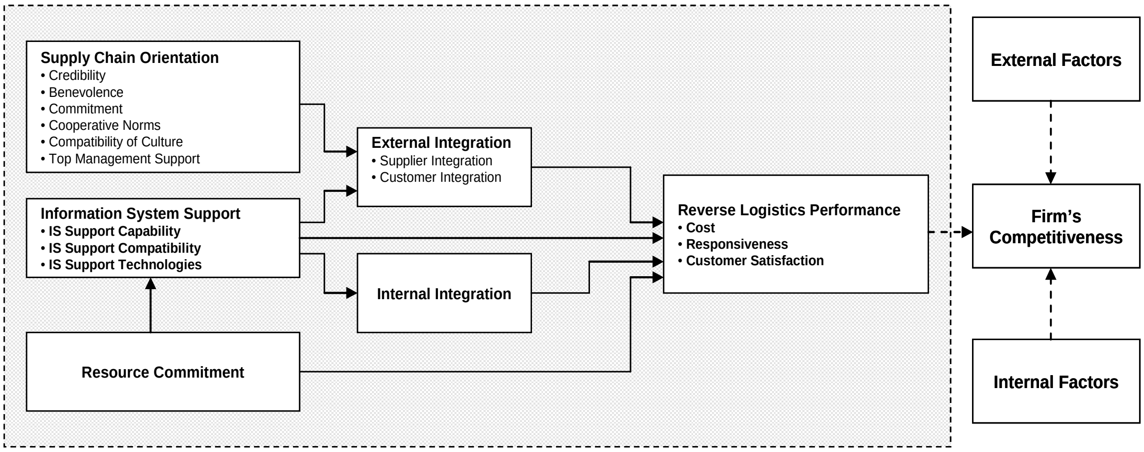
- Main research question:
  "What are the important factors that influence reverse logistics performance and how do these factors affect the performance of reverse logistics process?"
- Specifying research questions:
  1. What is reverse logistics and how can reverse logistics contribute to the competitive advantage of a firm?
  2. What are the factors that influence the performance of reverse logistics processes?
  3. How does information system support directly and indirectly influence the reverse logistic performance?
  4. How does resource commitment directly and indirectly influence the reverse logistic performance?
  5. How do external integration and internal integration influence the reverse logistic performance?
  6. Is supply chain orientation an antecedent of external integration?

The second part discusses about the research methodology by going through topics starting from research design to methods for data analysis.

4.1 A CONCEPTUAL FRAMEWORK OF REVERSE LOGISTICS PERFORMANCE

Based on the literature review, the framework of this dissertation focuses on several factors that were expected to influence reverse logistics performance. Information system support and resource commitment were derived from the previous researches related to reverse logistics performance while external integration, internal integration, and supply chain orientation were added into the framework based on a review of logistics/supply chain literature. The conceptual framework presented in figure 4.1 illustrates the relationships among supply chain orientation, information system support, resource commitment, external integration, internal integration, and reverse logistics performance.

Figure 4.1: A Conceptual Framework of Reverse Logistics Performance



Source: Author

Based on the literature review, the proposed framework illustrates that while reverse logistics performance was expected to enhance competitiveness of a firm, there are other internal and external factors that also provide a firm with costs and value differentiation. Thus, the analysis of this framework was separated into two parts. The first part was done to answer the proposed research questions. In this part, the proposed model in the highlighted area was examined by a quantitative method to investigate relationships among constructs in the model including reverse logistics performance. The second part aimed to investigate a consequence of reverse logistics performance on a competitive advantage by qualitative means such as literature review and in-depth interview.

In this study, a set of control variables consisting of firm size, ownership structure, nationality of foreign shareholder, and sales volume was also proposed. The details of these control variables can be seen hereunder.

- **Firm Size:** Firm size is considered one of the most frequently studied contextual variables. Firm size was proposed as a control variable in this study due the possibility that firm size may affect the level of information system support, resource commitment, external integration, internal integration, and reverse logistics performance. Many of the previous literatures placed considerable emphasis on the size of a firm, especially because of the resources advantage that large firms possess and use to compete. The greater the resources of a firm, the higher capabilities of a firm to invest in information system support. In addition, large firms tend to have more negotiation power to force their partners on the implementation of supply chain integration. Finally, large firms may have a better system in place to effectively and efficiently handle reverse logistics process while small firms may be struggle in investing in such systems. Firm size in this study was defined by the number of employees. There are currently several definitions of small and medium enterprises (SMEs). In Thailand, the Office of Small and Medium Enterprises Promotion defined that, in the manufacturing sector, the SMEs are business entities that have fewer than 200 employees. However, firms in automotive industry are normally capital and labor intensive and tend to be larger than firms in other industries. Thus, this classification scheme may not be appropriate for the Thai automotive industry. In addition, in order to make the result of this research comparable with those of other international studies, this study utilized an international standard definition provided by the United States Small Business Administration (2003) which is frequently used by many researchers. The United States Small Business Administration recommended a threshold level of 500 employees, suggesting that a small firm should have fewer than 500 employees while a large firm has 500 employees or more.

- **Ownership Structure:** Ownership structure was proposed as a control variable in this study in order to remove the effect of foreigner on the degree of external integration and internal integration. Many experts suggested that the level of external integration and internal integration may be different between a Thai-owned firm and a joint venture or a foreign-owned firm since those firms may already have a system in place to facilitate external integration and internal integration. For example, a member of Japanese keiretsu groups may automatically integrate its operations with its supply chain members in the same group. Thai-owned firms, on the other hand, may take more time to blend themselves into the system and to possess the same level of external integration and internal integration. According to TAPMA (2003), ownership effect in this study is divided into four subgroups, consisting of pure Thai, Thai majority joint venture, foreign majority joint venture, and pure foreigner.
- **Nationality of Foreign Shareholder:** The nature of business operation, working style, and the extent of external integration and internal integration may be depending on the nationality of a shareholder of a firm. Firms with shareholders coming from different regions may give business priority on different issues. For example, Japanese firms normally focus on cooperation and coordination of business operations among group members while US firms normally emphasize on operation costs and efficiency. Thus, this study divided firms into four groups based on the nationality of foreign shareholders, i.e. Japanese shareholders, American shareholders, European shareholders, and shareholders from other countries.
- **Sales Volume:** As in the case of firm size, sales volume may affect the level of information system support, resource commitment, external integration, internal integration, and reverse logistics performance. Firms with large sales volume tend to be in a better financial position to invest in information system and other systems to facilitate the reverse logistics operation. In addition, managers of these firms do

not feel hesitate to commit several kinds of resources to improve the logistics process as well as external integration and internal integration. Thus, sales volume was also proposed as another control variable in this study.

4.2 HYPOTHESES DEVELOPMENT

4.2.1 External Integration and Reverse Logistics Performance

While integrating internal process can reduce redundancies in the operations, linking internal work processes with those of suppliers is as necessary. External integration allows synchronization of the core competencies to jointly improve service capabilities at lower total supply chain cost by reducing operational waste and redundancies (Stank et al. 2001a; Rodrigues et al., 2004; Gimenez and Ventura, 2005; Forza, 1996; Vargas et al., 2000). Successful integration should result in efficient logistics operations and significant performance improvement (Daugherty et al., 1996; Bowersox and Daugherty, 1995; Stank and Lackey, 1997; Boyer et al., 2003; Ellinger et al., 2000; Kahn and Mentzer, 1996; Stank et al., 1999). Since reverse logistics is a part of logistics process, it can be expected that such integration also enables efficient reverse logistic operations.

Customer integration allows a firm to access customer requirements and expectations which enables management to provide better service that its competitors cannot effectively match. In reverse logistics, managers that recognize customer value and design offerings to meet the specific value proposition will be able to enhance a performance of reverse logistics process. Customer integration allows a firm to continuously match its service capabilities with emerging customer expectations and enhance a performance of reverse logistics process. Furthermore, when conditions change and require alteration of standard return procedure, integrated suppliers are better positioned to quickly and accurately respond to customers' special requests.

While supply chain integration has been credited with achieving cost reductions, increasing efficiency and higher productivity (Gustin et al., 1995; Lambert et al., 1978; Rogers et al., 1992), it was frequently cited as providing benefits in the forms of reductions in inventory, shorter lead times, customer service enhancements, and improved forecasting and scheduling (Muller, 1991). Such improvement partly comes from the effective and efficient reverse logistics operations. Thus, the first hypothesis is proposed as follow:

H1: There is a significant positive relationship between External Integration and Reverse Logistics Performance.

External integration consists of two dimensions which are supplier integration and customer integration. These two dimensions may affect reverse logistics performance in different ways. Thus, another two sub-hypotheses are proposed below:

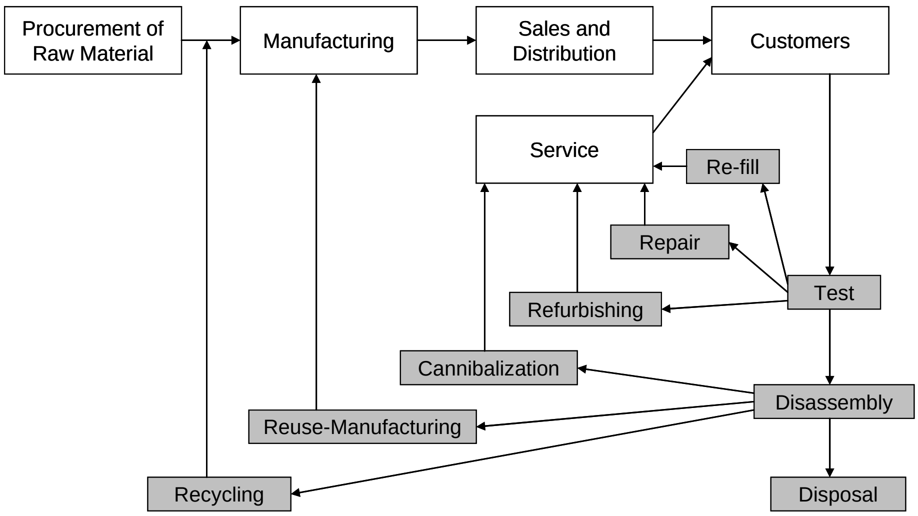
H1a: There is a significant positive relationship between Supplier Integration and Reverse Logistics Performance.

H1b: There is a significant positive relationship between Customer Integration and Reverse Logistics Performance.

4.2.2 Internal Integration and Reverse Logistics Performance

Reverse logistics process involves with many departments such as sales, service, manufacturing, marketing, and procurement. Figure 4.2 illustrated the possible movements of products returned to a company, which also involve with complicated information flows among departments. There is a need to share information among these departments in order to help managers making appropriate decision on procurement, inventory level of raw materials and spare parts, production schedules, and sales and marketing plan. Aligning internal activities is vital to eliminating parallel processes and work duplication. Top firms enhance performance by applying standardized operational and administrative practices to simplify operations and work routines to reduce the complexity associated with reverse logistics process. Such simplification and standardization allows a firm to enhance its responsiveness as well as to reduce operational costs. Suppliers who integrate cross-functionality among internal departments are in better position to set and meet more effective return delivery schedule that benefits their customers.

Figure 4.2: Reverse Logistics Options and Departments Involved with Each Alternative



Source: Krikke et al. (2003)

Internal integration among functional areas such as purchasing, production, scheduling, distribution, and sales is also associated with better inventory management and higher level of logistics performance (Stank and Lackey, 1997; Stank et al.; 2001b; Gimenez and Ventura, 2005). In the reverse logistics context, better internal information sharing and communication lead to the reduction of inventories for spare part as well as remanufactured and new products due to better forecasting and planning of reverse flows. Integration between reverse logistics process and production can reduce the stock level while avoiding spare part stock-outs, which is a main problem of long lead-time for repair services. High level of responsiveness and short cycle time leads to better customer satisfaction and better reverse logistics performance. From the reasons above, the second hypothesis is proposed that:

H2: There is a significant positive relationship between Internal Integration and Reverse Logistics Performance.

4.2.3 Information System Support and Reverse Logistics Performance

Information exchange has been recognized as a key logistics capability that enables improved firm performance (Bowersox et al., 1999; Zhao et al., 2001; Bharadwaj, 2000; Kearns and Lederer, 2003; Edward et al., 2001). Information system is providing an opportunity for companies to lower costs dramatically across the supply chain and to enhance quality of services (Edward et al., 2001; Stank and Lackey, 1997). In addition, information system can lead to better efficiency and effectiveness of the supply chain by minimizing cycle time, identifying optimal inventory levels, reducing warehouse space, and increasing inventory turnover (Narasimhan and Kim, 2001; Jayaram et al., 2000; Kaeli, 1990; Kaplan, 1986; Shull, 1987).

Integrated information systems would not only enhance quality as well as reduce cycle times and costs, but also eventually enhance the company's competitiveness and position it for future growth (Goldhar and Lei, 1991; Huggins and Schmitt, 1995; Kaeli, 1990; Kaltwasser, 1990; La Londe and Masters, 1990; Earl, 1989; Earl, 1993; Ives and Jarvenpaa, 1991; Kathuria et al., 1999; Porter and Millar, 1985). Information system allows customers to experience shorter lead time to get return authorization or credit approval as well as continuously available returns information. This will boost up customer satisfaction with the service of a firm. Based on the reasons above, it is proposed that:

H3: There is a significant positive relationship between Information System Support and Reverse Logistics Performance.

4.2.4 Information System Support and External Integration/Internal Integration

Information system support not only provides an opportunity to lower costs across the supply chain, but also acts as a part of the infrastructure supporting the integration of the extended enterprise. Information system support is the most important ingredient for supply chain integration that significantly improves the extent of internal and external information sharing (Daugherty et al., 1996; Edward et al., 2001). In addition, information system also supports the strategic linkages and increases coordination among supply chain partners to enhance the level of supply chain integration (Sanders and Premus, 2005; Bowersox, 1989; Vickery et al., 1999). Supply chain integration would not be feasible without the access to information that is accurate, timely and affordable (Bowersox and Calantone, 1998).

The literature suggested that the utilization of effective information technologies which give information capabilities and information compatibilities among supply chain members is expected to enhance the level of supply chain integration (Narasimhan and Kim, 2001; Moberg et al., 2002; Sander and Premus, 2005). Thus, the following hypotheses are proposed as follow:

H4: There is a significant positive relationship between Information System Support and External Integration.

External integration has two sub-dimensions; supplier integration and customer integration, which may be influenced by information system support in different ways. Thus, two sub-hypotheses are proposed below:

H4a: There is a significant positive relationship between Information System Support and Supplier Integration.

H4b: There is a significant positive relationship between Information System Support and Customer Integration.

Another hypothesis is also proposed to represent the relationship between information system support and internal integration as shown below:

H5: There is a significant positive relationship between Information System Support and Internal Integration.

4.2.5 Resource Commitment and Reverse Logistics Performance

Reverse logistics, as with most business operations, requires a wide range of resources ranging from personnel to technology-related resources. Resources are necessary for a reverse logistics program to reduce costs and improving customer service (Richey et al., 2005). Reverse logistics program will not be successful without a resource commitment to the implementation of the program (Tibben-Lembke, 2002).

The literature suggested that the lack of commitment in several types of resources is a cause of poor reverse logistics performance (Daugherty et al., 2001; Richey et al., 2004; Tibben-Lembke, 2002). Thus, a resource commitment in the technology to provide a good system is needed to enable an implementation of reverse logistics program. In addition, management shall commit financial resource to the reverse logistics program to facilitate the procurement and the implementation of a system or technology. Thus, financial resources are necessary to the development of reverse logistics program no matter if the program is developed internally or outsourced to the third-party. Finally, without managerial commitment, the management would not pay attention nor commit financial and technological resources to the reverse logistics program. Thus, a commitment in three types of resources, i.e. technological, managerial, and financial resource commitment, is required in order to overcome the early challenges and to implement a successful reverse logistics program (Das and Teng, 2000; Richey et al., 2004). The literature also suggested that firms committing more management resources to reverse logistics are more successful at achieving better reverse logistics performance than firms committing lower amounts of managerial resource to the program (Daugherty et al., 2001). Thus, sixth hypothesis is stated as follow:

H6: There is a significant positive relationship between Resource Commitment and Reverse Logistics Performance.

<u>4.2.6 Resource Commitment and Information System Support</u>

Most of the managers agree that one of the roles of information technology in their organization is to reduce costs. However, in order to get information system support in place, a firm must invest in the procurement and implementation of such system. It was estimated that several large firms spend up to 50 percent of their annual capital expenditures on IT/IS systems (Earl, 1989; Willcocks, 1992). Thus, a firm that lack financial resources would not be able to invest and implement any information system support.

In addition to financial resource commitment, managerial commitment is also needed to invest in new technologies and to combat any resistance to change (Moberg et al., 2002). Manager must commit in new information technologies and thereby find a way to get through the period of change. The implementation of information technologies is likely to fail without managerial resource commitment. In addition, technological resources commitment enables manager of a firm to make decision on investing in information systems. A firm that lacks these commitments would not be able to implement an information system nor having an access to it. Information system support is possible only when managers of a firm have resource commitment and provide financial, managerial, and technological resources to support the operation. Thus, it is proposed that:

H7: There is a significant positive relationship between Resource Commitment and Information System Support.

4.2.7 Supply Chain Orientation and External Integration

Supply chain orientation, based on literature review, is closely related to the coordination and integration of business processes and flows with those of other members of the supply chain to deliver value to customer advantage based on end-customer delivery (Stank et al., 2005; Mentzer et al., 2001; Bowersox et al., 1999). In a firm with supply chain orientation, the focus of all activities is extended beyond the firm to include integration of flows across the supply chain. Supply chain orientation would lead a business unit to practice supply chain management, characterized as the integration of key business processes across the network of organizations from end user through original suppliers (Lambert, 2004; Min and Mentzer, 2004). The higher the level of supply chain orientation, the greater the level of integration of key business processes across the supply chain (Stank et al., 2005). Therefore, it can be concluded that supply chain orientation is an antecedent of supply chain integration while the lack of supply chain orientation is considered a major barrier to supply chain integration. It is proposed that:

H8: There is a significant positive relationship between Supply Chain Orientation and External Integration.

The two dimensions external integration may be influenced by supply chain orientation differently. Thus, two sub-hypotheses are proposed below:

H8a: There is a significant positive relationship between Supply Chain Orientation and Supplier Integration.

H8b: There is a significant positive relationship between Supply Chain Orientation and Customer Integration.

4.3 SUMMARY OF HYPOTHESES

The summary of all the hypotheses in this study is presented in table 4.1.

Table 4.1: Summary of Hypotheses in the Current Study

Hypotheses	Statement
1	There is a significant positive relationship between External Integration and Reverse Logistics Performance.
1a	There is a significant positive relationship between Supplier Integration and Reverse Logistics Performance.
1b	There is a significant positive relationship between Customer Integration and Reverse Logistics Performance.
2	There is a significant positive relationship between Internal Integration and Reverse Logistics Performance.
3	There is a significant positive relationship between Information System Support and Reverse Logistics Performance.
4	There is a significant positive relationship between Information System Support and External Integration.
4a	There is a significant positive relationship between Information System Support and Supplier Integration.
4b	There is a significant positive relationship between Information System Support and Customer Integration.
5	There is a significant positive relationship between Information System Support and Internal Integration.
6	There is a significant positive relationship between Resource Commitment and Reverse Logistics Performance.
7	There is a significant positive relationship between Resource Commitment and Information System Support.
8	There is a significant positive relationship between Supply Chain Orientation and External Integration.
8a	There is a significant positive relationship between Supply Chain Orientation and Supplier Integration.
8b	There is a significant positive relationship between Supply Chain Orientation and Customer Integration.

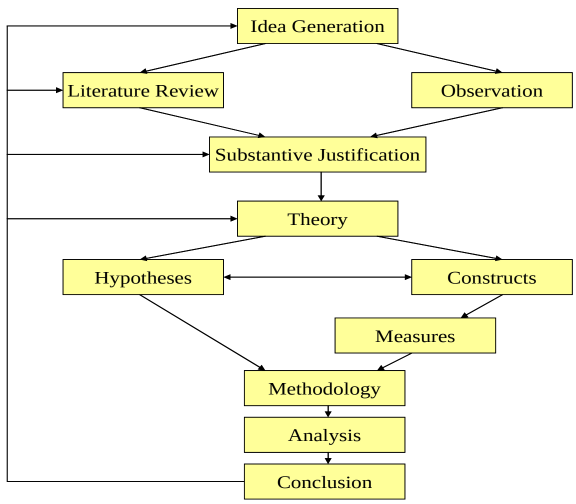
After the hypotheses development, the next part presents the research methodology of the current study. It begins with the explanation of the research framework, research design, and population and sampling method. The next section describes the main research tool for this study by discussing the development of measures for the constructs proposed in the model as well as the development of questionnaire. The detail on the data collection method is also presented by going through the steps of preliminary interview, pilot study, and data collection. Finally, the method of data analysis for this study is discussed.

4.4 RESEARCH FRAMEWORK

The current study employs a research framework derived from "A Framework of Logistics Research" defined by Mentzer and Kahn (1995). The authors defined a comprehensive perspective on the logistics research process as shown in the figure 4.3. The proposed framework is presented as an involved, continuous process that integrates three distinct dimensions of research stages which are 1) Idea Generation to Substantive Justification 2) Theory Construction to Methodology, and 3) Methodology to Conclusion and Future Research.

The research process begins with the generation of idea, which might arise from a literature review, observation, or both. Then the literature review is conducted in order to provide an historical perspective of the respective research area and an in-depth account of independent research endeavors. Observation is also done in order to establish general principles in the topic of interest. Literature review and observation are two forms of logical induction that leads to substantive justification. While substantive justification drives the researchers to develop research questions and provide the foundation and rationale of how the subject of interest will make a significant and important contribution to its discipline.

Figure 4.3 Framework of Logistic Research



Source: Mentzer and Kahn (1995)

After establishing substantive justification, the researcher shall derive theories about the current phenomena to be studied. Then the hypotheses are developed to conceptually link with the theory through the process of logical deduction. At the same time, constructs are developed and operationalized to represent different component of a theory. Measures that properly reflect these constructs shall also be developed to establish correspondence between the abstract constructs and the measurements. After the methodology is properly defined and conducted, the final stage of data analysis will be done in order to form conclusions that are rational explanations of observed relationships within research endeavor.

4.5 RESEARCH DESIGN

Descriptive research is research which describes the characteristics of population or phenomena (Zikmund, 2003). It is used to identify and obtain information of the characteristics of a particular problem or issue (Collis and Hussey, 2003). This research is a descriptive research with a main objective to investigate the relationship among supply chain orientation, information system support, resource commitment, external integration, internal integration, and reverse logistics performance. The model was proposed based on the literature review and previous research findings. Two independent variables, including supply chain orientation and resource commitment, were proposed in the model. In addition, information system support, external integration, and internal integration were proposed as mediating variables. These variables were expected to mediate the relationship between the supply chain orientation and resource commitment and reverse logistics performance, which is a dependent variable in this study. A questionnaire, developed from the related theoretical framework and previous studies, is a major research tool. In addition, two types of triangulation techniques defined by Denzin (1989) were also employed. The first technique was the data triangulation as the data were collected from several people in different positions of the Thai automotive supply chain. Experts from both car assemblers and first-tier suppliers were interviewed to provide insight information related to the model. The second technique was the "between" method triangulation, which combines dissimilar methods to investigate a set of data. The current study employs different research methods such as questionnaire survey, structured and unstructured interviews, and observation to obtain the required information in this study.

4.6 POPULATION AND SAMPLING

4.6.1 Population Identification

Thai automotive industry was selected in the current research based on several reasons. With the production capacity as well as domestic and export market size, Thai automotive industry is definitely important to Thai economy. In 2005, an automobile production alone, with approximated value of 500 billion baht, accounted for more than 5% of the country's GDP of 7,103 billion baht. In addition, Richey et al. (2005) mentioned that, for companies in the automotive industry, a large part of their distribution operations focuses on handling returns. Their day-to-day operations include the reclamation of used parts/products as well as returns of damaged product, overstocks, incorrect shipments, etc. These companies retrieve the items for re-manufacturing and/or refurbishing in preparation for re-sale. The interview with experts in Thai automotive industry also suggested that reverse logistics is mandatory in the industry. To ensure uninterrupted operations of the manufacturer, suppliers shall provide effective and efficient reverse logistics process to deal with returns of defectives products and incorrect shipments.

In addition, several studies involved with supply chain integration had been done in this industry (Van Hoek, 1998; Doyle and Snyder, 1999; Frohlich and Westbrook, 2001; Lemke et al., 2002; Spekman et al., 2002; Narasimhan and Kim, 2002). From the interview with experts and a previous research (Chookhiatti, 2005), it was found that supply chain integration does exist in Thai automotive industry. A relatively long production lead time, demand fluctuation, and the need for quick response in the industry requires integration among departments within a firm as well as integration with external parties to perform forecasting and planning. Customers normally share critical information about real market demand in the timely manner while suppliers put a lot of effort on just-in-time delivery to meet the tight schedule of production process. Towill et al. (2002) recommended that all of these parties must be unified or think and act as a single entity to avoid any delay in the fulfillment process. These reasons suggest that Thai automotive industry is appropriate for the investigation of the relationships between information system support, resource commitment, supply chain orientation, external integration, internal integration, and reverse logistics performance.

Thai automotive supply chain can be divided into upstream and downstream parts. The upstream supply chain deals with first-tier and second-tier suppliers while the downstream supply chain involves with distributors and dealers. The current study focuses on the upstream automotive supply chain due to a couple reasons. The first reason is related to the importance of reverse logistics activities in the upstream supply chain. Based on the in-depth interviews, reverse logistics is mandatory in the upstream supply chain of Thai automotive industry. In the upstream automotive industry, car assemblers are involved with the variety of auto-parts, for instance, engines, suspension control and spring, axels, hubs, and so on. When any product is defective, reverse logistics activities must be done at once to ensure an uninterrupted operation of the car assembler. In that case, reverse logistics becomes a top priority for both car assembler and supplier. The problem shall be solved as soon as possible, normally within a few hours. Although reverse logistics is also necessary in the downstream supply chain, it is less critical when compared with that in the upstream side. When a product is found to be defective in the downstream automotive supply chain, it may take days or weeks to complete the reverse logistics process. Another reason is related to the level of supply chain integration in the upstream automotive industry. TAPMA (2003) recommended that, to deal with a number of parties and variety of auto-parts, automobile manufacturers must have fully integrated activities with their suppliers. This complicated supply chain environment leads to the higher level of integration and information sharing among members in the upstream supply chain compared with the downstream supply chain.

The upstream automotive industry consists of approximately 1,709 firms which can be divided into first-tier, second-tier, and third-tier suppliers. A group of first-tier supplier firms that supply auto-parts, or automotive components, directly to car assemblers was selected as a target population in this study because of the following reasons.

First, this study investigates the relationship between internal and external integration and reverse logistics performance. Since external integration is divided into two dimensions, i.e. supplier and customer integration, the respondent shall be able to integrate its operations with both its customers and its suppliers. Automobile manufacturers were excluded from the sampling frame because their customers basically are dealers and consumers. Frohlich and Westbrook (2001) suggested that it should be careful when studying integration in settings where there are large customer bases. The broad variety of customer characteristics and requirements makes it more difficult for a firm to integrate with customers.

Another reason is due to the position of a first-tier supplier on the upstream automotive supply chain that is very appropriate for this study. The focus of this study is a direct supply chain that involves with second-tier suppliers, first-tier suppliers, and car assemblers. Automobile manufacturers were defined as the customers while second-tier suppliers were the suppliers in the supply chain. The exclusion of second-tier suppliers from the sampling frame was due to the fact that majority of suppliers for these firms are raw material manufacturers which may not be operating in the automotive industry and may have different supply chain nature.

Although car manufacturers and second-tier suppliers were excluded from the sampling frame, they are not out of the scope of this study. According to a concept of a direct supply chain (Mentzer et al., 2001), the selection of first-tier supplier also involved with its relationship that is extended from a dyadic perspective to view the relationships of three entities, i.e. a focal firm (first-tier suppliers), its supplier (second-tier supplier), and its customers (car manufacturer).

In addition, first-tier supplier was selected as a unit of analysis for this research because the number of first-tier suppliers is large enough for an empirical research. With seventeen car assemblers[1] in Thailand, the number of automobile manufacturers is not adequate to provide statistical inference for quantitative data analysis used in this study. For indirect suppliers which include second- and third-tier suppliers, although the number of these firms is even larger than that of the first-tier suppliers, the population of these firms has not been precisely defined. In addition, some of these firms which supply general raw materials or equipment are not even considered as operating in Thai automotive industry. These firms were not selected since they may have different characteristics and level of supply chain integration with their supply chain partners.

In conclusion, first-tier suppliers which consist of firms supplying parts and equipment directly to car assemblers were defined as the population and the sampling frame of this study.

4.6.2 Sampling Frame

The sampling frame was composed by consolidating the name lists from four sources, which are The Federation of Thai Industries (FTI), Thailand Automotive Institute (TAI), Thai Auto-Parts Manufacturers Association (TAPMA), and Thai Automotive Industry Association (TAIA). The consolidation resulted in a name list of 508 first-tier supplier firms. This sampling frame was further used for data collection.

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[1] Toyota Motor (Thailand) Co., Ltd. (Toyota), M.M.C. Sitthiphon Co., Ltd. (Mitsubishi), Isuzu Motor (Thailand) Co., Ltd. (Isuzu), Siam Nissan Automobile Co., Ltd. (Nissan-commercial car), Honda Car Automobile (Thailand) Co., Ltd. (Honda), Siam Konlakarn and Nissan Co., Ltd. (Nissan-passenger car), Auto Alliance (Thailand) Co., Ltd. (Ford and Mazda), Bangchan General Assembly Co., Ltd. (Honda, Opel, Daihatsu, Holden, Hyundai and Chrysler), Thonburi Assebler Co., Ltd. (Mercedes Benz), Y.M.C. Assembly Co., Ltd. (BMW, Peugeot, Audi and Volkswagen), Thairung Union Car PLC. (Isuzu and Nissan-commercial car), Hino Motor (Thailand) Co., Ltd. (Hino), Thai Swedish Assembly Co., Ltd. (Volvo, Chrysler, Renault), Siam V.M.C. Yarnyon Co., Ltd. (VMC), Motor and Lee Seng Co., Ltd. (Daewoo), General Motor (Thailand) Co., Ltd. (GM), BMW Manufacturing (Thailand) Co., Ltd. (BMW and Rover).

4.6.3 Sample Size Determination

Three methods were simultaneously employed to calculate an appropriate sample size. The first method was based on the recommendation of Hair et al. (1998). It was recommended that multivariate analysis requires a sample size between 5 to 20 observations for each attribute of independent variable in the proposed model. In this study, there are a total of 13 attributes under 5 variables i.e. six attributes for supply chain orientation, three for information system support, one for resource commitment, two for external integration, and one for internal integration. Thus, based on this method, the require sample size for multivariate analysis of this study is in the range of 65 to 260 samples.

The second method the sample size can be calculated using the method recommended by Yamane (1967). The formulation is illustrated as follows:

$$n = \frac{N}{1 + Ne^2}$$

where;

n	=	The required sample size
N	=	The size of the target population
e	=	Significance level

The number of target population in this study (N) is 508 firms. The significant level (e) that is normally used by researchers in social science is between 0.05-0.10. Thus, the required sample sized (n) should be in the range of 84 observations and 224 observations.

The last method of sample size calculation was based on the requirement of Structural Equation Modeling (SEM) which is the statistical tool used for quantitative data analysis and hypotheses testing in this study. SEM relies on tests which are sensitive to sample size as well as to the magnitude of differences in covariance matrices. Thus, the sample size is particularly important when using SEM to analyze the data. There are differences in the appropriate sample sizes recommended by different authors. Kline (1998) considers sample sizes under 100 to be “untenable” in SEM while Loehlin (1992) recommends at least 100 cases, preferably 200. However, this study followed the rule of thumb proposed by Stevens (1996), which stated that the sample size shall have at least 15 cases per each measured variable or indicator. Thus, this rule of thumb suggested that the require sample size of this study is 195 samples.

In summary, in attempt to gain acceptable statistical inference, the sample size of 100 observations (as required by SEM) should be referred as the least desirable but acceptable size in this study since it does not violate the underlying assumption of the three methods used. However, this study aims to collect at least 224 observations which is a more conservative number in order to lower the significance level to .05 and to gain more statistical inference power.

4.6.4 Sampling Procedure

This study employed a method of simple random sampling. Based on the previous study in Thai automotive industry (Chookhiatti, 2005), a response rate reached 48.4% when the data collection was done by a drop-off delivery survey. Thus, in order to receive 224 sets of questionnaire back from the respondents, a self-administered questionnaire was randomly distributed to 463 auto-parts suppliers in the list of sampling frame.

4.7 SURVEY RESEARCH TOOL

4.7.1 Development of Measures

In order to collect the necessary information required to test the hypothesized relationships among supply chain orientation, information system support, resource commitment, external integration, internal integration, and reverse logistics performance, measures for the constructs of interest were developed based on the literature review. Churchill (1979) recommended five steps of measurement development to ensure high content validity, construct validity and construct reliability of the measures. In the first step, a literature review must be conducted to create a pool of items that captures the domain of each research construct. Secondly, each statement in the item pool is carefully modified and adapted so that the wording is precise and not redundant. Third, preliminary interviews are employed to define the scope and content of the measures, to develop survey questionnaire of the study, and to get experts' opinion about format of the survey questionnaire as well as the clarity of questionnaire in order to verify content validity and construct validity. Since the measurement was originally developed in English and part of the respondents in this study were Thais, the fourth step concerning the translation of questionnaire to Thai and back translation into English by a fluent bilingual speaker who has the academic research background is required. The last step involved with a pilot test to check if there is any flaw in the questionnaire (McDaniel and Rogers, 1999), to determine any problem of ambiguity of questions, and to examine the pool of items with the actual data in order to finalize the questionnaire.

In this study, there is a need to develop a measurement for six main constructs which are supply chain orientation, information system support, resource commitment, external integration, internal integration, and reverse logistics performance. Following is the discussion on the measurement development of these six constructs.

4.7.1.1 Supply Chain Orientation

Supply Chain Orientation is a second-order construct which is defined as the implementation by an organization of the systemic, strategic implications of the tactical activities involved in managing the various flows in a supply chain (Min and Mentzer, 2004) that stresses a systemic view stretching beyond the focal firm to include coordination of business processes and flows with those of other members of the supply chain for the purpose of creating a strategic advantage based on end-customer value delivery. Supply Chain Orientation consists of six first-order constructs which are Credibility, Benevolence, Commitment, Cooperative Norms, Compatibility of Culture, and Top Management Support.

Credibility is defined as a firm's belief that its partner stands by its word (Anderson and Narus, 1990), fulfills promised role obligations, and is sincere (Dwyer and Oh, 1987; Scheer and Stern, 1992). Benevolence is defined as a firm's belief that its partner is interested in the firm's welfare (Deutsch, 1958; Larzelere and Huston, 1980; Rempel et al., 1985), is willing to accept short-term dislocations (Anderson et al., 1987), and will not take unexpected actions that would have a negative impact on the firm (Anderson and Narus, 1990). These two constructs represents trust between organizations.

Commitment is defined as “an exchange partner believing that an ongoing relationship with another is so important as to warrant maximum efforts at maintaining it; that is, the committed party believes the relationship endures indefinitely. Cooperative norm is defined as "the perception of the joint efforts of both the supplier and distributor to achieve mutual and individual goals successfully while refraining from opportunistic actions" (Siguaw et al., 1998). Organizational Compatibility is defined as a compatible corporate culture and management techniques of each firm in a supply chain. Finally, Top management support is described as leadership and commitment to change.

In this study, the measurement items of supply chain orientation are based on the ones developed by Min and Mentzer (2004). A total of 20 measurement items were used to measure six dimensions of supply chain orientation. The details of the measurement items can be seen in table 4.2.

Table 4.2: Measurement Items for Supply Chain Orientation

Dimension	Measurement Items	Modified and Derived from
Credibility	Promises made to your supply chain members by your firm are reliable.	Min and Mentzer (2004)
	Your firm is trusted by your supply chain members regarding to the knowledge related to your products and/or services.	Min and Mentzer (2004)
	Your firm does not make false claims to your supply chain members.	Min and Mentzer (2004)
	Your firm is open in dealing with your supply chain members.	Min and Mentzer (2004)
Benevolence	When making important decisions, your supply chain members are concerned about your welfare.	Min and Mentzer (2004)
	When you share your problems with your supply chain members, you know they will respond with understanding.	Min and Mentzer (2004)
	In the future you can count on your supply chain members to consider how their decision and actions will affect you.	Min and Mentzer (2004)
	When it comes to things that are important to you, you can depend on your supply chain member's support.	Min and Mentzer (2004)
Commitment	You defend your supply chain members when outsiders criticize them, if you trust them.	Min and Mentzer (2004)
	You are patient with your supply chain members when they make mistakes that cause you trouble but are not repeated.	Min and Mentzer (2004)
Cooperative Norm	Your firm is willing to make cooperative changes with your supply chain members.	Min and Mentzer (2004)
	You believe your supply chain members must work together to be successful.	Min and Mentzer (2004)
	You view our supply chain as a value added piece of your business.	Min and Mentzer (2004)
Compatibility of Culture	Your firm's goal and objectives are consistent with those of your supply chain members.	Min and Mentzer (2004)
	Your firm and your supply chain members have similar operating philosophies.	Min and Mentzer (2004)
Top Management Support	Top managers repeatedly tell employees that this firm's survival depends on its adapting to supply chain management.	Min and Mentzer (2004)
	Top managers repeatedly tell employees that building, maintaining, and enhancing long-term relationship with your supply chain member are critical to firm's success	Min and Mentzer (2004)
	Top managers repeatedly tell employees that sharing valuable strategic/tactical information with your supply chain members is critical to this firm's success.	Min and Mentzer (2004)
	Top managers repeatedly tell employees that sharing risk and rewards is critical to this firm's success.	Min and Mentzer (2004)
	Top management offers various education opportunities about supply chain management.	Min and Mentzer (2004)

Source: The Author

For this set of measurement items, Min and Mentzer (2004) tested the internal consistency reliability of the first order factors through Cronbach's alpha or bivariate correlation. For Credibility, Benevolence, Cooperative Norms, and Top Management Support, the standardized Cronbach's alpha exceeded either Nunnally (1978) or the Hair et al. (1998) criterion (i.e. 0.78, 0.87, 0.66, and 0.84 respectively). Regarding Commitment and Compatibility, both of which were two-item factor, the bivariate correlation was significant at the 0.01 level. Thus, it was concluded that the Supply Chain Orientation measurement items passed the reliability test. The Supply Chain Orientation scale was also tested by examining the unidimensionality through confirmatory factor analysis. The result showed that the unidimensionality for each factor was found to exist. Thus, this study continued to use this well-developed scale to measure the construct of Supply Chain Orientation.

4.7.1.2 Information System Support

Stank et al. (2001) defined information system support as the ability of information systems to provide operational managers with sufficient and timely information to manage logistical activities. In this study, Information System Support is defined as firm's existing information coordination systems to support the integrated demand and supply chain. Based on the work of Daugherty et al. (2002), Information System Support is a second-order construct which consist of three first-order constructs; IS Support Capability, IS Support Compatibility, and IS Support Technologies.

IS Support Capability is defined as the ability of information system to deliver information that is readily available and accurate in order to anticipate and accommodate operational changes and customer demands. The items used to measure the level of IS Support Capability were derived and modified from Daugherty et al. (2002) and Sander and Premus (2005). The details are illustrated in table 4.3.

Table 4.3: Measurement Items for IS Support Capability

Dimension	Measurement Items	Modified and Derived from
IS Support Capability	Your firm's information system can provide accurate information	Daugherty et al. (2002)
	Your firm's information system can provide information when ever you need	Daugherty et al. (2002)
	Your firm's information system capability is excellent relative to the industry standard	Sander and Premus (2005)

Source: The Author

IS Support Compatibility is defined as “the extent to which the firm is able to design and invest hardware and software that are compatible with those of its trading partners to facilitate information exchange process” (Global Logistics Research Team at Michigan State University, 1995). Daugherty et al. (2002) also referred information system support compatibility to how easy it is to use and how compatible it is with other systems in the supply chain. The measurement items of IS Support Compatibility were derived and modified from Daugherty et al. (2002), Kwon and Suh (2004), and Closs and Savfitskie (2003). The items are shown in table 4.4.

Table 4.4: Measurement Items for IS Support Compatibility

Dimension	Measurement Items	Modified and Derived from
IS Support Compatibility	Your firm’s information system allows a daily download of information	Daugherty et al.(2002)
	Your firm’s information system can provide information that is formatted to facilitate usage	Daugherty et al.(2002)
	Your firm’s information system can provide real-time information	Daugherty et al.(2002)
	Your firm’s information system can provide internal connectivity	Daugherty et al.(2002)
	Your firm’s information system can provide external connectivity	Daugherty et al.(2002)
	Your firm shares common information technology (software) to facilitate communication with the partner	Kwon and Suh (2004)
	Your firm’s information system can obtain information from your suppliers and customers to facilitate operational plans and reduce reliance on forecasting.	Closs and Savfitskie (2003)

Source: The Author

Sander and Premus (2005) defined IS Support Technology as technology used to acquire, process, and transmit information for more effective decision making. In this study, IS Support Technologies is defined as systems utilized in a company to support the use of information system. The measurement items for IS Support Technologies were based on Daugherty et al. (2002), Jayaram et al. (2000) and the result of in-depth interviews. The details are presented in table 4.5.

Table 4.5: Measurement Items for IS Support Technologies

Dimension	Measurement Items	Modified and Derived from
IS Support Technology	Your firm utilizes these hardware and software technologies to assist with returns handling:	Daugherty et al. (2002)
	- Internet/Website	New item based on interviews
	- E-mail	New item based on interviews
	- Electronic Data Interchange (EDI)	Daugherty et al. (2002), Jayaram et al. (2000)

Source: The Author

4.7.1.3 Resource Commitment

Resource commitment is defined as the allocation of tangible and intangible resources available to the firm that enable it to produce efficiently and/or effectively a market offering that has value for some market segment(s) (Hunt, 2000). The measurement items of Resource Commitment in this study were based on the previous studies of Daugherty et al. (2001), Richey et al. (2004), and Richey et al. (2005). These items were also modified based on the result of the interviews to fit with the context of this study. The measurement items are illustrated in table 4.6.

Table 4.6: Measurement Items for Resource Commitment

Dimension	Measurement Items	Modified and Derived from
Resource Commitment	Your firm commits considerable level of *technological resources* to logistics program	Daugherty et al. (2001), Richey et al. (2004), Richey et al. (2005), In-depth interviews
	Your firm commits considerable level of *managerial resources* to logistics program	Daugherty et al. (2001), Richey et al. (2004), Richey et al. (2005), In-depth interviews
	Your firm commits considerable level of *financial resources* to logistics program	Daugherty et al. (2001), Richey et al. (2004), Richey et al. (2005), In-depth interviews

Source: The Author

4.7.1.4 External Integration

Bagchi et al. (2005) defined external integration as the comprehensive collaboration among supply chain network members in strategic, tactical, and operational decision-making. External integration in this study consists of supplier integration and customer integration.

Based on the previous studies of Frohlich and Westbrook (2001) and Narasimhan and Kim (2002), supplier integration is referred to as the extent to which the firm is able to develop shared operational activities with its most important supplier. In this study, supplier integration is defined as the extent to which the firm is able to deploy collaborative processing with its valued suppliers. Supplier integration focuses on linking internal work processes with those suppliers (Stank et al., 2001a) to jointly achieve improved service capabilities at lower total supply chain cost (Bowersox et al., 2002). Derived and modified from Rodrigues et al. (2004), Closs and Savitskie (2003), Sander and Premus (2005), Stank et al. (2001b), and Stank and Lackey (1997), the measurement items for supplier integration is illustrated in table 4.7.

Table 4.7: Measurement Items for Supplier Integration

Dimension	Measurement Items	Modified and Derived from
Supplier Integration	Your firm effectively shares operational information externally with selected suppliers	Rodrigues et al. (2004), Closs and Savitskie (2003)
	Your firm effectively shares cross-functional processes with suppliers	Sander and Premus (2005)
	Your firm engages in collaborative planning with suppliers	Sander and Premus (2005)
	Your firm shares cost information with suppliers	Sander and Premus (2005)
	Your firm has increased operational flexibility through supply chain collaboration with suppliers	Rodrigues et al. (2004)
	Your firm successfully integrate operations with suppliers by developing interlocking programs and activities	Rodrigues et al. (2004)
	Your firm is actively involved in initiatives to standardized supply chain practices and operations	Rodrigues et al. (2004)
	Your firm establishes direct communication with suppliers to improve responsiveness	Stank and Lackey (1997)
	Your firm has developed performance measures that extend across supply chain relationships	Stank et al. (2001b)
	Your firm experiences improved performance by integrating operations with supply chain partners	Stank et al. (2001b)
	Your firm has supply chain arrangements with suppliers that operate under principles of shared rewards and risks	Stank et al. (2001b)
	Your firm benchmarks best practices/processes and shares results with supplier	Stank et al. (2001b)

Source: The Author

Stank et al. (2001a) defined customer integration as the competence firms use to create lasting distinctiveness with customers of choice. Fawcett and Magnan (2002) also called this type of integration as a forward integration. However, Frohlich and Westbrook (2001) and Narasimhan and Kim (2002) looked at another aspect of customer integration and defined it as the extent to which the firm is able to develop shared operational activities with its most important customer. Measurement items for customer integration were derived and modified from Rodrigues et al. (2004), Closs and Savitskie (2003), Stank et al. (2001b), and Stank and Lackey (1997). The measurement items for customer integration are illustrated in table 4.8.

Table 4.8: Measurement Items for Customer Integration

Dimension	Measurement Items	Modified and Derived from
Customer Integration	Your firm effectively shares operational information externally with selected customers	Rodrigues et al. (2004), Closs and Savitskie (2003), Stank et al. (2001b)
	Your firm has increased operational flexibility through supply chain collaboration with customers	Rodrigues et al. (2004)
	Your firm successfully integrate operations with customers by developing interlocking programs and activities	Rodrigues et al. (2004)
	Your firm is able to accommodate a wide range of unique customer requests by implementing preplanned solutions	Closs and Savitskie (2003)
	Your firm has different, unique logistics service strategies for different customers	Closs and Savitskie (2003)
	Your firm has established a program to integrate and facilitate individual customer requirements across your firm	Closs and Savitskie (2003)
	Your firm establishes direct communication with customers to improve responsiveness	Stank and Lackey (1997)
	Your firm has supply chain arrangements with customers that operate under principles of shared rewards and risks	Stank et al. (2001b)

Source: The Author

4.7.1.5 Internal Integration

Internal integration is defined as the core competence derived from linking internal activities to best support customer requirements at the lowest total system cost (Stank et al., 2001a). Fawcett and Magnan (2002) defined internal integration as cross-functional process integration within the firm. Narasimhan and Kim (2002) defined internal integration as the extent to which the firm is able to develop shared operational activities across departments within the firm. The measurement items of internal integration were based on the previous studies of Stank et al. (2001b), Sander and Premus (2005), Rodrigues et al. (2004), and Closs and Savitskie (2003). The details of the measurement items are shown in table 4.9.

Table 4.9: Measurement Items for Internal Integration

Dimension	Measurement Items	Modified and Derived from
Internal Integration	Your firm extensively utilizes cross-functional work teams for managing day-to-day operation	Rodrigues et al. (2004)
	Your firm use cross-functional collaboration in strategic planning	Sander and Premus (2005)
	Your firm has extensively redesigned work routines and processes over the past three years	Rodrigues et al. (2004)
	The orientation of your firm has shifted from managing function to managing processes	Rodrigues et al. (2004)
	Your firm effectively shares operational information between departments	Rodrigues et al. (2004), Closs and Savitskie (2003), Sander and Premus (2005), Stank et al. (2001b)
	Your firm utilizes integrated database and access method to facilitate information sharing	Stank et al. (2001b), Sander and Premus (2005)
	Your firm has adequate ability to share both standardized and customized information internally	Stank et al. (2001b)
	Your firm provides objective feedback to employees regarding integrated logistics performance	Stank et al. (2001b)
	Your firm's compensation, incentive, and reward systems encourage integration	Stank et al. (2001b)

Source: The Author

4.7.1.6 Reverse Logistics Performance

Based on an extensive review of logistics, reverse logistics, and supply chain literature, the measurement of reverse logistics performance in this study was divided into three dimensions. According to Porter (1991), competitive advantage of the firm is based on a firm's ability to perform interrelated economic activities at a collectively lower cost than rivals, or to perform some activities in unique ways that create end-customer value. Hence, the first dimension of reverse logistics performance measurement in this study reflects the cost aspect of reverse logistics process. A well-managed reverse logistics process shall be able to provide costs advantage to the firm compared with its competitors regarding to reverse logistics process. The result of depth interviews with experts in Thai automotive industry also suggested that cost is one of the most important elements for logistics and reverse logistics performance measurement. In general, all expenses occurred for product returns are responsible by the first-tier supplier because problems such as defective product or faulty order processing are caused by first-tier suppliers. Therefore, while car assemblers concern mainly with logistics cost since it ultimately reflects the price of products, first-tier suppliers concern with both logistics and reverse logistics costs. With high reverse logistics cost, these first-tier supplier would not be able to compete with other firms in the market. Thus, these firms see reverse logistics cost as a very crucial element to measure the performance of reverse logistics process. The measurement items to evaluate a cost performance dimension of reverse logistics process, derived and modified from Stank et al. (2001a), Daugherty et al. (1996), Sander and Premus (2005), Rodrigues et al. (2004), Daugherty et al. (2002), Autry et al.(2001), and Stank and Lackey (1997), can be seen in table 4.10.

Table 4.10: Measurement Items for Cost Performance

Dimension	Measurement Items	Modified and Derived from
Cost Performance	Your firm achieves a relatively low overall cost involving with reverse logistics through efficient reverse logistics operations compared with your competitors.	Stank et al. (2001a), Daugherty et al. (1996), Sander and Premus (2005), Rodrigues et al. (2004)
	Your firm can achieve a relatively low level of inventory investment in products and spare parts through efficient reverse logistics operations compared with your competitors.	Daugherty et al. (2002), Autry et al. (2001), Stank and Lackey (1997)
	Your firm can reduce overall costs through efficient reverse logistics operations.	Daugherty et al. (2002), Autry et al. (2001)

Source: The Author

In term of customer value, the current study proposed two dimensions of performance measurement, i.e. responsiveness and customer satisfaction, to evaluate reverse logistics program performance. These two dimensions of performance measurement are extensively used in the literature in logistics and supply chain area. Result of in-depth interviews also suggested that, in addition to cost, responsiveness is also a crucial factor for car assemblers to evaluate their suppliers. As a production line must be operating continuously, any problem with product return shall be solved immediately to avoid operation interruption. Thus, most car assemblers put responsiveness as one of the criteria in their evaluation manual. Derived and modified from Stank et al. (2001a), Stank et al. (2001b), Closs and Savitskie (2003), and Stank et al. (1996), the measurement items regarding to the responsiveness of reverse logistics program are shown in table 4.11.

Table 4.11: Measurement Items for Responsiveness

Dimension	Measurement Items	Modified and Derived from
Responsiveness	Your reverse logistics process has the ability to respond to needs and wants of key customers	Stank, et al. (2001a), Stank et al. (2001b), Closs and Savitskie (2003)
	Your reverse logistics process can provide emergency services to customers	Stank et al. (1996)
	Your reverse logistics process can adjust its operations to meet unforeseen needs that might occur	Stank et al. (1996)
	Your reverse logistics process is flexible in response to requests	Stank et al. (1996)
	Your reverse logistics process handles the returns well	Stank et al. (1996)

Source: The Author

For the measurement items of customer satisfaction, they were derived and modified from the previous studies of Stank et al. (2001a), Stank et al. (2001b), Closs and Savitskie (2003), Rodrigues et al. (2004), Daugherty et al. (1996), and Daugherty et al. (2002). The details are illustrated in table 4.12.

Table 4.12: Measurement Items for Customer Satisfaction

Dimension	Measurement Items	Modified and Derived from
Customer Satisfaction	Your reverse logistics process match with your customers' expectations very well.	Stank et al. (2001a), Stank et al. (2001b), Closs and Savitskie (2003), Rodrigues et al. (2004)
	Your reverse logistics process helps the firm to Improve customer service.	Daugherty, Ellinger, and Gustin (1996)
	Your customers are delighted with the returns handling of your firm	Daugherty, Myers, and Richey (2002)
	It is a pleasure dealing with your firm with respect to returns handling.	Daugherty, Myers, and Richey (2002)

Source: The Author

4.7.2 Operational Definitions

The operational definitions of the constructs are summarized in table 4.13.

Table 4.13: Operational Definitions of All Constructs and Dimensions

Construct/Dimension	Operational Definition
Supply Chain Orientation	The implementation by an organization of the systemic, strategic implications of the tactical activities involved in managing the various flows in a supply chain that stresses a systemic view stretching beyond the focal firm to include coordination of business processes and flows with those of other members of the supply chain for the purpose of creating a strategic advantage based on end-customer value delivery.
Credibility	A firm's belief that its partner stands by its word, fulfills promised role obligations, and is sincere.
Benevolence	A firm's belief that its partner is interested in the firm's welfare, is willing to accept short-term dislocations, and will not take unexpected actions that would have a negative impact on the firm.
Commitment	An exchange partner believing that an ongoing relationship with another is so important as to warrant maximum efforts at maintaining it; that is, the committed party believes the relationship endures indefinitely.
Cooperative Norms	The perception of the joint efforts of both the supplier and distributor to achieve mutual and individual goals successfully while refraining from opportunistic actions.
Compatibility of Culture	A compatible corporate culture and management techniques of each firm in a supply chain.
Top Management Support	Leadership and commitment to change.
Information system support	Firm’s existing information coordination systems to support the integrated demand and supply chain
IS Support Capability	The ability of information system to deliver information that is readily available and accurate in order to anticipate and accommodate operational changes and customer demands.
IS Support Compatibility	The extent to which the firm is able to design and invest hardware and software that are compatible with those of its trading partners to facilitate information exchange process.
IS Support Technologies	Systems utilized in a company to support the use of information system.
Resource Commitment	The allocation of tangible and intangible resources available to the firm that enable it to produce efficiently and/or effectively a market offering that has value for some market segment(s).
External integration	The comprehensive collaboration among supply chain network members in strategic, tactical, and operational decision-making.
Supplier integration	The extent to which the firm is able to develop shared operational activities with its most important supplier.
Customer integration	The extent to which the firm is able to develop shared operational activities with its most important customer.
Internal integration	The extent to which the firm is able to develop shared operational activities across departments within the firm.
Reverse Logistics Performance	A performance of reverse logistics processes based on aspects of costs, responsiveness, and customer satisfaction.

Source: The Author

4.7.3 Questionnaire Development

After the measurement items of all the constructs involved in the model were completely developed, a self-administered questionnaire was constructed. The questionnaire was structured into five sections as illustrated in table 4.14.

Table 4.14: Content of Questions Proposing in the Questionnaire

Section	Content
A	Demographic of respondent and the firm
B	Supply Chain Orientation, Information System Support, and Resource Commitment
C	External Integration (Supplier and Customer Integration)
D	Internal Integration
E	Reverse Logistics Performance

Source: The Author

The first section of the questionnaire includes questions related to biographic data of the respondent and business information. In the biographic data section, the questions, such as, position of the respondent in the firm, percentages and reasons of product returns, nationality of shareholders, number of employees, business experience, etc. are included.

The second section aims to collect information regarding to the level of supply chain integration, information system support, and resource commitment that a firm possesses. The respondents were asked whether they are agreed with the statement provided based on the six-point Likert scale ranging from extremely disagree (1) to extremely agree (6). Six-point Likert scale was used to avoid neutral responds made by respondents. While 5-point Likert scale has been popular among researchers, some problems have been found. Many researchers pointed out that respondents tend to select a neutral response when they do not know or have not experienced with the questions asked. When this happened, it is better to leave the items blank instead of putting neutral responses. Otherwise, the result might be misleading. In addition, some researchers prefer to have an even number of ratings in the scale to have respondents commit to either the positive or negative end of the scale.

The third section of the questionnaire aims to assess the extent that a firm engages in external integration. This section was divided into two subsections; supplier integration and customer integration. In both subsections, respondents were asked whether they are agreed with the statement provided based on the six-point Likert scale ranging from extremely disagree (1) to extremely agree (6).

In the fourth and fifth sections, the respondents were asked to rate the degree of internal integration and reverse logistics performance of its firm respectively. The fifth section contains three subsections which reflect the three dimensions of reverse logistics performance, i.e. cost performance, responsiveness, and customer satisfaction. In both sections, the respondents were asked whether they are agreed with the statement relating to internal integration and reverse logistics performance. These two sections also utilize a six-point Likert scale ranging from extremely disagree (1) to extremely agree (6).

The total length of this questionnaire is five pages which is within the acceptable range that does not exhaust the respondent during the survey (Churchill, 1999). Questionnaire is in both English and Thai because some respondents are Thais. Questionnaire was originally developed in English and then translated to Thai by a fluent bilingual speaker, who has a strong academic research background. After that, it was back translated to English to ensure that the translation matched the original version. This back-to-back translation or translation verification technique has been widely used with a good outcome (Davis and Cozensa, 1993; Zikmund, 1996).

4.8 DATA COLLECTION

4.8.1 Preliminary Interview

A panel of preliminary interviews was conducted in order to gain more knowledge and information regarding to Thai automotive industry as well as the nature of reverse logistics process in this particular industry. The first step was done by conducting a semi-structured interview with an academic who previously did a research in supply chain management in Thai automotive industry. All definitions of constructs were clarified and general information related to supply chain management in the industry was gained from the interview.

An interview was also conducted with two first-tier suppliers in Thai automotive industry. The first one is a supplier who supplies interior parts such as console, seat, and interior accessories to a car assembler. The interviewee has more than 15 year business experience in this industry. This interview lasted for approximately two hours. The second interview was done with a large battery supplier to car assemblers. The interviewee is a sales and customer service expert with a long experience in this industry. The interview lasted about 1 hour. These two interviews provided the information on the reverse logistics processes in Thai automotive industry, information systems that are currently in used, and how the supply chain integration is implemented. Some sentences and wordings in the questionnaire were refined while a two items about information system technologies were added.

Two more experts working with car assemblers were also interviewed to provide another aspect of supply chain and reverse logistics that might be different from that of suppliers. Both companies are truck assemblers which have business relationships with a large number of first-tier suppliers. The interviewees provided information regarding reverse logistics and supply chain integration in Thai automotive industry that is consistent with the information gained during the interviews with first-tier suppliers. Comments on relationships between information system support, resource commitment, and reverse logistics program were also made. These five interviews, together with an extensive review of related literature, were used to check the content and construct validity and to develop a sound research instrument.

4.8.2 Pretest

After the questionnaire was successfully developed, a pretest was conducted with the objective to ensure the interpretability of the questionnaire items and to finalize the questionnaire (McDaniel and Rogers, 1999). The appropriate sample size for the pretest was calculated based on two methods. The first method, as recommended by Sudman (1976), requires the sample size of the pretest to be between 20 and 50 samples. McDaniel and Rogers (1999) proposed another rule of thumb which suggests that the sample size should be more than 5% of the total population, or approximately 26 samples in this study. Thus, the appropriate sample size for the pretest was conservatively set at 50 observations. The pretest was carried out during April-May, 2006. First-tier suppliers listed in the sampling frame were initially contacted by phone and asked if they are willing to participate. The questionnaires were mainly given to the participants by hand. However, some participants requested the surveyors to send the questionnaire via other means such as fax and e-mail. It took approximately one month to collect 51 sets of questionnaires. Three of the questionnaires were found to be incomplete and discarded. Thus, 48 responses were used as pre-testing data for the questionnaire analysis.

The first step is to assess the reliability of the questionnaire by utilizing item-to-total correlation & Cronbach's alpha coefficient. The alpha coefficient values of first order or second order constructs should exceed the minimum threshold value of 0.7 as recommended by Nunnally (1978). The result suggested that there is an acceptable degree of internal consistency for all the key constructs in the questionnaire. The Cronbach's alpha coefficients of all the constructs exceeded the threshold value as can be seen in table 4.15. The Cronbach's alpha coefficients for all dimensions of each key construct were also considered satisfactory with the magnitude ranges from .713 to .913 as illustrated in the next part. However, one measurement item of internal integration was found to have an item-to-total correlation of only 0.07 which means that it does not correlate with other items. Therefore, this item was deleted to purify the scale. After the deletion, the Cronbach's alpha coefficient of this construct increased from .788 to .831.

Table 4.15: Summary of Scale Reliability and their Internal Consistency

Construct	Cronbach's Alpha
Supply Chain Orientation	.899
Information System Support	.824
Resource Commitment	.788
External Integration	.926
Internal Integration	.788
Reverse Logistics Performance	.921

The second step is to access discriminant validity of the constructs by utilizing principle component analysis (PCA) and exploratory factor analysis (EFA). It is required that, to demonstrate the satisfactory evidence of discriminant validity, the factor loadings of all items loaded in each dimension are high (above 0.3) and their signs are in the same direction (Hair et al., 1998). The exploratory factor analysis was conducted for supply chain orientation, information system support, external integration, and reverse logistics performance. Since resource commitment and internal integration contain only one dimension, the exploratory factor analysis is not required.

For supply chain orientation, six dimensions consisting of 20 items were proposed. However, the result of PCA illustrated that only five dimensions were extracted. The details can be seen in table 4.16. The result indicated that commitment and cooperative norm are loaded in the same component. It is possible for commitment to be loaded with other dimensions since there are only two measurement items for this dimension. However, these two dimensions, commitment and cooperative norm, are considered as separated dimensions based on their different definitions and characteristics. For credibility, benevolence, compatibility of culture, and top management support, the measurement items are loaded separately in four components as proposed.

Table 4.16: Factor Analysis and Scale Reliability for Supply Chain Orientation

Supply Chain Orientation		Component					
Dimension	Question Items	1	2	3	4	5	Alpha
Credibility	Promises made to your supply chain members by your firm are reliable.				.716		.825
	Your firm is trusted by your supply chain members regarding to the knowledge related to your products and/or services.				.726		
	Your firm does not make false claims to your supply chain members.				.890		
	Your firm is open in dealing with your supply chain members.				.324		
Benevolence	When making important decisions, your supply chain members are concerned about your welfare.			.820			.871
	When you share your problems with your supply chain members, you know they will respond with understanding.			.885			
	In the future you can count on your supply chain members to consider how their decision and actions will affect you.			.583			
	When it comes to things that are important to you, you can depend on your supply chain member's support.			.583			
Commitment	You defend your supply chain members when outsiders criticize them, if you trust them.	.773					.869
	You are patient with your supply chain members when they make mistakes that cause you trouble but are not repeated.	.877					
Cooperative Norm	Your firm is willing to make cooperative changes with your supply chain members.	.417					.791
	You believe your supply chain members must work together to be successful.	.363					
	You view our supply chain as a value added piece of your business.	.822					
Compatibility of Culture	Your firm's goal and objectives are consistent with those of your supply chain members.					.629	.721
	Your firm and your supply chain members have similar operating philosophies.					.909	
Top Management Support	Top managers repeatedly tell employees that this firm's survival depends on its adapting to supply chain management.		.847				.872
	Top managers repeatedly tell employees that building, maintaining, and enhancing long-term relationship with 4your supply chain member are critical to firm's success		.445				
	Top managers repeatedly tell employees that sharing valuable strategic/tactical information with your supply chain members is critical to this firm's success.		.610				
	Top managers repeatedly tell employees that sharing risk and rewards is critical to this firm's success.		.558				
	Top management offers various education opportunities about supply chain management.		.926				

Cumulative percent of initial Eigen value: 5 components = 78.10 %

For information system support, the result of PCA demonstrated three factors which are consistent with the proposed dimensions. The details can be seen in table 4.17.

Table 4.17: Factor Analysis and Scale Reliability for IS Support

IS Support		Component			
Dimension	Question Items	1	2	3	Alpha
IS Support Capability	Your firm's information system can provide accurate information			.917	.827
	Your firm's information system can provide information when ever you need			.768	
	Your firm's information system capability is excellent relative to the industry standard			.853	
IS Support Compatibility	Your firm's information system allows a daily download of information	.446			.825
	Your firm's information system can provide information that is formatted to facilitate usage	.640			
	Your firm's information system can provide real-time information	.753			
	Your firm's information system can provide internal connectivity	.775			
	Your firm's information system can provide external connectivity	.781			
	Your firm shares common information technology (software) to facilitate communication with the partner	.483			
	Your firm's information system can obtain information from your suppliers and customers to facilitate operational plans and reduce reliance on forecasting.	.577			
IS Support Technologies	Internet/Website		.883		.858
	E-mail		.876		
	Electronic Data Interchange (EDI)		.778		

Cumulative percent of initial Eigen value: 3 components = 63.85 %

For external integration, 20 measurement items with 2 dimensions were proposed. The result of the PCA illustrated that most items are loaded properly as proposed. The exception was one item which asks respondents about their experiences in the improved performance caused by integrating operations with supply chain partners. This item was not loaded in the proposed dimension and was deleted in order to purify the scale. The details can be seen in table 4.18.

Table 4.18: Factor Analysis and Scale Reliability for External Integration

External Integration		Component		
Dimension	Question Items	1	2	Alpha
Supplier Integration	Your firm effectively shares operational information externally with selected suppliers		.671	.903
	Your firm effectively shares cross-functional processes with suppliers		.829	
	Your firm engages in collaborative planning with suppliers		.552	
	Your firm shares cost information with suppliers		.686	
	Your firm has increased operational flexibility through supply chain collaboration with suppliers		.675	
	Your firm successfully integrate operations with suppliers by developing interlocking programs and activities		.782	
	Your firm is actively involved in initiatives to standardized supply chain practices and operations		.825	
	Your firm establishes direct communication with suppliers to improve responsiveness		.365	
	Your firm has developed performance measures that extend across supply chain relationships		.770	
	Your firm experiences improved performance by integrating operations with supply chain partners	.713*		
	Your firm has supply chain arrangements with suppliers that operate under principles of shared rewards and risks		.431	
	Your firm benchmarks best practices/processes and shares results with supplier		.644	
Customer Integration	Your firm effectively shares operational information externally with selected customers	.771		.881
	Your firm has increased operational flexibility through supply chain collaboration with customers	.824		
	Your firm successfully integrate operations with customers by developing interlocking programs and activities	.827		
	Your firm is able to accommodate a wide range of unique customer requests by implementing preplanned solutions	.779		
	Your firm has different, unique logistics service strategies for different customers	.418		
	Your firm has established a program to integrate and facilitate individual customer requirements across your firm	.612		
	Your firm establishes direct communication with customers to improve responsiveness	.793		
	Your firm has supply chain arrangements with customers that operate under principles of shared rewards and risks	.619		

Cumulative percent of initial Eigen value: 2 components = 55.77 %
* Item is deleted.

For reverse logistics performance, 12 measurement items with 3 dimensions were proposed. However, the result of PCA indicated that only 2 components were extracted. Responsiveness and customer satisfaction were loaded together in the same component. The literature suggested that both responsiveness and customer satisfaction contribute to the customer value. Thus, the two components, based on the outcomes of PCA, can be considered as cost and value components. The details can be seen in table 4.19.

Table 4.19: Factor Analysis and Scale Reliability for Reverse Logistics Performance

Reverse Logistics Performance		Component		
Dimension	Question Items	1	2	Alpha
Cost Performance	Your firm achieves a relatively low overall cost involving with reverse logistics through efficient reverse logistics operations compared with your competitors.		.699	.713
	Your firm can achieve a relatively low level of inventory investment in products and spare parts through efficient reverse logistics operations compared with your competitors.		.849	
	Your firm can reduce overall costs through efficient reverse logistics operations.		.684	
Responsiveness	Your reverse logistics process has the ability to respond to needs and wants of key customers	.516		.913
	Your reverse logistics process can provide emergency services to customers	.673		
	Your reverse logistics process can adjust its operations to meet unforeseen needs that might occur	.502		
	Your reverse logistics process is flexible in response to requests	.776		
	Your reverse logistics process handles the returns well	.849		
Customer Satisfaction	Your reverse logistics process match with your customers' expectations very well.	.645		.858
	Your reverse logistics process helps the firm to Improve customer service.	.869		
	Your customers are delighted with the returns handling of your firm	.832		
	It is a pleasure dealing with your firm with respect to returns handling.	.719		

Cumulative percent of initial Eigen value: 2 components = 67.60 %

In summary, the pretest result indicated that the reliability analysis of all the items was satisfactory. The alpha coefficients of all constructs and their dimensions, vary from 0.713 to 0.926 which exceed the minimum threshold value of 0.7 as recommended by Nunnally (1978). The result of exploratory factor analysis was also satisfactory. Most of the measurement items were loaded in corresponding components that are consistent with what were proposed in the literature. However, two measurement items were deleted to purify the scale since the factor loading of one item was significantly loaded in a wrong component and another item had low item-to-total correlation. Thus, this questionnaire was modified by deleting these items and then used as the major research tool for the survey.

4.8.3 Survey Data Collection

Due to the limited number of firms in Thai automotive industry and a need for relative large sample size, the current study mainly utilized a technique of a drop-off delivery survey as tool in the final stage of data collection (Cooper and Emory, 1995). A drop-off delivery survey provides several benefits such as reducing a chance of mail missing which makes the response rate of the drop-off delivery survey higher than that of mail survey. In addition, a drop-off delivery survey help identifying the respondents' geographic location and allows additional information to be gathered and observed during the visit to reduce the risk of non-response bias.

A drop-off delivery survey consisted of three steps. The first step was done by contacting all the firms in the list of sampling frame by phone in order to introduce this research and to solicit the contact person. In the second step, the first visit was made to the contacts persons in the firms which were willing to participate. During the visit, the questionnaire was hand-in to the target respondent after a brief overview of the research was made. The target respondents responded to the questionnaire by themselves or asked the surveyor to lead the questionnaire and mark in the answer whenever the respondent replied. In the third step, a revisit was made if the respondent could not finish the questionnaire on the date of delivery. In this case, the respondent was convinced not to send it back via mail, fax, or email but wait for a revisit. These three steps were performed until the number of usable questionnaires reaches the level required in this study.

Although drop-off delivery survey was mainly used in this study, there was also an exception. Some target respondents preferred to receive or return the questionnaire by mail, e-mail, or fax while others decided to respond to the questionnaire with a surveyor over the telephone. Due to time constraint, a team of surveyors were hired to collect the data. Members of the team are professionals working in a well-known research firm which have an excellent background and experience in business research and data collection with firms. In addition, several experts in the industry were also asked to facilitate the data collection process and to collect the data from their partners or other contacting firms operating as first-tier suppliers in Thai automotive industry.

In order to be able to provide valid and reliable responses to the questionnaire, a target respondent was clearly defined. Since the study involves with reverse logistics and supply chain integration, target respondents must be involving with operations management that focuses on work flows across many departments including purchasing, production, logistics, or marketing and sales. Although respondents working in middle or upper management levels were preferred, answers provided by operating level officers were acceptable if the surveyor could proof that the respondents had adequate knowledge on reverse logistics and supply chain integration of their firm.

4.9 DATA ANALYSIS

After all the data were collected, a data analysis was done in order to test the proposed hypotheses. The process of data analysis was divided into 4 steps as illustrated in table 4.20.

Table 4.20 Steps of Data Analysis

Data Preparation	• Data Coding and Data Entry • Treatment of Missing Data • Checks for Non-Response Bias
Respondent Profiles	• Descriptive Statistics
Item Analysis	• Means and Standard Deviations of Items • Reliability Analysis • Exploratory Factor Analysis
Structural Equation Modeling Analysis	• Structural Equation Modeling Assumption Checks • Confirmatory Factor Analysis of the Measurement Models • Model Fitting • Hypotheses Testing • Alternative Model

Source: The Author

4.9.1 Data Preparation

The process of data preparation can be divided into three parts, i.e. data coding and data entry, treatment of missing data, and checks for non-response bias. For data coding, responses were keyed to SPSS version 14.0 after the items were coded as a number. Variable names were defined and used to represent the measurement items in order to make the data analyses easier to understand and interpret. For treatment of missing data, this study utilized a method called listwise deletion, which deals with incomplete data by excluding all cases that have missing data in at least one of the selected variables (Hair et al., 1998).

Finally, a check for non-response bias was also done. Non-response bias is referred to the statistical difference in results between a survey that includes only those who responded and a survey that would also include those who failed to respond (Zikmund, 2003). Non-response is often crucial in a questionnaire survey because the research design is based on the fact that the researcher attempts to generalize from the sample to the population (Collis and Hussey, 2003). When there is non-response, it is recommended that researchers should attempt to evaluate how non-response subjects compare with subjects for whom data exists (Bourque and Clark, 1991). The assessment of non-response bias is used to determine if the collected data set and useable questionnaires are representatives of the population of this study. The potential non-response bias was assessed by comparing early-respondent firms with late-respondent firms on the means of all proposed constructs, as suggested by Armstrong and Overton (1977). A *t*-test for equality of means of the two groups was performed by using SPSS.

4.9.2 Respondent Profiles

The first step in data analysis is to perform demographic analysis. Based on the data from usable questionnaires, descriptive data analysis will be done to identify descriptive information of the respondents such as respondent profiles and business profiles (product category, tier of service, ownership structure, nationality of major foreign shareholder, business experience, firm size, and its most important customer).

4.9.3 Item Analysis

Since this study employed multi-items measure to reduce the possibility that a single item might be misinterpreted (Tallman et al., 1997), these items are subject to a purification process as recommended by Churchill (1999). Thus, it is essential to examine construct reliability and validity in order to confirm the applicability of measures to the study.

The evaluation of measures started with assessment of means and standard deviation of the constructs. Then the reliability of multi-item scales was assessed by the test of internal consistency and the test of unidimensionality. Internal consistency refers to the homogeneity of a set of items. The rationale for the assessments rests on the fact that items in a scale should behave similarly (Churchill, 1999). The internal consistency of multiple-item scales is assessed by computing coefficient alpha (Cronbach's alpha) and item-to-total statistics in SPSS. For a dimension of construct that has only two items, the bivariate correlation between the two items will be tested. Unidimensionality is demonstrated when items of a construct have acceptable fit on a single factor solution (Hair et al., 1998). In order to assess unidimensionality, an exploratory factor analysis was done.

The next step in the evaluation of measures is to assess validity of constructs. By definition, validity refers to the degree to which inferences can legitimately be made from manner in which the construct is operationalized (McDaniel and Roger, 1999). Simply stated, validity judges whether the researchers actually measure what they attempt to measure. In this study, the assessment of validity will be divided two types; content validity and construct validity.

Content validity or face validity refers to the degree to which the content of a measure reflects the conceptual domain that it is intended to encompass (Churchill, 1999). Content validity can be assessed by investigating the procedures used to develop the research instrument. The developed instrument must be based on a literature review and must be confirmed by interviewing experts and a pilot study.

In order to evaluate construct validity, researcher shall assess discriminant validity and the convergent validity (Davis and Cosenza, 1993). By definition, discriminant validity refers to the degree to which items are measuring a unique construct, that is, the extent to which an item is measuring only its respective theoretical construct of interest (DeVellis, 1991). In order to demonstrate high discriminant validity, Churchill (1999) suggested that a measure shall not correlate too highly with measures from which it is supposed to differ (Churchill, 1999). Thus, the discriminant validity was assessed by considering factor loadings in a confirmatory factory analysis. If factor loadings of all items loaded in the factor are high and their signs are in the same direction, these results provide satisfactory evidence of discriminant validity for these sets of items (Zou and Osland, 1998; Hair et al., 1998).

Another type of validity is a convergent validity which concerned with the similarity, or convergence, between individual questionnaire items that are measuring the same construct (DeVellis, 1991). Again, the convergent validity was assessed by considering factor loadings in a confirmatory factory analysis. If factor loadings of all items loaded in the factor are high (above 0.3) and strongly significant, these results provide satisfactory evidence of convergent validity for these items (Hair et al., 1998).

4.9.4 Assessment of Structural Relationship/Hypotheses Testing

In order to answer the research questions and test the proposed hypotheses, Structural Equation Modeling (SEM) was utilized. Compared with multiple regression, structural equation modelling is more powerful since it takes into account the modeling of interactions, nonlinearities, correlated independents, measurement error, correlated error terms, multiple latent independents each measured by multiple indicators, and one or more latent dependents, also each with multiple indicators. SEM may be used as a more powerful alternative to multiple regression, path analysis, factor analysis, and analysis of covariance.

Another reason for the utilization of SEM was based on the advantages of SEM compared to multiple regression analysis. Such advantages include more flexible assumptions (particularly allowing interpretation even in the face of multicollinearity), use of confirmatory factory analysis to reduce measurement error by having multiple indicators per latent variable, the desirability of testing models overall rather than coefficients individually, the ability to rest model with multiple dependents, the ability to model mediating variables, the ability to model error terms, the ability to test coefficients across multiple between-subjects groups, and ability to handle difficult data (time series with autocorrelated error, non-normal data, and incomplete date). Thus, the SEM was used as a main statistical tool to test the hypotheses proposed in this study

4.10 CONCLUSION

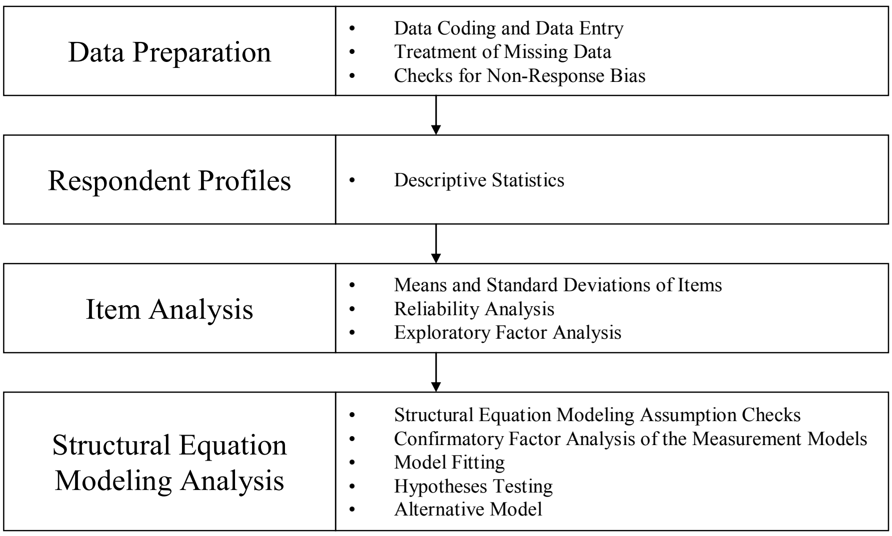
This chapter explained in details the hypotheses development and research methodology. Based on the proposed conceptual framework of reverse logistics performance, 8 main hypotheses and 6 sub-hypotheses were proposed to describe the relationships among supply chain orientation, information system support, resource commitment, external integration, internal integration, and reverse logistics performance. Research methodology was also discussed to provide details on research design, population and sampling, development of measures, preliminary interview, pilot study, and methods for data analysis. The Thai automotive industry was selected as context of this research. The measurement items, derived from previous literature and interviews, were tested to investigate the reliability and validity of the questionnaire. The overall results of reliability analysis and factor analysis were satisfactory. However, two measurement items were deleted to purify the questionnaire. The revised questionnaire was then used as major research tool for the survey in the next stage.

CHAPTER 5

DATA ANALYSIS AND RESULTS

This chapter describes the procedure and the result of data analysis. Based on the research methodology illustrated in chapter 4, this chapter is divided into four main parts. In the first part, a data preparation is explained including data coding and entry, treatment of missing data, and checks for nonresponse bias. The second part deals with descriptive data analysis in order to provide the overview of the respondent profiles. The third part involves the evaluation of measures by checking reliability and validity of the measurement items used. In the last section, the structural equation modeling analysis is illustrated to explain the structural relationship of the model and test the proposed hypotheses. The diagram of the data analysis procedures and methods can be seen in figure 5.1.

Figure 5.1: Data Analysis Procedure and Methods



Source: The Author

5.1 DATA PREPARATION

The process of data preparation can be divided into three sections, i.e. data coding and data entry, treatment of missing data, and checks for non-response bias. The details are presented hereunder.

5.1.1 Data Coding and Data Entry

Information from the 234 completed questionnaires were keyed to SPSS version 14.0 and used for further analyses. Items were coded and responses to each item were assigned a number. Variable names were defined and used to represent the measurement items in order to make the data analyses easier to understand and interpret. A total of 76 variable names were defined to represent the measurement items used in this study; 20 items for supply chain orientation, 14 items for information system support, 3 items for resource commitment, 19 items for external integration, 8 items for internal integration, and 12 items for reverse logistics performance. The details of measurement items for each construct and their pertaining variable names can be seen in Appendix B.

5.1.2 Treatment of Missing Data

For survey data collection, this study utilized a technique of a drop-off delivery survey (Cooper and Emory, 1995) as previously explained in chapter 4. In addition to the known benefits of this data collection method such as reducing a chance of mail missing, a drop-off delivery survey also reduces the number of incomplete questionnaires and missing data. During the visit, the target respondents could respond to the questionnaire by themselves or ask the researcher to lead the questionnaire and mark in the answer whenever the respondent replies. In either case, the researcher knew immediately if the questionnaire is incomplete or if data is missing. However, from a total of 243 questionnaires that were collected from the target respondents, 9 of them were still found to be incomplete with some missing values. In general, there are two methods frequently used to treat the missing values. The first method is a listwise deletion which deals with incomplete data by excluding all cases that have missing data in at least one of the selected variables (Hair et al., 1998). Listwise deletion is also frequently labeled as casewise deletion. Another method is a pairwise deletion which calculates a correlation between each pair of variables from all cases that have valid data on those two variables and omits cases which do not have data on a variable used in the current calculation. Although both methods are popular among researchers, there are some advantages and disadvantages of listwise deletion and pairwise deletion. For listwise deletion, if missing data are randomly distributed across cases, the valid cases in the data set might not be large enough to perform a statistical analysis. For pairwise deletion, on the other hand, different calculations, such as different correlation coefficients, would utilize different cases and would have different sample sizes which may lead to serious problems. For example, pairwise deletion may cause a systematic bias which results from a hidden systematic distribution of missing data, causing different correlation coefficients in the same correlation matrix to be based on different subsets of subjects. However, pairwise deletion may be necessary when overall sample size is small or the number of cases with missing data is large while listwise deletion is preferred over pairwise deletion when sample size is large in relation to the number of cases which have missing data. In this study, where the number of cases with missing data was considered small compared with the total number of observations, listwise deletion was selected. Thus, after deleting 9 cases with missing data, a total of 234 sets of data were used for data analyses.

5.1.3 Checks for Non-Response Bias

Since the data collection was spread over a three month period from June to September 2006, the possibility of non-response bias was assessed by comparing early and late respondents (Armstrong and Overton, 1977). Early respondents (n = 126) completed the questionnaire during the first half of the three month period and late respondents (n = 108) completed the questionnaire in the second half of the period. A *t*-test was performed to compare the means of all constructs reported by early respondents and late respondents in order to determine if the responses from these two groups were significantly different. The results of the *t*-test can be seen in table 5.1.

Table 5.1: Construct Mean Comparison between Early and Late Respondents

Construct	Early Respondents (n = 126)	Late Respondents (n = 108)	Mean Difference[b]
Supply Chain Orientation	4.22 (0.79)	4.18 (0.86)	0.04 *(0.43)*
Information System Support	3.98 (1.07)	4.12 (1.03)	-0.14 *(-0.98)*
Resource Commitment	3.58 (0.97)	3.73 (1.03)	-0.15 *(-1.16)*
External Integration	4.16 (0.93)	4.18 (0.93)	-0.02 *(-0.24)*
Internal Integration	4.10 (0.96)	4.19 (0.91)	-0.09 *(-0.74)*
Reverse Logistics Performance	4.28 (0.94)	4.34 (0.94)	-0.07 *(-0.56)*

Notes:
[a] Each item is measured based on 6-point Likert scale (1=Extremely Disagree, 6=Extremely Agree); Standard Deviations are shown in parentheses
[b] Mean Differences were tested by independent *t*-test; *t*-value is illustrated in italic parentheses
* $p < .05$; ** $p < .01$; *** $p < .001$

The result of the *t*-test indicated that none of the six key constructs were statistically different between the early respondent group and late respondent group. Therefore, non-response bias did not appear to be a problem in this study.

5.2 RESPONDENT PROFILES

While 508 first-tier suppliers were defined as the targeted population in this study, the total number of respondents who were willing to participate in this study was 243, indicating a population response rate of 47.83%. However, of this number, 9 observations were not usable due to missing values. Therefore, a total of 234 observations were used for data analysis, resulting in a usable response rate of 46.06%.

In order to understand the characteristics of the respondents in this study, the descriptive statistics of respondents were done based on the 234 sets of complete questionnaires received during the three month period. All of the respondents were qualified to answer the questionnaire as they reported to involve with operation management that focuses on work flows across many departments including purchasing, production, logistics, marketing and sales. By categorizing these respondents based on their positions, it was found that 17 of the respondents (7.26%) were working in the top management level while 28 respondents (11.97%) were working in operational level. Thus, the majority of the respondents (189 respondents, 80.77%) were working in middle management level since these respondent firms were considerably large which made top management of the firms difficult to reach by the researcher. In many cases, the questionnaire was initially reviewed by the top management and then pass on to responsible person in middle management or operational levels.

For product category, 44 respondents (18.80%) supplied interior parts to car assemblers. The others supplied engine (39 firms), body work (33 firms), raw material (21 firms), steering (20 firms), brake (19 firms), electrical system and electronics (19 firms), suspension (17 firms), drivetrain (16 firms), wheel (3 firms), and tire (3 firms), respectively. The details can be seen in table 5.2.

Table 5.2: Product Category of the Respondents

Product Category	Frequency	Percentage
Interior parts	44	18.80
Engine	39	16.67
Body work	33	14.10
Raw material	21	8.97
Steering	20	8.55
Brake	19	8.12
Electrical system and electronics	19	8.12
Suspension	17	7.27
Drivetrain	16	6.84
Wheel	3	1.28
Tire	3	1.28
Total	**234**	**100**

For the proportion of sales between foreign market and local market, 75 respondents (32.05%) supplied solely to local market. The other firms, although supplied products to both local and foreign markets, mainly focused on local markets. A total of 222 respondent firms (94.87%) had more than 50% of their sales on local market. Only 7 respondent firms in this study supplied their products to foreign market more than local market. The rest of 5 respondent firms reported that they sold their products to foreign market and local market equally.

For tiers of services, 89 respondents (38.03%) act only as direct suppliers of car assemblers. A total of 143 (61.11%) respondents supplied to both car assemblers and first-tier/second-tier suppliers. Only 2 respondents supplied to car assemblers, first-tier/second-tier suppliers, and other industries, such as, electronics industry, electrical appliance industry, and spare parts-industry simultaneously.

The average percentage of product return based on the sales volume and its standard deviation were reported at 2.53% and 1.85% respectively. However, it was reported that the percentage of product return was ranged from 0.1% to 10% of the total quantity of products delivered to customers. Majority of the respondents (61 firms) reported the average product return rate of 2%. A total of 31 respondents reported that their firms had the product return rate of 5% or more while 35 respondents reported that their firms had the product return rate of less than 1 %. The detail can be seen in table 5.3.

Table 5.3: Percentage of Product Return based on the Sales Volume

Percentage of Product Return	Frequency	Percent
Less than 1 percent	35	14.95
1-1.99 percent	42	17.95
2-2.99 percent	71	30.34
3-3.99 percent	43	18.38
4-4.99 percent	12	5.13
5 percent or more	31	13.25
Total	**234**	**100**

Product returns were caused by several reasons. It was reported that, on average, majority of product returns (51.01%) were caused by defective products while 24.31% of product returns were due to incorrect product specification. Another 22.05%

of product returns were sent back as a result of faulty order processing. The rest of product returns (2.63%) were done for recycling and other purposes.

There are several definitions that can be used to classify a size of a firm. The Office of Small and Medium Enterprises Promotion suggest that small and medium enterprises (SMEs) shall have fewer than 200 employees. If this definition is used in this study, 82 (35%) of the respondent firms will be classified as small and medium firms while 152 (65%) of them will be classified as large firms. Since firms in the automotive industry, especially those that are first-tier suppliers, are capital and labor intensive and tend to be larger than firms in other industries, this classification scheme may not be appropriate for this research. Thus, this study followed the definition provided by the United States Small Business Administration (2003) which defined a small business as an independent business having fewer than 500 employees while a large firm shall has 500 employees or more. By comparing the percentage of product return of the large firms and small firms in this study, it was found that the average rate of product returns of small firms was significantly higher than that of large firm (0.89%, p<0.001). The *t*-test result can be seen in table 5.4.

Table 5.4: Mean Comparison of Product Returns Based on Firm Size

	Small Firms (n = 157)	Large Firms (n = 77)	Mean Difference [b]
Average Product Returns [a]	2.81 (2.09)	1.93 (0.98)	0.89*** (4.44)

Notes:

[a] The average product return was measured in percentage (%); Standard Deviations are shown in parentheses

[b] Mean Differences were tested by independent *t*-test; *t*-value is illustrated in italic parentheses

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

The significant difference between the average product return rates of small firms and large firms arises partly from the superior quality assurance system used in the manufacturing process of large firms. Since a quality assurance system frequently require an extensive investment in equipment and personnel, large firms typically have better system in place which leads to smaller percentage of product return caused by defective products. In addition, large firm tend to have more systematic procedures to deal with order tracking, production scheduling, and order filling. Thus, the returns caused by faulty order processing or incorrect product specification are normally less in large firms. Finally, due to the size of business, large firms normally concern more about their reputation compared with small firms. Thus, most of the large firms heavily focus on improving their product quality and processes to ensure that customers receive the right product, in the right quantity and the right condition, at the right place, at the right time, for the right customer, at the right cost. Small firms, on the other hand, normally have relatively limited resources to improve product quality and process compared with that of large firms. Thus, large firms are in better position to keep the lower percentage of product returns compared with small firms.

Other mean comparisons for product returns were also performed based on characteristics such as ownership structure, nationality of foreign shareholder, sales volume, and product category. The details of the ANOVA can be seen in table 5.5.

Table 5.5: Mean Comparison of Product Returns based on Other Characteristics

Average Product Returns[a]

Ownership Structure				
Thai-Owned (n = 50)	Thai Majority JV (n = 42)	Foreign Majority JV (n = 42)	Foreign-Owned (n = 100)	Difference[b]
2.71 (1.58)	2.17 (1.53)	2.81 (2.03)	2.00 (2.00)	1.07

Nationality of Foreign Shareholder				
Japanese (n = 134)	European (n = 16)	American (n = 11)	Others (n = 23)	Difference[b]
2.54 (2.08)	2.60 (1.66)	1.49 (1.04)	2.50 (1.19)	0.99

Sales Volume			
<100M (n = 64)	101M-500M (n = 100)	>501M (n = 70)	Difference[b]
2.82 (1.78)	2.56 (2.17)	2.19 (1.29)	2.06

Product Category				
Engine/ Drive train (n = 55)	Steering/Suspension/ Brake/Wheel/Tire (n = 62)	Body Work/ Interior (n = 77)	Electronics/ Raw Material (n = 40)	Difference[b]
2.33 (1.68)	2.16 (1.42)	2.61 (1.75)	2.42 (1.64)	1.03

Notes:
[a] The average product return was measured in percentage (%); Standard Deviations are shown in parentheses
[b] Mean Differences were tested by one-way ANOVA; *F*-value is presented
* $p < .05$; ** $p < .01$; *** $p < .001$

It can be seen from the ANOVA result shown in table 5.5 that the average rate of product return did not depend on ownership structure, nationality of foreign shareholder, sales volume, and product category. The differences of average product return rates among firms categorized by using different types of characteristics, except the firm size as measured by the number of employees, were not significant.

For the ownership structure of the respondent firms, majority of the respondent (100 firms, 42.73%) were wholly owned by foreign shareholders. Only 50 firms (21.37) percent of the respondents were wholly owned by Thais. The rest 84 respondents were joint venture firms which can be equally divided into two groups, i.e. Thai majority joint venture (42 firms) and foreign majority joint venture (42 firms).

In joint venture firms, most of them had Japanese investors as major foreign shareholders (134 firms, 72.83%). Only 16 firms (8.70%) had European shareholders and 11 firms (5.98%) had American shareholders. The rest (23 firms, 13.04%) had shareholders from other countries such as China, Malaysia, Singapore, Germany, and Taiwan.

All the respondent firms had at least three-year business experience in the automotive industry. It was recommended by the informants during the in-depth interviews that three-year business experience should be long enough for these firms to develop shared key operational activities with their trading partners as well as internal integration among departments within their firms. While the average business experience of 234 respondent firms was 12.62 years, it varied from 3 year to 40 years. A total of 161 respondents (68.80%) had at least 10 years of experience in the automotive industry.

The smallest firm in this study had only 20 employees while the largest had 3,100 employees. The average number of employees for the respondent firms was 488.59. The sales volume of the respondents varied from less than 50 million baht to more than 3,000 million baht. The details can be seen in table 5.6.

Table 5.6: Sales Volume of the Respondents

Sales Volume	Frequency	Percent
Less Than 50 Million Baht	34	14.53
50-100 Million Baht	30	12.82
101-200 Million Baht	61	26.07
201-500 Million Baht	39	16.66
501-1,000 Million Baht	31	13.25
1,001-2,000 Million Baht	20	8.55
2,001-3,000 Million Baht	14	5.98
More Than 3,000 Million Baht	5	2.14
Total	**234**	**100**

The most important customer that accounts for the largest portion of the respondents' annual sales was also reported by the respondents. The largest portion of respondents (76 firms, 32.48%) reported that Toyota was their most important customer. Isuzu was the most important customer for 54 respondents (23.08%) in this study. Honda, Mitsubishi, and Nissan were claimed to be the most important customer of 40 (17.09%), 19 (8.12%), and 16 (6.84%) respondents respectively. The details can be seen in table 5.7.

From the analysis of respondent profiles, it can be seen that respondents were in the business of producing all kinds of automotive parts categorized by Thailand Automotive Institute (TAI) (2002). While majority of the firms were owned by foreign shareholders, a portfolio of respondents also included Thai-owned firms, and joint venture firms. Based on the sales volume, respondent firms consisted of small, medium, and large firms with the sales volume widely distributed from less than 50 million baht to more than 3,000 million baht. Finally, although most of the respondent firms have Japanese car assemblers as their most important customers, many of them also supplied automotive parts to European and American car assemblers. Thus, it can be concluded that the respondents in this study were distributed across all types of characteristics. The data from these respondents will be used for further analysis explained in the next sections.

Table 5.7: The Most Important Customers

Most Important Customer	Frequency	Percent
Toyota	76	32.48
Isuzu	54	23.08
Honda	40	17.09
Mitsubishi	19	8.12
Nissan	16	6.84
Ford & Mazda	8	3.42
Mercedes-Benz	7	2.99
BMW & Rover	6	2.56
Others	8	3.42
Total	**234**	**100**

5.3 ITEM ANALYSIS

5.3.1 Means and Standard Deviations of Constructs

In order to understand the overview of the responses reported for each construct, the means and standard deviations of all constructs are presented. In this study, the questionnaire was designed to use multiple measurement items for each of the constructs. Thus, the mean and standard deviation of the unweighted summated score for each major construct are presented instead of the mean and standard deviation for each measurement item. The details can be seen in table 5.8.

Table 5.8: Means and Standard Deviations of Constructs

Construct	Minimum	Maximum	Mean	Std. Deviation
Supply Chain Orientation	2.20	5.95	4.20	0.82
Information System Support	2.15	6.00	4.04	1.05
Resource Commitment	2.00	6.00	3.65	0.99
External Integration	2.26	6.00	4.17	0.93
Internal Integration	2.00	6.00	4.14	0.93
Reverse Logistics Performance	2.08	6.00	4.31	0.94

However, there is a possibility that each construct may be affected by some of the firm's characteristics. In order to determine if these characteristics should be defined as control variables during the data analysis, the investigation should be done to evaluate whether responses made by each group of firms divided by certain characteristics, such as firm size, ownership structure, nationality of foreign shareholder, and sales volume, were significantly different from each other. Thus, the analysis of control variables is illustrated in the next section.

5.3.2 Control Variables

Control variables in this study include firm size, ownership structure, nationality of foreign shareholder, and sales volume. These control variables were examined with the proposed constructs in this study including supply chain orientation, information system support, resource commitment, external integration, internal integration, and reverse logistics performance. Two statistical tools including ANOVA and *t*-test were used to examine the effects of control variables on the constructs.

5.3.2.1 Firm Size

In order to see if the means of the proposed constructs were different across the sizes of the firms, respondents were divided into two groups. The classification was based on the definition of United States Small Business Administration (2003), which defined a small business as an independent business having fewer than 500 employees. Using this classification, a total of 157 small firms and 77 large firms participated in this study. The result of *t*-test can be seen in table 5.9.

Table 5.9: Mean Comparison of Constructs based on Firm Size

Construct	Small Firm (n = 157)	Large Firms (n = 77)	Mean Difference[b]
Supply Chain Orientation	4.23 (0.80)	4.15 (0.86)	0.08 *(0.65)*
Information System Support	4.09 (1.05)	3.95 (1.05)	0.14 *(0.99)*
Resource Commitment	3.70 (1.01)	3.54 (0.97)	0.16 *(1.18)*
External Integration	4.23 (0.93)	4.05 (0.92)	0.18 *(1.41)*
Internal Integration	4.22 (0.94)	4.00 (0.91)	0.22 *(1.70)*
Reverse Logistics Performance	4.37 (0.93)	4.18 (0.93)	0.19 *(1.50)*

Notes:
[a] Each item is measured based on 6-point Likert scale (1=Extremely Disagree, 6=Extremely Agree); Standard Deviations are shown in parentheses
[b] Mean Differences were tested by independent *t*-test; *t*-value is illustrated in italic parentheses
* $p < .05$; ** $p < .01$; *** $p < .001$

The result indicated that there was no significant difference in the means of supply chain orientation, information system support, resource commitment, external integration, internal integration, and reverse logistics performance between a group of small firms and a group of large firms in this study. Thus, based on the data of this study, these two subgroups categorized by the number of employees were not different and a pool of 234 useable samples could be used for further analysis.

5.3.2.2 Ownership Structure

The analysis of variance (ANOVA) was performed in order to investigate if the mean differences of constructs across different types of shareholder structure (i.e. Thai owned, Thai majority joint venture, foreign majority joint venture, and foreign owned) were significant. In this study, there were 50 Thai-owned firms, 42 Thai majority joint venture firms, 42 foreign majority joint venture firms, and 100 foreign-owned firms. The result of ANOVA can be seen in table 5.10.

Table 5.10: Mean Comparison of Constructs based on Ownership Structure

Construct	Thai-Owned (n = 50)	Thai Majority JV (n = 42)	Foreign Majority JV (n = 42)	Foreign-Owned (n = 100)	Difference[b]
Supply Chain Orientation	4.19 (0.89)	4.19 (0.79)	4.05 (0.91)	4.27 (0.77)	0.71
Information System Support	3.95 (1.10)	3.97 (1.00)	4.03 (1.08)	4.13 (1.05)	0.41
Resource Commitment	3.63 (1.05)	3.57 (1.00)	3.54 (1.00)	3.73 (0.97)	0.50
External Integration	4.15 (1.01)	4.04 (0.81)	4.13 (1.03)	4.25 (0.89)	0.58
Internal Integration	4.15 (0.95)	4.17 (0.86)	4.06 (1.02)	4.17 (0.93)	0.15
Reverse Logistics Performance	4.25 (0.97)	4.24 (0.87)	4.24 (1.07)	4.39 (0.90)	0.43

Notes:
[a] Each item is measured based on 6-point Likert scale (1=Extremely Disagree, 6=Extremely Agree); Standard Deviations are shown in parentheses
[b] Mean Differences were tested by one-way ANOVA; *F*-value is presented
* $p < .05$; ** $p < .01$; *** $p < .001$

It can be seen from table 5.10 that there was no significant difference in the means of supply chain orientation, information system support, resource commitment, external integration, internal integration, and reverse logistics performance across the 4 subgroups of firms with different ownership structures. Thus, there was no need to put ownership structure as a control variable in this study. A pool of 234 useable samples was used for further analysis

5.3.2.3 Nationality of Foreign Shareholder

From the result of the demographic analysis, it was found that the main shareholders in the joint venture firms were Japanese, American, and European shareholders, as well as investors from other countries as previously described. It is interesting to see if the mean values of the proposed constructs were significantly different across different nationalities of the shareholders. The result of ANOVA can be seen in table 5.11.

Table 5.11: Mean Comparison of Constructs based on Nationality of Shareholders

Construct	Japanese (n = 134)	European (n = 16)	American (n = 11)	Others (n = 23)	Difference[b]
Supply Chain Orientation	4.23 (0.77)	4.00 (0.79)	4.00 (1.06)	4.30 (0.92)	0.53
Information System Support	4.10 (1.03)	4.15 (0.98)	3.66 (0.93)	4.00 (1.18)	0.63
Resource Commitment	3.60 (0.95)	4.19 (1.09)	3.67 (1.16)	3.58 (0.98)	1.29
External Integration	4.21 (0.86)	4.24 (0.99)	3.75 (0.87)	4.12 (1.08)	0.69
Internal Integration	4.18 (0.90)	4.14 (1.04)	3.69 (0.93)	4.15 (1.05)	0.69
Reverse Logistics Performance	4.36 (0.89)	4.29 (1.02)	3.92 (0.94)	4.30 (0.94)	0.61

Notes:
[a] Each item is measured based on 6-point Likert scale (1=Extremely Disagree, 6=Extremely Agree); Standard Deviations are shown in parentheses
[b] Mean Differences were tested by one-way ANOVA; *F*-value is presented
* $p < .05$; ** $p < .01$; *** $p < .001$

No significant difference was found in the mean values of supply chain orientation, information system support, resource commitment, external integration, internal integration, and reverse logistics performance between subgroups of firms with different nationalities of shareholders. Thus, a nationality of shareholders was not a control variable in this study and a pool of 234 useable samples was used for further analysis.

5.3.2.4 Sales Volume

It was suspected by some informants in the automotive industry during the in-depth interviews that the sales volume of a firm may be related to the level of supply chain orientation, information system support, resource commitment, external integration, internal integration, and reverse logistics performance. Therefore, ANOVA was conducted to confirm this idea. The result of ANOVA can be seen in table 5.12.

Table 5.12: Mean Comparison of Constructs based on Sales Volume

Construct	<100M (n = 64)	101M-500M (n = 100)	>501M (n = 70)	Difference[b]
Supply Chain Orientation	4.25 (0.87)	4.17 (0.80)	4.20 (0.82)	0.15
Information System Support	3.96 (1.08)	4.03 (1.04)	4.14 (1.05)	0.55
Resource Commitment	3.54 (1.00)	3.73 (1.01)	3.63 (0.97)	0.69
External Integration	4.16 (1.01)	4.15 (0.89)	4.21 (0.90)	0.10
Internal Integration	4.16 (0.96)	4.09 (0.90)	4.22 (0.95)	0.42
Reverse Logistics Performance	4.27 (0.98)	4.29 (0.92)	4.36 (0.93)	0.17

Notes:
[a] Each item is measured based on 6-point Likert scale (1=Extremely Disagree, 6=Extremely Agree); Standard Deviations are shown in parentheses
[b] Mean Differences were tested by one-way ANOVA; *F*-value is presented
* $p < .05$; ** $p < .01$; *** $p < .001$

The result indicated that the levels of supply chain orientation, information system support, resource commitment, external integration, internal integration, and reverse logistics performance were not different across subgroups of firms categorized by sales volume in this study. Thus, the result suggested that sales volume was not a control variable in this study which allows the total of 234 useable samples to be used for further data analysis.

In summary, the construct mean comparisons among subgroups of firms that were categorized by firm size, ownership structure, nationality of shareholder, and sales volume indicated that the means of supply chain orientation, information system support, resource commitment, external integration, internal integration, and reverse logistics performance) were not different across the subgroups. Thus, these characteristics of firms were not used as control variables in this study. The data analyses in the next steps were based on the total of 234 useable responses.

5.3.3 Reliability Analysis

A reliability analysis must be performed in order to see if the measurement items used in the questionnaire were reliable and could be used for the data analysis in the next step. Cronbach's alpha coefficient provides a summary measure of the inter-correlation that exists among a set of items. A high Cronbach's alpha (close to 1.0) indicates high internal consistency while a low Cronbach's alpha (close to 0.0) indicates low reliability. Cronbach's alpha coefficient of .70 or higher was recommended by Nunnally (1978) to shows high reliability. In this study, the reliability analysis was divided into two levels which were construct level and dimension level. The summary of scale reliability and their internal consistency at both levels is illustrated in table 5.13.

Table 5.13: Scale Reliability and Internal Consistency

Construct/Dimension		Cronbach's Alpha	
		Construct Level	Dimension Level
Supply Chain Orientation		.962	
	Credibility		.952
	Benevolence		.932
	Commitment		.918
	Cooperative Norm		.925
	Compatibility of Culture		.904
	Top Management Support		.936
Information System Support		.963	
	IS Support Capability		.939
	IS Support Compatibility		.976
	IS Support Technologies		.757
Resource Commitment		.904	
External Integration		.985	
	Supplier Integration		.979
	Customer Integration		.971
Internal Integration		.970	
Reverse Logistics Performance		.975	
	Cost		.948
	Responsiveness		.963
	Satisfaction		.960

From table 5.13, it can be seen that the Cronbach's alpha coefficients for all constructs exceeded the minimum threshold value of 0.7 as recommended by Nunnally (1978). In addition, the result of the reliability assessment at a dimension level was also satisfactory as they ranged from 0.757 to 0.976. Supplier integration dimension had the highest reliability while IS support technologies had the lowest reliability.

The item-to-total analysis for all set of items measuring the constructs except IS support technologies appeared normal with corrected item-to-total subscale correlations higher than .5 as recommended by Nunnally (1978). For IS support technologies, however, the item-to-total analysis indicated that there was a problem with one item. The result of item-to-total analysis for this dimension was shown in table 5.14.

Table 5.14: Item-to-Total Analysis for IS Support Technologies

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
ISTECH1	11.3846	7.345	.770	.841	.578
ISTECH2	11.3376	7.332	.785	.832	.570
ISTECH3	11.3590	7.965	.777	.780	.594
ISTECH4	12.2265	10.734	.105	.016	.953

From table 5.14, it can be seen that item ISTECH4 had a very low corrected item-to-total correlation (0.105) which explained why the Cronbach's alpha coefficients for IS support technologies dimension was relatively lower than those of other dimensions. In general, items with corrected item-to-total subscale correlations below .50 should be deleted (Nunnally, 1978) since they might not share equality in the common core of the construct (Churchill, 1999). If this item is deleted, the value of Cronbach's alpha will increase from 0.757 to 0.953. Based on the questionnaire, ISTECH4 represents the use of Electronic Data Interchange (EDI) to assists with the return handling. The depth-interviews with several informants working in the automotive industry suggested that, due to its large amount of investment required, EDI is normally found only in large firms. Thus, most of the small firms may not have the EDI system in place and may rather use other cost-effective technologies such as Internal and e-mail to take care of the returns. For this reason, it is no surprise to see that this measurement item had low correlation with other items in the same group. In order to purify the scale, the ISTECH4 was deleted and would not be used for further data analysis.

5.3.4 Exploratory Factor Analysis

The next step of data analysis requires the assessment of constructs validity of all the constructs proposed in this study. Exploratory factor analysis (EFA) with Varimax rotation was performed in this step. The number of factors extracted was based on the scree test criterion as recommended by Hair et al. (1998). Factors with eigenvalue of more than one would be considered a significant and powerful measurement items (Hair et al., 1998). Factors with eigenvalue of less than 1 would therefore be disregarded. If the factor loadings of all items loaded in each dimension are high (above 0.3) and their signs are in the same direction, the discriminant validity of the measurement is considered satisfactory (Hair et al., 1998). To purify the scale, measurement items with low loadings (<.50), low communalities (<.30), and/or high cross-loadings (>.40) would be eliminated (Hair et al., 1998; Churchill, 1979). In addition, Hair et al. (1998) recommended that Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy should be conducted in order to see if the data is adequate for the factor analysis. A KMO of higher than .80 is recommended while a KMO of less than .5 is not acceptable. In addition, the Bartlett's test of Sphericity was also performed to test the significance of the corresponding correlation matrix. The p-value of less than .05 illustrates a significant correlation among all items which indicate that the factor analysis is suitable for the analysis of that particular dataset (Hair et al., 1998).

The exploratory factor analysis was done for constructs that have more than one dimension i.e. supply chain orientation, information system support, external integration, and reverse logistics performance. The result of exploratory factor analysis for supply chain orientation is illustrated in table 5.15.

Table 5.15: Factor Analysis of Supply Chain Orientation

Supply Chain Orientation		Component					
Dimension	Question Items	1	2	3	4	5	6
Credibility	CRED1	.822					
	CRED2	.807					
	CRED3	.836					
	CRED4	.782					
Benevolence	BENE1			.812			
	BENE2			.845			
	BENE3			.832			
	BENE4			.800			
Commitment	COMM1						.794
	COMM2						.800
Cooperative Norm	NORM1				.746		
	NORM2				.790		
	NORM3				.748		
Compatibility of Culture	COMP1					.810	
	COMP2					.857	
Top Management Support	TOPM1		.698				
	TOPM2		.717				
	TOPM3		.713				
	TOPM4		.704				
	TOPM5		.811				

Cumulative percent of initial Eigen value: 6 components = 86.16 %
KMO Measure =.935, p =.000

The result of exploratory factor analysis for supply chain orientation construct indicated that the supply chain orientation construct consists of six dimensions which are credibility, benevolence, commitment, cooperative norm, compatibility of culture, and top management support. These six factors accounted for 86.16 percent of the total variance. The KMO measures of sampling adequacy indicated a satisfactory result (.935) while the Bartlett's test of Sphericity is significant at p<.000. All items were highly loaded in these six factors as all factor loadings exceeded the cutoff point of .05 (Hair et al., 1998). The result was consistent with what was proposed in the literature. These 20 items were used for further data analysis.

An exploratory factor analysis was also done with information system support. Based on the result of reliability analysis, one item (ISTECH4) was deleted and was not taken into the exploratory factor analysis. Thus, a total of 13 measurement items were included into the analysis. There were 3 measurement items for IS support capability, 7 measurement items for IS support compatibility, and 3 measurement items for IS support technologies. The result of exploratory factor analysis is shown in table 5.16.

Table 5.16: Factor Analysis for IS Support

IS Support		Component		
Dimension	Question Items	1	2	3
IS Support Capability	ISCAP1			.712
	ISCAP2			.761
	ISCAP3			.784
IS Support Compatibility	ISCOMP1	.806		
	ISCOMP2	.820		
	ISCOMP3	.782		
	ISCOMP4	.802		
	ISCOMP5	.818		
	ISCOMP6	.812		
	ISCOMP7	.817		
IS Support Technologies	ISTECH1		.813	
	ISTECH2		.821	
	ISTECH3		.787	

Cumulative percent of initial Eigen value: 3 components = 88.76 %
KMO Measure =.965, p =.000

The result of exploratory factor analysis indicated that all items were loaded significantly as proposed into three dimensions which are IS support capability, IS support compatibility, and IS support Technologies. These three factors account for 88.76% of the total variance. The KMO measures of sampling adequacy indicated a satisfactory result (.965) while the Bartlett's test of Sphericity is significant at p<.000. As all measurement items were highly loaded into these three factors as proposed, all of them were continue to be used in the data analysis.

Exploratory factor analysis was also required for external integration. There were a total of 11 measurement items to evaluate the level of supplier integration and 8 measurement items to evaluate the level of customer integration. The result of exploratory factor analysis for external integration is shown in table 5.17.

Table 5.17: Factor Analysis for External Integration

External Integration		Component	
Dimension	Question Items	1	2
Supplier Integration	SI1	.734	
	SI2	.748	
	SI3	.769	
	SI4	.754	
	SI5	.749	
	SI6	.712	
	SI7	.730	
	SI8	.729	
	SI9	.782	
	SI10	.810	
	SI11	.832	
Customer Integration	CI1		.806
	CI2		.836
	CI3		.759
	CI4		.749
	CI5		.772
	CI6		.776
	CI7		.740
	CI8		.734

Cumulative percent of initial Eigen value: 2 components = 83.09 %
KMO Measure =.980, p =.000

From the result of the exploratory factor analysis, the measurement items were highly loaded into two components which are supplier integration and customer integration as proposed. These two factors accounted for 83.09% of the total variance. The KMO measures of sampling adequacy indicated a satisfactory result (.980) while the Bartlett's test of Sphericity is significant at $p<.000$. No problem was found from the exploratory factor analysis. All the items were used for data analysis in the next stage.

Finally, the exploratory factor analysis was done for the reverse logistics performance. A total of 12 measurement items were used to evaluate reverse logistics performance, i.e. 3 measurement items for cost performance, 5 measurement items for responsiveness, and 4 measurement items for satisfaction. The result of the exploratory analysis can be seen in table 5.18.

Table 5.18: Factor Analysis for Reverse Logistics Performance

Reverse Logistics Performance		Component		
Dimension	Question Items	1	2	3
Cost Performance	COST1			.744
	COST2			.707
	COST3			.784
Responsiveness	RESP1	.784		
	RESP2	.759		
	RESP3	.715		
	RESP4	.796		
	RESP5	.779		
Customer Satisfaction	SATISF1		.835	
	SATISF2		.767	
	SATISF3		.800	
	SATISF4		.762	

Cumulative percent of initial Eigen value: 3 components = 89.35 %
KMO Measure =.953, p =.000

All items were highly loaded into three components which are cost performance, responsiveness, and customer satisfaction as proposed. These three factors explained 89.35 percent of the total variance of the data. The KMO measures of sampling adequacy indicated a satisfactory result (.953) while the Bartlett's test of Sphericity is significant at p<.000 which provided a significant support on the use of this factor analysis result. None of the items was deleted. All the measurement items were used for the data analysis in the next step.

The results of the exploratory factor analysis for supply chain orientation, information system support, external integration, and reverse logistics performance were satisfactory. It suggested that the construct validity for the measurement items used to evaluate these constructs does exist and these measurement items could be used for data analysis in the next stage.

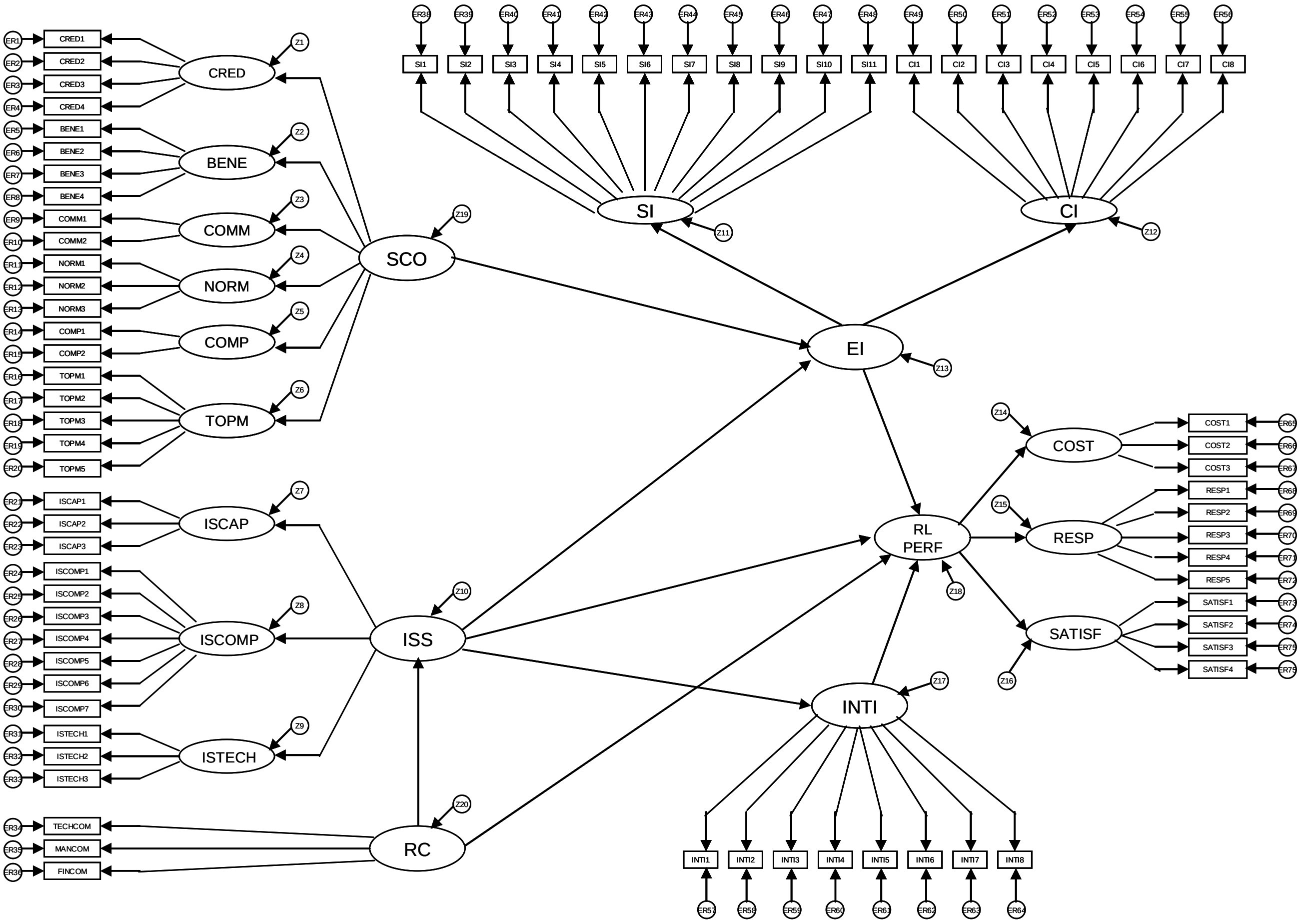
5.4 STRUCTURAL EQUATION MODELING ANALYSIS

In order to test the hypotheses proposed in this study, a structural equation modeling analysis was utilized as a main statistical tool. AMOS (Analysis of Moment

Structures) version 6.0 was used to assess construct measures and model fit. AMOS has been gaining greater use among researchers because of its several benefits such as ease of use, flexibility, and additional options, e.g. treatment of missing data, group invariance, and bootstrapping (Byrne, 2001; Kline, 1998; Maruyama, 1998). The method used in AMOS represents a direct approach that is based on maximum likelihood estimation (MLE) and, thus, is theoretically based (Arbuckle, 1996). By applying the MLE for missing data, estimates exhibit the least bias compared to estimates generated from other missing data treatments, such as listwise deletion, pairwise deletion, and mean imputation (Little and Rubin, 1989). Since AMOS is based on the Maximum Likelihood Estimation (MLE), it is required that the data meet specific assumptions related to continuous and normally distributed endogenous variables. These assumptions should be met or at least approximated to ensure trustworthy results.

After the assessment of structural equation modeling assumptions, the process of structural equation modeling analysis can be divided into two steps. The first step involved the assessment of construct validity from separate estimations of the measurement models. The measurement model, which deals with the latent variables and their indicators, provides a confirmatory assessment of convergent and discriminant validity (Anderson and Gerbing, 1988). Latent variables are the unobserved or constructs or factors which are measured by their respective indicators which can be observed such as items in a survey instrument. This step is necessary as there is no point in proceeding to the structural model until measurement model is proof to be valid. The second step involved the simultaneous estimation of the measurement and structural models to assess nomological validity. In this study, the structural equation modeling analysis was conducted by using AMOS 6.0. Figure 5.2 shows the path model of this study which was tested in the structural equation modeling analysis.

Figure 5.2: Path Diagram of the Reverse Logistics Performance Model



5.4.1 Structural Equation Modeling Assumption Checks

Structural equation modeling is a flexible and powerful extension of the general linear model. Like any statistical method, it features a number of assumptions. These assumptions should be met to ensure trustworthy results. Thus, the following assumptions should be checked before conducting further analysis.

5.4.1.1 Sample Size

The desirable sample size for this study was previously proposed in chapter 4. By using several methods of sample size calculation, including the one based on structural equation modeling requirement (Hair et al., 1998; Yamane, 1967; Kline, 1998; Loehlin, 1992; Stevens, 1996), 224 cases are a minimum requirement for the data analysis in this study. Consequences of using smaller samples include more convergence failures (the software cannot reach a satisfactory solution), improper solutions (including negative error variance estimates for measured variables), and lowered accuracy of parameter estimates and, in particular, standard errors. In this study, 234 usable questionnaires were used for data analysis. Thus, there was no problem with the requirement on sample size.

5.4.1.2 Continuous Variables, Univariate and Multivariate Normal Distribution

Structural equation modeling requires variables to be continuous and normally distributed. In this study, an interval scale, i.e. six-point Likert scale, was used to measure all variables. Thus, the assumption for continuous variables was met (Zigmund, 2003). In order to check if the variables are normally distributed, both univariate and multivariate normal distribution should be investigated.

Kolmogorov-Smirnov (K-S) statistical test of univariate normality has been used by many researchers to assess the univariate normal distribution. However, Filliben (2003) suggested that the most serious limitation of K-S test is that the parameters of the test distribution must be fully specified in advance. When parameters of the test distribution are estimated from the samples, the critical region of the K-S test is no longer valid and the power of the test to detect departures from the hypothesized distribution is seriously diminished. Thus, in stead of the K-S test, the Q-Q plot was used in this study to assess the univariate normality of the data. The visual inspection of the Q-Q plots for each construct showed no severe violations of normality as all points clustered around the straight diagonal line indicating a univariate normality of the data.

Since structural equation modeling estimate the path coefficients based on the maximum likelihood estimation (MLE) method, multivariate normal distribution of endogenous variables is required (Garson, 2006). In general, a violation of this assumption would normally inflate chi-square value and create upward bias in critical values for determining coefficient significant (Hair et al, 1995). Thus, the multivariate normality of four endogenous variables, i.e. information system support, external integration, internal integration, and reverse logistics performance, were assessed by using AMOS test of normality.

The result of AMOS test of normality was evaluated based on the value of skewness and kurtosis. The result indicated that no strong skewness and kurtosis existed for the distribution of the four endogenous variables. For IS support, the coefficient of multivariate non-normality was not significant (multivariate=-.728; $z=-.436$, $p>.05$). The critical ratios for all measurement items in the measurement model of IS support were lower than 2.57 ($p>.01$) which indicated normal distribution of the data. For external integration, the coefficient of multivariate non-normality was not significant (multivariate=.677; $z=.183$, $p>.05$). The critical ratios for all measurement items in the measurement model of external integration were also lower than 2.57 ($p>.01$) which indicated that the data was normally distributed. For internal integration, the problem of multivariate non-normal distribution did not exist as the coefficient of multivariate non-normality was not significant (multivariate=-.509; $z=-.112$, $p>.05$) and the critical ratios for all measurement items in the measurement model of internal integration did not exceed 2.57 ($p>.01$). Finally, the test of normality for reverse logistics performance indicated a satisfactory result as the coefficient of multivariate non-normality was not significant (multivariate=1.549; $z=.646$, $p>.05$). In addition, the critical rations for all measurement items in the measurement model of reverse logistics performance are lower than 2.57 ($p>.01$). Therefore, these tests of normality indicated that the data for all endogenous variables were normally distributed and could be used for the data analysis in the next step. The results of normality tests can be seen in Appendix C.

5.4.1.3 Correlations and Multicollinearity

Another two structural equation modeling assumptions that need to be assessed are the correlations and multicollinearity among the latent variables. Initially, pairwise correlations among the latent variables were examined. Table 5.19 illustrates the correlations between supply chain orientation, information system support, resource commitment, internal integration, and external integration which are the independent variables for the model.

Table 5.19: Correlations between Independent Constructs

	SCO	ISS	RC	INTI	EI
SCO					
ISS	.502**				
RC	.150*	.034			
INTI	.736**	.587**	.223**		
EI	.785**	.604**	.281**	.817**	

Notes:
SCO = Supply Chain Orientation; ISS = Information System Support; RC = Resource Commitment; INTI = Internal Integration; EI = External Integration
** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

In order to test the proposed sub hypotheses, another model which determines supplier integration and customer integration independently should be assessed by using structural equation modeling. Thus, the correlations between supplier integration, customer integration, and other independent variables in the model were also assessed. The result is shown in table 5.20.

Table 5.20: Correlations between Independent Constructs

	SCO	ISS	RC	INTI	SI	CI
SCO						
ISS	.502**					
RC	.150*	.034				
INTI	.736**	.587**	.223**			
SI	.765**	.571**	.286**	.787**		
CI	.772**	.618**	.259**	.809**	.809**	

Notes:
SCO = Supply Chain Orientation; ISS = Information System Support; RC = Resource Commitment; INTI = Internal Integration; SI = Supplier Integration; CI = Customer Integration
** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

The results shown in table 5.19 and table 5.20 indicated that no multicollinearity problem existed. All correlations between independent variables were less than the cutoff point of .90 as suggested by Hair et al. (1998). However, the problem of multicollinearity should also be assessed by conducting a regression with unweighted summated scores for each construct. Based on the regression result, a problem of multicollinearity can be examined by considering the values of the tolerance and variance inflation factor. A problem of multicollinearity may exist when the tolerance value is close to 0 while there is no sign of multicollinearity problem when the tolerance value is close to 1. However, there is no defined cut-off point for the tolerance value. Thus, the Variance Inflation Factor (VIF) shall be examined. The Variance Inflation Factor shall be less than 10 to demonstrate that no problem of multicollinearity exists (Mason and Perreault, 1991; Neter et al., 1985; Hair et al., 1998). The result of the regression is shown in table 5.21.

Table 5.21: Regression Analysis Result

Construct	ß	Tolerance	VIF
(Constant)	-.037		
SCO	.064*	.376	2.657
ISS	.058***	.609	1.641
RC	.008	.877	1.140
INTI	.476***	.156	6.396
EI	.441***	.121	8.287

Notes:
Dependent Variable is Reverse Logistics Performance; F= 1047.52, p=.000; R^2 = .95
* p < .05; ** p < .01; *** p < .001

Since supplier integration and customer integration would be examined independently in order to test sub hypotheses, another regression model was done to examine the value of tolerance and VIF for supplier integration and customer integration. The result of the regression is shown in table 5.22.

Table 5.22: Regression Analysis Result

Construct	ß	Tolerance	VIF
(Constant)	-.039		
SCO	.060*	.375	2.664
ISS	.052**	.597	1.675
RC	.008	.877	1.140
INTI	.457***	.150	6.650
SI	.181***	.142	7.049
CI	.287***	.113	8.862

Notes:
Dependent Variable is Reverse Logistics Performance; F= 900.63, p=.000; R2 = .96
* p < .05; ** p < .01; *** p < .001

The results shown in table 5.21 and table 5.22 were considered satisfactory. The values of Variance Inflation Factor (VIF) vary from 1.140 to 8.862 which were lower than the recommended threshold level of 10. The values of tolerance also indicated satisfactory result. Thus, no problem of multicollinearity was illustrated in this study.

5.4.2 Confirmatory Factor Analysis of the Measurement Models

A confirmatory factor analysis (CFA) was conducted to examine the factor structure of the measures used in this study as it is driven by theory rather than by data (Kelloway, 1998). Confirmatory factor analysis also examines the validity of scales and the appropriateness of their use in a structural equation model and confirms that the indicators sort themselves into factors corresponding to how the researcher has linked the indicators to the latent variables. By using confirmatory factor analysis, the convergent validity can be assessed by evaluating the parameter estimates and *p*-values. First, the parameter estimates were high in value and statistically significant ($p < .05$), meeting the criteria proposed by Anderson and Gerbing (1988) for convergent validity. Second, the values of the average variance extracted (AVE) were equal to or higher than the suggested critical value of .50 which means that the variance captured by constructs was larger than variance due to error (Fornell and Larcker, 1981; Bagozzi and Yi, 1988). In addition, Bagozzi and Yi (1988) recommended that the construct reliabilities should be more than .60 to demonstrate that the scales were reliable. In this step of the structural equation modeling process, the measurement model must be assessed by a confirmatory factor analysis in order to validate the measurement model. The researcher should proceed to the stage of structural model fitting only if the measurement model is successfully validated.

There are several indicators for a well-fitted measurement model. Generally, the measurement model is evaluated by determining the chi-square value ($\chi 2$) and fit indices. The chi-square statistics of the measurement model should not be significant and the fit indices shall be more than .90 to illustrate satisfactory result.

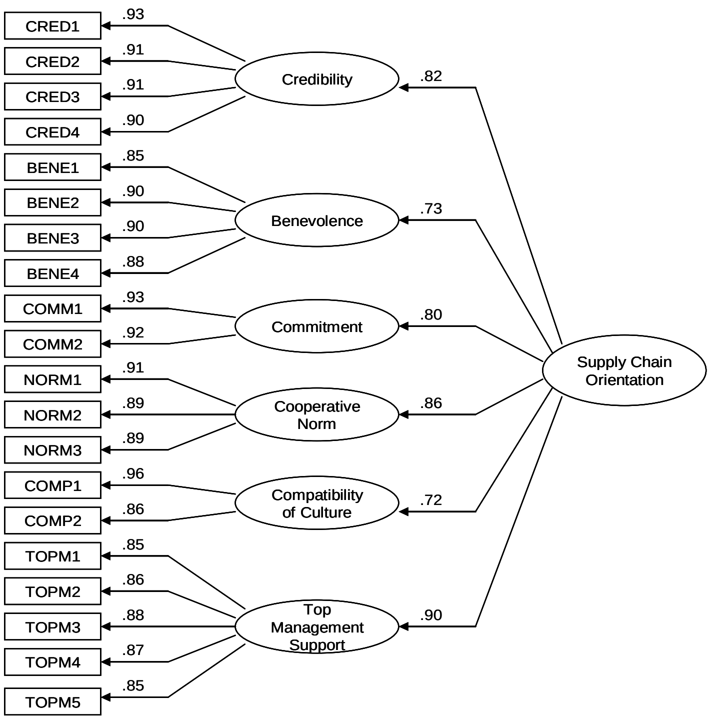
However, in many cases, the chi-square may be significant even when the model is valid. This problem is due to the characteristics of chi-square which depends largely on the sample size. Normally, chi-square statistics is recommended when the sample size is in the range of 100-200 (Hair et al., 1998). When the sample size is larger than 200, interpretation of chi-square statistics might be misleading. Thus, the chi-square value was not used in this study where the sample size is 234. On the other hand, the model was evaluated by using the ratio of the chi-square to the degrees of freedom which is not sensitive to sample size. The use of chi-square per degree of freedom has been recommended by several researchers (e.g. Joreskog and Sorbom, 1989; Mueller, 1996). The value of chi-square per degree of freedom shall be lower than the recommended level of 3.00 (Kline, 1998; Byrne, 2001) in order to be an indicative of good fit. In addition to the chi-square per degree of freedom, the model was also evaluated based on three fit indices which are Incremental fit index (IFI), Tucker-Lewis coefficient (TLI), and Comparative fit index (CFI). Incremental fit index (IFI) and Tucker-Lewis coefficient (TLI), also called Non-Normed fit index (NNFI), are the relative indices that address the question how well the proposed model explains the set of observed data when comparing with other possible models (Hu and Bentler, 1999). The model is validated only when the values of IFI and TLI exceed .90 as recommended by Bentler and Bonett (1980), Bentler (1990), and Hair et al. (1998). Comparative fit index (CFI), on the other hand, measures the relative improvement of fit of the hypothesized models over the independence model. Bentler (1992) recommended that value of CFI should exceed .90 for a well-fitting model. Finally, the Root mean Square Error of Approximation (RMSEA) was also evaluated. RMSEA value of less than 0.08 indicates an adequate fit while a RMSEA value of less than 0.05 indicates a very good fit (Brown and Cudeck, 1993).

Confirmatory Factor Analysis was conducted for all latent constructs proposed in this study, i.e. supply chain orientation, information system support, resource commitment, external integration, internal integration, and reverse logistics performance. The results of the confirmatory factor analysis for these constructs can be seen in the next sub-sections.

5.4.2.1 Supply Chain Orientation

The measurement model of supply chain orientation is shown in figure 5.3. Supply chain orientation consists of 6 dimensions which are credibility, benevolence, commitment, cooperative norm, compatibility of culture, and top management support. Since supply chain orientation is a latent construct that can not be directly measured, a total of 20 measurement items were used as observed variables for this construct. Thus, there were 20 first-order variables and 6 second-order variables in the measurement model of supply chain orientation. Both credibility and benevolence were measured by 4 measurement items which are CRED1-CRED4 and BENE1-BENE4 respectively. Commitment and was measured by 2 items which are COMM1 and COMM2. For cooperative norm, 3 items, i.e. NORM1-NORM3, were used to measure the dimension. Compatibility of culture was measured by 2 items which are COMP1 and COMP2. Finally, top management support was measured by 5 measurement items which are TOPM1-TOPM5. The details of the model and results of the confirmatory factor analysis can be seen in figure 5.3.

Figure 5.3: Measurement Model of Supply Chain Orientation



χ^2 = 298.50, DF = 164, p = .000; χ^2/DF = 1.82; RMSEA = .059; IFI = .971; TLI = .967; CFI = .971; AVE = .73; α = .98

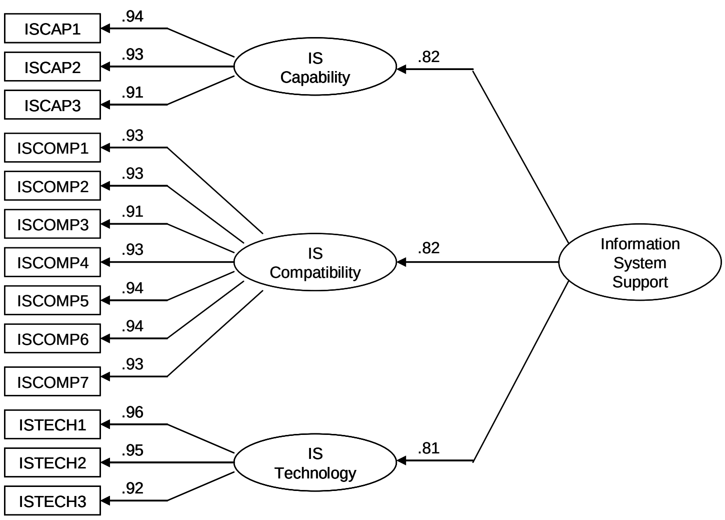
The result of the confirmatory factor analysis for supply chain orientation revealed that the measurement model was fitted well to the data. The value of χ^2/DF was equal to 1.82 which was below the cutoff point of 3. All fit indices exceeded the threshold level of .90 (IFI = .971 TLI = .967; CFI = .971). All of the regression coefficients between each observed variable and its corresponding dimension in the first order confirmatory factor analysis were significant at $p<.001$ level. The regression coefficients for the first order confirmatory factor analysis varied from .85 to .96. For the second order CFA, the regression coefficients between each dimension and supply chain orientation construct were also significant at $p<.001$. The regression coefficients for the second order confirmatory factor analysis varied from .72 to .90. Finally, both average variance extracted (AVE) and construct validity indicated satisfactory result at .73 and .98 respectively.

5.4.2.2 Information System Support

Information system support construct consists of three dimensions; IS capability, IS compatibility, and IS technology. A total of 13 measurement items were used to measure these 3 dimensions and the information system support construct. IS capability was measured by 3 items which are ISCAP1-ISCAP3. For IS compatibility, it was measured by 7 items which are ISCOMP1-ISCOMP7. Finally, IS technology was measured by 3 items which are ISTECH1-ISTECH3. The measurement model of information system support can be seen in figure 5.4.

The result of the confirmatory factor analysis for information system support indicated that the measurement model was fitted well with the data. The value of χ^2/DF was lower than the recommended level of 3 (χ2/DF = 2.33). All fit indices were well above the threshold level of .90 which indicated an excellent fitted model (IFI = .979 TLI = .975; CFI = .979). All of the regression coefficients between each observed variable and its corresponding dimension in the first order confirmatory factor analysis were significant at $p<.001$ level. The regression coefficients for the first order confirmatory factor analysis varied from .91 to .96. For the second order CFA, the regression coefficients between each dimension and supply chain orientation construct were also significant at p<.001. The regression coefficients for the second order confirmatory factor analysis varied from .81 to .82. Finally, both average variance extracted (AVE) and construct validity indicated satisfactory result at .73 and .97 respectively.

Figure 5.4: Measurement Model of Information System Support

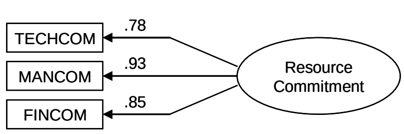


χ^2 = 151.70, DF = 65, p = .000; χ^2/DF = 2.33; RMSEA = .076; IFI = .979; TLI = .975; CFI = .979; AVE = .73; α = .97

5.4.2.3 Resource Commitment

The construct of resource commitment was measured by 3 measurement items which are TECHCOM, MANCOM, and FINCOM. The measurement model and the result of confirmatory factor analysis for resource commitment can be seen in figure 5.5.

Figure 5.5: Measurement Model of Resource Commitment



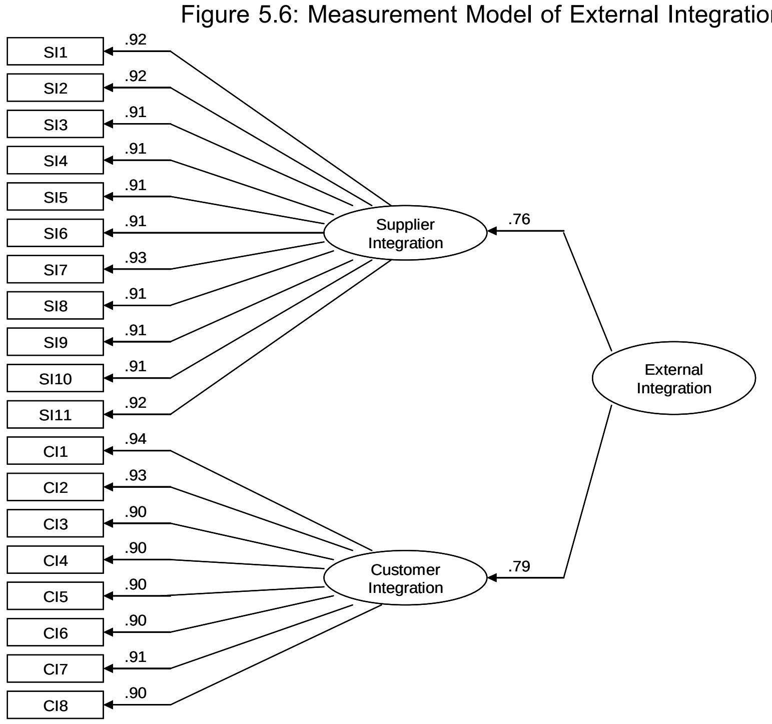
χ^2 = 11.22, DF = 1, p = .001; χ^2/DF = 11.22; RMSEA = .209; IFI = .977; TLI = .932; CFI = .977; AVE = .55; α = .79

The result of the confirmatory factor analysis indicated that the model was fitted well with the data. All the fit indices exceeded the threshold level of .90 (IFI = .977; TLI = .932; CFI = .977). All of the regression coefficients between each observed variable and resource commitment construct were significant at p<.001 level. The regression coefficients varied from .78 to .93. The average variance extracted (AVE) and construct validity indicated satisfactory result at .55 and .79 respectively. Although the chi-square per degree of freedom of this measurement model is relatively high, it was suggested that, in many circumstances, the use of chi-square to evaluate the fit of the model may be misleading. Thus, it was suggested that with a reasonable sample size (e.g. n>200) and good approximate fit as indicated by other fit tests (e.g., IFI, TLI, CFI, RMSEA, and others), the effect of the chi-square test may be discounted and that a chi-square test is not a reason by itself to modify the model (Kline, 1998).

5.4.2.4 External Integration

External integration consists of 2 dimensions, i.e. supplier integration and customer integration. For supplier integration, it was measured by 11 measurement items which are SI1-SI11. Customer integration was measured by 8 items which are CI1-CI8. Thus, there are 19 first-order variables and 2 second-order variables in the measurement model of external integration. The detail of the measurement model for external integration can be seen in figure 5.6.

Figure 5.6: Measurement Model of External Integration



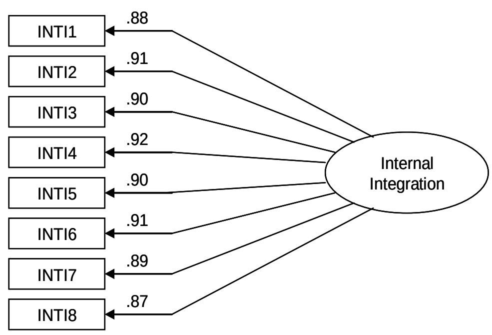
$\chi 2$ = 471.28, DF = 152, p = .000; $\chi 2$/DF = 3.10; RMSEA = .095; IFI = .948; TLI = .971; CFI = .948; AVE = .75; α = .98

The result of the confirmatory factor analysis indicated that the measurement model was fitted well with the data. All of the fit indices exceeded the threshold level of .90 (IFI = .948; TLI = .971; CFI = .948). In the case of large sample analyses (n>200), the value of chi-square may inflate which allows some researchers to accept the chi-square per degree of freedom to be as high as 5.0 to consider a model adequate fit (Kline, 1998). Thus, the value of chi-square per degree of freedom from this measurement model ($\chi 2$/DF = 3.10) is acceptable. All of the regression coefficients between each observed variable and its corresponding dimension in the first order confirmatory factor analysis were significant at $p<.001$ level. The regression coefficients for the first order confirmatory factor analysis varied from .90 to .94. For the second order CFA, the regression coefficients between each dimension and supply chain orientation construct were also significant at $p<.001$. The regression coefficients for the second order confirmatory factor analysis are .76 and .79. Finally, both average variance extracted (AVE) and construct validity indicated satisfactory result at .75 and .98 respectively.

5.4.2.5 Internal Integration

Internal integration was measured by 8 measurement items which are INTI1-INTI8. The detail of the measurement model for internal integration can be seen in figure 5.7.

Figure 5.7: Measurement Model of Internal Integration



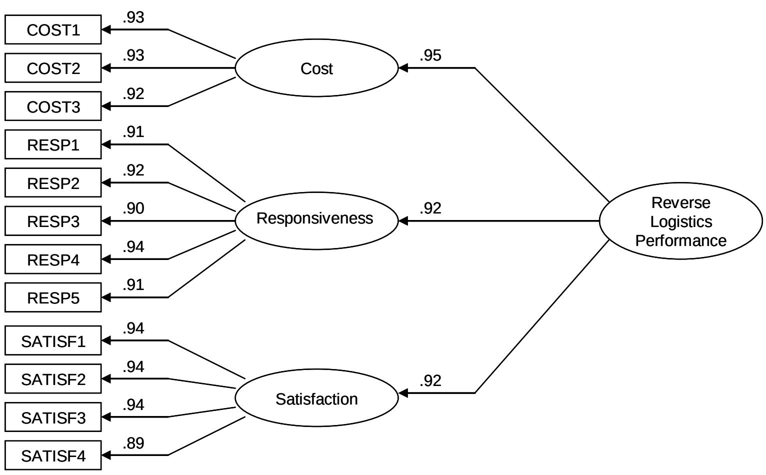
χ^2 = 39.72, DF = 20, p = .005; χ^2/DF = 1.98; RMSEA = .065; IFI = .991; TLI = .988; CFI = .991;
AVE = .73; α = .95

The result of the confirmatory factor analysis indicated that the model was fitted well with the data. All the fit indices far exceeded the threshold level of .90 (IFI = .991; TLI = .988; CFI = .991). All of the regression coefficients between each observed variable and resource commitment construct were significant at p<.001 level. The regression coefficients varied from .87 to .92. The average variance extracted (AVE) and construct validity indicated satisfactory result at .73 and .95 respectively.

5.4.2.6 Reverse Logistics Performance

Reverse logistics performance construct consists of 3 dimensions, i.e. cost, responsiveness, and satisfaction. The cost dimension was measured by 3 measurement items which are COST1-COST3. For the responsiveness dimension, it was measured by 5 measurement items which are RESP1-RESP5. Finally, satisfaction dimension was measured by 4 measurement items which are SATISF1-SATISF4. The measurement model of reverse logistics performance can be seen in figure 5.8.

Figure 5.8: Measurement Model of Reverse Logistics Performance



χ^2 = 176.03, DF = 51, p = .000; χ^2/DF = 3.45; RMSEA = .103; IFI = .968; TLI = .958; CFI = .967;
AVE = .79; α = .98

The result of the confirmatory factor analysis for reverse logistics performance construct indicated that the model was fitted well with the data. All of the fit indices exceeded the threshold level of .90 (IFI = .968; TLI = .958; CFI = .967). In this study, where the sample size is larger than 200, the value of chi-square may inflate which makes it acceptable to have the chi-square per degree of freedom to be as high as 5.0 to consider a model adequate fit (Kline, 1998). All of the regression coefficients between each observed variable and its corresponding dimension in the first order confirmatory factor analysis were significant at $p<.001$ level. The regression coefficients for the first order confirmatory factor analysis varied from .89 to .94. For the second order CFA, the regression coefficients between each dimension and supply chain orientation construct were also significant at $p<.001$. The regression coefficients for the second order confirmatory factor analysis are .92 and .95. Finally, both average variance extracted (AVE) and construct validity indicated satisfactory result at .79 and .98 respectively.

In summary, the confirmatory factor analysis for all the constructs provided satisfactory results. The construct validity, which refers to the extent to which a measurement method accurately represents a construct and produces an observation distinct from that produced by a measure of another construct, was assessed in two ways. First, convergent validity tests if all the items measuring a latent variable cluster together and form a single latent variable. Second, discriminant validity tests the degree to which a latent variable differs from others ones in a model.

For convergent Validity, the measurement models provided evidence of convergent validity as shown in the parameter estimates and p-values. First, the parameter estimates were high in value and statistically significant ($p < .05$), meeting the criteria proposed by Anderson and Gerbing (1988) for convergent validity. Second, all the values of the average variance extracted (AVE) were equal to or higher than the suggested critical value of .50 (Bagozzi and Yi, 1988; Fornell and Larcker, 1981). Indicators for each of the latent constructs also exhibited acceptable reliability (α), ranging from .79 to .98.

For discriminant validity, it was assessed by analyzing average variance extracted values. The discriminant validity between these constructs was established if the square roots of the average variance extracted for each second-order construct were greater than all corresponding correlations (Fornell and Larcker, 1981). The result of confirmatory factor analysis indicated that the square roots of AVE values exceeded the correlations between constructs in all cases. Therefore, the discriminant validity between the constructs in all models was established.

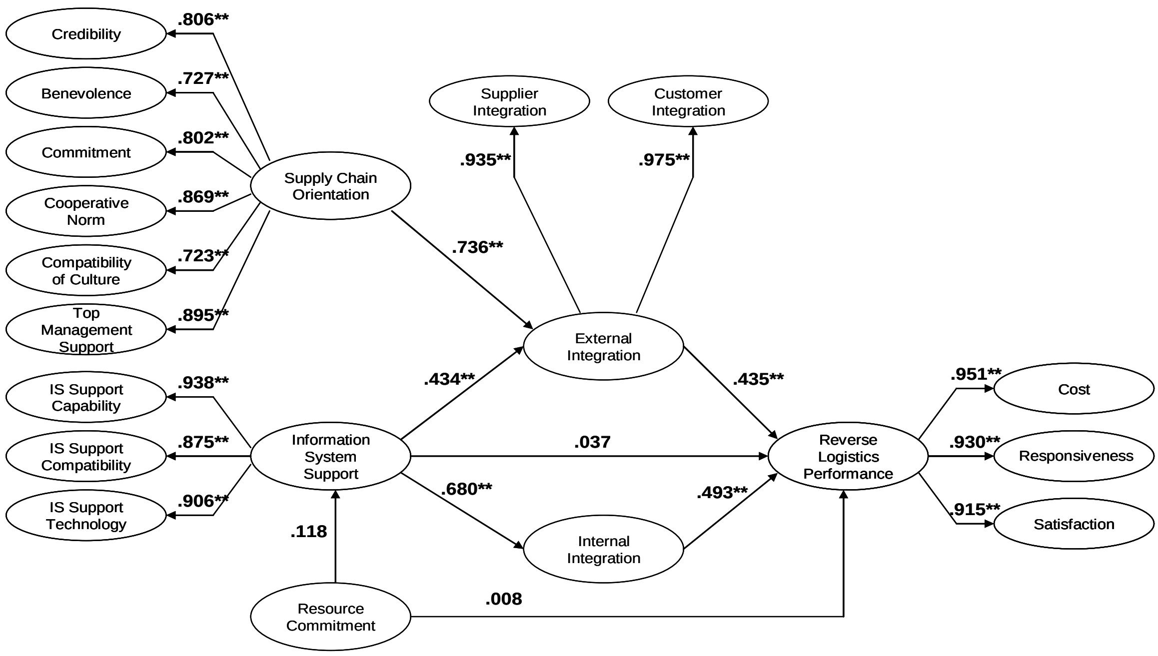
The results therefore suggested that the construct validity exists for all the proposed constructs. No measurement was deleted during this step. In the next step, the analysis of structural model was performed in order to test the proposed hypotheses.

5.4.3 Model Fitting and Main Hypotheses Testing

The second step of the structural equation modeling process is to estimate model parameters and examine the structural relationship among proposed constructs. In general, this process is done in two ways. For the first method, a researcher can create composite scores across indicators of each construct and then use only one indicator for each construct. This method is frequently used by many researchers due to its simplicity and its ability to avoid a possible collinearity in correcting for measurement error if exogenous variables are highly correlated. In this method, the analysis of individual measurement items is avoided by summing the items that define a measurement scale together and entering only the corresponding total score into the structural equation model. Although this method can simplify the analysis by drastically reducing the number of manifest variables, it is done at the expenses of losing a rigor and meaning as the relations of the individual items with each other and the latent variables are ignored (Gerbing et. al, 1994). To provide a rigorous and meaningful analysis, this study, therefore, utilized the second method for the structural equation modeling analysis by including all the measurement items in the model as first and second order factors. The diagram of the model was previously shown in figure 5.2.

The structural model was constructed based on the proposed model and hypotheses. The result of model fitting and parameter estimation is shown in figure 5.9.

Figure 5.9: Structural Model of Reverse Logistic Performance



χ^2 = 4660.45, DF = 2679, p = .000; χ^2/DF = 1.74; RMSEA = .056; IFI = .917; TLI = .914; CFI = .917
* p < .05; ** p < .01

To examine structural relationships, the hypothesized model was estimated. The model was found to have a relatively good fit (χ^2/DF = 1.74, RMSEA = .056; IFI = .917; TLI = .914; CFI = .917). Based on the proposed model, the structural equation corresponding with the path diagram can be proposed as:

$$\text{RL Performance} = .037^{*}\text{ISS} + .008^{*}\text{RC} + .435^{*}\text{EI} + .493^{*}\text{INTI} + \varepsilon \qquad R^2 = .600$$

In order to summarize the relationships among constructs in the model, the parameter estimates and p-values are shown in table 5.23.

Table 5.23: Parameter Estimates and Test of Significance

Construct		Construct	Unstandardized Regression Weight	Standard Error	Critical Ratio	p-value	Standardized Regression Weight
SCO	→	EI	.636	.082	1.663	.000	.736
ISS	→	EI	.314	.036	8.752	.000	.434
ISS	→	INTI	.568	.052	10.823	.000	.680
ISS	→	RLPerf	.040	.079	.510	.610	.037
RC	→	ISS	.136	.082	1.663	.096	.118
EI	→	RLPerf	.652	.086	7.605	.000	.435
INTI	→	RLPerf	.639	.090	7.119	.000	.493
RC	→	RLPerf	.010	.060	.164	.869	.008

Although the result indicated that the model had a relatively good fit, it can be seen from table 5.23 that not all of the proposed relationships were significant. However, this table allows the consideration to be made only on the direct impact between the proposed constructs. In order to provide the more insight relationships between constructs, both direct and indirect relationship among the constructs are proposed in table 5.24.

Table 5.24: Summary of Direct Effects, Indirect Effects, and Total Effects

Construct	➡	Construct	Standardized Effects			Unstandardized Effects		
			Direct	Indirect	Total	Direct	Indirect	Total
SCO		EI	.736		.736	.636		.636
SCO		RLPerf		.320	.320		.415	.415
ISS		EI	.434		.434	.314		.314
ISS		INTI	.680		.680	.568		.568
ISS		RLPerf	.037	.524	.561	.040	.568	.608
RC		ISS	.118		.118	.136		.136
RC		EI		.051	.051		.043	.043
RC		INTI		.080	.080		.077	.077
RC		RLPerf	.008	.066	.074	.010	.082	.092
INTI		RLPerf	.493		.493	.639		.639
EI		RLPerf	.435		.435	.652		.652

In order to test the proposed hypotheses, the unstandardized regression weights and the tests of significance must be considered. The relationships between each pair of constructs and hypotheses testing results are explained in the following subsections.

5.4.3.1 External Integration and Reverse Logistics Performance

The result of the structural equation modeling analysis indicated that the relationship between external integration and reverse logistics performance is significant as hypothesized. The unstandardized regression weight was estimated at .652 (p = .000). Thus, there is a significant positive relationship between external integration and reverse logistics performance. Hypothesis 1 is therefore supported by the data in this study.

External integration can be accomplished by the continuous automation and standardization of logistics functions, and by efficient information sharing and strategic linkage with suppliers and customers. A firm with external integration would completely share information on products, processes and specification changes, exchange technology and design, focus on strategic rather than tactical issues, and commit in long-term relationship (Stevens, 1989). Since external integration ensures that operational interfaces between firms are synchronized by ensuring that all activities are conducted by the supply chain entity that best creates the service and cost configuration to meet customer requirements (Rodrigues et al., 2004), the result revealing that external integration would lead to superior reverse logistics performance is no surprise.

External integration allows supply chain partners to synchronize their core competencies to jointly improve service capabilities at lower total supply chain cost (Stank et al. 2001a; Forza, 1996). External integration would help a firm reduce operational waste and redundancies in a supply chain, which allows a firm not only to lower cost of reverse logistics, but also enhance responsiveness and provide better customer satisfaction. Thus, in order to improve a performance of reverse logistics program, a firm needs to focus on implementing external integration with its suppliers and customers.

5.4.3.2 Internal Integration and Reverse Logistics Performance

For the relationship between internal integration and reverse logistics performance, the result of the structural equation modeling analysis shown in table 5.23 exhibited a significant relationship between the two construct as proposed. The unstandardized regression weight was estimated at .639 (p = .000). Thus, hypothesis 2 is supported.

The impact of each construct to reverse logistics performance can be compared by considering standardized regression weights of the paths between each construct to reverse logistics performance. In this case, it was found that internal integration has a strongest direct impact on the reverse logistics performance (ß = .493) compared with that of other constructs, i.e. external integration (ß = .435), information system support (ß = .037), and resource commitment (ß = .008).

Both internal integration and external integration are crucial factors that impact a performance of reverse logistics process. Although the direct impact of internal seems to be somewhat higher than that of external integration, the difference does not suggest that internal integration is more important than external integration. On the other hand, both external integration and internal integration must be performed together to ensure that the reverse flow of products returned from end customer would progress smoothly to the point of origin. A lack of either external integration or internal integration would create a bottle neck in a supply chain which is the cause of inefficiency in reverse logistics process, long lead time of product returns, high product return costs, and slow response to customer requests.

A firm can achieve internal integration by linking operations into a seamless, coordinated, and synchronized operational flow across internal function areas such as marketing and sales, procurement, manufacturing and assembly, and finished goods distribution. It is crucial that people at all levels of the organization share information, learn collaboratively across departmental boundaries, and think in terms of entire processes in becoming more adaptive and creative. Thus, internal integration must be done both horizontally across all department in the organization and vertically across all levels of organization to ensure that the redundancies in return processes are minimized or even eliminated.

5.4.3.3 Information System Support and Reverse Logistics Performance

The result of the structural equation modeling analysis suggested that the relationship between information system support and reverse logistics performance is not statistically significant (ß = .040, p = .610), indicating that the variance in information system support did not account for a large proportion of variance found in reverse logistics performance. Thus, hypothesis 3 is not supported.

Although the result was different from what was previously proposed, this was no surprise since there were different views on the impact of information system support on reverse logistics performance. Many researchers found that information system support is a competitive weapon that leads to a superior performance (El-

Ansary, 1992; Glazer, 1991; Kopicki et al, 1993; Porter, 1985; Porter and Millar, 1985), especially for logistics operations (Closs et al., 1997; Daugherty et al, 1995; Mentzer and Firman, 1994; Rogers et al, 1991; Stank et al., 1999; Stank et al., 1996, William et al., 1997). An empirical study of Daugherty et al. (2002), on the other hand, found that there was no relationship between information system support and operating/financial performance.

There is a possible explanation for the result of the analysis of the initial model. Although the relationship between information system support and reverse logistics performance was found to be not statistically significant, it does not mean that information system support is not important to the performance of reverse logistics process. On the other hand, the result in table 5.24 suggested that while the direct relationship between information system support and reverse logistics performance was not statistically significant, the regression coefficient for the indirect relationship was estimated at .524. In this case, information system support can provide influence to reverse logistics performance through internal and external integration. The significance of these mediating relationships can be tested by the Sobel test (Sobel, 1982) which is used to test whether a mediator carries the influence of an independent variable to a dependent variable. The formula of the Sobel test can be seen below:

z-value = a*b/SQRT(b2*sa2 + a2*sb2)

Where:

a = Unstandardized regression coefficient for the association between IV and mediator.
sa = standard error of a.
b = Unstandardized for the association between the mediator and the DV (when the IV is also a predictor of the DV).
sb = standard error of b.

The reported *p*-values are drawn from the unit normal distribution under the assumption of a two-tailed z-test of the hypothesis that the mediated effect equals zero in the population.

The calculation was based on the result of the initial model fitting. For the significance of mediating effect of internal integration on the relationship between information system support and reverse logistics performance, the values of a, sa, b, sab were equal to .568, .052, .639, .090 respectively. The calculated z-value was 5.953 which indicated that the mediating effect is significant at $p<.000$.

For the significance of mediating effect of external integration on the relationship between information system support and reverse logistics performance, the values of a, sa, b, sab were equal to .314, .036, .652, .086 respectively. The calculated z-value of 5.722 implied that the mediating effect is also significant at $p<.000$. Thus, it can be concluded that information system support significantly influenced reverse logistics performance through both internal and external integration. Thus, although the direct relationship between information system support and reverse logistics performance was not significant, information system support is still crucial to the superior performance of reverse logistics process.

5.4.3.4 Information System Support and External Integration

It can be seen from the result of the structural equation modeling analysis that the relationship between information system support and external integration was found to be significant (ß = .314, p = .000). Therefore, hypothesis 4 is supported by the data in this study.

Information system support is necessary to enhance the level of external integration. Since external integration requires integration of business processes, information sharing, and coordination among the supply chain members (Daugherty et al., 1996; Edward et al., 2001; Sanders and Premus, 2005; Bowersox, 1989; Vickery et al., 1999), information system support would play a vital role in facilitating and enhancing external integration. Information system capability, compatibility, and technologies can help firms in the supply chain to achieve the external integration. Even firms in a supply chain agrees to share information or to integrate their operations with other supply chain members, it may be difficult to implement external integration without information system support that is capable of providing information that can be continuously accessible and shared across organizations. Thus, it is no surprise to see that information system support is an antecedent of external integration.

In addition to information system support capability, a compatibility of information system support among supply chain members is also important for the implementation of external integration. If the information system supports are incompatible among supply chain members, the exchange of information and process in the supply chain cannot be done in an effective and efficient manner. The flow of information may be struggled with a need to convert information in one system into the format that can be assessed by other systems. This process may cause complexities in operation, incomplete information exchange, higher costs of information sharing, and inconvenience in working with other supply chain partners. Thus, a lack of information system compatibility among supply chain members would prohibit a firm from a successful implementation of external integration.

Firms in the automotive industry are currently implementing several types of technologies to ensure that communication and information exchange between supply chain partners can be done effectively and efficiently. While it was common to see firms in the automotive industry used specially developed information systems that require high investment in the past, the current trend of technologies is moving toward low-cost, open systems which allow any firm, regardless of its size, to possess a capable information system to facilitate the implementation of external integration.

Although information system support is necessary for the implementation of external integration, it is not adequate. External integration, as suggested by the result of structural modeling analysis, also depends on other factors such as supply orientation. Thus, in order to improve the extent of external integration with other supply chain members, a firm needs to consider both factors simultaneously.

5.4.3.5 Information System Support and Internal Integration

The path coefficient for the relationship between information system support and internal integration was found to be significant (ß = .568, p = .000). Thus, hypothesis 5 is supported. The result is consistent with what was found in the literatures (Daugherty et al., 1996; Edward et al., 2001). Information system support not only enhances the level of external integration, but also internal integration.

Internal integration can be done by achieving coordination and integration of a number of interdependent activities simultaneously across major functional areas to provide various additional dimensions and ways in which logistics can create incremental customer value. Such coordination and integration requires a capable information system support in order to facilitate the coordination and information sharing among internal departments of a firm. Similar to the case of external integration, internal integration is difficult to implement without information system support that are capable of providing information that can be continuously accessible and shared across internal departments of a firm.

When a reverse flow of product enters into a system, several departments of a firm need to cooperate and share information with each other in order to effectively respond to the product return. For example, when products are returned from customers, sales and marketing departments may need to cooperate and share information related to product return with warehouse, production department, procurement department, and other related departments. Although each department is responsible only for its own tasks, they need information and cooperation from other departments in order to ensure that product return is handled effectively. A lack of information system support that is capable of providing the necessary information in a timely manner would prohibit a firm's internal departments to cooperate and share information with each other. Thus, it can be concluded that information system support is one of the most important factors that promote internal integration of a firm.

5.4.3.6 Resource Commitment and Reverse Logistics Performance

The result of the structural equation modeling analysis indicated that the relationship between resource commitment and reverse logistics performance was not statistically significant (ß = .010, p = .869). Thus, hypothesis 6 is not supported.

Although the literature suggested that resource commitment is important to the superior reverse logistics performance (Richey et al., 2005; Tibben-Lembke, 2002; Daugherty et al., 2001; Richey et al., 2004; Das and Teng, 2000), the result of the structural equation modeling analysis for the initial model indicated otherwise. The result can be explained by the fact that although a commitment in several kinds of resource to logistics operation was expected to provide a direct impact to reverse logistics performance, the relationship may be mediated by other factors such as external integration and internal integration. Since external integration and internal integration was found to be important factors that provide impact to performance of reverse logistics program, it is possible that the relationship between resource commitment and reverse logistics performance might be mediated by external and internal integration. In that case, the relationship between resource commitment and reverse logistics performance would not be a direct one, but rather an indirect relationship. Thus, there is a need to investigate other kinds of relationship between resource commitment and reverse logistics performance before a conclusion can be made.

From the result of the structural equation modeling analysis, the modification indices suggested that the model would have a better fit if the relationship between resource commitment and internal integration and between resource commitment and external integration were established (MI = 10.131, Par Change = .162 and MI = 18.068, Par Change = .151 respectively). Thus, it is possible that resource commitment neither directly affects reverse logistics performance nor indirectly affects reverse logistics performance through information system support. On the other hand, resource commitment might indirectly affect reverse logistics performance through internal and external integration. The analysis of these relationships will be conducted in the structural equation modeling analysis of the alternative model presented in the following chapter.

5.4.3.7 Resource Commitment and Information System Support

The path coefficient between resource commitment and information system support revealed that the relationship between the two constructs, although positive as proposed, was not significant ($\beta = .136$, $p = .096$). Thus, hypothesis 7 is not supported. It is possible that the resource commitment in this study was assessed by the level of three kinds of resource (technological, managerial, and financial) that were dedicated to overall logistics program. These resources are dedicated not only to information system support, but also other parts of the logistics system such as equipment, personnel training, process improvement program and so on. Thus, investment in information system support alone may represent only a small portion of overall resource committed to logistics system of a firm. A firm's commitment in several kinds of resources is focused on improving the performance of logistics and reverse logistics process, rather than the information system support in specific. Thus, the relationship between resource commitment and information system might not be clear and significant in this study. Since the data analysis suggested that resource commitment did not have any statistically significant direct relationship with both reverse logistics performance and information system support, it is interesting to investigate further if resource commitment can indirectly influence reverse logistics performance through external integration and internal integration as suggested by the modification indices of the structural equation modeling analysis.

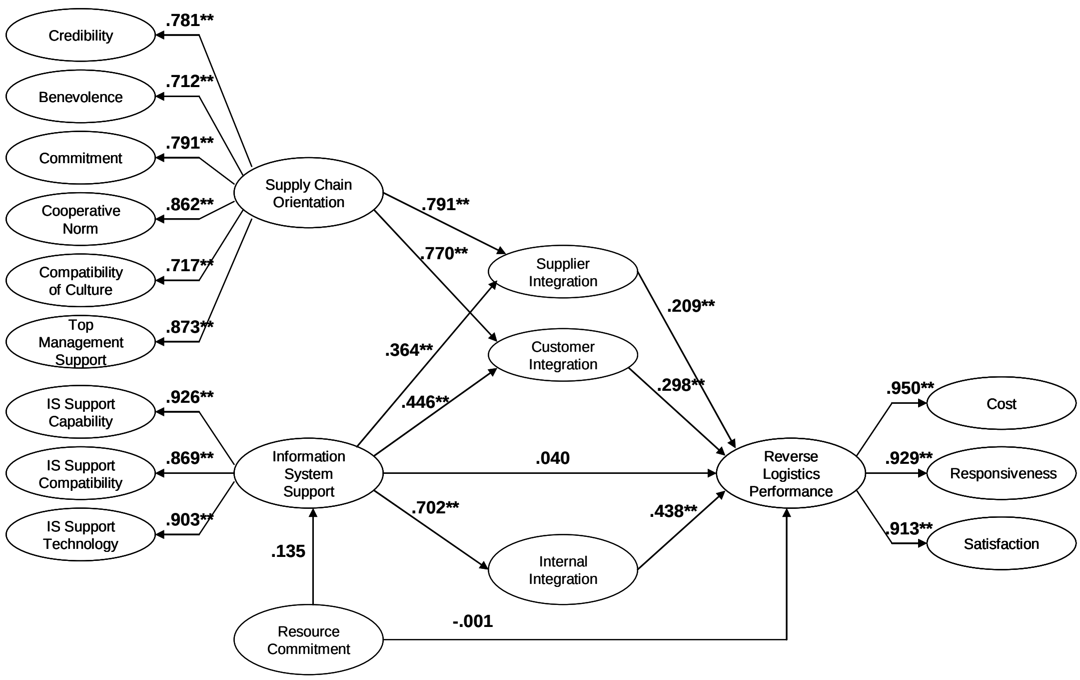
5.4.3.8 Supply Chain Orientation and External Integration

The result of the structural equation modeling analysis indicated that the relationship between supply chain orientation and external integration was positive and significant as proposed (ß = .636, *p* = .000). Thus, hypothesis 8 is supported. By considering the standardized effects, it can be seen that supply chain orientation provided the strongest influence on external integration (ß = .736) compared to information system support (ß = .434) and resource commitment (ß = .051). The result was consistent with the literature which stated that supply chain orientation would lead a business unit to practice supply chain management, characterized as the integration of key business processes across the supply chain (Lambert, 2004; Min and Mentzer, 2004; Stank et al., 2005). However, the result suggested that, although supply chain orientation provides the strongest impact to the level of external integration, it is not the only factor. Thus, a manager may also consider other factors such as information system support, and resource commitment as well.

5.4.4 Model Fitting and Sub-Hypotheses Testing

While the structural equation modeling analysis can test all the main hypotheses proposed in this study, it cannot be used to test the proposed sub-hypotheses. In addition to 8 main hypotheses, 6 sub-hypotheses were also proposed which are H1a, H1b, H4a, H4b, H8a, and H8b. These sub-hypotheses were proposed because external integration consists of two important dimensions; supplier integration and customer integration. Since these two dimensions may independently affect or be affected by other constructs, it is crucial to test their relationships separately. Thus, another structural equation model was proposed and analyzed. The structural model that was used to test the proposed sub-hypotheses can be seen in figure 5.10.

Figure 5.10: Structural Model of Reverse Logistic Performance



χ^2 = 4763.17, DF = 2678, p = .000; χ^2/DF = 1.78; RMSEA = .058; IFI = .913; TLI = .909; CFI = .912
* p < .05; ** p < .01

The result of the model fitting indicated that the model fit relatively well (χ^2/DF = 1.78; RMSEA = .058; IFI = .913; TLI = .909; CFI = .912) even when the external integration construct was replaced by its two dimensions, i.e. supplier integration and customer integration.

In order to summarize the relationships among constructs in this model, the parameter estimates and test of significance are shown in table 5.25.

Table 5.25: Parameter Estimates and Test of Significance

Construct		Construct	Unstandardized Regression Weight	Standard Error	Critical Ratio	p-value	Standardized Regression Weight
SCO	→	SI	.750	.064	11.634	.000	.791
SCO	→	CI	.809	.067	12.103	.000	.770
ISS	→	SI	.284	.035	8.219	.000	.364
ISS	→	CI	.386	.038	10.088	.000	.446
ISS	→	INTI	.596	.054	11.130	.000	.702
ISS	→	RLPerf	.043	.082	.524	.601	.040
RC	→	ISS	.152	.080	1.890	.059	.135
RC	→	RLPerf	-.001	.059	-.020	.984	-.001
SI	→	RLPerf	.291	.107	2.725	.006	.209
CI	→	RLPerf	.374	.102	3.679	.000	.298
INTI	→	RLPerf	.560	.091	6.136	.000	.438

5.4.4.1 Supplier/Customer Integration and Reverse Logistics Performance

When external integration constructs was replaced by its two dimensions, i.e. supplier integration and customer integration, analysis of the structural model revealed that the relationship between supplier integration and reverse logistics performance was positive and significant as proposed (ß = .291, *p* = .006). In addition, the relationship between customer integration and reverse logistics performance was also positive and significant (ß = .374, *p* = .000). Thus, hypothesis 1a and 1b are supported. Both supplier integration and customer integration are important to superior reverse logistics performance as suggested by the literature (Daugherty et al., 1996; Bowersox and Daugherty, 1995; Stank and Lackey, 1997; Boyer et al., 2003; Ellinger et al., 2000; Kahn and Mentzer, 1996; Stank et al., 1999; Gustin et al., 1995; Lambert et al., 1978; Rogers et al., 1992).

In order to achieve high reverse logistics performance, there is a need for a firm to integrate its operation to both its customers and its suppliers. On the customer side, a firm with customer integration can share information on product returns such as quantity, type, and schedule of product returns, with its customers. Such information sharing allows a firm to be able to respond to product return on a timely basis at the lowest costs. For example, if a firm knows in advance what kind and amount of products will be returned from its customers, a firm can prepare for such returns by altering the production and delivery scheduling, preparing inventory for product replacement, contacting its suppliers for the causes and solutions for the return, and so on. While these activities effectively reduce costs related with product returns and enhance a firm's responsiveness, they cannot be done without information sharing with its customers. In addition, there is a need to cooperate with its customers. Cooperation with customers allows a firm to effectively deal with product returns by synchronizing return processes between trading partners. Successful cooperation with its supplier can smooth a product return process and result in efficient logistics operations and significant performance improvement. Furthermore, a firm with customer integration is in a good position to access customer requirements and expectations which enables management to provide better service that its competitors cannot effectively match. In many cases, product returns may not occur on a regular basis. When customers request for product returns, there might be a need to alter standard return procedures. Customer integration allows a firm to quickly and accurately respond to customers' special requests. Thus, customer satisfaction with product returns would be enhanced by customer integration.

On the supplier side, the need for supplier integration is equally important to that on a customer side. In many cases, the problem of defective products returned from customers may not cause by a firm itself, but its suppliers. Thus, reverse logistics process may not deal only with a customer side, but also with a supplier side. A firm is then needed to share information and cooperate with its suppliers. Cooperation and information sharing with its suppliers allows a firm's suppliers to provide a quick respond to product return at lowest possible costs. Thus, both customer integration and supplier integration are needed to lower a total cost of product returns, enhance a responsiveness of whole supply chain, and improve customer satisfaction.

5.4.4.2 Information System Support and Supplier/Customer Integration

For the impact of information system support on the level of supplier integration and customer integration, the result of structural model analysis indicated that information system support was positively related to supplier integration and customer integration as proposed (ß = .284, p = .000 and ß = .386, p = .000 respectively). These findings were consistent with the literature (Daugherty et al., 1996; Edward et al., 2001; Sanders and Premus, 2005; Bowersox, 1989; Vickery et al., 1999; Bowersox and Calantone, 1998; Narasimhan and Kim, 2001; Moberg et al., 2002; Sander and Premus, 2005). Thus, hypotheses 4a and 4b are supported.

Customer and supplier integration requires extensive cooperation and information sharing among a firm, its suppliers, and its customers. Without an information system support, such cooperation and information sharing would not be done in an efficient and effective manner. A capable information system support allows a firm to cooperate and share information with its customers and suppliers with high accuracy, fast respond time, and lowest costs. E-mail and Internet, for example, enable an effective and reliable communication among partners on different locations at very low cost compared with traditional communication such as telephone or ordinary mail services. In addition, instead of taking several days to deliver a document to a business partner, a firm can spend only few seconds to transmit a document in an electronic format by using information system support.

However, without information system compatibility among supply chain partners, a highly capable information system support would not be able to effectively enhance supplier integration and customer integration. Since reverse logistics involve both forward and reverse flow of information among supply chain partners, information system must be able to support the flow of information not only inside a firm, but also flow of information between firms. Ideally, information system support of firms operating in the same supply chain shall be compatible with each other to enable seamless cooperation and information sharing in the supply chain. If information system supports of supply chain partners are incompatible, it would be very difficult for firms to effectively communicate with its partners through their information systems even each system alone can provide information to match the need of each firm. The problem of information system incompatibility can be solved by using an open system or using a system that is accepted as an industry standard. For example, e-mail and Internet are becoming a standard for communication among all firms while a close system such as EDI system is fading away in some industries.

5.4.4.3 Supply Chain Orientation and Supplier/Customer Integration

Supply chain orientation was expected to significantly affect the levels of supplier integration and customer integration. Consistent with the literature (Lambert, 2004; Min and Mentzer, 2004; Stank et al., 2005), the result of the structural model analysis revealed that the path coefficients between supply chain orientation and supplier integration was found to be positive and significant as proposed ($ß = .750$, $p = .000$). Same result was found for the relationship between supply chain orientation and customer integration ($ß = .809$, $p = .000$). Therefore, hypothesis 8a and 8b are supported.

Supply chain orientation focuses on a systemic view stretching beyond a focal firm to include coordination of business processes and flows with those of other members of the supply chain. A firm with supply chain orientation would consider cooperation and information sharing not only among departments or business functions inside a firm, but also across its business partners operating in the same supply chain. In order to cooperate and share information with its suppliers or customers, a firm needs to develop a trust, consisting of credibility and benevolence, with its partners first. Then a commitment in the relationships with its suppliers and customers as well as a cooperative norm should be developed. Without such commitment in the relationship and cooperative norm, a firm would not want to share information or work with its supply chain partners. Finally, an organizational compatibility and top management support are needed to ensure that the integration between a firm and its customers/suppliers can be done smoothly. Thus, these elements of supply chain orientation are crucial for a successful implementation of customer integration and supplier integration.

5.4.5 Summary of Hypotheses Testing Results

In this study, a total of 8 main hypotheses and 6 sub-hypotheses were proposed and tested by analyzing two structural equation models. A summary of hypotheses testing results can be seen in table 5.26.

Table 5.26: Summary of Hypotheses Testing Results

Hypotheses	Statement	Result
1	There is a significant positive relationship between External Integration and Reverse Logistics Performance.	Supported
1a	There is a significant positive relationship between Supplier Integration and Reverse Logistics Performance.	Supported
1b	There is a significant positive relationship between Customer Integration and Reverse Logistics Performance.	Supported
2	There is a significant positive relationship between Internal Integration and Reverse Logistics Performance.	Supported
3	There is a significant positive relationship between Information System Support and Reverse Logistics Performance.	Not Supported
4	There is a significant positive relationship between Information System Support and External Integration.	Supported
4a	There is a significant positive relationship between Information System Support and Supplier Integration.	Supported
4b	There is a significant positive relationship between Information System Support and Customer Integration.	Supported
5	There is a significant positive relationship between Information System Support and Internal Integration.	Supported
6	There is a significant positive relationship between Resource Commitment and Reverse Logistics Performance.	Not Supported
7	There is a significant positive relationship between Resource Commitment and Information System Support.	Not Supported
8	There is a significant positive relationship between Supply Chain Orientation and External Integration.	Supported
8a	There is a significant positive relationship between Supply Chain Orientation and Supplier Integration.	Supported
8b	There is a significant positive relationship between Supply Chain Orientation and Customer Integration.	Supported

5.5 CONCLUSION

This chapter explained the details of the data analysis procedures for this study. All the necessary tests and assumptions were conducted to ensure validity of the data analyses. No problem related to the data and the analysis was found in this study. None of the six proposed constructs was affected by firm's characteristics such as firm size, ownership structure, nationality of foreign shareholder, and sales volume, suggesting that there was no need to put these characteristics as control variables in this study. The measurement items used in this study were valid and reliable with only one measurement item deleted during the process of reliability analysis. The confirmatory exploratory factor analysis indicated satisfactory results for all measurement models which suggested high construct validity. The two structural model fittings were conducted to test 8 main hypotheses and 6 sub-hypotheses. With the exception of 3 main hypotheses related to information system support and resource commitment, all other hypotheses were supported by the data. Finally, both direct and indirect effects of proposed constructs on reverse logistics performance were identified from the result of model fittings. In the next chapter, an alternative model will be proposed and analyzed while research findings will also be discussed.

CHAPTER 6

FINDINGD AND DISCUSSION

While the details of data analysis, modeling fittings, and hypotheses testing were explained in chapter 5, this chapter moves on to focus on findings gained from the data analysis. The alternative model and result of alternative model fitting are presented in order to provide a basis for discussion. Finally, research findings are discussed based on both quantitative data analysis and in-depth interviews.

6.1 ALTERNATIVE MODEL

In chapter 5, the initial model fitting showed that while majority of hypotheses were supported by the empirical study while some hypotheses were not supported. Thus, an attempt was made to find a better fitted model compared to the initial model shown in figure 5.9. There are two key issues to improve the model fitting. The first is to eliminate the relationships that are not significant in the model. However, this method can improve the model fitting only at a marginal level. In this case, the links between resource commitment and reverse logistics performance, resource commitment and information system support, and information system support and reverse logistics performance, were removed from the structural model based on the result of initial model fitting.

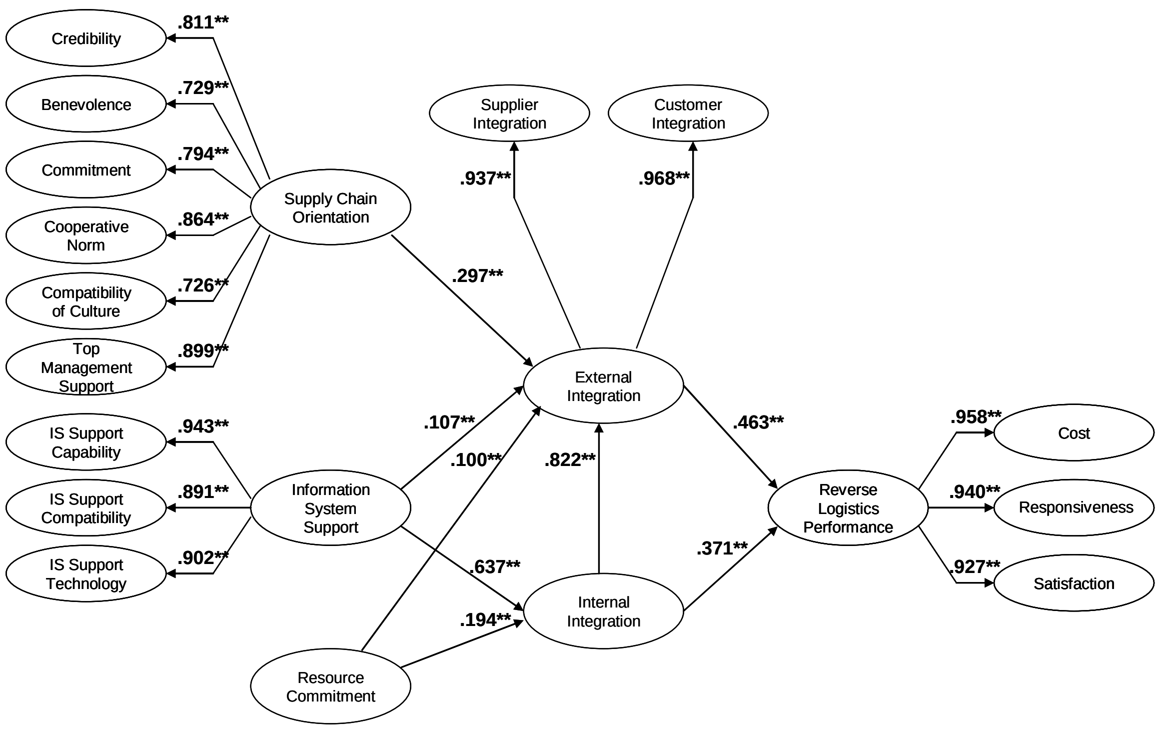
The second method is to consider if there should be other relationships between the constructs that were not previously proposed in this study. This consideration should be based on two key issues. The first issue is the modification indices from the result of the structural equation modeling. AMOS allows for the use of modification indices to generate the expected reduction in the overall model fit chi-square for each possible path that can be added to the model. Thus, modification index is often used to alter models to achieve better fit by identifying the links that should be added to the model. In addition to the modification indices, another issue must be taken into account when developing an alternative model. Even the modification indices are considered, the model modification must be done carefully and with theoretical justification. The blind use of modification index runs the risk of capitalization of chance and model adjustments which make no substantive sense (Silvia and MacCallum, 1988). In this study, there were many links that can be added to the model to improve model fitting as suggested by AMOS. However, these links can only be supported by theory or other reasonable empirical evidences. Otherwise, the added links in the model would not be justifiable.

During the period of in-depth interviews and data collection, there were suggestions from the result of in-depth interviews on the relationships between some constructs that were not previously proposed in the hypotheses development stage. The most important links that should be considered, as suggested by theory and modification index, was a relationship between internal integration and external integration. In the literature review, the relationship between internal and external integration is controversial. Stevens (1989) suggested that firms must achieve a relatively high degree of collaboration among internal processes before initiating external integration. Gimenez and Ventura (2005), on the other hand, believed that internal integration and external integration influences one another. In many cases, it was found that internal integration and external integration were independently developed depending on the situation. Thus, the relationship between internal and external integration was not proposed in the hypotheses development.

The result of the structural model fitting, on the other hand, indicated that there should be a link between internal integration and external integration. The link from internal integration to external integration would lead to a better fitting model (MI = 44.400, Par Change = .240). This suggestion is consistent with the stage of integration proposed by Stevens (1989). Thus, the relationship between internal integration and external integration, i.e. internal integration would lead to external internal, was added to the alternative model.

In addition, several comments from in-depth interviews suggested that resource commitment shall also influence the level of internal integration and external integration. These comments were also supported by the result of the structural model fitting. The AMOS output suggested that the links from resource commitment to internal integration and from resource commitment to external integration would improve the model fitting (MI = 10.131, Par Change = .162 and MI = 18.068, Par Change = .151 respectively). Thus, these two relationships were also added to the alternative structural model. The alternative model was then developed based on these modifications. In order to examine if the alternative model fits well with the data and if the proposed relationships are statistically significant, the structural equation modeling analysis of the alternative model must be done. The result of the model fitting for the alternative structural model can be seen in figure 6.1.

Figure 6.1: Alternative Structural Model of Reverse Logistic Performance



χ^2 = 4436.09, DF = 2679, p = .000; χ^2/DF = 1.65; RMSEA = .053; IFI = .926; TLI = .924; CFI = .926

* p < .05; ** p < .01

The result of the alternative model fitting indicated an improvement in the model fits compared with the initial model. The comparison of the fit indicators between the two models can be seen in table 6.1.

Table 6.1: Model Fit Comparison

Model	χ^2	DF	χ^2/DF	RMSEA	IFI	TLI	CFI
Initial	4660.45	2679	1.74	.056	.917	.914	.917
Alternative	4436.09	2679	1.65	.053	.926	.924	.926

From table 6.1, it can be seen that the alternative structural model was fitted better with the data compared with the initial proposed model. The parameter estimates and test of significance for all the proposed relationships in the alternative model can be seen in table 6.2.

Table 6.2: Parameter Estimates and Test of Significance

Construct		Construct	Unstandardized Regression Weight	Standard Error	Critical Ratio	p-value	Standardized Regression Weight
SCO	→	EI	.249	.029	8.501	.000	.297
ISS	→	EI	.074	.027	2.768	.006	.107
ISS	→	INTI	.521	.051	10.233	.000	.637
RC	→	EI	.080	.024	3.360	000	.100
RC	→	INTI	.183	.052	3.530	000	.194
INTI	→	EI	.702	.051	13.820	000	.822
INTI	→	RLPerf	.531	.167	3.171	.002	.371
EI	→	RLPerf	.776	.200	3.873	.000	.463

The results shown in table 6.2 indicated that all the relationships in the alternative structural model were statistically significant. Based on the alternative model, the structural equation corresponding with the path diagram can be proposed as:

$$\text{RL Performance} = .463*\text{EI} + .371*\text{INTI} + \varepsilon \qquad R^2 = .664$$

Although the equation suggested that there were only two factors, i.e. external integration and internal integration, that would predict a performance of reverse logistics process, these two factors were not actually the only factors to affect the reverse logistics performance. While reverse logistics performance can be directly influenced by external integration and internal integration, the result of structural equation modeling analysis suggested that there were also indirect relationships in the alternative model that link supply chain orientation, information system support, resource commitment, and internal integration to reverse logistics performance. Thus, both direct and indirect relationships must be considered simultaneously. The summary of direct effects, indirect effects, and total effects from AMOS output can be seen in table 6.3.

Table 6.3: Summary of Direct Effects, Indirect Effects, and Total Effects

Construct		Construct	Standardized Effects			Unstandardized Effects		
			Direct	Indirect	Total	Direct	Indirect	Total
SCO	→	EI	.297		**.297**	.249		**.249**
SCO	→	RLPerf		.137	**.137**		.193	**.193**
ISS	→	EI	.107	.524	**.630**	.074	.366	**.440**
ISS	→	INTI	.637		**.637**	.521		**.521**
ISS	→	RLPerf		.528	**.528**		.618	**.618**
RC	→	EI	.100	.160	**.260**	.080	.129	**.209**
RC	→	INTI	.194		**.194**	.183		**.183**
RC	→	RLPerf		.192	**.192**		.259	**.259**
INTI	→	EI	.822		**.822**	.702		**.702**
INTI	→	RLPerf	.371	.380	**.751**	.531	.545	**1.076**
EI	→	RLPerf	.463		**.463**	.776		**.776**

It can be seen in table 6.3 that all the proposed constructs have either direct effect, indirect effect, or both, to reverse logistics performance. Supply chain orientation, information system support, and resource commitment, although do not have any direct relationship with reverse logistics performance, had shown a considerable level of indirect relationships. Based on the alternative model, all the proposed constructs are crucial for the development of a good reverse logistics system. The detailed discussion of this finding as well as the effects of each construct to the reverse logistics performance is explained in the next section.

6.2 RESEARCH FINDINGS AND DISCUSSION

In the alternative model, three relationships between constructs that were found to be not statistically significant in initial model fitting were removed while three new relationships were added. The result of alternative model fitting revealed that the proposed relationships were mainly consistent with that of the initial model. The significant relationships in the initial model were also found to be significant in the alternative model. In addition, all new relationships proposed in the alternative model were also found to be statistically significant. By comparing the model fit indicators of the initial model with those of the alternative model, it can be concluded that the alternative model was an improvement over the initial model, i.e. it was fit better with the data in this study.

In order to get into more details, each of the constructs is discussed in turn based on the result of the structural equation modeling analysis of the alternative model.

6.2.1 Supply Chain Orientation

Several authors had explained in the literature that supply chain orientation is an antecedent of external integration (Lambert, 2004; Min and Mentzer, 2004; Stank et al., 2005) since it leads a firm to extend its activities to integrate business processes and flows with those of other members in the supply chain. The result of the structural equation modeling analysis was consistent with the literature. The result from both initial model fitting and alternative model fitting illustrated that supply chain orientation directly influenced the level of external integration of a firm. The unstandardized beta coefficient was equal to .636 (p=.000) in the initial model fitting and .249 (p=.000) in the alternative model fitting. The consistent result confirmed that the relationship between supply chain orientation and external integration was positive and significant.

In addition to supply chain orientation, the alternative model suggested that the level of external integration can also be influenced by other factors, i.e. information system support and resource commitment. However, it was suggested by many informants during in-depth interviews that while other factors can also influence the level of external integration, supply chain orientation is mandatory for the initiation of external integration. Firms without supply chain orientation may not be able to create coordination of business processes and flows with those of other members of the supply chain since these activities requires more than just a system to support the operations or a commitment in several kinds of resources.

Supply chain orientation consists of several elements, i.e. credibility, benevolence, commitment, cooperative norm, organizational compatibility, and top management support, which are necessary for a firm to initiate an external integration. Lacking some of the elements would lead to low level of supply chain orientation and external integration while lacking all these elements would prohibit supply chain orientation and external integration of a firm. Thus, in order to increase the level of integration with its suppliers and customers, a firm needs to develop all the six elements together.

In addition to the direct relationship between supply chain orientation and external integration, supply chain orientation also indirectly influences the level of reverse logistics performance (ß = .193). The result suggested the indirect effect of supply chain orientation on reverse logistic performance was mediated by external integration, i.e. supply chain orientation leads a firm to initiate external integration with its suppliers and customers which, in turn, enhances reverse logistics performance. Thus, even supply chain orientation did not directly influence reverse logistics performance, it cannot be excluded from the model. Supply chain orientation should be considered along with other factors by a manager of a firm that intends to improve its reverse logistics performance.

In this study, the average unweighted summated score of supply chain orientation construct was equal to 4.20 and ranged between 2.20 to 5.95. The high value of the score suggested that firms in the automotive industry already had a considerable level of supply chain orientation. This finding was based on the fact that the average business experience of firms in this study was 12.62 years and the characteristics of this industry which requires cooperation and coordination among firms in the supply chain. During the long period of their operations, relationships between business partners had been continuously developed which leads to an increasing level of cooperation and coordination between firms in the supply chain. Such cooperation and coordination would allow firms to trust each other as credibility and benevolence were enhanced over time. In addition, as firms in the automotive industry normally attempt to create long-term relationships with their partners to ensure consistent product quality and reliable services, a commitment in relationship as well as and organizational compatibility between trading partners would also be developed. Thus, it is no surprise to see firms that had been in the business for a long time having long-term relationships as well as the six crucial elements of supply chain orientation, i.e. credibility, benevolence, commitment, cooperative norm, organizational compatibility, and top management support, with their good business partners.

6.2.2 Information System Support

The finding from the structural equation modeling analysis of the alternative model suggested that information system support can significantly influence the level of external integration and internal integration (ß = .074, p=.006 and ß = .521, p=.000 respectively). The direct relationship between information system support and external integration was relatively low since there was also indirect effect of information system support on the external integration. By including the indirect effect of information system support on external integration that was mediated by internal integration, the total effect of information system support on external integration was .440. This finding was consistent with the literature (Bowersox and Calantone, 1998; Narasimhan and Kim, 2001; Moberg et al., 2002; Sander and Premus, 2005). Information system support can act as a part of the infrastructure to support the integration of the extended enterprise. Information system support that can provide accurate, timely, and affordable information can help firms improve the extent of internal and external information sharing and increase coordination among supply chain partners (Daugherty et al., 1996; Edward et al., 2001; Sanders and Premus, 2005; Bowersox, 1989; Vickery et al., 1999).

In this study, the data suggested firms in the Thai automotive industry had a considerable level of information system support. However, the use of EDI was mainly limited to large firms as it required both investment and commitment in the technologies. Since several technologies, such as internet and e-mail, are widely available nowadays, most firms cut down the use of EDI and replaced the system with new technologies. In order to develop external integration, many firms in the industry are using a web-based technology to allow coordination and information sharing with their supply chain partners such as "GEos[1]" and "Panda[1]". In addition, several firms use a software packages that are specially designed to serve integration of internal functions and departments such as "Kerridge[1]". While these software packages may frequently be customized to match with the need of a firm, they are normally designed to provide compatibility and interoperability with information system used for external integration among supply chain partners. Thus, these information technologies allow both internal integration and external integration to be done simultaneously in order to enable a seamless flow of information on both forward and reverse directions of the supply chain.

The result of in-depth interviews revealed that firms in the Thai automotive industry are increasingly depending on the use of information system support to deal with their suppliers and customers. Although communication between trading partners are frequently done by phone, web-based communication are becoming very popular since it can help firms improve convenience, flexibility, and accuracy of the information exchange. If firms have capable information system support that is also compatible with their business partners, such system would help enhance the level of supply chain integration. However, while information system support can directly affect the level of external integration and internal integration, having only information system support is

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[1] GEos, Panda, and Kerridge are systems and software applications specially developed by software companies to allow supply chain partners in the automotive industry to effectively communicate and share information with each others as well as to integrate and automate their internal operations.

not adequate to achieve successful supply chain integration. Supply chain orientation is still required to stimulate management of a firm to initiate integration among supply chain partners. Thus, both information system support and supply chain orientation must co-exist within a firm to ensure successful integration.

The literature (Edward et al., 2001; Stank and Lackey, 1997; Narasimhan and Kim, 2001; Jayaram et al., 2000; Kaeli, 1990; Kaplan, 1986; Shull, 1987) also suggested that information system support would help firms enhance reverse logistics performance by lowering costs drastically across the supply chain, providing better efficiency and effectiveness, minimizing cycle time, identifying optimal inventory levels, reducing warehouse space, increasing inventory turnover and enhancing quality of services. However, the results of structural equation modeling analysis revealed that information system support did not have a significant direct relationship with reverse logistics performance. This finding was consistent with Daugherty et al. (2002) which reported that the direct relationships between information system support and operating/financial performance as well as satisfaction were not statistically significant. In Daugherty et al. (2002), the authors commented that the relationship was not statistically significant because operating/financial performance relates to a short-term perspective which is unlikely to be immediately affected by information system support.

In the current study, there is a different explanation for this finding. Although the direct relationship between information support and reverse logistics performance was found to be not statistically significant, it does not mean that information system support can not provide immediate effect to the performance of reverse logistics program. On the other hand, it was found that performance of reverse logistic process mainly depends on external integration and internal integration (β = .776, p=.000 and β = .531, p=.002 respectively). Thus, information system support, that directly influences the level of external integration and internal integration, would also indirectly influence reverse logistics performance. From the result of AMOS, a considerable level of indirect relationship between information system support and reverse logistics performance (β = .618) was found as illustrated in table 6.3. In addition, the result of Sobel test (Sobel, 1982) in section 5.4.3.3 also confirmed that this indirect relationship between information system support and reverse logistics performance was statistically significant. Therefore, it can be said that although information system support does not affect reverse logistics performance directly, it can influence performance of reverse logistics process through external and internal integration. Without a capable and compatible information system support, the level of external integration and internal integration would be diminished. Since reverse logistics performance mainly depends on the extent of external integration and internal integration of a firm, information system support is then considered important to the development of successful reverse logistics program. Information system support would facilitate external integration and internal integration of a firm which would ultimately lead to a better reverse logistics performance.

Therefore, consistent with the literature, information system support would help firms improve reverse logistics performance by lowering costs across the supply chain, providing better efficiency and effectiveness, minimizing cycle time, enhancing quality of services, and so on. However, in order to generate such performance improvement, the investment in information system support capability, compatibility, and technologies must be done in the way that can enhance the extent of external integration and internal integration of a firm. With more information sharing and cooperation among supply chain partners and among departments inside a firm, the performance of reverse logistics can then be improved.

6.2.3 Resource Commitment

In the initial structural model, it was proposed that resource commitment would directly influence the level of information system support and reverse logistics performance. The result of initial model fitting, however, pointed out that these relationships were not significant as proposed while the result of the alternative model fitting revealed that the relationship between resource commitment and reverse logistics performance were mediated by external and internal integration.

As explained earlier, investment in information system support alone may represent only a small portion of a firm's overall resource committed to the firm's logistics program. Thus, the strength of direct relationship between resource commitment and information system support may not be distinguished. However, the result of in-depth interviews suggested that a commitment in technological, managerial, and financial resources is needed to achieve supply chain integration, i.e. external integration and internal integration. Supply chain integration requires firms to allocate several kinds of resources to develop a system that allows information sharing and coordination among internal departments as well as among members in the supply chain. Not only financial resource is needed to invest in a technology that would facilitate the integration, managerial resource commitment is also needed to promote the use of the system and the process of integration.

The result of the alternative model fitting was consistent with comments from the result of in-depth interviews. It was found that there were significant direct relationship between resource commitment and external integration and internal integration (ß = .080, p=.000 and ß = .183, p=.000 respectively). By comparing the standardized coefficients of these two relationships, it can be seen that the strength of the direct relationship between resource commitment and external integration (ß = .100) was weaker than that between resource commitment and internal integration (ß = .194). However, if both direct and indirect effects were considered simultaneously, it can be seen that the strength of relationship between resource commitment and external integration (ß = .260) was stronger than that between resource commitment and internal integration (ß = .194). This was due to the indirect relationship between resource commitment and external integration that was mediated by internal integration (ß = .160).

Since external integration and internal integration are crucial factors that would affect reverse logistics performance, significant positive relationships between resource commitment and external integration and internal integration would imply indirect relationship between resource commitment and reverse logistics performance. From the result of AMOS, it can be seen in table 6.3 that a considerable level of indirect relationship between resource commitment and reverse logistics performance did exist (ß =.259). This result suggested that resource commitment would help a firm to enhance the performance of reverse logistics process as proposed in this study by allowing a firm to enhance the extent of its external integration and internal integration. If the objective of a firm is to improve the performance of reverse logistics process, the commitment in managerial, financial, and technological resources must be provided with the aims to improve the integration among supply chain partners and among internal departments of a firm.

Therefore, although there was no direct relationship between resource commitment and reverse logistics performance, a resource committed to logistics operation would lead to higher level of external and internal integration as well as better reverse logistics performance. On the other hand, a lack of resource committed to logistics program would diminish the level of external and internal integration as well as a performance of reverse logistics process. Thus, resource commitment is also considered important and necessary for a successful implementation of reverse logistics program.

6.2.4 External Integration

In this study, external integration was proposed to directly affect reverse logistics performance due to its several benefits to the organization and supply chain as a whole. The literature suggested that external integration can improve service capabilities, customer service, and increase efficiency of logistics operations as well as productivity (Daugherty et al., 1996; Bowersox and Daugherty, 1995; Stank and Lackey, 1997; Boyer et al., 2003; Ellinger et al., 2000; Kahn and Mentzer, 1996; Stank et al., 1999). In addition, external integration is also capable of reducing operational waste, redundancies, inventory, lead time, and total supply chain cost (Stank et al. 2001a; Rodrigues et al., 2004; Gimenez and Ventura, 2005; Forza, 1996; Vargas et al., 2000; Gustin et al., 1995; Lambert et al., 1978; Rogers et al., 1992). The result of the alternative model fitting was consistent with the literature. The finding suggested that there was a significant positive relationship between external integration and reverse logistics performance (ß =.776, p=.000), indicating that external integration is a predictor for reverse logistics performance.

Based on the in-depth interviews, most informants agreed that external integration is essential for a development of a good reverse logistics system. There is a need for supply chain partners to extensively cooperate and share information on product returns since type and volume of returned products entered into a system are normally difficult to predict. Such effective cooperation and coordination among supply chain partners would ensure a responsive reverse logistics system. External integration is increasingly important especially in the case of large customers or suppliers, which deal with many business partners. Without proper integration among supply chain partners, such complex system would make it more difficult to effectively manage product returns.

The model also suggested that there were several antecedents for external integration. The finding suggested that external integration was significantly affected by internal integration (ß =.702, p=.000), supply chain orientation (ß =.249, p=.000), information system support (ß =.074, p=.006), and resource commitment (ß =.080, p=.000). By comparing the standardized regression weights of these four direct relationships, it was found that internal integration had the most influence on external integration (ß = .822) compared with supply chain orientation (ß = .297), information system support (ß = .107) and resource commitment (ß = .100). However, if the standardized total effect of these four constructs on external integration were compared, the result was different. In this case, while internal integrations still provided the highest impact on external integration (ß = .822), the impact of information system support on external integration became stronger (ß = .630) than supply chain orientation (ß = .297) and resource commitment (ß = .260). This was due to an indirect relationship between information system support and external integration that was mediated by internal integration.

Therefore, this study suggested that internal integration is an important antecedent for external integration, which is consistent with the stages of supply chain integration proposed by Steven (1989) and suggestion made by Bowersox (1989). The stages of supply chain integration suggested that firms progress from independent operation for each function to functional integration, internal integration, and external integration respectively. However, some informants working in the automotive industry commented that firms must have a considerable level of supply chain orientation to move from the stage of internal integration to external integration. Thus, supply chain orientation is mandatory for firms to initiate external integration in the supply chain while information system support and resource commitment are facilitators of external integration. After the establishment of internal integration, these three factors are crucial for the development of effective external integration with other members in the supply chain.

6.2.5 Internal Integration

Supply chain integration consists of two types of integration, i.e. external integration and internal integration. The result of in-depth interviews suggested that both kinds of integration must be performed simultaneously in order to smooth out the reverse logistics process. A lack of either internal integration or external integration in a supply chain would create a bottle neck which affects a performance of reverse logistics process. Internal integration among functional areas would lead to better inventory management and higher level of logistics performance (Stank and Lackey, 1997; Stank et al.; 2001b; Gimenez and Ventura, 2005). In addition, internal integration also helps firms reduce inventory, enhance customer service, and improve forecasting and scheduling (Muller, 1991). The result of the data analysis was consistent with the literature and result of in-depth interviews. Internal integration was found to have a significant positive relationship with reverse logistics performance ($ß$ =.531, p=.002).

In the initial model, it was proposed that internal integration should be affected only by information system support and should provide only direct effect to reverse logistics performance. The result of the alternative model fitting, however, suggested different relationships. Internal integration was found to be significantly affected not only by information system support (ß =.521, p=.000), but also resource commitment (ß =.183, p=.000). In addition, it was also found that internal integration lead not only to reverse logistics performance (ß =.531, p=.002), but also to external integration (ß =.702, p=.000). The relationship between internal integration and resource commitment was proposed based on the result of AMOS and in-depth interviews while relationship between internal integration and external integration was based on the result of AMOS and literature. Thus, there were both direct and indirect relationships between internal integration and reverse logistics performance. The standardized indirect relationship was estimated at .360 while the standardized direct relationship was estimated at .371. The standardized total effect of internal integration on reverse logistics performance is relatively high (ß =.751) compared with all other constructs in this study, suggesting that internal integration is a very important factor for the development of a good reverse logistics system.

6.2.6 Reverse Logistics Performance

Reverse logistics performance consists of three dimension, i.e. cost, responsiveness, and satisfaction. In this study, all of the proposed constructs provided either direct, indirect, or both, effects to the level of reverse logistics performance. While there were direct impacts of only external integration and internal integration on reverse logistics performance, the others provided indirect impacts through these two factors. In order to evaluate which factor provided the highest impact on the performance of reverse logistics process, a standardized total effect of those factors on reverse logistics performance must be considered.

The result of the structural equation modeling analysis suggested that internal integration provided the highest impact on reverse logistics performance ($ß_{direct}$ =.371, $ß_{indirect}$=.380, and $ß_{total}$ =.751). Internal integration is considered very important to reverse logistics process because it does not only benefit reverse logistics process as explained previously, but also leads to external integration, which is also another important factor to enhance the performance of reverse logistics process.

The next most important factor was information system support ($ß_{direct}$ =.000, $ß_{indirect}$=.528, and $ß_{total}$ =.528). The importance of information system support was not due to the direct benefit of information system support on reverse logistics performance, but rather indirect benefits. Information system support is a crucial element that is required by a firm to facilitate both external and internal integration. Without adequate information system support, a firm would experience difficulties to coordinate and share information between its departments and supply chain partners. With such difficulties, an effective reverse logistics system would hardly be implemented.

The third most important factors was external integration ($ß_{direct}$ =.463, $ß_{indirect}$=.000, and $ß_{total}$ =.463). With all the reasons previously explained in a previous section, external integration is a necessary component of a good reverse logistics program. The fourth and fifth most important factors for reverse logistics performance are resource commitment ($ß_{direct}$ =.000, $ß_{indirect}$=.192, and $ß_{total}$ =.192) and supply chain orientation ($ß_{direct}$ =.000, $ß_{indirect}$=.137, and $ß_{total}$ =.137) respectively. Like information system support, resource commitment benefits reverse logistics process by enhancing the level of external integration and internal integration of a firm. Supply chain orientation, on the other hand, leads only to external integration. No evidence was found to illustrate the relationship between supply chain orientation and internal integration.

6.3 CONCLUSION

This study revealed that supply chain orientation, information system support, resource commitment, external integration, and internal integration are crucial factors that lead to a development of effective and efficient reverse logistics program. While the impacts of external integration and internal integration on reverse logistics performance were never explored, this study illustrated that these two factors are the most important factors that affect the performance of reverse logistics process. Other factors, although not as important as these two factors, are also necessary since they are considered significant antecedents of external integration and internal integration. The result of the structural equation modeling analysis suggested that all these constructs are interrelated and none of them can be ignored or excluded from the model.

Although the result of the structural equation modeling analysis revealed that supply chain orientation provides the least impact on reverse logistics performance in this study, it is important to the development of a good reverse logistics program. A lack of supply chain orientation would prohibit a firm to initiate external integration with its business partners. Since external integration provides a major impact on a performance of reverse logistics process, a lack of external integration would ultimately suffer the performance of reverse logistics process.

This study suggested that external integration can be initiated when there is a supply chain orientation inside a firm. However, information system support and resource commitment play an important role to facilitate the external integration and internal integration of a firm. Since information system support provides the strategic linkages and increases coordination among supply chain partners (Sanders and Premus, 2005; Bowersox, 1989; Vickery et al., 1999), a firm without information system support might not be able to effectively integrate operations or share information either among its internal departments or among its supply chain partners. Without external integration and internal integration, reverse logistics program would hardly be successful.

External integration and internal integration also requires commitment with managerial, financial, and technological resources from a management of a firm. Managerial resource commitment is very important for the implementation of supply chain integration since it would help a firm overcome resistance to change which normally happens when people in the organization are required to change the way they work. Financial and technological resources commitment would allow a firm to invest and implement several technologies that would facilitate external integration and internal integration of a firm. Thus, resource commitment is one of the crucial elements that contribute to the success and performance of reverse logistics program.

External integration and internal integration are vital to the performance of reverse logistics program in terms of costs, responsiveness, and customer satisfaction. External integration would help a firm to increase reverse logistics performance by reducing operational waste and redundancies which can be normally seen when operations between firms in the same supply chain are not synchronized. In addition, external integration also help firms solve problems related to reverse logistics such as high inventory level, long lead times, poor customer service, and ineffective forecasting and scheduling. Information sharing among supply chain partners allows a firm to make a better forecast on product returns, create effective production scheduling, provide quick response and reduce lead time of product returns, and improve customer service. While external integration provides a strong direct impact on the performance of reverse logistics process, internal integration can provide both direct and indirect impact to reverse logistics performance. Internal integration can improve a performance of reverse logistics process by eliminating parallel processes and work duplication. In addition, internal integration would also help managers make appropriate decision on procurement, inventory level, production schedules, and sales and marketing plan. All these benefits from internal integration lead to more efficient and cost-effective operation, better responsiveness, and higher satisfaction.

It can be seen that all of the proposed constructs are interrelated and can provide either direct or indirect impacts on reverse logistics performance. A lack in any of these factors would affect the other factors and definitely deteriorate a performance of reverse logistics program. Thus, this study suggested that all of these factors must be considered simultaneously when any firm needs to develop a good reverse logistics program.

CHAPTER 7

CONCLUSION

This chapter aims to provide a conclusion for this dissertation. The chapter starts with a summary of this dissertation and explanation of how this dissertation achieves its proposed research objectives and answers the research questions. Theoretical contribution and managerial implication are then discussed. Finally, the chapter concludes this dissertation with research limitations and suggestions for future research.

7.1 RESEARCH SUMMARY

The main objective of this dissertation was to develop a framework to identify factors that influence reverse logistics performance and to test the framework empirically. Based on the literature review and in-depth interviews, five main constructs, i.e. supply chain orientation, information system support, resource commitment, external integration, and internal integration, were identified as important antecedents of reverse logistics performance. The conceptual model consisting of relationships among these constructs was then developed based on the previous literature.

In order to empirically test the model, the Thai automotive industry was selected as a context of this study. The selection of the Thai automotive industry was based on the reasons that a large part of their distribution operations focuses on handling returns. In addition, the nature of this industry encourages firms to have supply chain integration among supply chain members. After the questionnaire was developed, it was distributed to 468 first-tier supplier firms in the industry by using a drop-off delivery survey method. A total of 243 questionnaires were received while 234 of them were usable for data analysis.

Data analysis was conducted based on this set of questionnaires. A descriptive data analysis was performed to understand the characteristics of the respondents in this study. In addition, item analysis was done to evaluate a reliability and validity of measures used in this study. The result of the item analysis was satisfactory, suggesting that these measures could be used for further analysis. The last part of data analysis was done by conducting a structural equation modeling analysis. The first structural equation model was investigated to test 8 main hypotheses while the analysis of second structural equation model was used to test 6 sub-hypotheses. While the majority of hypotheses were supported by the data, result of the analysis as well as comments from industry experts suggested that an improvement could be made to the model. Thus, an alternative model was developed based on the result of initial model fitting and comments from industry experts. The structural equation modeling analysis of the alternative revealed that the alternative model was fitted better with the data compared with the initial model. The findings of the research gained from data analysis and in-depth interviews were then discussed to answer the research questions and to provide more insights on the reverse logistics performance model.

In order to develop to a better understanding of reverse logistics process and to investigate the relationships between information system support, resource commitment, supply chain orientation, external integration, internal integration, and reverse logistics performance, five researches objective were proposed in chapter 1. With a comprehensive literature review, in-depth interview, and structural equation modeling analysis, this dissertation has achieved all the proposed research objectives. The summary of how each of the five research objectives was achieved is illustrated hereunder:

1. *To provide comprehensive theoretical and practical perspectives of reverse logistics including several aspects of reverse logistics such as the development of its definitions, reverse logistics activities, related costs and benefits of reverse logistics, differences between logistics and reverse logistics, and difference between reverse logistics and green logistic.*

In order to provide comprehensive theoretical and practical perspectives of reverse logistics, a literature review was done in this study to discuss about reverse logistics in details on all of the specified issues. The development of reverse logistics definition was explained in chronological order. While the earliest definition of reverse logistics was provided by Lambert and Stock (1981), other definitions were proposed by several authors.

In addition, reverse logistics activities were identified. Reverse logistics activities consist primarily of product or packaging which can be originated by either supply chain partners or end users for different reasons. Several reverse logistics activities, e.g. stock balancing return, faulty order processing, detective/unwanted product, and recalls, were discussed in this dissertation. Furthermore, the discussion was also made to examine the differences between logistics and reverse logistics in several aspects such as uncertainly in product type and volume, origin and destination of product flows, and cost structure.

The differences between reverse logistics and green logistics were also illustrated in this dissertation. While some activities can be considered as pure reverse logistics or pure green logistics, there are many activities to which both reverse logistics and green logistics can be equally applied such as recycling and remanufacturing. Finally, costs and benefits of reverse logistics were presented in this study.

2. To explore the factors that influence the reverse logistics performance.

In order to achieve the second research objective, a literature review and in-depth interview were done. Previous researches in the logistics and supply chain areas and the result of in-depth interviews suggested that several factors, i.e. supply chain orientation, information system support, resource commitment, external integration, and internal integration, are crucial factors that influence the reverse logistics performance.

3. To investigate how the proposed factors affect reverse logistics performance.

This study achieved this research objective by conducting a literature review and in-depth interviews in order to gain understanding on all the constructs proposed in this study and to investigate the relationships among these constructs. Both relationships between the proposed factors and reverse logistics performance and relationships among the proposed factors were investigated and identified in this study. Supply chain orientation, information system support, resource commitment, external integration, and internal integration were found to positively affect the reverse logistics performance.

4. To develop a model that examines the relationships between supply chain orientation, information system support, resource commitment, external integration, internal integration, and reverse logistic performance.

After the relationships between supply chain orientation, information system support, resource commitment, external integration, internal integration, and reverse logistics performance were investigated, a total of 8 main hypotheses and 6 sub-hypotheses were proposed to examine the relationships between these constructs. While the main hypotheses were proposed to investigate the relationships between the proposed constructs and reverse logistics performance, the sub-hypotheses were proposed because external integration consists of two dimensions, i.e. customer integration and supplier integration, which may affect or be affected by other constructs in the model differently. Thus, there was a need to separately investigate relationships related to customer integration and supplier integration. For this reason, two reverse logistics performance models were developed in this study.

The first reverse logistics performance model was developed in order to test the main hypotheses. In this model, external integration was considered as one construct consisting of two dimensions, i.e. customer integration and supplier integration. In order to test the sub-hypotheses, the second reverse logistics performance model was also developed. In the second model, customer integration and supplier integration were treated, not as dimensions of external integration, but as different constructs in the model. The graphical illustration of both models can be seen in figure 7.1 and 7.2.

Figure 7.1: Reverse Logistic Performance Model (For Main Hypotheses Testing)

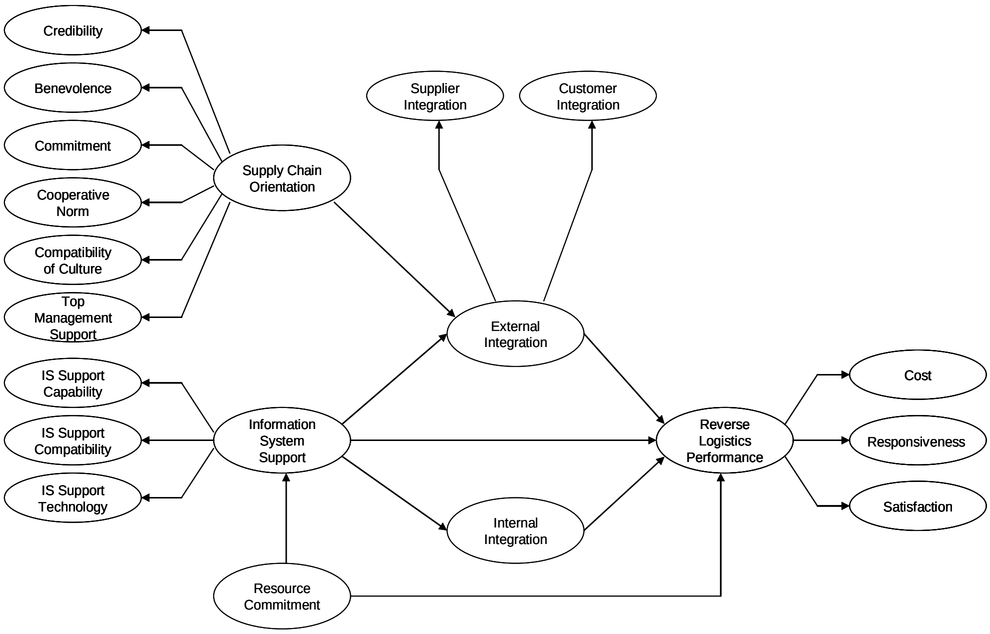
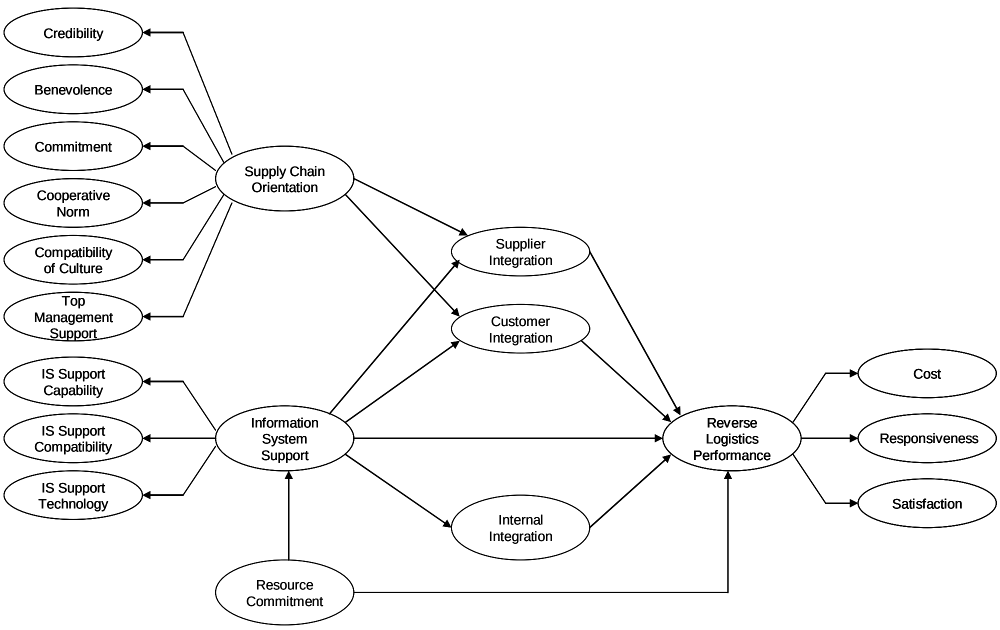


Figure 7.2: Reverse Logistic Performance Model (For Sub-Hypotheses Testing)



5. *To examine the fit of the proposed model in the context of the Thai Automotive Industry.*

After the model was proposed, this study achieved its fifth research objective by conducting a structural equation modeling analysis to examine the fit of the proposed models in the context of the Thai automotive industry. All the main hypotheses and sub-hypotheses were tested at this stage. The result of the structural equation modeling analysis suggested that the proposed models fitted well with the data. However, since some of the proposed relationships were not statistically significant, an alternative model was proposed in order to provide an improvement to the original model.

This dissertation not only achieved the proposed research objectives, but also answered both main and specifying research questions listed in chapter 1. The answer corresponding to the main research question was illustrated hereunder.

- *What are the important factors that influence reverse logistics performance and how do these factors affect the performance of reverse logistics process?*

This study revealed that five important factors, i.e. supply chain orientation, information system support, resource commitment, external integration, and internal integration could directly and indirectly influence a performance of reverse logistics process. To be more specific, external integration and internal integration directly influence reverse logistics performance. In addition, internal integration and supply chain orientation could indirectly affect reverse logistics performance through external integration. Finally, information system support and resource commitment could indirectly influence reverse logistics performance through external integration and internal integration.

All of the specifying research questions were also answered in this dissertation. The answers for each of the specifying research questions can be seen hereunder.

- *What is reverse logistics and how can reverse logistics contribute to the competitive advantage of a firm?*

In order to answer this specifying research question, several definitions of reverse logistics provided by previous researchers were presented. This study followed the definition of reverse logistics provided by Rogers and Tibben-Lembke (2001) which defined reverse logistics as "The process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods, and related information from the point of consumption to the point of origin for the purpose of recapturing or creating value or proper disposal." In addition, this study discussed how reverse logistics can be a source of competitiveness of a firm. With its several benefits, reverse logistics can create customer value and achieve cost and differentiation advantages through each of the four common bases of competition, i.e. cost, quality, flexibility, and response time (Handfield and Nichols, 1999).

- *What are the factors that influence the performance of reverse logistics processes?*

Based on literature review, in-depth interviews, and structural equation modeling analysis, this study answered this specifying research question by suggesting that supply chain orientation, information system support, resource commitment, external integration, and internal integration are the factors that influence reverse logistics performance. While external integration and internal integration can directly influence a performance of reverse logistics process, supply chain orientation, information system support, and resource commitment can indirectly influence a performance of reverse logistics process through external integration and internal integration. Table 7.1 summarizes the direct, indirect, and total impacts of the proposed factors on the reverse logistics performance based on the structural equation modeling analysis of the alternative model.

Table 7.1: Impacts of the Proposed Factors on Reverse Logistics Performance

Construct	Standardized Effects		
	Direct	Indirect	Total
Supply Chain Orientation		.137	.137
Information System Support		.528	.528
Resource Commitment		.192	.192
External Integration	.463		.463
Internal Integration	.371	.380	.751

- *How does information system support directly and indirectly influence the reverse logistic performance?*

The result of structural equation modeling analysis suggested that information system support does not provide statistically significant impact on the performance of reverse logistics process. However, significant indirect relationships between information system support and reverse logistics performance that were mediated by external integration and internal integration were found in this study. Information system support facilitates an implementation of external integration and internal integration. With external integration and internal integration, a firm would be able to achieve better reverse logistics performance.

- *How does resource commitment directly and indirectly influence the reverse logistic performance?*

The result of the structural equation modeling analysis revealed that resource commitment could indirectly influence reverse logistics performance through external integration and internal integration. The higher level of commitment in managerial, financial, and technological resources to a logistics program would help a firm to enhance its external integration and internal integration. With the implementation of external integration and internal integration, a good reverse logistics performance can be achieved. However, a direct relationship between resource commitment and reverse logistics performance was found to be not statistically significant in this study.

- *How do external integration and internal integration influence the reverse logistic performance?*

The result of structural equation modeling analysis indicated that supply chain integration, categorized into external integration and internal integration, positively and directly influences reverse logistics performance. In addition, there was also an indirect relationship between internal integration and reverse logistics performance that was mediated by external integration. Thus, it can be concluded that supply chain integration provide a significant positive impact on the performance of the reverse logistics process.

- *Is supply chain orientation an antecedent of external integration?*

Both literature review and the result of data analysis clearly confirmed a significant positive relationship between the supply chain orientation and external integration. Thus, supply chain orientation is an antecedent for external integration.
In this section, a summary of this dissertation was explained to provide an overview of this study. In addition, the explanation of how this dissertation met each research objective and answers all of the research questions was illustrated. In the next sections, theoretical contributions, managerial implications, limitations, and future researches will be presented.

7.2 THEORETICAL CONTRIBUTIONS

Theoretical contributions of this study can be elaborated in many aspects. First of all, this study is the first attempt to investigate the effect of supply chain integration on reverse logistics performance. The finding suggested that both external integration and integration can directly influence the performance of reverse logistics process. While the concept of supply chain integration is not new, it had never been studied in relation to reverse logistics performance before.

In the past, supply chain integration had been studied in many aspects. Many studies explored several antecedents for supply chain integration while the others examined the effects of supply chain integration on overall firm's performance or overall logistics process. However, none of them focused on the aspect of reverse logistics performance. In addition, in the previous studies related to reverse logistics performance, only few factors influencing reverse logistics performance were identified. Supply chain integration had been ignored regardless of its importance to overall firm's performance or logistics process in specific. Thus, this study is considered a successful attempt to fill this gap in the literature.

The second theoretical contribution in this study is the identification of a structural relationship between supply chain orientation, information system support, resource commitment, external integration, internal integration, and reverse logistics performance. In the previous studies (Autry et al., 2001; Daugherty et al., 2001; Daugherty et al., 2002; Richey et al., 2004; Richey et al., 2005), although direct and indirect relationships were proposed between some of these factors and reverse logistics performance, all of these factors were never considered simultaneously. The result of this study can help explain the reasons why some of the proposed relationships in previous studies were not significant or supported by the data. For example, the relationship between information system support and reverse logistics performance that was found to be not statistically significant in the study of Daugherty et al. (2002) can be explained by the result of this study. The relationship was found to be not statistically significant because the relationship was not a direct relationship as proposed rather than because of the inability of information system support to immediately performance of reverse logistics process as explained in their study. This study revealed that there was an indirect relationship between information system support and reverse logistics performance. Another case can be seen when there was a mixed result on the examination of relationship between resource commitment and reverse logistics performance in the study of Daugherty et al. (2001). Thus, the current study helps identify and test other aspects of relationships as well as confirms some of the previously proposed relationships.

For the third theoretical contribution, this study is the first to utilize structural equation modeling analysis to empirically investigate the reverse logistics performance model. While previous studies mainly used regression analysis to examined the reverse logistics performance model, the current study examine the model by using structural equation modeling analysis which has several advantages over other methods. The use of structural modeling analysis helps this study in creating more complicated structural model and examining all the proposed constructs simultaneously. The result of the analysis can provide more insights on the relationships among the constructs which could not be evaluated in the previous studies.

The fourth contribution is related to the role of supply chain integration on reverse logistics performance. In addition to the identified direct effect of external integration and internal integration on reverse logistics performance, this study also illustrated and examined the mediating role of external integration and internal integration on the relationships between other proposed constructs and reverse logistics performance. The finding suggested that external integration and internal integration not only directly influence reverse logistics performance, but also mediate the relationships between supply chain orientation, information system support, and resource commitment and reverse logistics performance.

In the past, the stages of supply chain integration (Stevens, 1989) was conceptually proposed, but had never been empirically tested before. In addition, several researchers and experts in various industries had different comments on the relationship between external integration and internal integration. While some of them commented that internal integration is an antecedent of external integration, the others suggested that the relationship exists in the opposite direction as explained chapter 2. Thus, the fifth theoretical contribution of this study is based on the proposed relationship between external integration and internal integration in an alternative structural model. This study empirically tested this part of the stages of supply chain integration concept proposed by Stevens (1989). The result of this study supported that, in addition to other factors that influence external integration, integration among departments inside a firm would lead to external integration with supply chain partners.

In addition, the current study can be considered an application of the arcs of integration concept proposed by Frohlich and Westbrook (2001) in the context of reverse logistics. Frohlich and Westbrook (2001) empirically investigated the relationship between the degree of supply chain integration and operational performance. The finding suggested that an outward-facing supply chain focus is associated with higher performance than strategies biased toward either suppliers or customers. The current study also considered external integration as supplier integration and customer integration independently, but in the specific context of reverse logistics performance rather than operational performance of a firm. The result was in the same direction as what was previously suggested. Both supplier integration and customer integration was found to directly influence reverse logistics performance. It can be interpreted that both supplier integration and customer integration are required to enhance the performance of reverse logistics process while having only supplier integration or customer integration would lead to inferior reverse logistics system.

Finally, there have been controversial arguments among previous researchers whether firm's characteristics such as firm size, sales volume, ownership structure, and nationality of foreign shareholder would affect the level of supply chain integration as well as reverse logistics performance. For example, a previous study of reverse logistics done by Autry et al. (2001) tried to examine the relationship between firm size/sales volume and reverse logistics performance. The result, however, was inconclusive. Based on the result of data analysis, this study shed light on this issue by suggesting that level of supply chain integration and reverse logistics performance were not influenced by all these firms' characteristics, i.e. firm size, sales volume, ownership structure, and nationality of foreign shareholder.

7.3 MANAGERIAL IMPLICATIONS

There are a number of managerial implications in which this study elaborates for firms in the automotive industry as well as in other industries. First of all, in order to improve performance of reverse logistics process, a firm must focus on both external integration and internal integration. The result suggested that having internal integration or external integration alone, although provides positive effect on reverse logistics performance, is not adequate. Thus, both external integration and internal integration shall be conducted together among departments inside a firm as well as among members in the supply chain to ensure an effective operation. For external integration, it shall be done on both supplier and customer sides to guarantee that the reverse logistics operation will run smoothly throughout the supply chain.

There are many activities that a firm should execute to create external integration with suppliers and customers. To be more specific, these activities range from sharing operational information, cost-related information, cross-functional processes, and performance measurement scheme. In addition, collaborative planning, initiation of standardized supply chain practices and operation, and direct communication with business partner, shall also be done to enhance the level of external integration. For internal integration, a firm shall use cross-functional collaboration among departments in strategic planning, focus on managing process rather than function, shares operational information between departments, utilizes integrated database and access method to facilitate information sharing.

In addition, the study also not only pointed out that external integration and internal integration are the important factors that lead to reverse logistics performance, but also identified antecedents for external integration and internal integration. Based on the result of this study, supply chain orientation is considered one of the factors that lead to external integration. Several researchers suggested that supply chain orientation would lead a firm to practice supply chain integration (Mentzer et al., 2001; Lambert, 2004; Min and Mentzer, 2004; Stank et al., 2005) while a lack of supply chain orientation is considered a major barrier to supply chain integration. A firm would possess a certain level of supply chain orientation in order to create external integration and enhance reverse logistics performance. In order to create supply chain orientation within a firm, it was suggested that firms should develop and maintain the six cultural elements of relations, i.e. credibility, benevolence, commitment, cooperative norm, organization compatibility, and top management support, with its supply chain partners. Consistent with the literature (Narasimhan and Kim, 2001; Moberg et al., 2002; Sander and Premus, 2005), information system support was found to be another crucial element that helps improve both external integration and internal integration of a firm. Moreover, not only directly influencing external integration and internal integration, information system support also indirectly influence a performance of reverse logistics process. Thus, a firm should possess an information system support that has both capability and compatibility. In term of capability, information system support of a firm should be able to provide accurate information in a timely manner. For system capability, the system should be user-friendly and formatted to facilitate usages so that anyone can access the system without a problem. In addition, the system shall provide both internal and external connectivity. It should allow internal people to access necessary information of their own departments as well as of other departments. Moreover, the system should facilitate the cooperation and coordination of internal departments of a firm as well as between a firm and its supply chain partners. Finally, information system support should not only act as an information database of a firm, but also a tool that enable and facilitate communication for internal departments as well as among supply chain partners.

Resource commitment was also found to be an antecedent of external integration and internal integration. Since external integration and internal integration requires various types of resource committed to the operation, a manager of a firm must have a resource commitment in three types of resources, i.e. managerial resource, financial resource, and technological resource.

As it was found that a firm's characteristics did not significantly influence the level of supply chain integration as well as reverse logistics performance, manager of a firm shall be able to develop a good reverse logistics program regardless of the size or the sales volume of a firm. Although it was argued that a size of a firm would have an impact on the investment in information technology and other kinds of resources, this study revealed that any firm now has an access to low-cost, readily available information system that are capable of support external integration and internal integration of a firm. The level of reverse logistics performance or supply chain integration would be depending more on other factors such as supply chain orientation and commitment on resources than the actual amount of investment.

Another insight was also found from in-depth interview with experts in the Thai automotive industry. Most of the informants reported that first-tier supplier firms lean heavily on customer integration due to the influence from carmakers while allow supplier integration to play only a minor role. As Christopher (1998) postulated that the strength of a direct supply chain depends on the weakest chain in the direct supply chain, these first-tier suppliers should not pay high attention only on demand side. Managers, on the other hand, should play an important role to initiate and manage internal integration, supplier integration, and customer integration simultaneously to ensure reverse logistics performance of a supply chain.

7.4 LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCHES

Despite the insights gained through this study, certain limitations can also serve as avenues for further studies. First of all, the scope of reverse logistics in this study focused only on product returns caused by certain reasons such as defective product and faulty order processing. In fact, there are also other reasons for returning products such as stock balancing return, end of life/season and unwanted product which were excluded from this study. This limitation is due to the characteristics of the Thai automotive industry which has only certain types of product returns. Although the author expected that the model of reverse logistics performance proposed in this study may not be affected by types of product returns, it is too early to provide such conclusion.

The second limitation is the use of single industry research. Since each industry may have its own characteristics of product return and supply chain integration, the use of samples drawn from a single-industry may raise concerns over the generalizability of the findings to other industries. Replications of this study are necessary to determine the applicability of this study and the magnitude of parameter estimates outside the automotive industry and to other countries. Thus, future researches may be done to replicate the study in other industries such as electronics, catalog retailing, or FMCG (Fast Moving Consumer Goods) industries in order to expand the external validity of the model and to generalize the findings of this study.

The third limitation of this study is based on the scope of supply chain integration. In this study, supply chain integration focused only on an integration of a direct supply chain consisting of a respondent (first-tier supplier), its supplier (second-tier supplier), and its customers (car assembler). In fact, reverse logistics deals with a reverse flow of products and information from the end user to the origin of the product. Thus, integration among all supply chain members in every level is required to smooth out the operation and to enhance reverse logistics performance. This study focused only on direct supply chain by evaluating both supply chain integration and reverse logistics performance at a direct supply chain level. Although this is acceptable, future researches may improve the study by attempting to measure supply chain integration and reverse logistics performance of an extended supply chain or, if possible, of a whole supply chain.

The fourth limitation is the focus on the research on the supply chain on the demand side in which reverse logistics processes are done between firms. Since the characteristics of relationships between B2B (Business to Business) and B2C (Business to Customer) might be different, it is interesting to investigate if the model can also be applied in other settings where the customer is an end user. Thus, future researches can be done on the supply side of the automotive industry that deals with product returns made by end customer to car dealers and car assemblers, or in other industries which product return from customer is considered strategically important such as catalog retail industry.

Finally, the model was developed to accommodate selected factors that influence reverse logistics performance based on the barriers of reverse logistics process proposed by Tibben-Lembke and Rogers (2002). Other factors such as innovation and relationship commitment were omitted from this study since they were not listed as major barriers to reverse logistics process. Future research should expand beyond the scope of this study by considering additional variables, such as business strategies and supply chain strategies. Morash (2001) suggested that both business strategies, e.g. cost leadership and differentiation, and supply chain strategies, e.g. operational excellent and customer closeness, may influence a supply chain performance in terms of cost, productivity, quality, and customer service. Thus, it is interesting to investigate if business and supply chain strategies can also influence reverse logistics performance. These two factors may be included in future research in order to improve the reverse logistics performance model.

It is also interesting to see the relationship between the performance of logistics process and reverse logistics process of a firm. While the characteristics of logistics and reverse logistics are different in many aspects, their performance could be partially influenced by similar factors such as information system support and supply chain integration. In general, a firm with good logistics process is also expected to perform well on reverse logistics process. However, such conclusion can not be made since there might other specific factors that might provide a strong impact to the performance of logistics and reverse logistics processes independently such as management's attention on reverse logistics process or the importance of reverse logistics process on the performance of a firm. Such factors allow the performance of logistics and reverse logistics of the same firm to be different. Thus, a future research may be conducted to develop a model to explain the relationship between the performance of logistics and reverse logistics of a firm.

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APPENDIX

Appendix A:

Research Questionnaire

Supply Chain Integration and Reverse Logistics Performance Questionnaire

Dear Executives,

This questionnaire is a part of a research study currently being carried out by a doctoral candidate in the Faculty of Commerce and Accountancy from the Joint Doctoral Program in Business Administration (JDBA) at Chulalongkorn University, Thammasat University, and National Institute of Development and Administration (NIDA). The researcher is exploring the factors that influence the performance of reverse logistics process. "**Reverse Logistics process**" refers to the product return process made by your customer to your company as well as the return process made by your company to your supplier for several purposes such as defective product return or warranty claiming. It also includes other processes related with such return until the problem is solved as agreed by your company, your supplier, and your customer such as product replacement, product repair, or credit the money back.

The research focuses on firm's resources and supply chain integration in the Thai Automotive Industry which is considered one of the most important industries in Thailand. The result of this study will help firms developing supply chain management strategies and reverse logistics process in order to enhance firm's performance in terms of costs and customer satisfaction as well as enhancing competitive position of Thai Automotive Industry in the world market.

Since you are equipped with profound knowledge and extensive experience in the industry, your participation and valuable information will be very beneficial to this study. Please complete the questionnaire with answers that best representing facts and your opinion in every section. This questionnaire consists of 5 sections and takes about 20 minutes to finish. Please be assured that your response is strictly confidential and only aggregate results are reported.

Thank you for your contribution to this research. If you would like a summary of the result, please fill in your information in the last page of this questionnaire.

Sincerely Yours,

Mr. Vouravis Veerakachen
Doctoral Candidate
Thammasat University

Remarks: In case that you have questions or concerns with this questionnaire, you may contact the researcher via telephone at 0-1555-7777 or via e-mail at vouravis_v@yahoo.com

Section A: About Yourself and Your Organization

Instruction: Please mark (X) at your response in the following questions. For the questions with blank spaces, please fill in the number or contents.

1. Does your specific job in the company involve operations management that focuses on work flows across many departments including purchasing, production, logistics, marketing and sales?
   - ☐ No (please forward this survey to the person you see fit. Thank you)
   - ☐ Yes

2. What is your current position in the company? ______________________________

3. What is your company's auto-parts category?
   - ☐ Engine & Components ☐ Drivetrains ☐ Steering
   - ☐ Suspension ☐ Brakes ☐ Wheels
   - ☐ Tires ☐ Body Works ☐ Interiors
   - ☐ Electrical Systems & Electronics ☐ Materials Components
   - ☐ Others, please specify _______________________

4. What is the proportion of your sales between foreign market and local market in 2005?
   Local market _____________% of total sales Foreign market_____________% of total sales

5. How many percent does your company supply directly and/or indirectly to **local** automakers?

☐ as a direct supplier to automakers (Tier 1)	___________ %
☐ as an indirect supplier to automakers (Tier 2 or Tier 3)	___________ %
☐ as other, please specify _________________________	___________ %
Total	____100____ %

6. At present, the returned products are accounted for_____________% of total sales
What are the types of return made by your customers and their relative percentages compared to total returned products?
   - ☐ Defective product return ___________ % ☐ Faulty order processing ___________ %
   - ☐ Incorrect product specification ______ % ☐ Recycle packaging/material ___________ %
   - ☐ Others, please specify: ___________________ Percentage compared to sales ___________ %

7. What is you company's shareholder structure?

☐ Shares of Thai owner(s)	___________ %
☐ Shares of foreign owner(s)	___________ %
Total	____100____ %

8. If your company has foreign shareholders, where does the major foreign shareholder come from?
   ☐ Japan ☐ Europe ☐ United States ☐ Others, please specify _______________

9. How long has your company been in the business? _________________________________ years.

10. How many employees (salary and man-day earners) are there in your company? _________ employees.

11. In the year 2005, what was your company's total annual sale?
   - ☐ Less than 50 million Baht ☐ 50-100 million Baht ☐ 101-200 million Baht
   - ☐ 201-500 million Baht ☐ 501-1,000 million Baht ☐ 1,001-2,000 million Baht
   - ☐ 2,001-3,000 million Baht ☐ more than 3,000 million Baht

12. Who is your most important customer (car assembler) that accounts for the largest portion of your annual sales?
   - ☐ Toyota ☐ Mitsubishi ☐ Isuzu ☐ Daihatsu & Hyundai
   - ☐ Honda ☐ Ford & Mazda ☐ Nissan ☐ Volvo, Chrysler & Renault
   - ☐ BMW & Rover ☐ Mercedes Benz ☐ Peugeot, Audi, Volkswagen & Kia
   - ☐ GM, Isuzu, Chevrolet, Holden, Opel, Subaru, Vauxhall & Alfa Romeo
   - ☐ Wholesalers/Retailers (please specify __________) ☐ Others, please specify __________

Section B: Your Opinion on the Following Factors

Instruction: Please mark (X) at the number best representing your opinion in each of the following areas.
Remark: "**Information System Support**" refers to *the information system that your company uses to support various logistics activities such as sales and marketing, finance, purchasing, production planning, inventory management, customer service, and product return.*

A. Supply Chain Orientation	Extremely Disagree ⟷					Extremely Agree
1. Promises made to your supply chain members by your firm are reliable.	1	2	3	4	5	6
2. Your firm is trusted by your supply chain members regarding to the knowledge related to your products and/or services.	1	2	3	4	5	6
3. Your firm does not make false claims to your supply chain members.	1	2	3	4	5	6
4. Your firm is open in dealing with your supply chain members.	1	2	3	4	5	6
5. When making important decisions, your supply chain members are concerned about your welfare.	1	2	3	4	5	6
6. When you share your problems with your supply chain members, you know they will respond with understanding.	1	2	3	4	5	6
7. In the future you can count on your supply chain members to consider how their decision and actions will affect you.	1	2	3	4	5	6
8. When it comes to things that are important to you, you can depend on your supply chain member's support.	1	2	3	4	5	6
9. You defend your supply chain members when outsiders criticize them, if you trust them.	1	2	3	4	5	6
10. You are patient with your supply chain members when they make mistakes that cause you trouble but are not repeated.	1	2	3	4	5	6
11. Your firm is willing to make cooperative changes with your supply chain members.	1	2	3	4	5	6
12. You believe your supply chain members must work together to be successful.	1	2	3	4	5	6
13. You view our supply chain as a value added piece of your business.	1	2	3	4	5	6
14. Your firm's goal and objectives are consistent with those of your supply chain members.	1	2	3	4	5	6
15. Your firm and your supply chain members have similar operating philosophies.	1	2	3	4	5	6
16. Top managers repeatedly tell employees that this firm's survival depends on its adapting to supply chain management.	1	2	3	4	5	6
17. Top managers repeatedly tell employees that building, maintaining, and enhancing long-term relationship with your supply chain members are critical to this firm's success.	1	2	3	4	5	6
18. Top managers repeatedly tell employees that sharing valuable strategic/tactical information with your supply chain members is critical to this firm's success.	1	2	3	4	5	6
19. Top managers repeatedly tell employees that sharing risk and rewards is critical to this firm's success.	1	2	3	4	5	6
20. Top management offers various education opportunities about supply chain management.	1	2	3	4	5	6
B. Information System Support	Extremely Disagree ⟷					Extremely Agree
1. Your firm's information system can provide accurate information	1	2	3	4	5	6
2.Your firm's information system can provide information when ever you need	1	2	3	4	5	6
3. Your firm's information system capability is excellent relative to the industry standard	1	2	3	4	5	6

B. Information System Support (Continued)	Extremely Disagree ↔					Extremely Agree
4. Your firm's information system allows a daily download of information	1	2	3	4	5	6
5. Your firm's information system can provide information that is formatted to facilitate usage	1	2	3	4	5	6
6. Your firm's information system can provide real-time information	1	2	3	4	5	6
7. Your firm's information system can provide internal connectivity	1	2	3	4	5	6
8. Your firm's information system can provide external connectivity	1	2	3	4	5	6
9. Your firm shares common information technology (software) to facilitate communication with the partner	1	2	3	4	5	6
10. Your firm's information system can obtain information from your suppliers and customers to facilitate operational plans and reduce reliance on forecasting.	1	2	3	4	5	6
11. Your firm utilizes these hardware and software technologies to assist with returns handling						
11.1 Internet/Website	1	2	3	4	5	6
11.2 E-mail	1	2	3	4	5	6
11.3 Fax	1	2	3	4	5	6
11.4 Electronic Data Interchange (EDI)	1	2	3	4	5	6
C. Resource Commitment	Extremely Disagree ↔					Extremely Agree
1. Your firm commits considerable level of *technological resources* to logistics program	1	2	3	4	5	6
2. Your firm commits considerable level of *managerial resources* to logistics program	1	2	3	4	5	6
3. Your firm commits considerable level of *financial resources* to logistics program	1	2	3	4	5	6

Section C: Degree of External Integration

Instruction: Please mark (X) at the number best representing your opinion in each of the following areas.
Remark: "**Supplier**" refers to *"your most important supplier that accounts for the largest portion of your annual purchasing cost"*. **"Customer"** refers to *"your most important customer that accounts for the largest portion of your annual sales"*.

A. Supplier Integration	Extremely Disagree ↔					Extremely Agree
1. Your firm effectively shares operational information externally with selected suppliers	1	2	3	4	5	6
2. Your firm effectively shares cross-functional processes with suppliers	1	2	3	4	5	6
3. Your firm engages in collaborative planning with suppliers	1	2	3	4	5	6
4. Your firm shares cost information with suppliers	1	2	3	4	5	6
5. Your firm has increased operational flexibility through supply chain collaboration with suppliers	1	2	3	4	5	6
6. Your firm successfully integrate operations with suppliers by developing interlocking programs and activities	1	2	3	4	5	6
7. Your firm is actively involved in initiatives to standardized supply chain practices and operations	1	2	3	4	5	6
8. Your firm establishes direct communication with suppliers to improve responsiveness	1	2	3	4	5	6
9. Your firm has developed performance measures that extend across supply chain relationships	1	2	3	4	5	6

A. Supplier Integration (Continued)	Extremely Disagree ⟷ Extremely Agree					
10. Your firm has supply chain arrangements with suppliers that operate under principles of shared rewards and risks	1	2	3	4	5	6
11. Your firm benchmarks best practices/processes and shares results with supplier	1	2	3	4	5	6
B. Customer Integration	Extremely Disagree ⟷ Extremely Agree					
1. Your firm effectively shares operational information externally with selected customers	1	2	3	4	5	6
2. Your firm has increased operational flexibility through supply chain collaboration with customers	1	2	3	4	5	6
3. Your firm successfully integrate operations with customers by developing interlocking programs and activities	1	2	3	4	5	6
4. Your firm is able to accommodate a wide range of unique customer requests by implementing preplanned solutions	1	2	3	4	5	6
5. Your firm has different, unique logistics service strategies for different customers	1	2	3	4	5	6
6. Your firm has established a program to integrate and facilitate individual customer requirements across your firm	1	2	3	4	5	6
7. Your firm establishes direct communication with customers to improve responsiveness	1	2	3	4	5	6
8. Your firm has supply chain arrangements with customers that operate under principles of shared rewards and risks	1	2	3	4	5	6

Section D: Degree of Internal Integration

Instruction: Please mark (X) at the number best representing your opinion in each of the following areas.

A. Internal Integration	Extremely Disagree ⟷ Extremely Agree					
1. Your firm use cross-functional collaboration in strategic planning	1	2	3	4	5	6
2. Your firm has extensively redesigned work routines and processes over the past three years	1	2	3	4	5	6
3. The orientation of your firm has shifted from managing function to managing processes	1	2	3	4	5	6
4. Your firm effectively shares operational information between departments	1	2	3	4	5	6
5. Your firm utilizes integrated database and access method to facilitate information sharing	1	2	3	4	5	6
6. Your firm has adequate ability to share both standardized and customized information internally	1	2	3	4	5	6
7. Your firm provides objective feedback to employees regarding integrated logistics performance	1	2	3	4	5	6
8. Your firm's compensation, incentive, and reward systems encourage integration	1	2	3	4	5	6

Section E: Reverse Logistics Performance

Instruction: Please mark (X) at the number best representing your opinion in each of the following areas.
Remark: "**Reverse logistics process**" refers to *the product return process made by your customer to your company as well as the return process made by your company to your supplier for several purposes such as defective product return or warranty claiming. It also includes other processes related with such return until the problem is solved as agreed by your company, your supplier, and your customer such as product replacement, product repair, or credit the money back.* "**Overall reverse logistics costs**" refers to *costs related to reverse logistic process including transportation, inventory holding, collection, sorting, quality diagnosis, handling costs, and etc.*

A. Cost Performance	Extremely Disagree ↔					Extremely Agree
1. Your firm achieves a relatively low overall costs involving with reverse logistics through efficient reverse logistics operations compared with your competitors	1	2	3	4	5	6
2. Your firm can achieve a relatively low level of inventory investment in products and spare parts through efficient reverse logistics operations compared with your competitors	1	2	3	4	5	6
3. Your firm can reduce overall costs through efficient reverse logistics operations.	1	2	3	4	5	6
B. Responsiveness	Extremely Disagree ↔					Extremely Agree
1. Your reverse logistics process has the ability to respond to needs and wants of key customers	1	2	3	4	5	6
2. Your reverse logistics process can provide emergency services to customers	1	2	3	4	5	6
3. Your reverse logistics process can adjust its operations to meet unforeseen needs that might occur	1	2	3	4	5	6
4. Your reverse logistics process is flexible in response to requests	1	2	3	4	5	6
5. Your reverse logistics process handles the returns well	1	2	3	4	5	6
C. Customer Satisfaction	Extremely Disagree ↔					Extremely Agree
1. Your reverse logistics process match with your customers' expectations very well.	1	2	3	4	5	6
2. Your reverse logistics process helps the firm to Improve customer service.	1	2	3	4	5	6
3. Your customers are delighted with the returns handling of your firm	1	2	3	4	5	6
4. It is a pleasure dealing with your firm with respect to returns handling.	1	2	3	4	5	6

Thank you for completing the survey. The result of this survey will be depicted in a summary report. If you would like a copy of this report, please provide us with the following:

Name	
Address	

For any inquiries please do not hesitate to contact:
e-mail: vouravis_v@yahoo.com or phone: (01) 555-7777

Thank you again for your cooperation

แบบสอบถามเกี่ยวกับการประสานงานในห่วงโซ่อุปทานและความสามารถในการส่งสินค้าคืน

เรียน ท่านผู้บริหาร

แบบสอบถามฉบับนี้ เป็นส่วนหนึ่งของการศึกษาวิจัยโดยนักศึกษาปริญญาเอกในโครงการร่วมผลิตบัณฑิตระดับปริญญาเอก สาขาบริหารธุรกิจของคณะพาณิชย์ศาสตร์และการบัญชี แห่งจุฬาลงกรณ์มหาวิทยาลัย มหาวิทยาลัยธรรมศาสตร์ และ สถาบันบัณฑิตพัฒนบริหารศาสตร์ (The Joint Doctoral Program in Business Administration or JDBA) เนื่องด้วยผู้วิจัย กำลังศึกษาเกี่ยวกับปัจจัยสำคัญที่ทำให้การส่งคืนสินค้ากลับไปยังผู้ผลิต (Reverse Logistics) เป็นไปอย่างมีประสิทธิภาพ ทั้งนี้ **การส่งคืนสินค้า** ในที่นี้ หมายรวมถึง กระบวนการที่เกิดขึ้นทั้งหมด ตั้งแต่การส่งสินค้าคืนของลูกค้าของท่าน เนื่องจากเหตุผลต่างๆ เช่น สินค้าไม่ตรงตามสเปค สินค้าชำรุด หรืออื่นๆ รวมทั้งการที่ท่านต้องส่งสินค้าทั้งหมดหรือบางส่วนกลับไปยัง ซัพพลายเออร์ของท่านเพื่อการเคลมในกรณีต่างๆ จนกระทั่งท่านและลูกค้าของท่านได้รับการแก้ไขปัญหาอย่างเรียบร้อยตามที่ได้มีการตกลงไว้ เช่น การส่งสินค้าใหม่ทดแทน การซ่อมแซมสินค้าแล้วส่งคืน การคืนเงินค่าสินค้า หรืออื่นๆ

งานวิจัยนี้ได้ให้ความสำคัญกับทรัพยากรของบริษัท และ การประสานงานในห่วงโซ่อุปทาน (Supply Chain Integration) ของอุตสาหกรรมยานยนต์ซึ่งเป็นหนึ่งในอุตสาหกรรมหลักของประเทศ ซึ่งผลของการศึกษาในครั้งนี้ จะสามารถนำไปใช้ ประกอบการพัฒนา กลยุทธ์ในการบริหารห่วงโซ่อุปทาน (Supply Chain Management) และการจัดการเกี่ยวกับการส่งสินค้ากลับ เพื่อเพิ่มประสิทธิภาพการดำเนินงานของผู้ประกอบการในอุตสาหกรรมทั้งในด้านต้นทุน และ ความพึงพอใจของลูกค้า อันจะนำไปสู่การเพิ่มศักยภาพการแข่งขันของอุตสาหกรรมไทยในตลาดโลกต่อไป

เนื่องจากท่านเป็นผู้หนึ่งที่มีความรู้และประสบการณ์ ที่จะมีส่วนสำคัญยิ่งในการให้ความรู้และข้อเสนอแนะที่จะเป็นประโยชน์อย่างยิ่งต่องานวิจัยนี้ จึงเรียนมาเพื่อขอความร่วมมือจากท่านในการตอบแบบสอบถามฉบับนี้ให้ครบถ้วนตามข้อเท็จจริงหรือความคิดเห็นของท่านมากที่สุด แบบสอบถามฉบับนี้ประกอบด้วย 5 กลุ่มคำถามหลัก ซึ่งจะใช้เวลาในการตอบคำถามทั้งสิ้นโดยประมาณ 20 นาที ซึ่งข้อมูลของท่านจะถูกปกปิดเป็นความลับ และนำไปใช้ในการวิเคราะห์ทางสถิติโดยภาพรวมเท่านั้น โดยจะไม่มีการเปิดเผยข้อมูลเป็นรายบุคคล

ผู้วิจัยใคร่ขอขอบพระคุณในความอนุเคราะห์ของท่านมา ณ โอกาสนี้ และในกรณีที่ท่านต้องการทราบบทสรุปของงานวิจัยนี้ กรุณากรอกรายละเอียดภายในตารางในหน้าสุดท้ายของแบบสอบถามที่เสร็จสมบูรณ์แล้ว

ขอแสดงความนับถือ
นาย วรวิศว์ วีรคเชนทร์
นักศึกษาระดับปริญญาเอก
มหาวิทยาลัยธรรมศาสตร์

หมายเหตุ: ในกรณีที่ท่านมีข้อสงสัยประการใดเกี่ยวกับการตอบแบบสอบถามในครั้งนี้ ท่านสามารถติดต่อผู้วิจัยได้ที่หมายเลขโทรศัพท์ 0-1555-7777

ส่วน A: ข้อมูลเกี่ยวกับตัวท่านและบริษัท

<u>คำชี้แจง</u>: โปรดทำเครื่องหมาย (X) ลงในช่อง ☐ ที่ตรงกับคำตอบของท่าน หรือเติมข้อความ/ตัวเลขลงในช่องว่าง

1. หน้าที่ความรับผิดชอบของท่านในบริษัท เกี่ยวข้องกับ การบริหาร/การปฏิบัติการ ที่ครอบคลุมกระบวนการทำงานของหลายๆแผนก ตั้งแต่ฝ่ายจัดซื้อ ฝ่ายผลิต การขนส่งโลจิสติกส์ ไปจนถึง ฝ่ายขายและการตลาด หรือไม่

☐ ไม่ใช่ (กรุณาส่งต่อแบบสำรวจนี้ให้กับบุคคลที่มีหน้าที่สอดคล้องตามที่อ้างถึง ขอบคุณครับ)
☐ ใช่

2. ตำแหน่งปัจจุบันของท่านในบริษัท________________________________

3. สินค้าของบริษัทท่านจัดอยู่ในหมวดของชิ้นส่วนยานยนต์ประเภทใดต่อไปนี้

☐ เครื่องยนต์ (Engine) ☐ ระบบขับเคลื่อน (Drivetrains) ☐ ระบบควบคุม (Steering)
☐ ระบบกันสะเทือน (Suspension) ☐ ระบบเบรค (Brakes) ☐ ล้อรถ (Wheels)
☐ ยางรถ (Tires) ☐ งานตัวถัง (Body Works) ☐ ตกแต่งภายในรถ (Interiors)
☐ ระบบไฟฟ้า อิเลคโทรนิค (Electrical Systems & Electronics) ☐ วัตถุดิบ (Materials Components)

☐ อื่นๆ, โปรดระบุ ____________________

4. สัดส่วนการจัดจำหน่ายสินค้าระหว่างตลาดในประเทศและตลาดต่างประเทศในปี 2548 เป็นอย่างไร

ตลาดในประเทศ ____________% ของยอดขายรวม ตลาดต่างประเทศ ____________% ของยอดขายรวม

5. บริษัทท่านส่งชิ้นส่วนให้กับผู้ผลิตรถยนต์ในประเทศทั้งโดยตรงและโดยอ้อมคิดเป็นสัดส่วนเปอร์เซนต์เท่าไร

☐ ในฐานะที่เป็นซัพพลายเออร์โดยตรง (เทียร์ 1) จำนวน _______ %
☐ ในฐานะที่เป็นซัพพลายเออร์โดยอ้อม (เทียร์ 2 หรือ เทียร์ 3) จำนวน _______ %
☐ ในฐานะอื่นๆ (โปรดระบุ) ______________________ จำนวน _______ %

รวมทั้งหมด จำนวน __100___ %

6. ปัจจุบันลูกค้าของท่านมีการคืนสินค้าคิดเป็น_________% เมื่อเทียบกับยอดขาย

โดยมีสาเหตุใดบ้างและคิดเป็น**กี่เปอร์เซ็นต์ของ<u>ปริมาณสินค้าที่ส่งคืนทั้งหมด</u>** (เลือกตอบได้มากกว่า 1 ข้อ)

☐ สินค้ามีปัญหา/ชำรุด/มีตำหนิ _________% ☐ สินค้าที่ส่งมีปริมาณหรือชนิดไม่ตรงกับออเดอร์ _________%

☐ สินค้าไม่ตรงตามสเปค _________% ☐ สินค้าหมดอายุที่สามารถนำกลับมารีไซเคิลใหม่ _________%
☐ สาเหตุอื่นๆ (โปรดระบุ) ____________________________ คิดเป็น_________%

7. สัดส่วนการถือหุ้นในบริษัทท่าน

☐ สัดส่วนการถือหุ้นของคนไทย จำนวน _______ %
☐ สัดส่วนการถือหุ้นของคนต่างชาติ จำนวน _______ %

รวมทั้งหมด จำนวน __100___ %

8. ในกรณีที่บริษัทของท่านมีผู้ถือหุ้นเป็นคนต่างชาติ ผู้ถือหุ้นต่างชาติรายใหญ่ที่สุดมาจากที่ใด

☐ ญี่ปุ่น ☐ ยุโรป ☐ อเมริกา ☐ อื่นๆ (โปรดระบุ) ______________________

9. บริษัทท่านอยู่ในธุรกิจผลิตชิ้นส่วนยานยนต์จนถึงปัจจุบันเป็นระยะเวลานาน __________________________ ปี

10. บริษัทท่านมีพนักงานประจำที่รับเงินเดือน / ค่าแรงรายวัน รวมทั้งหมด จำนวน _______________________ คน

11. ในปีพ.ศ. 2548 บริษัทท่านมียอดขายคิดเป็นจำนวนทั้งสิ้นเท่าไร

☐ น้อยกว่า 50 ล้านบาท ☐ 50-100 ล้านบาท ☐ 101-200 ล้านบาท ☐ 201-500 ล้านบาท
☐ 501-1,000 ล้านบาท ☐ 1,001-2,000 ล้านบาท ☐ 2,001-3,000 ล้านบาท ☐ มากกว่า 3,000 ล้านบาท

12. ลูกค้า (ผู้ประกอบรถยนต์) ที่สำคัญที่สุด ที่บริษัทท่านขายสินค้าเป็นจำนวนมากที่สุดในแต่ละปีคือใคร

☐ Toyota ☐ Mitsubishi ☐ Isuzu ☐ Daihatsu & Hyundai
☐ Honda ☐ Ford & Mazda ☐ Nissan ☐ Volvo, Chrysler & Renault
☐ BMW & Rover ☐ Mercedes Benz ☐ Peugeot, Audi, Volkswagen & Kia
☐ GM, Isuzu, Chevrolet, Holden, Opel, Subaru, Vauxhall & Alfa Romeo
☐ ผู้ค้าอะไหล่ปลีก/ส่ง (โปรดระบุ) ________________ ☐ อื่นๆ (โปรดระบุ) ________________

ส่วน B: ระดับความเห็นของท่านที่มีต่อตัวแปรด้านล่าง

<u>คำชี้แจง</u>: โปรดทำเครื่องหมาย (X) ลงบนตัวเลขในแต่ละข้อความต่อไปนี้ ที่แสดงถึงความเห็นที่ดีที่สุดของท่านในด้านต่อไปนี้ <u>ทั้งนี้</u>: คำพูดใดๆที่กล่าวถึง "**ระบบเทคโนโลยีสารสนเทศ**" ในที่นี้ จะหมายถึง *ระบบเทคโนโลยีสารสนเทศต่างๆที่บริษัทของท่านใช้ในการสนับสนุนการทำงานที่เกี่ยวข้องกับระบบโลจิสติกส์ ซึ่งอาจรวมถึง การขายและการตลาด การเงิน การจัดซื้อ การวางแผนผลิต การจัดการสินค้าคงคลัง การบริการลูกค้า และการส่งคืนสินค้า*

A. Supply Chain Orientation	ไม่เห็นด้วยอย่างยิ่ง ←				→ เห็นด้วยอย่างยิ่ง	
1. สัญญาที่บริษัทของท่านให้ไว้กับบริษัทคู่ค้าของท่านมีความน่าเชื่อถือ	1	2	3	4	5	6
2. บริษัทของท่านได้รับความเชื่อถือจากบริษัทคู่ค้าในด้านความรู้ที่เกี่ยวกับสินค้าและบริการ	1	2	3	4	5	6
3. บริษัทของท่านไม่เคยเอาเปรียบบริษัทคู่ค้าโดยการเรียกร้องในสิ่งที่ไม่ถูกต้อง	1	2	3	4	5	6
4. บริษัทของท่านมีการพูดคุยกับบริษัทคู่ค้าอย่างเปิดเผยและตรงไปตรงมา	1	2	3	4	5	6
5. บริษัทคู่ค้าคำนึงถึงผลกระทบที่มีต่อบริษัทของท่านเสมอเวลาที่ตัดสินใจในเรื่องสำคัญ	1	2	3	4	5	6
6. เมื่อบริษัทของท่านบอกกล่าวปัญหาให้บริษัทคู่ค้าฟัง ท่านรู้ว่าบริษัทคู่ค้าจะตอบสนองด้วยความเข้าใจ	1	2	3	4	5	6
7. ในอนาคต ท่านสามารถวางใจบริษัทคู่ค้าในเรื่องของการตัดสินใจและการกระทำที่จะมีผลกระทบต่อบริษัทของท่าน	1	2	3	4	5	6
8. เมื่อมีเหตุการณ์สำคัญเกิดขึ้น ท่านสามารถขอความช่วยเหลือจากบริษัทคู่ค้าได้	1	2	3	4	5	6
9. สำหรับบริษัทคู่ค้าที่ท่านไว้ใจ ท่านจะคอยแก้ต่างให้ หากมีคนภายนอกมาพูดตำหนิ	1	2	3	4	5	6
10. ท่านอดทนแม้บริษัทคู่ค้าจะก่อปัญหาให้ท่านในบางครั้ง หากปัญหานั้นไม่ได้เกิดขึ้นซ้ำซาก	1	2	3	4	5	6
11. บริษัทของท่านยินดีที่จะร่วมมือกับบริษัทคู่ค้าในกรณีที่มีการเปลี่ยนแปลงเกิดขึ้น	1	2	3	4	5	6
12. ท่านเชื่อว่าบริษัทของท่านและบริษัทคู่ค้าสามารถทำงานร่วมกันให้สำเร็จได้	1	2	3	4	5	6
13. ท่านมองว่าห่วงโซ่อุปทาน (Supply Chain) เป็นสิ่งที่เสริมมูลค่าให้กับธุรกิจของท่าน	1	2	3	4	5	6
14. เป้าหมายและวัตถุประสงค์ของบริษัทของท่านกับบริษัทคู่ค้าเป็นไปในทางเดียวกัน	1	2	3	4	5	6
15. บริษัทของท่านและบริษัทคู่ค้ามีแนวคิดในการทำงานที่สอดคล้องกัน	1	2	3	4	5	6
16. ผู้บริหารระดับสูงมักจะบอกพนักงานเสมอว่าความอยู่รอดของบริษัทขึ้นอยู่กับความสามารถในการปรับตัวเข้ากับการจัดการห่วงโซ่อุปทาน (Supply Chain Management)	1	2	3	4	5	6
17. ผู้บริหารระดับสูงมักจะบอกพนักงานเสมอว่าการสร้าง การรักษา และการพัฒนาความสัมพันธ์ระยะยาวกับบริษัทคู่ค้าเป็นสิ่งสำคัญต่อความสำเร็จของบริษัท	1	2	3	4	5	6
18. ผู้บริหารระดับสูงมักจะบอกพนักงานเสมอว่าการแลกเปลี่ยนข้อมูลเชิงกลยุทธ์กับบริษัทคู่ค้าเป็นสิ่งสำคัญต่อความสำเร็จของบริษัท	1	2	3	4	5	6
19. ผู้บริหารระดับสูงมักจะบอกพนักงานเสมอว่าการร่วมรับทั้งความเสี่ยงและผลประโยชน์ร่วมกันกับบริษัทคู่ค้าเป็นสิ่งสำคัญต่อความสำเร็จของบริษัท	1	2	3	4	5	6
20. ผู้บริหารระดับสูงเปิดโอกาสให้พนักงานได้ศึกษาเกี่ยวกับการจัดการห่วงโซ่อุปทาน	1	2	3	4	5	6
B. Information System Support	ไม่เห็นด้วยอย่างยิ่ง ←				→ เห็นด้วยอย่างยิ่ง	
1. ระบบเทคโนโลยีสารสนเทศของบริษัทของท่านสามารถให้ข้อมูลที่เที่ยงตรง	1	2	3	4	5	6
2. ระบบเทคโนโลยีสารสนเทศของบริษัทของท่านสามารถให้ข้อมูลได้ในเวลาที่ท่านต้องการ	1	2	3	4	5	6
3. ความสามารถของระบบเทคโนโลยีสารสนเทศของบริษัทของท่านถือว่าดีเยี่ยมเมื่อเทียบกับมาตรฐานทั่วไปของบริษัทในอุตสาหกรรมเดียวกัน	1	2	3	4	5	6
4. ท่านสามารถดาวน์โหลดข้อมูลจากระบบเทคโนโลยีสารสนเทศของบริษัทเป็นประจำทุกวัน	1	2	3	4	5	6

B. Information System Support (ต่อ)	ไม่เห็นด้วยอย่างยิ่ง ⟷				เห็นด้วยอย่างยิ่ง
5. ระบบเทคโนโลยีสารสนเทศของบริษัทของท่านสามารถให้ข้อมูลที่ถูกจัดรูปแบบมาเพื่อความสะดวกในการใช้งาน	1	2	3	4	5	6
6. ระบบเทคโนโลยีสารสนเทศของบริษัทของท่านสามารถให้ข้อมูลได้ในแบบเรียลไทม์	1	2	3	4	5	6
7. ระบบเทคโนโลยีสารสนเทศของบริษัทของท่านสามารถให้การเชื่อมต่อภายในบริษัทได้	1	2	3	4	5	6
8. ระบบเทคโนโลยีสารสนเทศของบริษัทของท่านสามารถให้การเชื่อมต่อภายนอกบริษัทได้	1	2	3	4	5	6
9. บริษัทของท่านใช้ซอฟแวร์เทคโนโลยีสารสนเทศร่วมกันกับบริษัทคู่ค้าของท่านเพื่อการสื่อสารระหว่างกัน	1	2	3	4	5	6
10. ระบบเทคโนโลยีสารสนเทศของบริษัทของท่านสามารถดึงข้อมูลจากบริษัทคู่ค้าซึ่งเป็นการอำนวยความสะดวกในการวางแผนงานของบริษัท โดยไม่ต้องพึ่งข้อมูลจากการคาดการณ์มากนัก	1	2	3	4	5	6
11. บริษัทของท่านใช้ซอฟแวร์ และ เทคโนโลยี เหล่านี้ในการจักการกับการส่งคืนสินค้า						
11.1 Internet/Website	1	2	3	4	5	6
11.2 E-mail	1	2	3	4	5	6
11.3 Fax	1	2	3	4	5	6
11.4 Electronic Data Interchange (EDI)	1	2	3	4	5	6
C. Resource Commitment	ไม่เห็นด้วยอย่างยิ่ง ⟷					เห็นด้วยอย่างยิ่ง
1. บริษัทของท่านตั้งใจจะลงทุนด้านเทคโนโลยีกับระบบโลจิสติกส์	1	2	3	4	5	6
2. บริษัทของท่านตั้งใจจะลงทุนด้านการบริหารกับระบบโลจิสติกส์	1	2	3	4	5	6
3. บริษัทของท่านตั้งใจจะลงทุนด้านการเงินกับระบบโลจิสติกส์	1	2	3	4	5	6

ส่วน C: ระดับความร่วมมือภายนอกบริษัท

คำชี้แจง: โปรดทำเครื่องหมาย (X) ลงบนตัวเลขในแต่ละข้อความต่อไปนี้ ที่แสดงถึงความเห็นที่ดีที่สุดของท่าน

ทั้งนี้: คำพูดใดๆที่กล่าวถึง "**ซัพพลายเออร์**" ในที่นี้ จะหมายถึง *"ซัพพลายเออร์รายที่สำคัญที่สุด ที่บริษัทท่านซื้อสินค้าเป็นจำนวนมากที่สุดในแต่ละปี"* "**ลูกค้า**" ในที่นี้ จะหมายถึง *"ลูกค้ารายที่สำคัญที่สุด ที่บริษัทท่านขายสินค้าเป็นจำนวนมากที่สุดในแต่ละปี"*

A. Supplier Integration	ไม่เห็นด้วยอย่างยิ่ง ⟷					เห็นด้วยอย่างยิ่ง
1. บริษัทของท่านมีการแลกเปลี่ยนข้อมูลการปฏิบัติงานกับซัพพลายเออร์บางราย	1	2	3	4	5	6
2. บริษัทของท่านมีการแลกแปลี่ยนขั้นตอนการทำงานต่างๆกับซัพพลายเออร์	1	2	3	4	5	6
3. บริษัทของท่านมีการวางแผนการทำงานร่วมกันกับซัพพลายเออร์	1	2	3	4	5	6
4. บริษัทของท่านมีการแลกเปลี่ยนข้อมูลต้นทุนสินค้ากับซัพพลายเออร์	1	2	3	4	5	6
5. บริษัทของท่านเพิ่มความยืดหยุ่นในการทำงานที่ต้องอาศัยความร่วมมือในการทำงานกับซัพพลายเออร์ในห่วงโซ่อุปทาน	1	2	3	4	5	6
6. บริษัทของท่านประสบความสำเร็จในการประสานการทำงานกับซัพพลายเออร์ โดยสร้างกิจกรรมการทำงานให้เป็นกิจกรรมที่ต้องทำร่วมกัน	1	2	3	4	5	6
7. บริษัทของท่านมีส่วนริเริ่มในการปรับกิจกรรมและกระบวนการทำงานของห่วงโซ่อุปทานให้เป็นมาตรฐาน	1	2	3	4	5	6
8. บริษัทของท่านติดต่อโดยตรงกับซัพพลายเออร์เพื่อที่การตอบสนองการทำงานได้อย่างรวดเร็ว	1	2	3	4	5	6
9. บริษัทของท่านสร้างแบบประเมินประสิทธิภาพการทำงานที่ครอบคลุมทั้งห่วงโซ่อุปทาน	1	2	3	4	5	6

A. Supplier Integration (ต่อ)	ไม่เห็นด้วยอย่างยิ่ง ←					→ เห็นด้วยอย่างยิ่ง
10. บริษัทของท่านมีข้อตกลงกับซัพพลายเออร์ ด้านห่วงโซ่อุปทานภายใต้หลักการของการรับทั้งความเสี่ยงและผลประโยชน์ร่วมกัน	1	2	3	4	5	6
11. บริษัทของท่านมีการกำหนดวิธีการและกระบวนการปฏิบัติงานที่ดีที่สุดไว้ซึ่งจะมีการแลกเปลี่ยนผลการประเมินการทำงานกับซัพพลายเออร์ด้วย	1	2	3	4	5	6
B. Customer Integration	ไม่เห็นด้วยอย่างยิ่ง ←					→ เห็นด้วยอย่างยิ่ง
1. บริษัทของท่านมีการแลกเปลี่ยนข้อมูลการปฏิบัติงานกับลูกค้าบางราย	1	2	3	4	5	6
2. บริษัทของท่านเพิ่มความยืดหยุ่นในการทำงาน โดยอาศัยความร่วมมือกับลูกค้าในห่วงโซ่อุปทาน	1	2	3	4	5	6
3. บริษัทของท่านประสบความสำเร็จในการประสานการทำงานร่วมกับลูกค้า โดยสร้างกิจกรรมการทำงานให้เป็นกิจกรรมที่ต้องทำร่วมกัน	1	2	3	4	5	6
4. บริษัทของท่านสามารถจัดการกับความต้องการที่หลากหลายของลูกค้าโดยใช้วิธีที่เตรียมการไว้ล่วงหน้า	1	2	3	4	5	6
5. บริษัทของท่านมีแผนการทางด้านโลจิสติกส์ที่แตกต่างกันออกไปสำหรับลูกค้าแต่ละราย	1	2	3	4	5	6
6. บริษัทของท่านมีการสร้างการทำงานเพื่อประสานความต้องการของลูกค้าไปยังแผนกต่าง ๆของบริษัท	1	2	3	4	5	6
7. บริษัทของท่านติดต่อสื่อสารโดยตรงกับลูกค้าเพื่อเพิ่มความเร็วในการตอบสนองการทำงาน	1	2	3	4	5	6
8. บริษัทของท่านมีข้อตกลงด้านห่วงโซ่อุปทานร่วมกันกับลูกค้า ภายใต้หลักการของการแบกรับความเสี่ยงและผลประโยชน์ร่วมกัน	1	2	3	4	5	6

ส่วน D: ระดับความร่วมมือภายในบริษัท

คำชี้แจง: โปรดทำเครื่องหมาย (X) ลงบนตัวเลขในแต่ละข้อความต่อไปนี้ ที่แสดงถึงความเห็นที่ดีที่สุดของท่าน

A. Internal Integration	ไม่เห็นด้วยอย่างยิ่ง ←					→ เห็นด้วยอย่างยิ่ง
1. บริษัทของท่านใช้ความร่วมมือของบุคลากรที่ทำงานในด้านต่าง ๆในการวางแผนธุรกิจ	1	2	3	4	5	6
2. บริษัทของท่านมีการเปลี่ยนแปลงกระบวนการทำงานอย่างมากในสามปีที่ผ่านมา	1	2	3	4	5	6
3. บริษัทของท่านได้เปลี่ยนจากการบริหารแต่ละฟังก์ชั่นการทำงาน มาเป็นการบริหารกระบวนการทำงานโดยรวม	1	2	3	4	5	6
4. บริษัทของท่านมีการแลกเปลี่ยนข้อมูลการปฏิบัติงานกันระหว่างแผนก	1	2	3	4	5	6
5. บริษัทของท่านมีการใช้ฐานข้อมูลร่วมกันทำให้สามารถแลกเปลี่ยนข้อมูลระหว่างแผนกได้	1	2	3	4	5	6
6. บริษัทของท่านมีความสามารถเพียงพอในการแลกเปลี่ยนข้อมูลมาตรฐาน และข้อมูลเฉพาะ ทางภายในบริษัท	1	2	3	4	5	6
7. บริษัทของท่านมีการแจ้งพนักงานเกี่ยวกับการผลงานของการทำงานร่วมกันในด้านโลจิสติกส์	1	2	3	4	5	6
8. การจ่ายค่าตอบแทน และให้รางวัลจากการทำงาน ของบริษัทท่านจูงใจให้มีการทำงานร่วมกัน	1	2	3	4	5	6

ส่วน E: ผลการดำเนินงานในการส่งคืนสินค้า

คำชี้แจง: โปรดทำเครื่องหมาย (X) ลงบนตัวเลขในแต่ละข้อความต่อไปนี้ ที่แสดงถึงความเห็นที่ดีที่สุดของท่าน.
ทั้งนี้: คำพูดใดๆที่กล่าวถึง "**การส่งคืนสินค้า**" ในที่นี้ จะหมายถึง *กระบวนการที่เกิดขึ้นทั้งหมด ตั้งแต่การส่งสินค้าคืนของลูกค้าของท่าน เนื่องจากเหตุผลต่างๆ เช่น สินค้าไม่ตรงตามสเปค สินค้าชำรุด หรือ อื่นๆ รวมทั้งการที่ท่านต้องส่งสินค้าทั้งหมดหรือบางส่วนกลับไปยังซัพพลายเออร์ของท่านเพื่อการเคลมในกรณีต่างๆ จนกระทั่งท่านและลูกค้าของท่านได้รับการแก้ไขปัญหาอย่างเรียบร้อยตามที่ได้มีการตกลงไว้ เช่น การส่งสินค้าใหม่ทดแทน การซ่อมแซมสินค้าแล้วส่งคืน การคืนเงินค่าสินค้า หรืออื่นๆ*
"**ค่าใช้จ่ายในการส่งคืนสินค้า**" ในที่นี้ จะหมายถึง *ค่าใช้จ่ายที่เกี่ยวข้องกับการส่งคืนสินค้าต่างๆ รวมไปถึง ค่าขนส่ง ค่าเก็บรักษาสินค้าคงคลังที่เพิ่มขึ้นจากการคืนสินค้า ค่าใช้จ่ายในการเก็บคืน และตรวจสอบสินค้า รวมไปถึงค่าใช้จ่ายสำหรับการจัดการอื่นๆที่เกี่ยวข้อง*

A. Cost Performance	ไม่เห็นด้วยอย่างยิ่ง ←→					เห็นด้วยอย่างยิ่ง
1. บริษัทของท่านมีค่าใช้จ่ายในการส่งคืนสินค้าน้อยกว่าบริษัทคู่แข่งของท่าน เนื่องมาจากการส่งคืนสินค้าที่มีประสิทธิภาพ	1	2	3	4	5	6
2. บริษัทของท่านมีการลงทุนในสินค้าคงคลัง สำหรับสินค้าและอะไหล่ น้อยกว่าบริษัทคู่แข่งของท่านเนื่องมาจากการทำงานด้านการส่งคืนสินค้าที่มีประสิทธิภาพ	1	2	3	4	5	6
3. บริษัทของท่านมีค่าใช้จ่ายโดยรวมลดลง เนื่องมาจากการส่งคืนสินค้าที่มีประสิทธิภาพ	1	2	3	4	5	6
B. Responsiveness	ไม่เห็นด้วยอย่างยิ่ง ←→					เห็นด้วยอย่างยิ่ง
1. กระบวนการส่งคืนสินค้าของบริษัทท่านสามารถตอบสนองความต้องการของลูกค้ารายหลักๆได้	1	2	3	4	5	6
2. กระบวนการส่งคืนสินค้าของบริษัทท่านสามารถให้บริการในกรณีเร่งด่วนแก่ลูกค้าได้	1	2	3	4	5	6
3. กระบวนการส่งคืนสินค้าของบริษัทท่านสามารถปรับเปลี่ยนการทำงานเพื่อตอบสนองความต้องการที่ไม่ทราบล่วงหน้าของลูกค้า	1	2	3	4	5	6
4. กระบวนการส่งคืนสินค้าของบริษัทท่านมีความยืดหยุ่นในการตอบสนองความต้องการของลูกค้า	1	2	3	4	5	6
5. กระบวนการส่งคืนสินค้าของบริษัทท่านสามารถจัดการกับสินค้าที่ถูกส่งคืนได้เป็นอย่างดี	1	2	3	4	5	6
C. Customer Satisfaction	ไม่เห็นด้วยอย่างยิ่ง ←→					เห็นด้วยอย่างยิ่ง
1. กระบวนการส่งคืนสินค้าของบริษัทท่านเป็นไปตามความคาดหวังของลูกค้า	1	2	3	4	5	6
2. กระบวนการส่งคืนสินค้าของบริษัทท่านช่วยให้บริษัทสามารถบริการลูกค้าได้ดีขึ้น	1	2	3	4	5	6
3. ลูกค้าของท่านมีความพึงพอใจกับการระบบการส่งคืนสินค้าของบริษัทท่าน	1	2	3	4	5	6
4. ลูกค้าของท่านไม่รู้สึกลำบากใจเมื่อต้องส่งคืนสินค้าให้บริษัทท่าน	1	2	3	4	5	6

ขอขอบพระคุณที่ท่านสละเวลาในการกรอกแบบสอบถาม ผลที่ได้จากการศึกษานี้จะทำเป็นรายงานสรุป หากท่านประสงค์จะได้รายงานนี้ กรุณากรอกรายละเอียดเพิ่มเติมภายในตารางต่อไปนี้ :

ชื่อ	
ที่อยู่	

หากมีข้อสงสัยประการใด กรุณาติดต่อได้ที่
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Appendix B:

Measurement Items and Pertaining Variable Names

Supply Chain Orientation

Dimension	Measurement Items	Variables
Credibility	Promises made to your supply chain members by your firm are reliable.	CRED1
	Your firm is trusted by your supply chain members regarding to the knowledge related to your products and/or services.	CRED2
	Your firm does not make false claims to your supply chain members.	CRED3
	Your firm is open in dealing with your supply chain members.	CRED4
Benevolence	When making important decisions, your supply chain members are concerned about your welfare.	BENE1
	When you share your problems with your supply chain members, you know they will respond with understanding.	BENE2
	In the future you can count on your supply chain members to consider how their decision and actions will affect you.	BENE3
	When it comes to things that are important to you, you can depend on your supply chain member's support.	BENE4
Commitment	You defend your supply chain members when outsiders criticize them, if you trust them.	COMM1
	You are patient with your supply chain members when they make mistakes that cause you trouble but are not repeated.	COMM2
Cooperative Norm	Your firm is willing to make cooperative changes with your supply chain members.	NORM1
	You believe your supply chain members must work together to be successful.	NORM2
	You view our supply chain as a value added piece of your business.	NORM3
Compatibility of Culture	Your firm's goal and objectives are consistent with those of your supply chain members.	COMP1
	Your firm and your supply chain members have similar operating philosophies.	COMP2
Top Management Support	Top managers repeatedly tell employees that this firm's survival depends on its adapting to supply chain management.	TOPM1
	Top managers repeatedly tell employees that building, maintaining, and enhancing long-term relationship with your supply chain members are critical to this firm's success.	TOPM2
	Top managers repeatedly tell employees that sharing valuable strategic/tactical information with your supply chain members is critical to this firm's success.	TOPM3
	Top managers repeatedly tell employees that sharing risk and rewards is critical to this firm's success.	TOPM4
	Top management offers various education opportunities about supply chain management.	TOPM5

Information System Support

Dimension	Measurement Items	Variables
IS Support Capability	Your firm's information system can provide accurate information	ISCAP1
	Your firm's information system can provide information when ever you need	ISCAP2
	Your firm's information system capability is excellent relative to the industry standard	ISCAP3
IS Support Compatibility	Your firm's information system allows a daily download of information	ISCOMP1
	Your firm's information system can provide information that is formatted to facilitate usage	ISCOMP2
	Your firm's information system can provide real-time information	ISCOMP3
	Your firm's information system can provide internal connectivity	ISCOMP4
	Your firm's information system can provide external connectivity	ISCOMP5
	Your firm shares common information technology (software) to facilitate communication with the partner	ISCOMP6
	Your firm's information system can obtain information from your suppliers and customers to facilitate operational plans and reduce reliance on forecasting.	ISCOMP7
IS Support Technology	Your firm utilizes these hardware and software technologies to assist with returns handling	
	Internet/Website	ISTECH1
	E-mail	ISTECH2
	Fax	ISTECH3
	Electronic Data Interchange (EDI)	ISTECH4

Resource Commitment

Dimension	Measurement Items	Variables
Resource Commitment	Your firm commits considerable level of *technological resources* to logistics program	TECHCOM
	Your firm commits considerable level of *managerial resources* to logistics program	MANCOM
	Your firm commits considerable level of *financial resources* to logistics program	FINCOM

External Integration

Dimension	Measurement Items	Variables
Supplier Integration	Your firm effectively shares operational information externally with selected suppliers	SI1
	Your firm effectively shares cross-functional processes with suppliers	SI2
	Your firm engages in collaborative planning with suppliers	SI3
	Your firm shares cost information with suppliers	SI4
	Your firm has increased operational flexibility through supply chain collaboration with suppliers	SI5
	Your firm successfully integrate operations with suppliers by developing interlocking programs and activities	SI6
	Your firm is actively involved in initiatives to standardized supply chain practices and operations	SI7
	Your firm establishes direct communication with suppliers to improve responsiveness	SI8
	Your firm has developed performance measures that extend across supply chain relationships	SI9
	Your firm has supply chain arrangements with suppliers that operate under principles of shared rewards and risks	SI10
	Your firm benchmarks best practices/processes and shares results with supplier	SI11
Customer Integration	Your firm effectively shares operational information externally with selected customers	CI1
	Your firm has increased operational flexibility through supply chain collaboration with customers	CI2
	Your firm successfully integrate operations with customers by developing interlocking programs and activities	CI3
	Your firm is able to accommodate a wide range of unique customer requests by implementing preplanned solutions	CI4
	Your firm has different, unique logistics service strategies for different customers	CI5
	Your firm has established a program to integrate and facilitate individual customer requirements across your firm	CI6
	Your firm establishes direct communication with customers to improve responsiveness	CI7
	Your firm has supply chain arrangements with customers that operate under principles of shared rewards and risks	CI8

Internal Integration

Dimension	Measurement Items	Variables
Internal Integration	Your firm use cross-functional collaboration in strategic planning	INTI1
	Your firm has extensively redesigned work routines and processes over the past three years	INTI2
	The orientation of your firm has shifted from managing function to managing processes	INTI3
	Your firm effectively shares operational information between departments	INTI4
	Your firm utilizes integrated database and access method to facilitate information sharing	INTI5
	Your firm has adequate ability to share both standardized and customized information internally	INTI6
	Your firm provides objective feedback to employees regarding integrated logistics performance	INTI7
	Your firm’s compensation, incentive, and reward systems encourage integration	INTI8

Reverse Logistics Performance

Dimension	Measurement Items	Variables
Cost Performance	Your firm achieves a relatively low overall costs involving with reverse logistics through efficient reverse logistics operations compared with your competitors	COST1
	Your firm can achieve a relatively low level of inventory investment in products and spare parts through efficient reverse logistics operations compared with your competitors	COST2
	Your firm can reduce overall costs through efficient reverse logistics operations.	COST3
Responsiveness	Your reverse logistics process has the ability to respond to needs and wants of key customers	RESP1
	Your reverse logistics process can provide emergency services to customers	RESP2
	Your reverse logistics process can adjust its operations to meet unforeseen needs that might occur	RESP3
	Your reverse logistics process is flexible in response to requests	RESP4
	Your reverse logistics process handles the returns well	RESP5
Customer Satisfaction	Your reverse logistics process match with your customers’ expectations very well.	SATISF1
	Your reverse logistics process helps the firm to Improve customer service.	SATISF2
	Your customers are delighted with the returns handling of your firm	SATISF3
	It is a pleasure dealing with your firm with respect to returns handling.	SATISF4

Appendix C:

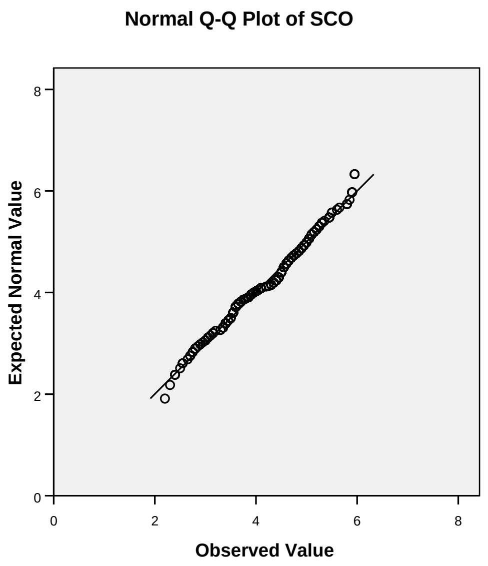
Tests of Normality

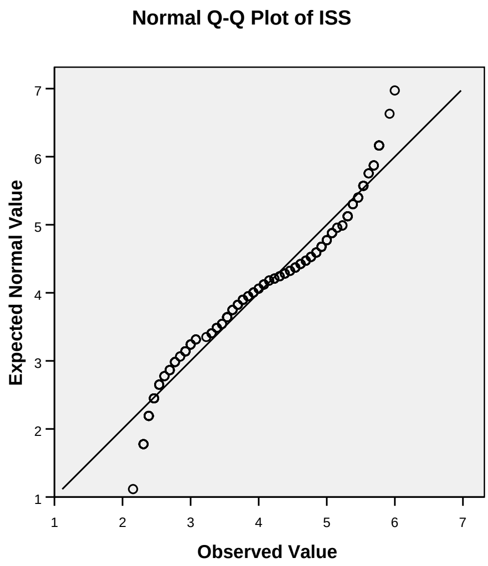
Kolmogorov-Smirnov Statistical Tests of Univariate Normality

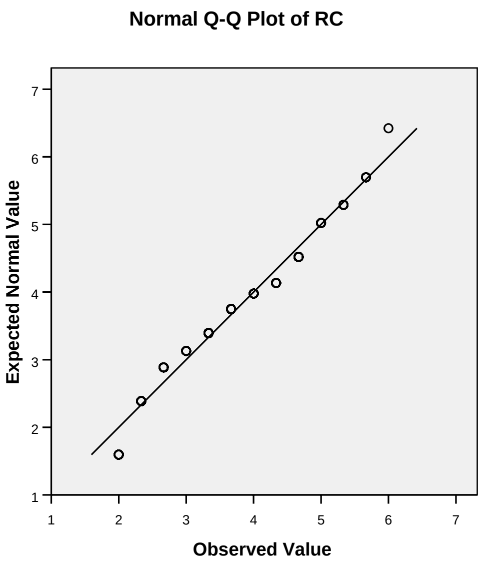
	Kolmogorov-Smirnov(a)			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
SCO	.093	234	.000	.985	234	.017
ISS	.089	234	.000	.952	234	.000
RC	.125	234	.000	.951	234	.000
EI	.062	234	.028	.976	234	.001
SI	.076	234	.002	.976	234	.001
CI	.067	234	.012	.976	234	.000
INTI	.106	234	.000	.973	234	.000
RLPERF	.136	234	.000	.963	234	.000

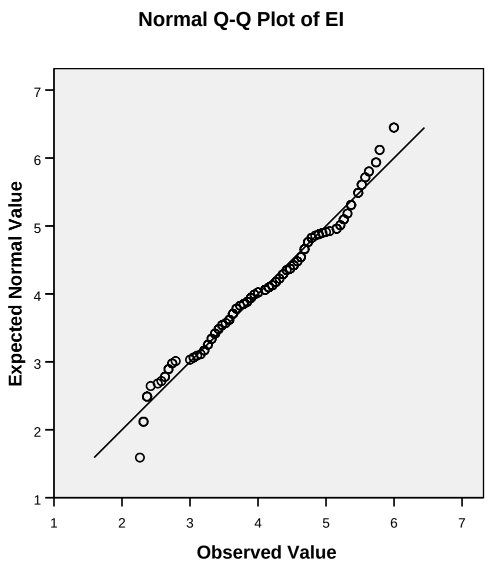
a Lilliefors Significance Correction

Q-Q Plots

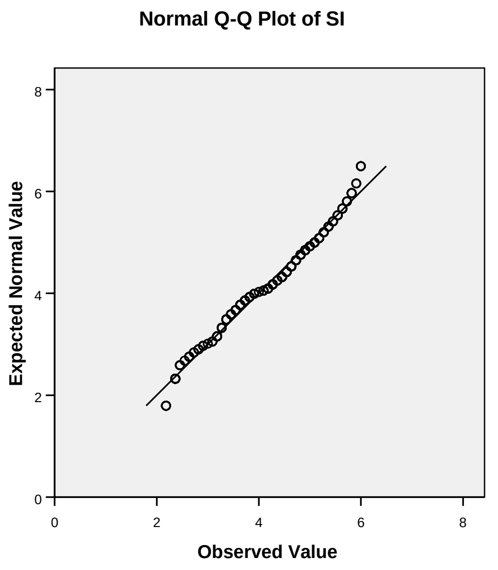

Normal Q-Q Plot of SCO
Expected Normal Value
Observed Value

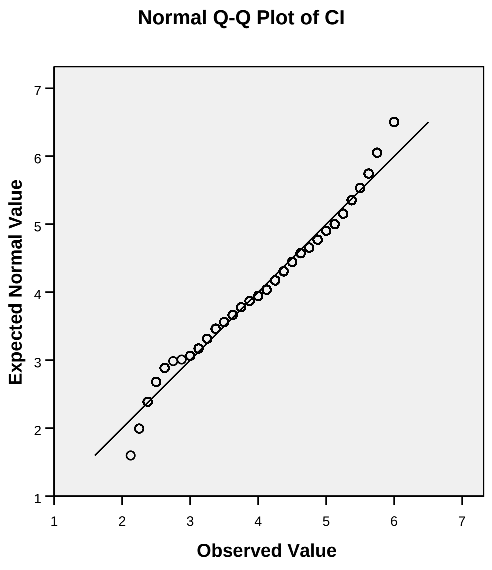

Normal Q-Q Plot of ISS
Expected Normal Value
Observed Value

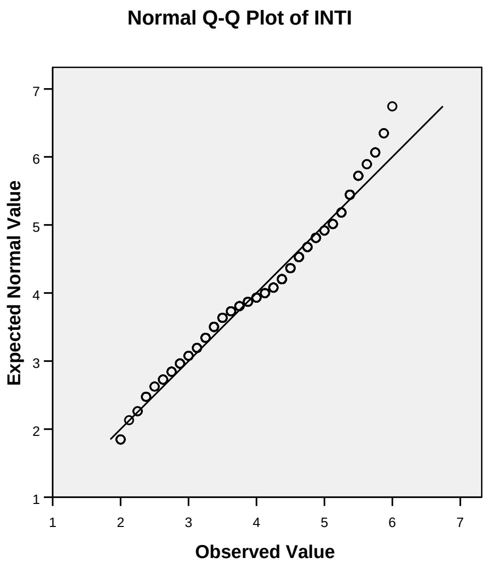

Normal Q-Q Plot of RC
Expected Normal Value
Observed Value

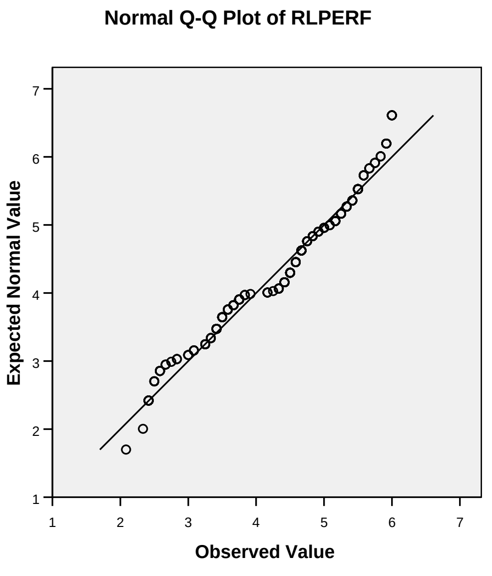

Normal Q-Q Plot of EI
Expected Normal Value
Observed Value

Q-Q Plots


Normal Q-Q Plot of SI
Expected Normal Value
Observed Value
0
2
4
6
8


Normal Q-Q Plot of CI
Expected Normal Value
Observed Value
1
2
3
4
5
6
7


Normal Q-Q Plot of INTI
Expected Normal Value
Observed Value
1
2
3
4
5
6
7


Normal Q-Q Plot of RLPERF
Expected Normal Value
Observed Value
1
2
3
4
5
6
7

Tests of Multivariate Normality

Information System Support

Assessment of normality (Group number 1)

Variable	min	max	skew	c.r.	kurtosis	c.r.
ISCAP1	2.000	6.000	.191	1.193	-.560	-1.748
ISCAP2	2.000	6.000	-.124	-.776	-.639	-1.994
ISCAP3	2.000	6.000	-.403	-2.517	-.618	-1.929
ISCOMP1	2.000	6.000	-.321	-2.007	-.496	-1.549
ISCOMP2	2.000	6.000	-.118	-.734	-.790	-2.468
ISCOMP3	2.000	6.000	-.115	-.720	-.671	-2.095
ISCOMP4	2.000	6.000	-.100	-.623	-.614	-1.916
ISCOMP5	2.000	6.000	-.202	-1.260	-.784	-2.448
ISCOMP6	2.000	6.000	-.231	-1.443	-.487	-1.520
ISCOMP7	2.000	6.000	-.130	-.815	-.571	-1.783
ISTECH1	2.000	6.000	-.183	-1.146	-.485	-1.513
ISTECH2	2.000	6.000	-.143	-.892	-.798	-2.490
ISTECH3	2.000	6.000	-.110	-.687	-.774	-2.418
Multivariate					-.728	-.436

External Integration

Assessment of normality (Group number 1)

Variable	min	max	skew	c.r.	kurtosis	c.r.
SI1	2.000	6.000	-.190	-1.188	-.592	-1.849
SI2	2.000	6.000	-.113	-.703	-.779	-2.433
SI3	2.000	6.000	.191	1.193	-.560	-1.748
SI4	2.000	6.000	-.019	-.121	-.706	-2.206
SI5	2.000	6.000	-.206	-1.288	-.586	-1.830
SI6	2.000	6.000	-.115	-.720	-.671	-2.095
SI7	2.000	6.000	-.143	-.892	-.798	-2.490
SI8	2.000	6.000	-.124	-.776	-.639	-1.994
SI9	2.000	6.000	-.133	-.831	-.657	-2.052
SI10	2.000	6.000	-.171	-1.066	-.711	-2.221
SI11	2.000	6.000	-.156	-.976	-.739	-2.308
CI1	2.000	6.000	-.118	-.734	-.790	-2.468
CI2	2.000	6.000	-.003	-.016	-.563	-1.759
CI3	2.000	6.000	-.130	-.815	-.571	-1.783
CI4	2.000	6.000	-.327	-2.040	-.360	-1.124
CI5	2.000	6.000	-.250	-1.562	-.411	-1.283
CI6	2.000	6.000	-.180	-1.123	-.456	-1.424
CI7	2.000	6.000	-.264	-1.646	-.460	-1.436
CI8	2.000	6.000	-.292	-1.822	-.497	-1.550
Multivariate					.677	.183

Tests of Multivariate Normality

Internal Integration

Assessment of normality (Group number 1)

Variable	min	max	skew	c.r.	kurtosis	c.r.
INTI1	2.000	6.000	-.183	-1.146	-.485	-1.513
INTI2	2.000	6.000	-.202	-1.260	-.784	-2.448
INTI3	2.000	6.000	-.100	-.623	-.614	-1.916
INTI4	2.000	6.000	-.397	-2.478	-.449	-1.402
INTI5	2.000	6.000	-.223	-1.390	-.577	-1.801
INTI6	2.000	6.000	-.180	-1.123	-.456	-1.424
INTI7	2.000	6.000	-.231	-1.443	-.487	-1.520
INTI8	2.000	6.000	-.077	-.479	-.379	-1.185
Multivariate					-.509	-.112

Reverse Logistics Performance

Assessment of normality (Group number 1)

Variable	min	max	skew	c.r.	kurtosis	c.r.
COST1	1.000	6.000	-.242	-1.511	-.592	-1.849
COST2	2.000	6.000	-.133	-.831	-.657	-2.052
COST3	1.000	6.000	-.386	-2.411	-.608	-1.900
RESP1	2.000	6.000	-.265	-1.655	-.406	-1.268
RESP2	2.000	6.000	-.397	-2.478	-.449	-1.402
RESP3	2.000	6.000	-.403	-2.517	-.618	-1.929
RESP4	2.000	6.000	-.156	-.976	-.739	-2.308
RESP5	2.000	6.000	-.223	-1.390	-.577	-1.801
SATISF1	2.000	6.000	-.321	-2.007	-.496	-1.549
SATISF2	2.000	6.000	-.418	-2.611	-.370	-1.156
SATISF3	1.000	6.000	-.454	-2.832	-.104	-.325
SATISF4	2.000	6.000	-.053	-.331	-.391	-1.222
Multivariate					1.549	.646