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From Responsiveness Strategy to Market Responsiveness:
A Pursuit of Responsive Supply Chains

by

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An Abstract of

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The current dynamic business environment, characterized by intense global competition, rapid technological advancement and volatile demand, constantly challenges firms to proactively and swiftly respond to turbulence. Responsiveness realizes when supply chain constituents work together toward the same direction. The responsive supply chain has emerged as an effective type of management philosophy for the current uncertain business environment. Differing from traditional supply chains that emphasized efficiency, the responsive supply chains focus on compressing time-to-market and at the same time increasing flexibility by connecting the downstream of the supply chain to its upstream through pull production, information technology, integrated product design, and collaborative practices with suppliers and customers. Despite the rich conceptualizations available on responsive supply chains, few studies have comprehensively and empirically studied the interrelationships between these constructs. This study purports to construct and test a research framework that comprehends the critical practices of responsive supply chains from a focal company perspective.

Structural equation modeling based on the sample of international manufacturing strategy survey found that (1) there is a significant relationship between the competitive market environment and the responsive product strategy, confirming the influence of the environment on strategy formulation; (2) advanced manufacturing technology, pull production, and product development programs are critical in compressing the manufacturing time, reducing procurement and manufacturing lead time, and increasing the speed of product delivery to customers; (3) interoganizational and interfunctional coordination through information sharing, coordination with suppliers and customers, and supply chain restructuring has a direct positive impact on internal production system integration.

This study makes three main contributions. First, this study derived a structural research model from coordination theory that addresses how firms increase market responsiveness through coordination mechanisms. Second, this study expanded coordination theory to supply chain level and shed light on the influence of supply chain restructuring on integration of Intra-organization level practices. Third, this study also provided various contextual analyses from plant size to globalization. Recommendations for future research and implications for managers are also discussed.

DEDICATION

To My Savior, Lord, and Good Shepherd, Jesus the Christ

ACKNOWLEDGEMENTS

"Have Faith in God" (Mark 11:22)

I thank God who has been my Savior, Heavenly Father, and Good Shepherd throughout my life. It was July, 1996 when I received the vision to become a faculty Shepherd, based on Mark 11:22. I used to be a man without confidence and direction and wasted away my talents and life. But the vision gave me the right perspective and confidence that by faith in God I can do everything. Despite my weaknesses and limitations, my Lord has gracefully guided me thus far. The completion of this dissertation speaks for the Lord that He is living and working in my life, and I would like to acknowledge what he has done for me.

First, the Lord led me to good Shepherds. Since 1995, Shepherd Daniel Rhee has been my Pastor. In Fall 1999 when I was wondering about my future direction, he sat down with me and encouraged me to pursue the vision to become a Ph.D. Shepherd. In Spring 2002, he sent me by faith to Toledo UBF as a missionary despite my immaturity. Since then he and Shepherdess Miso Rhee have prayed for me. During my stay in Toledo from August 2002 to August 2008, Dr. Paul and Missionary Sarah Hong have been my Good Shepherds. Missionary Sarah Hong often invited me and served me with delicious foods. She even taught me how to drive a car. Most of all, she has earnestly prayed for my family. Upon finishing my MA in Economics in 2005, Dr. Hong encouraged me to change my major from Economics to Business and later helped me to get into Ph.D. program at the University of Toledo. This was one of the best decisions that I made in my life. It was he who guided me to involve in research and to publish four papers before finishing my Ph.D. It was he who gracefully accepted my asking to become my dissertation chair and allowed me to use IMSS IV data. I'm thankful to him not just because he helped me so much but because I became his disciple and he became my true mentor and father-like Shepherd.

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Last of all, the Lord led me to the most beautiful, joyful, and prayerful wife, Angela. As her name suggests, she is like an angel and I am so lucky to be her husband. She has been putting up with all my pains and difficulties in addition to the arduous labors to take care of our daughters, Daniella and Joy. She deserves all the credits instead of me. Although they are babies now, I want to thank Daniella and Joy. I want them to know that they have brought me a great joy and a driving force to finish this dissertation in time. I'm most blessed because the Lord granted me this beautiful family in his grace.

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My prayer is that this Ph.D. degree may be used to honor and exalt the name of the Christ, my Lord and my Savior, throughout my life and beyond.

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CHAPTER 1: INTRODUCTION

Fundamental changes in external environments call for fundamental changes in internal environments (Hammer & Champy 2003). With the external environment becoming more dynamic, organizations face uncertainty and attempt to adapt to fluctuating demand and changes in consumer behaviors. Readily available technology, higher income, and greater access to information have empowered consumers to examine and compare products and services, and to find more opportunities for themselves. This dynamic nature of customer value not only varies across but also alters within the customer population over time (Parasuraman 1997), which necessitates firms to assess not only the current customers, but also the driving factors behind the changing perception of customers' future proposition (Flint et al. 1997).

When it comes to the supply chain, firms have responded to these dynamics in two ways. The first of these reactions has focused on reinforcing price competition and eliminating waste from all possible sources, from production to delivery (Womack et al., 1990; Womack and Jones, 1996). The lean paradigm modeled after Toyota's success in the 1980s and the early 1990s spurred the implementation of operational improvement programs such as Six Sigma and Total Quality Management. The second category of response to the dynamic environment has been to emphasize agility in the supply chain (Goldman et al. 1995; Mason-Jones et al. 2000). Agile supply chains stress flexibly and rapidly responding to the unpredictable demand (Christopher, 2000). Scholars and practitioners encourage firms to apply lean supply chains in a relatively stable market, and agile supply chains in a volatile market with high product variety (Fisher, 1997; Lee 2002; Vonderembse et al., 2007). The central concept of these supply chain management strategies lies in increasing efficiency. In other words, supply chain management aims at minimizing the usage of resources to deliver a successful product or service (Jüttner et al. 2007). These two approaches start from suppliers' side, and the demand orientation has been largely neglected.

1.1. Problem Statement

These efficiency-oriented and supply-central approaches pose considerable limitations on the supply chain in three ways. First, efficiency oriented supply chains have only a limited room for improvement. Skinner (1986) points out that increasing productivity and removing wasteful elements in labor and operations areas will not create the greatest value for a company. According to Skinner, direct labor costs hardly account for 10% of total sales. In contrast, sales could drastically decrease more than 20% of total revenue (Skinner 1986). Therefore, rather than excessively focusing on increasing efficiency in labor and production systems, firms should direct their attention to the structure and technology of the whole production. In the same vein, Porter (1996) warns that a cost-efficiency approach leads firms to concentrate on the short-term profitability instead of the long-term profitability (Porter 1996).

Second, efficiency-led supply chains may fail to synchronize their processes with customer changes. The crises that companies like Marks and Spencer, Sainbury, and Motorola faced in the late 1990s and early 2000s stemmed not from an inefficient supply chain but from their failure to promptly respond to the shift in the customer base

(Finkelstein 2003; Walters 2006). Motorola's market share in the total U.S. cell phone industry plummeted from 60% in 1994 to 31% in 1998 and then to 16% in 2002 (Finkelstein 2003). This result originated from their slow adaptation to digital technologies. Motorola failed to see the heavy customer demand for digital technology, and even surprisingly licensed the digital patents that they had to Nokia and Ericsson. These examples serve to demonstrate the need for scanning customer changes as well as making business processes efficient. As Lee (2004) indicated, high-speed, low-cost supply chains are vulnerable to unanticipated shifts in demand and supply (Lee, 2004).

The third limitation that efficient supply chains carry is the fact that efficiency-led management hinders firms from cultivating innovation-friendly culture, a critical advantage in the dynamic business environment. The recent decision by 3M to divest the Six Sigma program in order to revive its previous innovative culture speaks loud for this point (Hindo 2007). Since the implementation of Six Sigma, 3M could streamline its manufacturing processes, fulfilling the expectation of the former CEO, McNerney. However, it also brought a downside of efficiency-oriented management philosophy, which is discouraging innovation-provoking culture. Some argue that Six Sigma inculcated employees with a mindset that displaced innovative thinking. When leadership changed from McNerney to Buckley, the incoming CEO saw Six Sigma as the main reason that dispirited innovative way of thinking and risk-taking culture. He made a decision to "shift the corporate mandate back to sales growth, eased up on Six Sigma, and is looking for more innovative breakthroughs on his watch (Hindo 2007)." As shown in this example, management program for efficiency tends to suppress innovationencouraging culture. As a result, firms now pay attention to demand chain management in addition to the supply chain.

1.2. Toward Responsive Supply Chain Framework

In response to limitations that efficiency oriented supply chains, the responsive supply chain emerged in the late 1990s and the early 2000 as a management philosophy that emphasizes reflecting market orientation throughout supply chains (Lummus & Vokurka 1999; Shah 1999; Lee & Seungjin Whang 2001; Langabeer & Rose 2001; Hoover et al., 2001; Korhonen, Kati Huttunen & Eero Eloranta 1998; de Treville et al., 2004; Heikkilä 2002; Hines et al., 2002; Williams et al., 2002; Fischer 1997). Different from traditional supply chains, the responsive chain prioritizes continually connecting constituents in supply chains with demand information in order to proactively cope with customer changes in the front end of the supply chain. In contrast to the traditional supply chain that aims at improving efficiency in product production and delivery, the responsive supply chain aims at enhancing firms' profitability by strategically and operationally aligning upstream with sales channels, retailers, and distributors (Jüttner et al. 2007), and by managing downstream with agility in a cost-effective manner.

One of the key features that represent the responsive supply chain is agility. Agility is another source of competitiveness (Lee 2004; Stalk 1988). However, only a handful of companies have embarked on integrating their supply chains and demand chains. The challenges for the integration come from their different foci. Supply chain management usually aims at optimizing supply with an emphasis on the production to delivery process, whereas responsive chains concentrate on responding to demand with more emphasis on creating revenue by providing the right product at the right time and the right place. It is crucial for firms to acquire agility and cost-effectiveness to compete in volatile markets with much variation in demand and a short product life cycle, such as the fashion or other innovative products industry (Fischer 1997). A supply chain will not realize its potential, although it may work efficiently, if products that the chain is manufacturing and delivering do not match with the demand (SAP 2008).

Several reasons call for the responsive supply chain (RSC) management framework. First, supply chains should be market oriented to produce excellent results. Being market oriented requires having an excellent interfunctional coordination (Kohli & Jaworski 1990; Kohli, Jaworski & Kumar 1993; Jaworski & Kohli 1993; Day 1999; Drucker 1954). The emergence of supply chain management exemplifies the need for the integration of areas that encompass separated business functions. Market orientation has recognized this as an essential concept. Day (1994) theorized that a high profit firm should outshine in three capabilities: inside-out, outside-in, and spanning. In the 1980s and 1990s, many scholars have focused on deciphering the antecedents and capabilities of market-oriented firms. However, in supply chain context, it is still very much unclear how to connect market orientation and consumer orientation to supply chains, because there has been sparse research. How the market orientation can be extended to the context of the supply chain is an important gap in current research.

A few researchers advocate the need for responsive supply chains. An empirical study of more than 400 companies reported that the supply chain community has not been well acquainted with demand management, failing to coordinate the supply chain effectively (Mentzer & Moon 2004). Another global survey reported that only 49 out of

288 companies across the world have successfully linked the supply chain to customer orientation, and that these companies outperformed other firms that are yet to integrate the customer orientation (Deloitte Research 2002). The superior performance of firms that have embraced demand chains comes from their capacity to differentiate products, services, and delivery processes on a customer-by-customer basis. This enables companies to screen different customers and meet their wants with customized services (Jüttner et al. 2007). For example, companies that bind their supply chain with different customer segments can respond swiftly to the market, and cope with changing trends of customer preferences.

Second, the concept of the supply chain explicates the integration of agility and effectiveness both in upstream and downstream management. A few supply chain definitions are as follows:

> "A network of autonomous or semi-autonomous business entities collectively responsible for procurement, manufacturing, and distribution activities associated with one or more families of related products" (Swaminathan et al. 1996)
>
> "A network of facilities that procure raw materials, transform them into intermediate goods and then final products, and deliver the products to customers through a distribution system" (Lee & Billington 1995).
>
> "The management of materials, information, and funds from the initial raw materials supplier to the ultimate consumer' (Deloitte Consulting LLC 1999)

These definitions of the supply chain suggest that supply chains are concerned with moving goods through a network to the consumer more efficiently. To efficiently transform materials into products and to deliver them to customers requires firms to know what customers want. It is of no use to deliver unwanted goods that do not satisfy the customers. Firms, as a part of considering where profits could arise, should know what customers want and need. This requires having enhanced communications across the supply chain, and tailoring the supply chain to deliver the right products to the right places. As Rainbird (2004) pointed out, SCM efficiency itself does not create customer value and satisfaction because efficiency is regarding eliminating wastes in production process. There should be something more than efficiency. A company should not only pursue efficiency in the production process, but also effectiveness in quickly responding to customers' needs.

Third, a volatile environment calls for a responsive supply chain. The current economic environment is defined by three revolutionary forces: intense global competition, rapid technological advancements (Cameron & Quinn 1999), and innovative managerial practices (Champlin and Olson, 1994). Intense competitions are triggered by the development of technology, adoption of market economies on a worldwide scale, and increased economic power of consumers. These forces have made the world flatter than ever before (Friedman, 2005). Hubber (1984) delineates this as the shift from an industrial to post-industrial environment. Elements such as high degrees of turbulent change, competitiveness, information overload, organizational decline and uncertainty characterize the post-industrial environment. This phenomenon, called globalization, has caused fundamental changes in society including how to compete in business.

Volatile customer demand, the need to develop new products more quickly, and greater reliance on information technology epitomize today's market competition. A post-industrial firm no longer competes in a homogenous national market of which its segment is large and stable, and product life-cycles tend to be long. It competes, instead, in a heterogeneous global market, and in an environment of unpredictable turbulence, where product life-cycles are relatively short with new products emerging more quickly (Vonderembese et. al, 1997; Vonderembse and Nahm 2002). Leading companies demonstrate economy-of-scope rather than economy-of-scale, and concurrent competition on multiple criteria, such as quality, flexibility, cost, product performance, and time (Ferdows & De Meyer 1990).

1.3. Research Questions

The turbulent external environment for manufacturing firms presents a few challenges; they must produce a variety of products with high quality, short life cycles, and low prices. To remain viable in this competitive landscape, a manufacturing company must equip itself with the capacity to quickly respond to various changes (flexibility, time-based competition), to continuously create innovative products and processes (innovation), and to offer superior quality products (quality).

As firms try to become more competitive, business environment becomes more turbulent. Yesterday's success does not mean today's success; firms have to keep searching for ways to improve and innovate their products and services. This trend is especially evident in the high-tech industry and in the retail industry where customer demand fluctuates. In a global market, firms should be able to adjust their supply chain to meet the demand. At the center of this uncertain environment lies the philosophy expressed by Levitt in 1960: "To stay in existence, firms should not focus on selling products but on fulfilling customer needs" (Levitt 1960).

The current dynamic business environment, characterized by intense global competition, rapid technological advancement, and volatile demand, is constantly making firms operate customer-driven responsive supply chains. However, firms tend to stay producer-driven, aiming at increasing efficiency performance measures. The reasons are three-fold: (1) upstream (suppliers) is better controlled than downstream (customers); (2) suppliers' disruptions have a multiplier impact on downstream channels, and ultimately on customers; (3) component suppliers may have high value added with technological know-how and patent protection of their component parts. As a result, supply chain management studies have attempted to elucidate supplier development, collaboration, and integration along the manufacturing process.

While these practices play a significant role in increasing the supply chain efficiency, the reality of the ever-changing global market presents additional challenges for firms to manage: fluctuating and uncertain demands. These dynamics require firms to quickly innovate and deliver high valued products and services to customers via supply chains. In this context, it is critical for firms to understand the current and future customer expectation, and the market characteristics in order to link that information to the most effective alternatives. This can be the primary management philosophy and responsive supply chain management. Despite the recognition of the need for research in this field, a research model is yet to be developed that encompasses significant demand chain practices and examines the relationships between strategic intent and entailed practices. In addition, as of 2008, large scale empirical studies have not been conducted in this area.

This dissertation purports to construct a research framework for responsive supply chain management, and to empirically test the model with aims to answer the following research questions: (1) What is responsive supply chain? In other words, what are critical practices to implement responsive supply chain? (2) What are interrelationships among key practices for responsive supply chain? (3) What are outcomes of responsive supply chain? What are managerial and theoretical implications of responsive supply chain?

In an attempt to answer these research questions, this study targets to present an integrated responsive supply chain framework from a focal company perspective. There have been anecdotal evidences and some empirical study (Fischer 1997; Walters 2006; Walters & Rainbird 2004; Lee 2004; Lee & Billington 1995), but integrated responsive supply chain framework has not been found. After developing the integrated model, this study will attempt to empirically validate the model. This empirical validation will be valuable in that there has been lack of evidence that assesses the robustness and pervasiveness of responsive supply chain. Furthermore, an international study has been extremely rare. By validating the research model, this study will anticipate to expand lessons and implications of responsive supply chains.

1.4. Expected Contribution

This research examines: (1) strategic product strategy that arises in response to the competitive market environment; (2) major constituents of responsive supply chain managements such as proactive product development and commercialization, cross-functional integration, and technology usage with both customers and suppliers; (3) operational outcomes for demand-oriented firms, and its impact on business performances.

A major contribution is to show how a focal company build and implement responsive supply chain framework and examine the framework empirically. Using coordination theory, this study identifies coordination mechanisms in the supply chain as important constructs that trigger restructuring in the supply chain. This restructuring enables firms to reorganize their activities and integrate their manufacturing practices. Integration enhances market responsiveness and increases firm growth. This type of research that empirically examines the responsive supply chain practices has been rare. This study is unique in providing quite comprehensive research framework for responsive supply chain and empirically validating the framework.

Another contribution this research is anticipated to make is the clarification of the process that precedes pull production and integrated product design. Pull production and integrative product design are the culmination of time-based competition that produces a competitive advantage in an uncertain environment. These pull production and integrated production designs materialize when a firm connects its manufacturing system with its suppliers and customers through a collaborative coordination and information system. This study, in particular, sheds light on antecedents of pull production and integral product design programs. Although pull production summarizes a firm's efficiency and effectiveness, few researchers have explained the integral relationship between product design and collaborative supply chain practices. In order to create innovative products while increasing time-based competition competence, a manufacturing firm will have to address the challenge of integrating both external and internal collaboration with suppliers and customers. This study intends to elucidate this process.

The organization of this study is as follows. Chapter 2, entitled *Theory Development*, introduces and captures the important discussion about the research framework related to strategy, supply chain, and operational practices and outcomes. Based on literature review and theory development, this chapter presents a research framework of a responsive supply chain that addresses responsive product strategy and its influences on external and internal integration practices. Chapter 3, entitled *Research Methodology*, explains the approaches that this study takes to tackle the research questions and research framework. Using the International Manufacturing Strategy Survey IV, this study explicates the impacts of strategy, and the interrelationship between responsive supply chain practices and operational practices. Chapter 4, entitled *Structural Model Methods and Results,* reports the results of statistical analysis. Chapter 5, entitled *Contextual Analysis,* also report various contextual analyses to shed light on the research framework. Chapter 6, entitled *Discussion,* presents theoretical and managerial implications of this research and Chapter 7, entitled *Conclusion and Future Research* conclude this research by summarizing the study.

CHAPTER 2: THEORY DEVELOPMENT

2.1. Theoretical background

The following theories serve as the underpinning rationales behind the research framework for responsive supply chains in this research.

2.1.1. Value Chain Framework

Supply chain management concerns the integration of processes between firms, but a comprehensive introduction to major processes of supply chain management was lacking. In a seminal work, Lambert et al. (1998) filled this gap by introducing eight significant processes: Customer relationship management, customer service management, demand management, order fulfillment management, manufacturing flow management, procurement, product development and commercialization, and returns (Figure 2.1.3). These key processes serve to encourage cross-functional integration (Croxton et al. 2001).

Customer relationship management determines whom to serve. That is, identifying customer segments and target customers. It provides for product and service in demand and criteria to measure customer satisfaction. Customer service management aims to build up means to respond to customers, which includes coordination mechanism like information technology. Demand management is responsible for predicting customer demand on products and making contingency plan in case of unbalance between supply and demand. Order fulfillment management encompasses making and delivering products in the way that products are advertised and perceived to customers. Thus, it requires concerted efforts among manufacturing, logistics, and marketing. In this phase, logistic networks and manufacturability should undergo constant evaluation so that products produced might meet customer expectation. Manufacturing flow management primarily concerns with producing the products and achieving production agility to accommodate possible demand elasticity in the market. Supplier relationship management deals with identifying key suppliers and working with them to set improvement goals and incentives and programs for suppliers. If implementing collaborative planning, forecasting and replenishment with some suppliers, firms need to decide what technology it will use and how much it will fund suppliers to adopt the technology. New product development and commercialization is about developing the right product in a timely manner by involving key stakeholders of the market and the firm including key customers and suppliers. Successful product development and commercialization provides for sustainable competitive edge. Returns management addresses setting up guidelines and systems for products returned from customers.

Manufacturing flow management, out of these seven critical components of supply chain management, is of special interest of this research. The reason is that this study intends to explore crucial practices that increase market responsiveness through manufacturing. Croxton et al. (2001) introduce what processes to take when conducting manufacturing flow management at the strategic level. The first step is to determine manufacturing priorities by examining if business strategy is aligned with manufacturing, purchasing, and logistics strategies. Accomplishing congruence among strategies leads to the next step: gauging the extent of agility needed for the manufacturing and the supply chain. This step identifies what manufacturing capabilities and limitations the firm has and where to place decoupling point (i.e., to what extent to implement push production systems) (Naylor et al. 1999; Graves & Willems 2000).

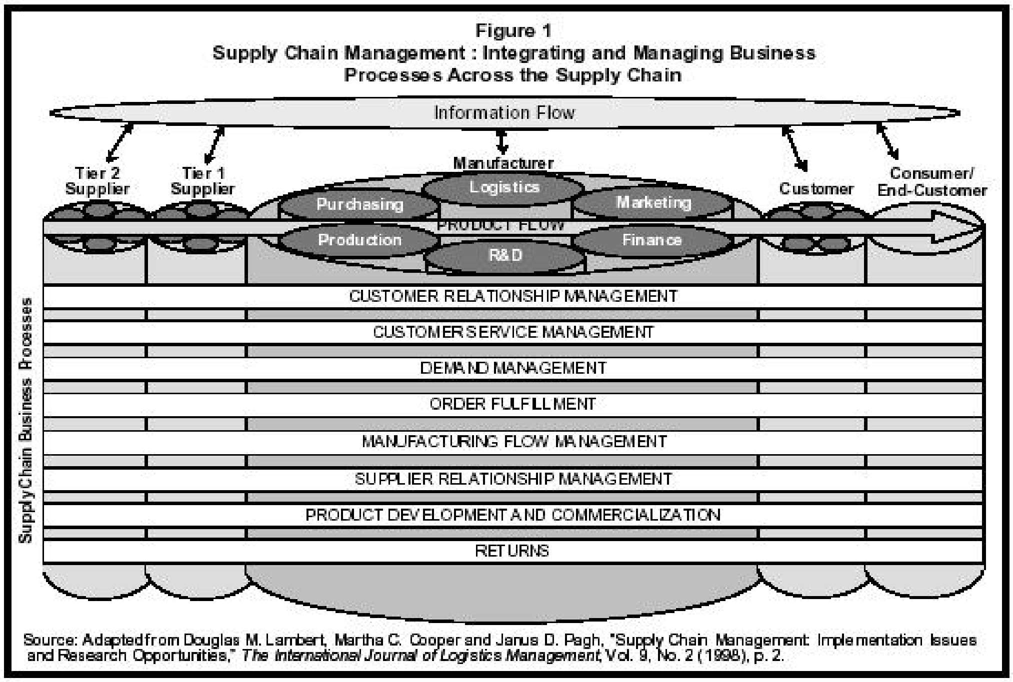


Figure 2.1.1 Value Chain Framework for Supply Chain Management

(Adopted from Lambert et al., 1998)

These decisions regarding capabilities, constraints, decoupling point, in turn, help firms to distinguish strategic manufacturing activities and relationships from unimportant ones. The firm accordingly make decisions as to if it will outsource, insource or develop certain capabilities. Furthermore, these decisions serve to guide which suppliers to select, to what extent to collaborate with those suppliers, and what kind of supplier development program to implement. Finally, the firm transforms inputs into final products via purchasing, manufacturing, logistics process, and delivers them to customers.

This information on manufacturing cycle has to be clearly shared with all the constituents of the organization in order to make informed decision regarding demand management, order fulfillment, supplier relationship management, and customer relationship management.

The value chain framework by Lambert and Cooper (2000) shows two things. First, the framework indicates that supply chain management is usually managed by a focal company. Revolving around a focal company, suppliers and customers are working together. Second, the framework also points to the nature of supply chain management. Supply chain is consisted of a variety of flows. A focal manufacturing company faces challenges to manage a variety of flows. Among major eight flows, this research will center on information flows, product design flows, and manufacturing flows.

Over the decades, scholars have paid attention to the different patterns of supply chains. In the 1980s and the early 1990s, the focus of supply chains was on the "lean" paradigm in response to the successful experiences in Toyota (Womack & Jones 2003) . The core concept of the lean supply chain is eliminating waste from production to delivery (Womack et al. 1990). In the late 1990s, the "agile" paradigm appeared in response to the turbulent market environments (Mason-Jones et al. 2000). Fisher (1997), for example, presented a typology based on types of products (i.e., functional and innovative) and supply chains strategy (i.e., efficient and responsive) (Fischer 1997). Some researchers further classified supply chains into three types: lean, agile, and leagile (Mason-Jones et al. 2000). Other researchers also classified different types of supply chains with a somewhat different emphasis (Christopher & Towill 2001; Goldsby et al. 2006; Vonderembse et al. 2006). Lean supply chains focus on cost reduction and process efficiency while agile supply chains focus on flexibility to market changes. Leagile supply chains, a hybrid concept of the lean and agile supply chain, are adopted when the Pareto rule or postponement principles apply, or when seasonal demand exists (Christopher & Peck 2004). Vonderembse et al. (2006) examined the relationship between product life cycle and supply chain, and Christopher and Peck (2004) introduced the concept of resilient supply chain that helps to manage risks in supply chains (M. Christopher & Peck 2004). Building upon Fisher's framework (1997), Lee (2002) put forth a demand and supply uncertainty framework that produces four types of SCS: efficient, risk-hedging, responsive, and agile (Lee 2002). Table 2.1 summarizes the four different types of supply chains.

Table 2.1.1. Characteristics of Supply Chains (Adapted from Lee, 2002 and Vonderembse et al., 2006)

Category	Efficient supply chain	Risk-hedging supply chain	Responsive supply chain	Agile supply chain
Supply Uncertainty	Low	High	Low	High
Demand Uncertainty	Low	Low	High	High
Definition	A ESC aims at achieving the highest cost efficiencies in the supply chain through the elimination of waste or non-value added process.	A RHSC aims at sharing risks in supply disruption through pooling and sharing resources.	A RSC aims at being rapidly adaptive to the change of customer needs and market volatility.	An ASC aims at being responsive and context-specific to customer needs, while the risks of supply shortages or disruptions are hedged by pooling inventory or other capacity resources.
Focus	Highest cost efficiencies in the supply chain	Cost efficiency and hedging the risk of supplier disruptions	Adaptability to rapidly changing customer needs.	Be market-oriented and have capacity to meet a wide variety of market niches simultaneously
Product Type	Functional	Functional	Innovative	Innovative
Competitive Priorities	Cost and quality	Cost, flexibility, quality	Speed, flexibility	Speed, flexibility, innovation
Supply Uncertainty	Low	High	Low	High
Demand Uncertainty	Low	Low	High	High
Supplier Relationship	Transaction-based	Relation-based	Time-based	Partnership-based

Scholars have recognized this issue and have attempted to distinguish the different types of supply chain from each other. A firm may pursue efficient supply chains when a market is mature and a competitive advantage is achieved through low cost and high productivity. Firms take the efficient supply chains strategy mainly to manufacture quality products efficiently and to provide customers with reliable services.

Risk-hedging supply chains are adopted when the supply chain is evolving in the presence of uncertainty but its market demand is stable and predictable. Hydro-electric power and some food producers are examples of this category (Lee 2002). To leverage supply uncertainties, a firm would increase the buffer stock for its core products or components, and attempt to share the cost of the safety stock with other companies. The retail industry or dealerships often utilize this strategy.

A firm that adopts responsive supply chains offers a variety of products with high quality and performance. Product innovation and improvement takes priority in RSC. To accommodate the customers' constantly changing demands, this supply chain may postpone making the final form of a product until the demand becomes known. Fashion apparel, computers, and pop music industries are representative of this strategy (Lee 2002).

Agile supply chains are the most flexible and the most market-oriented strategy, because firms in this category face uncertainty from both demand and supply sides. A firm surrounded by high uncertainty endeavors to adjust promptly to volatile market conditions and to the unpredictability of suppliers. The firm responds sensitively to the highly uncertain demand via a variety of products with features such as high quality, high performance, and excellent customer service. The firm will also hedge the potential risk associated with suppliers such as supplier disruptions by leaving room for flexibility. An example would be inventory pooling. The firms that implement agile supply chains can be found in high-end computers and semiconductor industries.

This research focuses on responsive supply chains that encompass the responsive supply chain and the agile supply chain from a focal company standpoint. It empirically examines manufacturing, supplier, and customer practices using these constructs.

2.1.2. Order Winner and Order Qualifier

Manufacturing strategy is defined as a pattern of decisions regarding both structural and infrastructural manufacturing issues, which forms a manufacturing system that allows a firm to meet a set of manufacturing objectives, and eventually overall business objectives (Skinner 1985; Hayes et al. 1988; Hill 2000; Skinner 1969). Hill (2000) stressed that the purpose of manufacturing strategy must not be limited to operations efficiency, but rather, be extended to creating strategic advantages by reflecting on the market situation and the marketing objectives. This can be made possible through satisfying both order qualifying and order winning criteria (Hill, 2000).

In the course of fulfilling qualifying and order-winning criteria, management faces the issue of determining specific domain of its manufacturing system (Hill, 2000; Slack and Lewis, 2003). Five domains are identified by Skinner (1965, 1985): plant and equipment, production planning and control, labor and staffing, product design and engineering, and organization and management. Slack and Lewis (2003) rephrases the content of manufacturing strategy into four areas: capacity, supply networks, process technology, and development and organization. These four areas are composed of structural and infrastructural issues. Although different scholars offer different definitions of these two issues, Slack and Lewis (2003) define structural domain as “the physical arrangement and configuration of the operation’s resources,” such as physical size and location of operations, and infrastructural domain as “the activities that take place within the operation’s structure,” such as process technology.

Some scholar distinguish these two by saying that structural issues are related to static elements while infrastructural ones are to dynamic elements. The task of the management is to match “the performance of an operation’s resources with the requirements of its markets” (Slack and Lewis, 2003), which is called “fit”. However, manufacturing strategy goes beyond static decision making. To develop or maintain a competitive edge in a constantly changing environment, it needs to have a dynamic adjustment process. In other words, manufacturing strategy keeps evolving by adjusting its structural and infrastructural issues to the changing market reality (Hill, 2000; Slack and Lewis, 2003). This process could be approached top-down or bottom-up (Frohlich & Dixon 2001; Hayes & Wheelwright 1984; Dangayach & Deshmukh 2001).

Voss & Blackmon (1998) identified three manufacturing frameworks after examining the history of manufacturing: 1) competing through manufacturing, 2) strategic choices in manufacturing, and 3) best practice. First, competing through manufacturing emphasizes the alignment between manufacturing capabilities and the competitive requirements of the marketplace. Strategic choices in manufacturing, on the other hand, is based on the coherence between the business and product context and the contents of manufacturing strategy. Another paradigm is to bench mark on best examples in implementing manufacturing strategy. Voss also stressed that each paradigm has its own strengths and weaknesses, and that each partly covers each other, and that they could be built into a continuous loop. The loop follows this order: strategic vision → key strategic choices → world-class performance. Those are not separate, but rather, a continuous iterative process (Hayes & Wheelwright 1984).

Slack and Lewis (2003) introduce dynamic aspects of manufacturing strategy. Static view focuses on determining the qualifying and order-winning criteria, and making the decisions about structural and infrastructural issues based on these criteria. This is the concept of "fit" (Hayes et al., 2005; Hill, 2000; Skinner, 1985; Slack and Lewis, 2003). However, alignment with market requirements would be only the first step toward excellence because market is not static but dynamic. As customer's preferences change and competitors enter the market, the qualifying and order-winning criteria could change. One example is that the US automobile industry used to think that cost was the order-winning criteria, but it changed with the entrance of Japanese firms that emphasized quality and delivery. As time went on, US firms attempted to catch up with Japanese firms by benchmarking them and improving quality of products, delivery speed and reliability, and customer service (Hill, 2000). However, since these became only the qualifying criteria, Japanese firms changed their strategy to providing cars of lower prices but with higher quality and service. As illustrated, market change forces the firm to adapt to the changing environment, and the inability to do so could result in a critical error in making business decisions.

To go beyond the static view of manufacturing strategy, Slack and Lewis (2003) presented a dynamic manufacturing strategy framework. It is composed of three steps: fit, sustainability, and risk. Fit was explained above, and sustainability means creating a competitive advantage and developing it to the extent that competitors cannot imitate it. If fit is about balancing between the market and the operations performance, sustainability is about "extending or improving market and operations performance while simultaneously maintaining the balance (Slack and Lewis, 2003)." The third step is risk. Risk is the potential for unwanted negative consequences from an operations-related event, which is caused by market uncertainty. When a firm is taking a risk, it would be out of fit, and therefore its resource is not optimally allocated, and an opportunity for turn-over is given to its competitors. It is necessary for the firm to examine its manufacturing strategy relative to market requirements, and reconfigure the strategy (Slack & Lewis 2003).

There is a tendency that if a firm adopts the best manufacturing practice or technology, it obtains a competitive advantage and stays competitive in the dynamic market. Many researchers report that this could be a myth. For example, Henard and Szymanski (2001) report that only 60% of new product development projects succeed. Implementing six sigma, TQM, or JIT does not ensure competitiveness. Rather, a firm should make every effort to foresee the market change, and adapt itself to the variation sensitively by readjusting its fit, constantly creating sustainability, and minimizing the risks.

Mason-Jones et al. (2000) extended the concepts of order winners and order qualifiers to supply chain context. They termed order qualifiers as market qualifiers and order winners as critical differentiators. They contend that firms with a lean supply chain focus have quality and reliability as market qualifiers and low price as order winner. Similarly, firms with agile supply chain focus have quality and reliability as market qualifiers and lead time as order winner. In their argument, what differentiate agile supply chain from lean supply chain is shortening speed of manufacturing from raw materials to final delivery. Aitken et al. (2005) also adopted this framework and stated that "where responsiveness is a key requirement demanding short lead-times, the focus is clearly on agility" (p.76). This research stream recognizes order winner and order qualifier framework by Hill as important contents of strategy that firms should take into consideration.

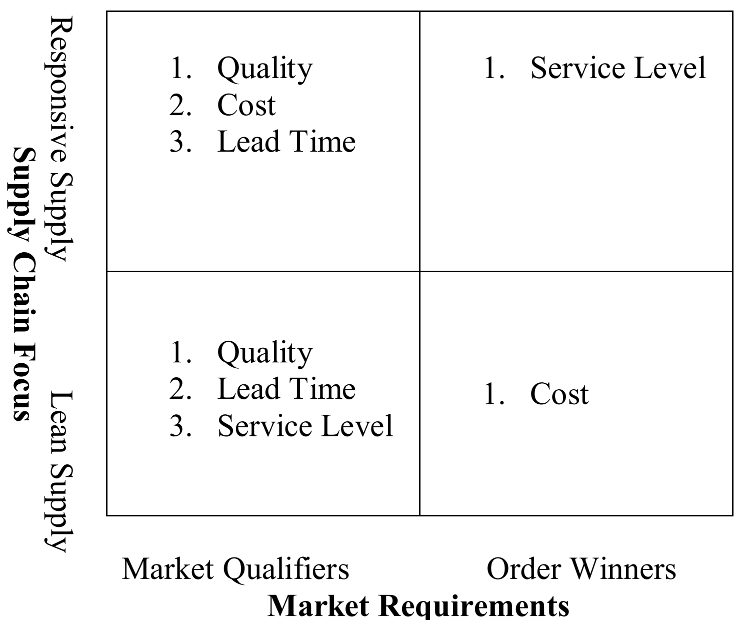


Figure 2.1.1. Order Winners and Market Qualifiers as Determinants of Supply Chain Focus (Adopted from Mason-Jones et al. 2000)

Figure 2.1.1 summarizes the application of order winner and order qualifier framework to supply chain context. This framework reflects the market status until the late 1990s, and thus it's not up to date. In the 2000s, the competition has become more intense and technology development has advanced more rapidly. As a result, product development life cycle shortened and product variety increased considerably. Customers demand more than good service: innovative and quality products. Some examples are the series of Apple's innovative products such as iPod, iTune, and iPhone. Another example is Wii by Nintendo, which changed the way to play video games, broadening customer bases for Wii and transforming the landscape of competition in the market. Nintendo used to fall behind Microsoft Xbox and Sony Playstation but, it now caught up the competition. These examples demonstrate that order winners have shifted to innovative products and wide product range. Thus, the framework shown in Figure 2.1.1 should be updated by changing order winner as shown in Figure 2.1.2 below.

Supply Chain Focus	Market Qualifiers	Order Winners
Responsive Supply	1. Quality 2. Lead Time 3. Cost 4. Service Level	1. Innovative features
Lean Supply	1. Quality 2. Lead Time 3. Service Level	1. Cost

Market Requirements

Figure 2.1.2.: Adapted Order Winners and Market Qualifiers in Supply Chain (Adapted from Mason-Jones et al. 2000)

Figure 2.1.2 recognizes innovative feature as order winner. In formulating manufacturing strategy, this order winner and order qualifiers should be reflected into the contents of the manufacturing strategy, and it will drive the focal firm to align its manufacturing practices and structure.

In summary, order winner and order qualifier is not cost-driven approach but evolved from cost and efficiency model to revenue and effective model. It is more of consumer-driven approach and attempts to understand and reflect multiple customers' requirements. When extending this framework to supply chain context, this approach integrates demand side with supply side at large. Therefore, order winner and order qualifier framework fits for responsive supply chain study.

2.1.3. Coordination Theory

Coordination theory is another framework that underpins this study. Coordination theory emerged in the mid 1980s by researchers who attempted to develop an interdisciplinary theme that embraces a variety of disciplines and thus can be applied to a number of areas. The theory development was motivated to answer how information technology would transform the world and, in particular, the ways people collaborate (Malone 1987; Malone & Crowston 1994; Olson et al. 2001). The theory consists of a few important concepts: dependencies, coordination mechanisms, and goals.

Firstly, dependencies are relationships between more than two activities, and they can be interpreted as interrelationship. A variety of dependences exist. One of dependencies often observed in manufacturing setting is "shared resources". For example, if more than two job shop workers are in a situation where they have to use a machine at the same time, it has the dependency of shared resources. Malone and Crowston (1994) introduce various dependencies such as task assignments, producer and consumer relationships, prerequisite constraints, transfer, usability, design for manufacturability, simultaneity constraints, and task.

Secondly, coordination mechanism is the process that resolves coordination problems that occur due to dependencies (Crowston 1997). The need for coordination among actors follows when activities have dependencies. In the above mentioned dependency of shared resources, setting a coordination mechanism may resolve the situation. The job shop members may come to agreement that they want to follow "first come/first serve" rule or they will ask for their manager's guidance. "First come/first serve" or management guidance are control mechanisms that resolve coordination problems that come from dependencies (Malone & Crowston 1994). Malone and Crowston (1994) took a various examples of the coordination mechanisms: priority order, budget, managerial decision, market-like bidding, notification, sequencing, tracking, economic order quantity, standardization, participatory design, concurrent engineering, scheduling, synchronization, goal selection, and task decomposition.

Thirdly, goals govern coordination mechanisms. In the aforementioned case of shared resources, the job members might choose "first come/first serve" principle if the goals are simply to avoid conflict between job shop members. However, the principle may lead to a situation where a job shop member cannot pay attention to urgent task. If the goal is to improve effectiveness of using the machine, the job members will request managers to utilize more systematic way such as scheduling (Malone 1988).

Coordination theory defines coordination as "managing dependencies between activities" (Malone & Crowston 1994, p. 90). Malone and his colleagues suggest that many activities from management to computer science could be categorized into a few classes by the types of dependencies. This categorization can be a powerful tool because it means categorizing various control mechanisms into a few classes and applying them to different disciplines. They take an example of applying control mechanisms acquired in warehouse management to computer systems to store memories and data (Malone 1987).

Now, how does coordination theory relate to information technology? One of primary research questions that Malone (1987) wanted to answer was "how will the widespread use of information technology change the ways people work together?" (Malone & Crowston 1994, p. 88). Information technology restructures the ways human organizations and markets work by significantly reducing costs involved in specific type of coordination. Malone and Crowston (1994) predict three effects.

A first-order effect is to replace manual coordination with automated one. Automated teller machines eliminated innumerable human clerks in bank office. A second-order effect is to amplify the volume of coordination used. In other words, people start to use ATMs more than before. The third-order effect is to allow the creation of more coordination-intensive structures. As people use AMT more often, bankers install AMTs widespread and focus on more important tasks such as loan consultation and investment of money into other options.

What kind of coordination-intensive structures would be formed when information technology reduces coordination cost? Malone and Crowston (1994) reason that the structures will become more horizontal and smaller in size. These firms will use markets as coordination mechanism more than internal decisions within firms as the transaction cost becomes cheaper when doing business in the market. The decrease in coordination cost will also lead to either centralized or decentralized structures (Gurbaxani & Whang 1991). If information technology decreases costs involved in decision making, it brings about more centralized structure. On the contrary, when information technology minimizes agency costs, it leads to more decentralized structure than before.

In summarizing coordination theory, two things deserve revisit. First, coordination is about managing dependencies by choosing or creating proper coordination mechanisms that are governed by a set of goals. Goals drive the coordination mechanisms that resolve dependences among resources, tasks, and activities.

Second, coordination results in restructuring. The change in coordination mechanisms results in changes in relationships among activities, tasks, and actors. In addition, information technology decreases certain coordination costs significantly. Business to business communication was once quite difficult to implement but information technology reduced costs involved in that coordination mechanism. Consequently, many firms adopted B2B communication method, which gave more power to a focal company who runs a reverse auction to its suppliers (Baltzan & Phillips 2008). The decrease in coordination costs enables firms to become less vertical and to disintermediate their middle management layers. In addition, information technology leads to either more centralized or decentralized structures, depending on whether information technology decreases decision information costs or agency costs more than the other.

How would coordination theory be applied to responsive supply chain framework? Responsiveness calls for change in coordination mechanism. Under the efficient supply chain framework, control and command were main coordination mechanisms. For example, in dealing with suppliers, manufacturers used to pursues cost-efficient strategy rather than long-term partnerships. Manufacturers were interested in optimization. However, responsive supply chain demands aim at meeting multiple customer requirements. Under responsive supply chain paradigm, coordination mechanisms need to be capable of handling inter-organizational network and integration with the net work. Thus, coordination mechanisms under responsive supply chain become more knowledge-intensive and relation-building. These changes in coordination mechanisms will bring in supply chain restructuring.

2.2. Research Framework

2.2.1. General Framework

Drawn from theories of order winner and order qualifier, value chain, and coordination, figure 2.2.1 presents the research framework for this study. Coordination theory suggests that the coordination mechanism is set to meet a set of goals. In a producer and customer relationship, firms increasingly prefer make-to-order to make-to-stock method because make-to-order eliminates the needs for storing products and work-in-process materials. This just-in-time method, one of production method is being adopted to meet the goal to make production and delivery process lean (Schonberger 1986; Womack & Jones 2003). However, firms that deal with functional products and competes on price may focus on using massive make-to-stock method. Firms set goals and accordingly choose appropriate coordination mechanisms. To meet their goals, entities such as firms or individuals choose or devise appropriate coordination mechanisms and implement them.

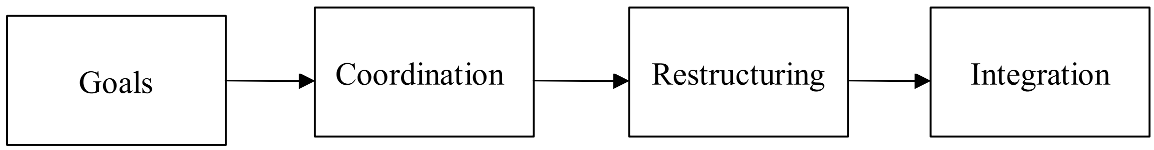


Figure 2.2.1. Research Framework

The employment of certain coordination mechanisms results in restructuring of the existing structures. For instance, Malone and Crowston (1994) understand usability as a type of dependencies between producer and customer. Usability means that products that a producer manufactures must be usable by consumers. Some mechanisms that deal with this dependency are standardization, communication with users, and participatory design. Participatory design, in particular, indicates that producers and customers actively take part in design of products from its early stage. Concurrent engineering can be understood as a form of participatory design. The change of coordination mechanism from standardization to participatory design leads firms to considering product design from its early stage and likely alters product architecture and production culture from vertical communication to horizontal communication.

Another example is Wal-Mart's inventory management method. Wal-Mart adopted the coordination mechanism that its suppliers have a direct access to point-of-sale data and manage their own inventories on the shelves in Wal-Mart (Lewis & Talalayevsky 1997). This adoption demanded a flatter distribution structure through disintermediation between Wal-Mart and Manufacturer, a form of restructuring that integrated distribution with sales systems. In other words, change in coordination mechanism brought restructuring in supply chain.

Kopczak (2005) defines supply chain restructuring as "significant changes in supply chain structure" (p. 228) that includes (1) change in the warehouse structure (number of tiers, number of warehouses, substitution of direct shipment for warehousing), (2) reassignment of tasks between tiers, (3) redistribution of inventory between tiers (e.g., centralized versus distributed stocking), (4) significant changes in transportation network, mode, consolidation points, (5) significant reassignment of roles and responsibilities among supply chain entities. These changes facilitate firms to integrate its internal manufacturing practices from technology to new product development.

2.2.2. Research Model

Figure 2.2.2 portrays the research framework for a responsive supply chain (RSC) from a focal company's standpoint. In accordance with general research framework, coordination theory is applied in the research model. Coordination in supply chain is driven by a set of goals, namely, responsive product strategy, and results in supply chain restructuring. Information sharing in supply chain plays a key role in fostering coordination in supply chain and making the structure among manufacturer and supplier and customers flatter than ever before. Supply chain restructuring, in turn, leads firms to integrate firms' internal manufacturing practices by adopting advanced manufacturing technology and by implementing pull production system and integrated product development. The internal integration helps firms to achieve market responsiveness and market responsiveness raise firm growth.

In a turbulent environment, a manufacturing company's production activities culminate in pull production. Pull production swiftly reacts to customer demands by changing production requirements. Operational efficiency and promptness, however, can be achieved through concerted efforts that involve not only manufacturing companies but also but also suppliers and retailers, as exemplified in the case of Toyota. To enhance effectiveness, operational collaboration with suppliers has to be extended to the customer level. By knowing what customers want, manufacturing companies can manufacture the right product. In this process, product design collaboration plays an important role. The product design stage determines eighty percent of product cost (Ferdows & De Meyer 1990; Anderson 2004). Involving customers as well as suppliers from the beginning result in an effective product design that reduces production costs and satisfies customer preferences (Koufteros et al., 2001). The process of fulfilling pull production through supplier and customer coordination, and integrated product design originates from careful planning at the strategic level.

A firm responds to the uncertain market environment, which is mainly caused by market dynamics and competition intensity. Firms respond to the uncertain market by setting their own business strategy according to their order winners and qualifiers. More specifically, firms would choose to compete on wider a product range, and frequently develop new as well as innovative products. In accordance with this business strategy, a firm would formulate its manufacturing goals to implement in four dimensions: customization, time to market, product innovativeness, and customer service and support. Since customer's preferences change quickly, customization capability, time to market, and product innovativeness play important roles in manufacturing. In addition, customer services and supports are critical for earning customers' loyalty.

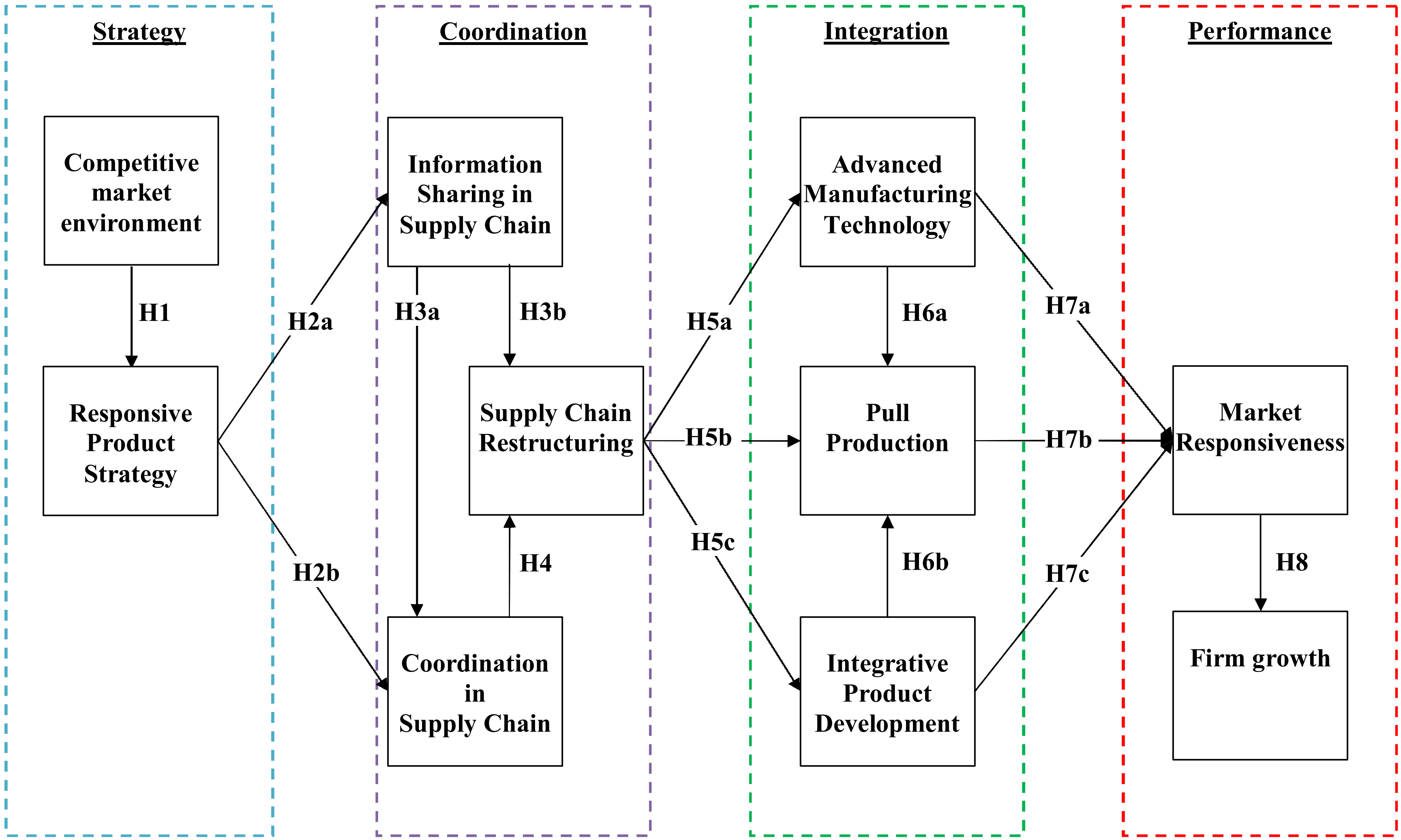


Figure 2.2.2. Research Model for Responsive Supply Chain

At the coordination level, strategic goals drive a firm to adopt coordinate mechanisms with suppliers and customers in order to achieve the goals to be more responsive to customers' requirements. Three components play important roles at this coordination level. The first is the information sharing in the supply chain. Time, geographical distances, and fast changing competitive landscapes urge firms to acquire efficient information systems in delivering products from demand management to order fulfillment. Information systems connect a manufacturing firm with its suppliers and customers especially through various information systems such as the internet or electronic data interchanges. Coordinating supply chain practices, the second construct at coordination level has received increasing attention because it is being recognized as a potential competitive weapon, as shown in the cases of Toyota, Dell and WalMart. Efficient product development exhibits concurrent engineering that engages the major stakeholders of product design with marketing, engineering, and manufacturing. Involving suppliers and customers from an early stage of the product design significantly decreases ambiguity and complexity, and enhances information sharing and adept product competence (Ellram et al., 2007; Koufteros et al., 2001).

At the Intra-organization level, a well-coordinated responsive chain enables a firm to implement pull production. A manufacturer attains information from customers, disseminates the information to suppliers, and receives requested components or materials in timely fashion. In addition, the firm continues to make efforts to integrate design and manufacturing at organizational and technological level, aiming to enhance agility in a dynamic market. An integrative product development program executed in a firm would make it easier for firms to implement pull production system promptly.

At the performance level, market responsiveness is defined by increasing time to market and delivery speed and reducing manufacturing and procurement lead time. The higher the degree of market responsiveness, the higher the level of effectiveness in implementing pull production systems. As the firm increases market responsiveness under a dynamic market situation, market performance such as sales, market share, and ROI will increase, too.

2.3. Strategy level of responsive supply chain

An important question to answer is how one can capture the responsive supply chain that a manufacturing firm implements. Although many approaches could be applied, this research believes that this should start from considering how firms formulate their product strategy in response to turbulent environment. The reason comes from the rationale that a firm's management practices reflect its values. Strategy can be defined as core values of a firm on which firms bases decision regarding contents of infrastructure and structure of manufacturing, supply chain and customer relationships. These decisions driven by strategy spread to all functions of a firm and further into supply chain practices. After all, a responsive supply chain results from a firm's decision to implement those practices with suppliers and customers. Therefore, responsive supply chain practices closely correlate with a focal firm's business and manufacturing strategy.

The strategic level of the responsive supply chain is comprised of three major constructs: competitive market environment and order winning priorities. The competitive market environment refers to the the circumstances under which a firm operates. The increasingly heterogeneous and competitive market drives firms to compete with more diverse, newer and more innovative products. In accordance with these order winning criteria, the manufacturing firm would focus on improving manufacturing functions such as product customization ability, mix flexibility, product innovativeness, and time to market. These strategies drive the firm to implement responsive supply chain practices with both suppliers and customers.

2.3.1. Competitive market environment

Champlin and Olson (1999) characterize the current economic environment into three revolutionary change forces: intense global competition, rapid technological advancements, and innovative managerial practices (Champlin & Olson 1999). Intense competitions triggered by development of technology, proliferation of democracy and market economy, and increased economic power of consumers have made the world flatter than ever before, resulting in intense competition and ever-changing dynamics in market place (Friedman 2005). Since the shift from an industrial to post-industrial environment, notable elements have been identified for this change such as high degrees of turbulent change, concurrent competition on multiple criteria, competitiveness, information overload, greater reliance on information technology, shortened new product development cycle, and increasing uncertainty (Nahm et al. 2004; De Meyer 1992; Anderson 2004). This phenomenon called globalization has brought fundamental changes in dimensions of competitions in the market.

This research takes a close look at two areas of turbulence: market dynamic and market competition. Market dynamic is defined as the degree of turbulence in a market (Emery & Trist, 1965). This concept is similar to uncertainty (Milliken, 1987), unpredictability (Cyert & March, 1963), and complexity (Galbraith 1973). The higher the degree of market segmentation, the higher the market dynamic is. The degree of market segmentation gauges the market size. In the industrial age, a market consists of a few stable and large segments that lead firms to utilize standardization of product components so that they could customize products quickly (Skinner, 1985). With competitors penetrating to specific market niches, however, market segments tend to constantly repeat shrinking and growing (Vonderembse et al. 1997).

The second source of turbulence in the external environment comes from market competition. Competition intensifies as globalization makes barriers of market entry lower, and invites more competitors from abroad to the market. Foreign competition has had a significant impact on domestic markets. Competitors bring various and unfamiliar capabilities and practices into the industry, and can add more unpredictability to the market environment. As a result, firms are under pressure to enhance productivity and efficiency, and to decrease the profit margin. In the meantime, competition offers opportunities for firms to acquire comparative advantage (Driffield et al. 2002). Firms that successfully face the competition will be prepared to compete with other companies.

2.3.2. Responsive Product Strategy

One of the problems that manufacturing management faces is that the manufacturing function is not taken seriously in forming and implementing business strategy. This is partly because corporate strategy is developed as the sum of each functional strategy, and also partly because the manufacturing management does not see the link to realize strategic role of manufacturing in marketing and corporate strategy. To resolve this issue, Hill (2000) presented five steps to link manufacturing to marketing when developing a corporate development strategy: "1) define corporate objectives, 2) determine marketing strategies to meet these objectives, 3) assess how different products qualify in their respective markets and win orders against competitors, 4) establish the appropriate process to manufacture these products (process choice), and 5) provide the manufacturing infrastructure to support production." His seminal work is the presentation of qualifying and order-winning criteria. Hill defined qualifiers as "criteria that a company must meet for a customer to even consider it as a possible supplier," and order-winners as "criteria that win the order."

The essential role of these criteria is facilitating the communication between manufacturing and marketing/ corporate strategy. In accordance with business objectives, marketing will conduct a sample research, provide future forecasts on sales volume for a certain period, and identify qualifiers and order winners. To derive clear and accurate information, marketing and accounting departments must then ask information about the actual cost of the manufacturing process. After debates and research, qualifiers and winners can be created, and the appropriate manufacturing strategy formulated.

Under market dynamism, firms need to proactively deal with challenges by acquiring innovation, manufacturing flexibility, speed, and quality.

2.3.2.1. Innovation

The turbulent environment also demands manufacturing firms to continually improve its processes and products in an innovative manner. Innovation has long been recognized as a significant competitive capability of manufacturing plants (Miller & Roth 1994) because it offers a critical source of sustainable competitive advantage (Khazanchi et al. 2007). With customers' preferences changing and technology developing rapidly and competitors entering market, firms are under relentless pressure to proffer innovative products. Shorter life cycle of products made it necessary for firms to offer new product introductions more frequently (von Braun 1990). To support the manufacture of new products and to improve plant competitiveness, process technologies are upgraded, or are replaced with new and advanced ones and operational and organizational practices are newly adopted or modified. Introductions of new products and modifications in process technologies, organizational and operational practices occur most frequently in high technology plants.

Products such as “iPod” by Apple computer and “Wii” by Nintendo have demonstrated the power of innovative products (Scanlon 2007). Both Apple and Nintendo have faced hard reality in market because of its strong competitors like Microsoft and Sony. However, their new products have paved way to turn around and newly compete on the market. Managing such product innovation helped them meet or even drive changing market demands. Like the product innovation, process innovation involves creating or improving methods of production, service or administrative operations.

Effective process innovation may enhance organizational efficiency and responsiveness. Jelinek and Schoonhoven (1990) argue that manufacturers with high technology orientation fail without making innovation take place rapidly and repeatedly. In his new economic theory, Baumol (1991) contends that to survive in an intensive global competition firms face the challenge to make innovation a routine process because innovation is more powerful weapon than price competition. Newton (1999) summarizes this trend by indicating innovation as the fourth dimension of competition in addition to cost, quality, and time. Putting these together, innovation is one of core competition dimension. With the frequent advances in technology development and inventions, customers look for innovative products more frequently than before.

2.3.2.2. Time-based Competition

Another aspect that post-industrial environment affects manufacturing design is time-based competition. Stalk (1998) views time as a resource that is more important than any other resources. Firms in turbulent environment should shorten the manufacturing process and new product development cycles and provide customers with a variety of products, in order to keep abreast of changing market situations. Time reduction in production and lead time increases flexibility of a plant. In this regard, manufacturing flexibility closely relates to time-based competition. Manufacturing flexibility necessitates time-based manufacturing.

Time-based manufacturing focuses on time compression techniques to improve responsiveness and enhance competitive capability (Koufteros et al. 1998). It is an externally focused production system that emphasizes quick response to changing customer needs. Its primary purpose is to reduce end-to-end time in manufacturing (Koufteros et al., 1998). For the next generation of managers and executives, time may become as important, or possibly more important, than quality or cost.

Firms that focus on time may also capture quality improvements and cost reductions. This implies increased efforts on quality programs inside an organization and between an organization and its suppliers. When trying to eliminate unnecessary steps that delay the delivery of services and goods, manufacturer also expects its suppliers to practice time–based manufacturing. Some examples of time-based manufacturing practices are shop-floor employee involvement in problem solving, reengineering setups, cellular manufacturing, quality improvement efforts, preventive maintenance, dependable suppliers, and pull production (Koufteros et al., 1998).

2.3.2.3. Quality

Simply put, quality can be defined as meeting or exceeding current and future customer requirements (Deming 1986). Without offering superior quality, manufacturing flexibility, time-based competition and innovation would not mean much to customers because offered products are off the customers' requirements. As increasing number of competitors enter the platform of markets, quality failure impose hard-to-recover threat to companies as it has been seen in the case of Dell. One would argue, "Isn't it too expensive to maintain high quality?" However, researches show that spending resources to produce high quality would save more resources that take to resolve problems from inappropriate qualities such as appraisal, internal and external failure costs. Furthermore, high quality products satisfy customers and build up customer loyalty to the firm while increasing flexibility and decreasing manufacturing costs. In a sense, achieving superior quality is the premise of manufacturing flexibility, time-based competition, and innovation. For this reason, firms drive themselves to obtain superior quality shown in various quality management programs such as six sigma and total quality management.

Table 2.3. Definition of Constructs of Strategic Level of RSC

Construct	Definition	Reference
Competitive market environment	Degree of turbulence in a market on account of intensity of competition and number of competitors	Emery & Trist, 1965 ; Milliken, 1987; Cyert & March, 1963; Vonderembse et al., 1997
Responsive Product Strategy	A set of order winners that aim to increase market responsiveness by mirroring customers' needs for innovative product features, wider product range and frequent products delivery	Calori & Ardisson, 1988; Porter, 1979; Porter, 1996; Hill, 2000; Hayes et. al, 2005

2.4. Coordination level of responsive supply chain

2.4.1. Information sharing in supply chain

Information sharing in supply chain refers to the way in which a manufacturer uses information technology to enhance communication with suppliers and customers in the areas such as order tracking, knowledge management, and collaboration. The development and proliferation of IT tools made it possible to incorporate supply chains into business processes, facilitating inter-organizational coordination.

The past 40 years of history has witnessed the rapid growth of information technology (IT) and its ever-increasing role in business (Keen 1991; Cline & Guynes 2001). In early days, manufacturing firms utilized IT mainly on an individual transaction basis, but now, it is used as a strategic weapon that not only designs the competitive manufacturing system but also manages supply chains (Coates 2000; Tan & Uijttenbrock 1997). Firms have striven to incorporate manufacturing functions and business strategies into the information system (Das et al. 1991). A successful integration of IT goes beyond assisting the common manufacturing function; it enables manufacturing firms to achieve product standardization, manufacturing flexibility, and supply chain integration that ultimately leads to a competitive advantage (Coates, 2000; Lee & Whang, 2000; Teo &

King, 1997) . The US Department of Energy (1997), in the report of the Next Generation Manufacturing Project, describes information systems as imperative to attaining the competitive advantage of reducing the product cost, process development cost, time to market, and risks in innovation.

The emergence of a commercial Radio Frequency Identification Device (RFID) about five years ago is an illustrative example of how information sharing can transform business practices and enhance efficiency and effectiveness. The emergence of RFID in the early 2000s led to sweeping changes in the way that organizations track goods in their supply chains. Large organizations, such as Wal-Mart, Proctor & Gamble, Gillette, and HP, have complex supply chains, and have adopted RFID; this has led to a ripple effect to their suppliers, and raised their interest in this technology.

RFID demonstrates how information sharing among the constituents in a supply chain could increase the supply chain visibility. A firm having supply chain visibility can reduce bottlenecks, and out-of-stock or low inventory levels in its supply chain. Supply chain visibility significantly lowers the uncertainty of goods, and enables firms to efficiently track and manage the flow of inventory or products (Kinsella 2003). As a result, the adoption of RFID enhances transparency in supply chains, and decreases bullwhip effects. For instance, Wal-Mart reduced its inventory stocks by 10 percent after adopting RFID (Kinsella 2003). RFID helped it to align and make information from the product distribution channels available to its suppliers so that they could reduce safety stock inventory, product trans-shipments, inventory obsolescence, material handling costs, and stock-outs (Kuchinska 2005). Furthermore, rich information exchange among partners in a supply chain makes it easier for firms to coordinate production and distribution, outsourcing functions and services, and partner with suppliers and (Straub et al. 2004). The accumulated information helps firms to analyze the performance of suppliers, scrutinize the bottlenecks, and identify portions that should be improved.

The theory of transaction cost explains the underlying rationale behind the implementation of IT tools-decreasing the coordinating costs of supply chain through IT tools. Malone and Laubacher (1998) report that IT provides firms with capabilities that migrate transaction costs. The key capabilities offered by IT are distant transaction, distant negotiation, and distant monitoring.

Information sharing can take a variety of forms. This research circumscribes it to areas such as data analysis, access to catalogues, order management, order and tracking management, knowledge management, and collaboration support services with suppliers and customers.

2.4.2. Coordination in Supply Chain

Supply chains are complex mechanisms based on a particular product they are designed to support. In recent decades, the supply chain has received increasing attention from both researchers and practitioners. Beginning in the 1980s and the early 1990s, researchers and practitioners focused on analyzing the general principles of supply chain management as an offshoot of an interest in Toyota's successful application of the "lean" paradigm (Womack & Jones 2003; Womack et al. 1990). The core concept of lean supply chains is to eliminate waste from the entire supply chain process, from production to delivery (Womack et al., 1990).

Starting in the late 1990s, researchers realized that supply chains strategies worked best when they were market-specific, and that certain types of supply chains fit better in an "agile" paradigm. Agile supply chains are able to respond flexibly to a rapidly changing market (Mason-Jones et al., 2000). Over the years, much effort was focused on finding the right supply chain for the right product, industry, and product life cycle. Fisher (1997), for example, suggested a typology of products/supply chains, and emphasized that a mismatch between the product type and the supply chain strategy could result in negative performance consequences.

More recently, collaborative supply chains have emerged as an implementation choice for firms dealing with rapid technological changes and hyper-competition. Today, industries and researchers widely recognize that supply chain collaboration brings transparency, efficiency, and synergy to a supply chain (Holweg et al. 2005).

Manufacturers face dependencies with their customers and suppliers. From product design to delivery, many issues demand close attention to managing these dependencies. Manufacturers, suppliers, and customers share their goals in that they want products that satisfy consumers. Coordination serves to meet these goals of participants through coordination mechanisms. Now, there could be a variety of coordination mechanisms. In a demand chain context, this research chooses to use sharing inventory knowledge, sharing production planning, and using collaborative planning, forecasting, and replenishment (CPFR) as coordination mechanisms. In the mean time, this study focuses on vendor managed inventory, CPFR, and physical integration of the supplier into the plant as coordination mechanisms. Coordination in a supply chain is an amorphous term. This study defines it as the practice of managing dependencies among entities and resources in the supply chain through planning decisions and sharing demand and delivery knowledge among the hub-manufacturer, suppliers, and customers.

More specifically, coordination in the supply chain contains two parts in this study: coordination with customers and coordination with suppliers. Coordination in the supply chain mainly concerns planning decisions and flow of good with strategic customers and suppliers. Coordination with customers means in this research that a focal company employs managing dependencies with customers through sharing inventory knowledge, production planning decisions, and demand forecast knowledge and through the usage of collaborative planning, forecasting and replenishment (CPFR). These methods intend to enhance active collaboration with strategic customers in response to competitive and volatile environment.

Another aspect of coordination in the supply chain comes from downstream of the supply chain: coordination with strategic suppliers. In planning decisions and flow of goods with key suppliers, a focal company shifts its supply chain coordination mechanisms from control and command to knowledge sharing and collaboration. Examples are vendor managed inventory, CPFR, and integration with the plant.

2.4.3. Supply Chain Restructuring

The concept of supply chain restructuring appeared in several researcher's works and the research is still in progress (Kopczak 1997; Croom 2001; Grant 2005; van Hoek et al. 1999). The most relevant study to supply chain restructuring appeared in Kopczak (1997). She introduced six types of supply chain restructuring: (1) faster modes, decreased cycle times, more direct shipment; (2) transportation route/LSP consolidation; (3) centralization of inventory/elimination of stocking points; (4) substitution of merge centers or consolidation/deconsolidation points for warehouses; (5) addition of a regional warehouse or a warehouse for a particular customer; (6) reassignment of roles and responsibilities among supply chain entities. Depending on the perspective, supply chain restructuring could be used in a variety of settings. In this research, supply chain restructuring refers to the extent of implementing action programs that will bring up significant changes in the supply chains. Restructuring in supply chain includes the suppliers' portfolio, the supplier development, and the coordination of flow of goods.

Supply chain restructuring research provides the means to make a firm more market-responsive, and to reduce the inventory lead time. This has happened substantively in Europe with the launch of the European Union that integrated many different economics regions into one (Kopczak, 1997). The development of technology enabled firms to eliminate unnecessary delays associated with administrative works, and helped them to reallocate their supply chains in a more decentralized way, and relegate responsibilities to suppliers and distributors. After conducting a survey on 26 partnerships in the computer industry, Kopczak identified at least 6 types of supply chains: (1) use of faster modes of transportation (air freight, express delivery), and more direct shipment; (2) consolidation of transportation routes, sometimes accompanied by relocation of consolidation/deconsolidation points; (3) elimination of local inventory stocking points, and centralization of inventories; (4) substitution of consolidation/deconsolidation points for ware- houses as mixing points; (5) addition of a regional warehouse, or of a warehouse for a particular customer; (6) reassignment of roles and responsibilities among supply chain entities.

The possibility of supply chain restructuring also increases as the market becomes more volatile and as competitors rapidly changes their strategy. It is reported that outsourcing is one of the strong drivers of supply chain restructuring. Firms that implement market responsive product strategy will face the question of how to approach supply chain restructuring.

Table 2.4. Definition of Constructs of Coordination level of RSC

Construct	Definition	Reference
Information Sharing in Supply Chain	Information sharing in supply chain refers to the usage of information technology by a manufacturer with the purpose of enhancing communication with suppliers and customers in areas such as order tracking, knowledge management, and collaboration services.	Cline & Guynes, 2001; Coates, 2000; Da Silveira et al. 2001; Goldman et al., 1995; Gunasekaran, 1998; Hoek et al., 2001; Keen, 1991; Teo & King, 1997
Coordination in Supply Chain	The mechanisms to manage dependencies among manufacturers and suppliers and customers in sharing planning decisions, demand, and delivery knowledge in order to increase collaboration	Barratt 2004; Chan et al. 2004; Holweg et al., 2005; Malone & Crowston 1994; Olson et al. 2001; Lewis & Talalayevsky 1997
Supply Chain Restructuring	The extent of implementing action programs that will bring significant changes in the supply chain, including the suppliers'/ customers' portfolio, the supplier/customer development, and the coordination of flow of goods.	Camm et al. 1997; Christman 1999; van Hoek et al. 1999; Voordijk 1999; Croom 2001; Grant 2005; Kopczak 2005

2.5. Intra-organization level of responsive supply chain

2.5.1. Advanced Manufacturing Technology

Manufacturing process design has changed over time as production itself has evolved from craft systems to modern industrial manufacturing (Skinner, 1985). Through this evolution, having an appropriate and efficient manufacturing process design has become increasingly important as investments have become larger, time lines longer, production volumes larger, and technological advances more rapid. Manufacturing or process design involves significant long-term, capital-intensive decisions which can determine the direction of a firm for years to come by developing a competitive or first mover advantage, or by leading the firm to an inappropriate, or worse, unprofitable manufacturing direction. Successful manufacturing design requires coordinating strategies and integrating multiple areas of the firm (Hayes & Wheelwright 1979a; Hayes & Wheelwright 1979b).

As manufacturing processes and customer needs have changed, so have manufacturing goals, changing from those of high volume to faster time, from those of standardization to increased flexibility and product variety, from those of secondary roles to primary roles, and from those of silo mentalities to integrative approaches. As manufacturing goals have evolved, researchers have recognized that the manufacturing design expectations of the past were no longer effective, and they had to be adapted to the changing market conditions. Part of this adaptation includes a growing recognition of the importance of product designs in the manufacturing process.

Amidst these changes, flexible manufacturing technologies have emerged as an alternative solution, because they enable firms to produce products at a lower cost but with a higher variety, thus increasing the firms' strategic flexibility (Lei et al. 1996). Flexible manufacturing technologies denote machines or technologies such as automated parts loading/unloading, automated guided vehicles (AGVs), flexible manufacturing/assembly systems (FMS/FAS/FMC), computer-aided inspection, and integrated design-processing systems (CAD-CAE-CAM-CAPP). These technologies open the potential for firms to acquire faster manufacturing speeds, greater product variety, and increased productivity (Lei et al. 1996). Manufacturing systems equipped with flexible manufacturing technologies increase production speed due to the reduced set up times and the relative ease of adopting product variants into the system. Greater product variety stems from their capability to accommodate more designs quickly, resulting in an increase in productivity.

2.5.2. Pull Production

Pull production can be defined as the production system in which the production is triggered by previous operations, and by the system's downstream and eventually actual customer demands (Koufteros, Vonderembse, & Doll, 1998; Siha, 1994; Spearman & Zazanis, 1992).

Pull production aims to reduce time to market by eliminating the time wasted in all aspects of value-creation and in the delivery process of the manufacturing system (Blackburn 1991). Firms that acquire agility through redesigning their process into pull production produce competitive advantages in their productivity, market share, premium prices, reduces risk, and customer services (Blackburn 1991; Koufteros et al. 2007; Stalk 1988). Pull production is a significant factor for time-based competition (Koufteros et al., 1998; Siha, 1994; Spearman & Zazanis, 1992).

The core idea behind pull production is that customers and their needs drive production so that the manufacturer makes what is demanded more efficiently. Customer demand triggers production, and manufacturers satisfy customers by speedily making and delivering the order to them (Deming, 1986; Koufteros et al., 2007; Schonberger, 1986). As a result, pull production system retains only the necessary work-in-process inventory, and reduces wasteful elements such as waiting time and over production.

2.5.3. Integrative product development programs

Early involvement of the supply chain stakeholders refers to collaborating with all the strategic constituents of the supply chain such as manufacturers, suppliers, marketing, and customers in the research and development phase.

Krishnan and Ulrich (2001) view the complexity of product design as "a deliberate business process involving hundreds of decisions", implying that a multitude of methods are used to tackle the issue. Among the various aspects to address the complexity of product design, early involvement of stakeholders in product design has received increasing attention as Japanese firms have first demonstrated the benefits of forming a collaborative and long-term relationship with suppliers (Brown & Eisenhardt, 1995; Clark, 1989; Dowlatshahi, 1998; Forza, Salvador, & Rungtusanatham, 2005; Koufteros et al., 2001; Takeishi, 2001).

In a comparative study of the Japanese, American, and European automobile industries, Clark (1989) reports that companies reaped significant advantages by integrating "a network of capable suppliers (p. 1261)" into the new product development process. Japanese firms tended to adopt a "high-supplier/high-unique parts" strategy, whereas American projects tended to pursue a "low-supplier/low-unique parts" strategy

(p. 1252). “In the Japanese system, in contrast, suppliers are an integral part of the development process: they are involved early, assume significant responsibility, and communicate extensively and directly with product and process engineers (p. 1252).” This early involvement of suppliers into the new product development process allowed the Japanese manufacturers to adequately tailor a part according to the specific requirements of a product. Moreover, the author found that increasing project scope has a critical influence on the performance of the product development project.

Another benefit from an early involvement of stakeholders in product development is that their capabilities in different spheres of expertise can come together (Dowlatshahi 1998). The partnerships among stakeholders provide an opportunity to put technological, organizational, manufacturing, and design competence together, inducing a synergic effect.

A turbulent market environment and frequently changing customer preferences demand that firms acquire capabilities to deal with these dynamics. The best way for a firm to deal with changing dynamics is to take a proactive approach as opposed to a reactive one, because reactions to competition are slower and more costly. Preventive actions begin in the product and process design stage. In this sense, acquiring competitive design competence enables firms to cope with uncertain environments more proactively and successfully. Thus, competitive design competence can be defined as the extent to which a firm can respond to market dynamics by increasing product customization, variety, and innovativeness.

Integrative product development programs mean implementing action programs that are designed to increase the product development performance by integration manufacturing, product development, and technology together (Bralla, 1986; Brown & Eisenhardt, 1995; Gerwin & Barrowman, 2002; Koufteros et al., 2002). Platform design, quality function deployment, design for manufacturing, teamwork, job rotation, and co-location and the implementation of CAD-CAM are examples of integrative product development programs. Research on this topic has received significant attention over the years because of its strategic importance in position.

In a turbulent market, volatile customer demands drive firms to find ways to deal with these dynamics. One method of tackling this kind of uncertainty is to take preventive actions. Proactive actions begin with the product and process design stage. By designing modularized and postponement-friendly products and processes, firms can cope more promptly with the uncertainty. Supporting these integrated design practices, design methodologies have been developed to propose design principles. One of these design methodologies is Design for Manufacture (DFM), which is a managerial approach to address manufacturing issues from the product design stage (Adler 1995). DFM emphasizes process cost reduction and the simultaneous improvement of production processes. While conventional design methods focus on sequential product development, DFM highlights a more concurrent and integrated design process. This integrated process intends to modify and restructure conventional design methods, creating and inserting manufacturing integration checkpoints into the new product development process. These checkpoints, by sharing information earlier across the new product impacted areas, can help reduce the component and material costs, and the lead time from product design to full scale production (Adler 1995). Based on previous literature and theory, one can infer a logical relationship between product design characteristics (such as product variety, product nature, or platform usage) and the selection of certain manufacturing process types.

Table 2.5. Definition of Constructs of Intra-organization level of RSC

Construct	Definition	Reference
Advanced Manufacturing Technology	A group of technologies that enables firms to produce a variety of products at lower cost and with higher speed.	Lei et al., 1996; Dean et al. 1992; Lowe 1995; Small & Chen 1995
Commitment for Pull Production	The degree of commitment to a production system to which the production is triggered by the previous operations and by the system downstream and eventually actual customer demands	Koufteros et al., 1998; Siha, 1994; Spearman & Zazanis, 1992; Koufteros et al., 2007.
Integrative Product Development Practices	The degree of implementing action programs that were designed to increase product development performance through integration among manufacturing, product development, and technology.	Bralla, 1986; Brown & Eisenhardt, 1995; Gerwin & Barrowman, 2002; Koufteros et al., 2002; Hong 2000; Hong et al. 2005

In order to accommodate expected increases in levels of product variety, supply chain designers have to anticipate and plan for the changes and challenges involved in managing a variety of products. Similar anticipatory logic may apply for the influence of platform strategy on supply chain design. If an original equipment manufacturer (OEM) utilizes a platform strategy, its supply chain might incorporate more flexibility to providing components. Given the innovative product designs, supply chains would have to be more flexible in order to consistently produce relatively new components and models. Additionally, products that require a high speed-to-market, i.e. the small electronics industry, need to have a highly responsive supply chain (Fisher, 1997), which in turn entails collaboration with the supplier and the customer. Based on these logical arguments, the following research proposal is suggested. Therefore, acquiring competitive design competence through integrated design practices allows firms to cope with uncertain environments more proactively and successfully.

2.6. Performance Level

Performance level consists of manufacturing performance and firm growth. The result of implementing responsive supply chain practices culminates on simultaneously compressing time to market and increasing customization capability, which is to enhance market responsiveness as a whole. As these operational outcomes improve in a short-term, such financial measures as sales, market share, ROS and ROI also expand in a long-term.

2.6.1. Market Responsiveness

Market responsiveness is defined as the extent to which an organization produces products and deliver them to customers promptly and accurately by compressing time in production and delivery processes (Handfield & Pannesi, 1995; Holmberg, 2000; Koufteros et al., 1998; Reichhart & Holweg, 2007; Stalk, 1988). Market responsiveness is one of the primary indicator that shows the extent of efficiency and effectiveness. Market responsiveness is measured through delivery speed, delivery dependability, manufacturing lead time, procurement lead time, and inventory turnover.

2.6.2. Customization Capability

Product customization plays a critical role in achieving manufacturing flexibility (Gerwin 1993). To remain competitive in a changing environment, there is a need to develop flexible production systems. In this regard, attaining product customization capability can give an essential competitive advantage to firms. Researchers initially identified product customization as product flexibility, a key competitive priority in the operations literature (Krajewski & Ritzman, 1999; Skinner, 1969; D'Souza & Williams, 2000). Later, the concept of product customization has been associated with product flexibility and product variety that leads to financial and marketing performance (Vickery et al. 1999). This study defines product customization capability as the ability of a firm to incorporate customers' needs and wants by producing a variety of customized products.

2.6.3. Firm growth

Firm performance refers to the extent of organization's achievement in terms of sales and market share. Market and firm growth should increase as firms implement the right strategy across its organization and supply chains. Researchers have utilized firm performance as one of the key measures of firms' effectiveness and efficiency (Stock et al. 2000; Yamin et al. 1999).

Measuring the outcomes of responsive supply chain helps to ensure effective implementation and improvement. Especially firm growth measures such as sales, market share, ROS and ROI gives more stable results as opposed to other measures. The assessment of performance measures would be great tool to assess the effectiveness to meet customer demands (Koufteros et al., 2007).

Table 2.6. Definition of Constructs of Performance Level of RSC

Construct	Definition	Reference
Market Responsiveness	Market responsiveness is defined as the extent to produce products that meet customer expectation and deliver them to customers promptly and accurately by compressing time in production and delivery processes	Handfield & Pannesi, 1995; Holmberg, 2000; Koufteros et al., 1998; Reichhart & Holweg, 2007; Stalk, 1988
Customization Capability	The ability of a firm to incorporate customers' needs and wants by producing a variety of customized products.	White, 1996; Pine et al., 1993; (Shawnee Vickery et al. 1999); Klein, 2007
Firm growth	The extent to which a firm increases sales or market share	Stock et al., 2000; Yamin et al., 1999; Koufteros et al., 2007

2.7. Hypothesis Development

2.7.1. Research Hypothesis 1

According to Venkatraman and Prescott (Venkatraman & Prescott 1990), scholars have found a strong relationship between environment and strategy, and Venkatraman and Prescott empirically reported that environment-strategy alignment has a positive impact on performance. Since Skinner's seminal work in 1969, studies have found the significance of aligning manufacturing strategy with business strategies. Organizational theory suggests that firm's strategy influenced by environments affects firm structure and performance. Table 2.7.1 summarizes this discussion.

Table 2.7. Impacts of strategy on firm structure and performance

Source	**Relationship**	**Reference**
Industrial organization theory	Market environment → firm strategy	Park & Mason 1990; Porter 1980
	Market environment → performance	Venkatraman & Prescott 1987
Organization theory	Market environment → firm structure	Lawrence & Lorsch 1986 Miles et al. 1978;
	Firm structure → performance	Hill & Pickering 1986; Park & Mason 1990;
Business policy theory	Firm strategy → firm structure	Grinyer et al., 1980
	Firm strategy → performance	Hambrick 1983; Park & Mason 1990;
	Product quality → profitability	Jacobson 1988; Venkatraman & Prescott 1987
Environment as moderators	Moderator between strategy and performance	Prescott 1986; Kirca et al., 2005

(Adopted from Marketing Science Institute, 1999, p. 172)

The turbulent external environment for manufacturing firms presents the challenges of producing a variety of products with high quality, shorter life cycles, and low prices. To remain competitive in the market, manufacturing company must equip itself with the capability to quickly respond to various changes (flexibility, time-based competition), to continuously innovate products and processes (innovation), and to offer superior quality products (quality).

The task of the management is to match "the performance of an operation's resources with the requirements of its markets" (Slack and Lewis, 2003), and this is called "fit". However, manufacturing strategy goes beyond static decision making. To acquire or maintain a competitive advantage in a constantly changing environment, it needs to have a dynamic adjustment process. In other words, manufacturing strategy continues to evolve by adjusting its structural and infrastructural processes to the changing market reality (Hill, 2000; Slack and Lewis, 2003).

Production competence theory (Cleveland et al. 1989; Safizadeh et al. 2000; Schmenner & Vastag 2006; Vickery 1991) suggests that alignment between business strategy and manufacturing strategy produces strong business performance. Business strategy consisted of order-winners will influence manufacturers to formulate and implement a corresponding functional strategy. For companies in dynamic environments, their objectives to offer a wider product range, and to frequently introduce new and innovative products require the manufacturing function to improve the product customization ability, mix flexibility, product innovativeness, and speed to market.

Contingency theory also suggests that firms have to make the fit between the environment and its strategy (Hofer 1975; Van de Ven & Drazin 1984). Therefore, it is hypothesized that:

Hypothesis 1: Firms operating in a competitive market environment will formulate a higher level of responsive product strategy than firms operating in a less competitive market environment.

2.7.2. Research Hypothesis 2

Responsive product strategy comprises of order winners that the manufacturing firm pursues in order to compress time to market and to increase customization capability. Examples of responsive product strategies are increasing product customization ability, increasing mix flexibility, reducing time to market, and making the product more innovative. According to the organization's culture and strategic orientation theory, when a firm pursues this strategic orientation, it results in a pattern that reflects the strategic orientation and organization culture (Nahm et al., 2004; Porter, 1980; Schein, 1996). Having the goals of increasing product variety and innovativeness, and of delivering new products frequently would urge firms to increase the level of information sharing in its supply chain, because they would have to assess the current product development situation as accurately as possible. Thus, to implement RPS, it is essential for firms to communicate relevant information about customer demands and supplier's status throughout the supply chain. In addition, to increase market responsiveness, firms need to frequently change information among suppliers, manufacturers, and customers.

Another aspect of RPS is coordination. Offering innovative products, making frequent new product delivery, and shortening product deliver time take coordination with suppliers and customers. A firm needs to know what products are in high demand and what are not. It should pay close attention to suppliers so that they could make constant improvement and innovation on product components. Moreover, the changes in demand information that happens on monthly or daily basis demand firms to maintain a close trust relationship with customers and suppliers. Thus, implementing RPS requires a great deal of coordination with suppliers and customers either in the form of information sharing or practices (Bharadwaj et al. 2007; Kulp et al. 2004; Gurbaxani & Whang 1991; Cline & Guynes 2001; Argyres 1999). Therefore, it is hypothesized that:

Hypothesis 2a: The higher the extent of responsive product strategy a firm implements, the higher level of information sharing in the supply chain the firm will achieve.

Hypothesis 2b: The higher the extent of responsive product strategy a firm implements, the higher level of coordination practices in the supply chain the firm will achieve.

2.7.3. Research Hypothesis 3

Gerwin (1987) emphasized the importance of flexibility that increases market responsiveness. He stated that the expected intensification of market instability will become the most important dimension of competition. In a changing competitive environment, there is a need to develop organizations and facilities that are considerably more flexible and responsive than existing ones. Sharing knowledge aids firms to move forward to this goal. In particular, information on operations flows and customer trends should be seamlessly shared in the supply chain. The flow of information throughout the supply chains can also increase market responsiveness by enhancing the level of communication among employees. Increasingly, information technology has been recognized as an essential enabler that facilitates the communication in the supply chain (Da Silveira et al. 2001; Vickery et al. 1999; Argyres 1999; Banker & Bardham 2006).

Information processing theory suggests that the usage of information technology helps firms to lower the cost involved in processing information (i.e., the cost of sending and receiving messages between actors) and to reduce the costs of processing information (i.e., the costs of sending organization's structure more efficient than others) (Argyres, 1999).

Further, coordination theory suggests that the advent of information technology lowered the cost of coordination significantly (Malone & Crowston 1994; Olson et al. 2001). For example, Wal-Mart mandated its top 100 suppliers to implement radio frequency identification (Kinsella 2003). This adoption made the coordination of supply chain activities much easier than before. In addition, Wal-Mart could now manage the inventory movement and probe changes in customer demands in real time. Therefore, it is hypothesized,

Hypothesis 3a: The higher the level of information sharing in the supply chain a firm implements, the higher the level of coordination in the supply chain the firm will achieve.

Information sharing enabled by the adoption of information technology further brings about restructuring the ways human organizations and markets work by significantly reducing costs involved in specific type of coordination. Malone and Crowston (1994) predict three levels of effects. Just as a car replaced carriages and horse-riding, so does information technology replace manual works among entities. This substitution triggers amplification of the usage of information technology and restructuring of the existing configuration. The restructuring can take various formats such as fewer coordination levels, smaller size, more centralized or decentralized structure (Malone & Crowston 1994; Gurbaxani & Whang 1991).

When it comes to the impact of information sharing on supply chain, information technology can bring many changes. First of all, the alteration in coordination mechanisms changes dependencies and relationships among activities, tasks, and actors. Second, information sharing through information technology adoption makes supply chain structure be simpler in greater scale. The decision making process could become either centralized or decentralized.

Moreover, increased information sharing produces a network effect. Suppliers, distributors, and manufacturers know how things are being progressed in the supply chain, and they can thus collaborate with each other. It also helps firms to spot symptoms of manufacturing or delivery delay, which informs them of possible restructuring opportunities at many intervals. Information sharing will eventually help firms to consider supply chain restructuring in terms of planning the flow of goods, and the supplier development.

Hypothesis 3b: The higher the level of information sharing in the supply chain a firm implements, the higher the level of supply chain restructuring the firm will achieve.

2.7.4. Research Hypothesis 4

Coordination theory suggests that implementing a certain coordination mechanism will entail restructuring between entities involved in the coordination (Malone & Crowston 1994; Lewis & Talalayevsky 1997). Coordination is adopted when there are dependencies or interrelationship among entities. For example, in the context of the supply chain, Malone and Crowston (1994) understand usability as a type of dependencies between producer and customer. Usability means that products that a producer manufactures must be usable by consumers. Some mechanisms that deal with this dependency are standardization, communication with users, and participatory design. Participatory design, in particular, indicates that producers and customers actively take part in design of products from its early stage. Concurrent engineering can be understood as a form of participatory design. The change of coordination mechanism from standardization to participatory design leads firms to considering product design from its early stage and likely alters product architecture and production culture from vertical communication to horizontal communication. Another example is Wal-Mart's inventory management method. Wal-Mart adopted the coordination mechanism that its suppliers have direct access to the point-of-sale data and manage their own inventories on the shelves in Wal-Mart (Lewis & Talalayevsky 1997). This adoption demanded a flatter distribution structure through disintermediation between Wal-Mart and Manufacturer, a form of restructuring that integrated distribution with sales systems.

Hypothesis 4: The higher the level of coordination in the supply chain a firm implements, the higher the level of supply chain restructuring the firm will achieve.

2.7.5. Research Hypothesis 5

Since advanced manufacturing technologies enable firms to produce a more product variety at varying production levels than ever before, the new types of supply chains must either adapt to or be redesigned to meet these changing manufacturing customer characteristics.

Researchers recognize the relationship between advanced manufacturing technologies and organizational design. For instance, Lei et al. (1996) stated, “The full exploitation of advanced manufacturing technologies, however, requires a flexible organization design that allows quick responses to take advantage of the capabilities of the technology” (p. 502). Flexible organization in Lei’s research refers to loosely coupled systems, modular structures, open systems, and learning laboratories. Extending this flexible organization to a supply chain context, implementing advanced manufacturing also requires flexible supply chain design. Flexibility cannot emerge without increased information sharing and collaboration with suppliers and customers. To make the advanced manufacturing works seamlessly, a hub–manufacturer must be able to collaborate with suppliers and customers, and to coordinate all activities at a higher level.

As a firm increases the level of supply chain restructuring, it will realize the need for implementing advanced manufacturing technology more and more by making it easier to collaborate with suppliers and customers. Advanced manufacturing technology enables a firm to absorb changing reality more readily. Advanced manufacturing technology gives more room to flexibly cope with changing situation. Therefore, it is hypothesized that:

Hypothesis 5a: The higher the level of supply chain restructuring a firm achieves, the higher level of advanced manufacturing technology the firm will implement.

Song & Nagi (1997) report that manufacturing flexibility strongly correlates with IT use. The challenges that manufacturers face in increasing manufacturing flexibilities are numerous. Among them, the following are a few of the main obstacles. First, the manufacturing has to provide its distributors with reliable information although they are geographically dispersed. Poor or inaccurate or inconsistent data could cause the supply chain to be chaotic. Second, manufacturing has to be able to encompass the disparate characteristics of partners. In addition, to increase the information flow, the focal firm has to offer a secure method of data exchange.

Koufteros et al. (2007) report that manufacturing firms that have succeeded in fostering internal and external communication were able to implement pull production better. For instance, when customer orders change, the manufacturer has to know the changes so that it can produce the right product for the customer. Employees on the shop-floor rely on one another to maintain a streamlined flow of material through the supply chain. When problems occur, employees are able to solve them quickly by receiving instantaneous feedbacks from the upper level management. In other words, the quality of communication removes the need for inventory, increasing pull production and the efficiency of the production system.

The efforts to restructure the supply chain increase the capability to compete on time. The more the firm restructures its supply chain, the more it optimizes its structure and eliminates wasteful parts from it. This means that pull production can be more readily implemented since the lead time cycle will be shortened. As a result, manufacturing firms can have access to customer trends and changes occurring across the supply chain.

In summary, the reasons that supply chain restructuring will increase pull production system are two-fold: (1) Supply chain restructuring eliminates wasteful elements in the supply chain and simplify working processes with suppliers and customers (Kopczak 1997; Croom 2001) and (2) supply chain restructuring helps to shorten production lead time that helps firms to communicate reliable information with suppliers and customers, which facilitates pull production (Camm et al. 1997; Grant 2005; van Hoek et al. 1999). Therefore, it is hypothesized that:

Hypothesis 5b: The higher the level of supply chain restructuring a firm achieves, the higher level of commitment for pull production the firm will achieve.

Several theoretical perspectives also lay the rationale for integrated product design. Brown & Eisenhardt (1995) surveyed product development literatures, and framed them into three perspectives: rational plan, communication web, and disciplined problem solving. The first perspective, product development as rational plan, believes that rational and careful planning precedes successful product development and launch. The plan starts from the internal organization such as marketing and manufacturing, and the strength of the internal organization strongly correlates with product success (Zirger & Maidique 1990). R&D involvement and predevelopment planning exemplify the rational planning.

The second theoretical perspective sees integrative product development as a communication web. The product development process opens a sphere for a variety of people with different expertise to come together, and to communicate their knowledge and perspectives. The key idea behind product development as a communication web is that interconnectedness among team members enhances information flows, which in turn leads them to achieve higher performance.

Collaboration with strategic suppliers and customers increases a firm's responsiveness to market changes (Holweg et al., 2005). This increased responsiveness is from the fact that supply chain restructuring brings greater customization capability to the supply chain. A hub manufacturer can more flexibly deal with market dynamics when it is supported by its suppliers and customers, thus giving it greater leeway to deal with various changes. For instance, to accommodate a customer's needs, a firm often has to procure different sets of components and materials from suppliers. From the customers' standpoint, a firm should know what the customers' needs and demands are. This information keeps the firm updated about the market situation, and enables it to customize products in the right way at the right time. For instance, Business Week (May, 2008) reports that GM is happy with a $3 billion loss in the first quarter of 2008 because they expected to have greater losses. One of primary reasons is that a major supplier decided to go strike. The supplier strike caused several important plants to come to a halt, causing significant losses, but with the resolution of the strike, the losses ended. This example shows the significant impact a key supplier could have on a company.

Restructuring the supply chain helps a firm to streamline its suppliers and customers. Optimized supply chains make it easier for constituents of the supply chain to share information regarding production process and customer's wants. Simplified and optimized supply chains also make it easier to integrate product development process from manufacturing to procurement to engineering.

Integrated product design is crucial for firms success in decreasing production errors and selling the right product. This process requires cross-functional integration which means the collaboration from suppliers and customers. Supply chain restructuring makes it clear who the main customers and suppliers are. This identification and clearer target help firms to communicate. Therefore, it is hypothesized that:

Hypothesis 5c: The higher the level of supply chain restructuring a firm achieves, the higher the integrated product design the firm will achieve.

2.7.6. Research Hypothesis 6

Tracey et al. (1999) report that advanced manufacturing technology contributes to creating a competitive edge for a company, and that the manufacturing executive's participation in corporate strategy formulation also plays an essential role in competing in the market. Stalk (1998) also reports that by acquiring AMT, Japanese companies were able to increase their manufacturing flexibility. AMT contributes to manufacturing flexibility. These flexibilities enable firms to implement time-based manufacturing practices, just-in-time systems, and mass customization, and to respond to the turbulent market situation.

IT/IS and other technologies are AMT that directly assist humans in performing tasks or even replace manpower by doing the tasks that humans once performed (Gunasekaran & McGaughey 2002). Such technologies as automated parts loading and unloading, automated guided vehicles, and automated storage-retrieval systems perform works related to suppliers and customers. These technologies reduce direct labor and increase efficiency in the production system. These AMTs also reduce set up times and enhance the capability of accommodating customer's needs (Lei et al. 1996). Therefore, it is hypothesized that:

Hypothesis 6a: The higher the level of advanced manufacturing technology a firm implements, the higher level of pull production the firm will achieve.

Integrated product design competence is a firm's aptitude for increasing the product customization, variety, and innovativeness by pursuing organizational and technological integration. The competence to integrate product design helps firms to simplify and modularize products architecture and design. Simplified and modularized product architecture means simplified and modularized production system which makes it easier to implement to pull production (Spearman & Zazanis 1992; Schonberger 1986; Naylor et al. 1999). Therefore it is hypothesized that:

Hypothesis 6b: The higher the level of integrated product development programs a firm implements, the higher level of pull production the firm will achieve.

2.7.7. Research Hypothesis 7

The advent of advanced manufacturing technology empowered firms to speedily offer customized products to customers at cheaper prices than before. These cost savings arise because advanced manufacturing technologies overcame the trade-offs among customization, costs, and speed (Lei et al. 1996). As technology develops further with inexpensive computing power, customization and production will become less and less expensive, leading firms to higher level of market responsiveness (Small & Chen 1995; Tracey et al. 1999; Lei et al. 1996). Therefore, it is hypothesized that:

Hypothesis 7a: The higher the level of advanced manufacturing technology implementation, the higher level of market responsiveness the firm will achieve.

The pull system employs a tangible way of controlling shop floor operations. The pull system increases manufacturing speed by leaving only a small amount of work-in-process in the production system. Moreover, it simplifies complexity in the production process by eliminating complicated elements (Schonberger 1986). To meet the pull production requirements, companies produce only what is needed at the time needed. Pull production has also often been associated with increased customer service, which is manifested in the more accurate and timely deliveries to customers. Corollary of pull production is a positive effect on meeting customer's demands in time efficiently (Spearman & Zazanis 1992; Naylor et al. 1999; Schonberger 1986). Therefore, it is hypothesized that:

Hypothesis 7b: The higher the level of pull production that a firm implements, the greater level of market responsiveness the firm will achieve.

Daft and Lengel's (1986) theory of organizational information processing provides a theoretical rationale for early planning and collaboration between design and manufacturing. Firms adopt advanced planning mechanisms to reduce uncertainty in the changing international market. Effective product development effort requires an appropriate understanding of uncertain market environments. At an coordination level, firms pursue a vision, set the direction for the future by responding to larger external and internal environmental changes, and establish overall goals of sustaining market shares. When there is a greater complexity of knowledge in products and processes, the need for clearly communicating design and manufacturing issues among the product development teams in advance is also greater (Jassawalla and Sashittal, 1999; Hong et al., 2004). In the international market, the more complex the product and services offerings are, the more critical it is for customers, engineering, manufacturing, and suppliers to engage with each other when employing early involvement and planning. Such early planning and involvement of key stakeholders enhance the likelihood of the organizational integration effort. Besides, such early planning, and the involvement of design and manufacturing also help to improve the selection and implementation of necessary technological resources, and to facilitate the technological integration in the firm. The organizational and technological integration of product development with manufacturing allows firms to not only shorten the product development lifecycle, but also to proffer right products that meet, or even exceed customer expectations.

Hypothesis 7c: The higher level of integrative product development practices a firm implements, the higher level of market responsiveness the firm will achieve.

2.7.8. Research Hypothesis 8

Market responsiveness and customization have long been known as key antecedents to firm performance (Klein, 2007; Pine et al., 1993; Vickery et al., 1999; White, 1996). Firms that provide customers with well-customized products exceed customers' expectation. Many researchers have found a positive association between market responsiveness and firm growth (Zhang et al., 2003; Tu et al. 2005). Therefore, it is hypothesized that:

Hypothesis 8: The higher market responsiveness a firm achieves, the higher level of firm growth it will achieve.

Table 2.7.2. summarizes hypotheses, the rationales behind the hypotheses, and references for them.

Table 2.7.2. Rationales of Hypotheses

Hypo-thesis	Definition	Reference
H1	Firms operating in a competitive market environment will formulate a higher level of responsive product strategy than firms operating in a less competitive market environment.	Venkatraman & Prescott 1987; Van de Ven & Drazin 1984; Hofer 1975; Cleveland et al. 1989; Hill 2000
Rationale (H1)	(1) Strategic fit between environment and firm strategy. (2) Competitive environment drives firms to offer innovative products more frequently.	
H2a **H2b**	The higher the extent of responsive product strategy, the higher the information sharing in the supply chain The higher the extent of responsive product strategy, the higher the level of coordination in the supply chain.	Bharadwaj et al. 2007; Kulp et al. 2004; Gurbaxani & Whang 1991; Cline & Guynes 2001; Argyres 1999
Rationale (H2a,b)	Increase in innovativeness and compression of product development cycle requires seamless information flows and close coordination in the supply chain level.	
H3a **H3b**	The higher the level of information sharing in the supply chain, the higher the level of supply chain restructuring. The higher the level of information sharing in the supply chain, the higher the level of coordination in the supply chain.	Da Silveira et al. 2001; Vickery et al. 1999; Argyres 1999; Banker & Bardham 2006; Crowston 1997; Olson et al. 2001; Malone & Crowston 1994
Rationale (H3a,b)	Coordination theory suggests (1) information technology enhances information sharing significantly by reducing coordination costs. (2) Information technology fosters coordination between entities in the supply chain. (3) Information sharing results in supply chain restructuring by making it flatter and simpler.	
H4	The higher the level of coordination in the supply chain, the higher the level of supply chain restructuring.	Malone & Crowston 1994; Crowston 1997; Lewis & Talalayevsky 1997
Rationale (H4)	Changes in coordination brings changes in structure.	
H5a	The higher the level of supply chain restructuring a firm achieves, the higher the firm will implement advanced manufacturing technology	Lei et al. 1996; Dean et al. 1992; Tracey et al. 1999
H5b	The higher the level of supply chain restructuring a firm achieves, the higher commitment for pull production the firm will achieve	Kopczak 1997; Voordijk 1999; Siha 1994; Koufteros 1999
H5c	The higher the level of supply chain restructuring a firm achieves, the higher integrated product design the firm will achieve	Kopczak 1997; Camm et al. 1997; Croom 2001; Grant 2005; Voordijk 1999; Hong

		2000; Hong et al. 2005
Rationale (H5a,b,c)	Implementing advanced manufacturing technology requires implementing flexible organizational system. As a firm restructures its supply chain, supply chain becomes simpler and flatter, which support the implementation of advanced manufacturing technologies, pull production, and integrated product development in the firm.	
H6a	The higher the level of advanced manufacturing technology a firm implements, the higher level of pull production the firm will achieve.	Tracey et al. 1999; Lei et al. 1996; Gunasekaran & McGaughey 2002; Stalk 1988
H6b	The higher the level of integrated product development programs a firm implements, the higher level of pull production the firm will achieve.	Spearman & Zazanis 1992; Schonberger 1986; Naylor et al. 1999
Rationale (H6a,b)	Implementing pull production assumes that production system speedily processes customer demands and supplier coordination. Advanced manufacturing technology helps firms to resolve trade-offs among variety, speed and cost. Integrated product design addresses meeting customer's expectation and simplifying product architecture and production process.	
H7a	The higher the level of advanced manufacturing technology implementation, the higher level of market responsiveness the firm will achieve.	Small & Chen 1995; Tracey et al. 1999; Lei et al. 1996
H7b	The higher the level of commitment for pull production, the higher level of market responsiveness the firm will achieve.	Spearman & Zazanis 1992; Naylor et al. 1999; Schonberger 1986
H7c	The higher the level of integrated product development practices, the higher level of market responsiveness the firm will achieve.	Hong 2000; Hong et al. 2005; Koufteros et al. 2002
Rationale (H7a,b,c)	Market responsiveness can be increased mainly in two ways: speed of order fulfillment and meeting or exceeding customer expectation. Pull production satisfies these two aspects because the pull-production-oriented system aims to manufacture and deliver what is ordered. Advanced manufacturing directly increases production speed and aids pull production. In addition, integrated product design embeds flexibility and modularity in product through integration in organization and technology. Therefore, advanced manufacturing technology, pull production, and integrated product development help firms to increase market responsiveness.	
H8	The higher market responsiveness a firm achieves, the higher level of firm growth it will achieve	Klein, 2007; Pine et al., 1993; Vickery et al., 1999; White, 1996
Rationale (H8)	Market responsiveness means to satisfy customer's needs speedily. When firms meets and surpasses customer expectation, their sales increases and market share expands.	

CHAPTER 3: RESEARCH METHODOLOGY

3.1. Data

In order to examine the research model presented in figure 2.1., empirical evidence was drawn from the International Manufacturing Strategy Survey (IMSS).

Table 3.1.1. Sample by country and region

Country	Asia	Europe	Middle East	North America	Oceania	South America	Total	Percent
Argentina						44	44	6%
Australia					14		14	2%
Belgium		32					32	4%
Brazil						16	16	2%
Canada				25			25	3%
China	38						38	5%
Denmark		36					36	5%
Estonia		21					21	3%
Germany		18					18	2%
Greece		13					13	2%
Hungary		54					54	7%
Ireland		15					15	2%
Israel			20				20	3%
Italy		45					45	6%
New Zealand					30		30	4%
Norway		17					17	2%
Portugal		10					10	1%
Sweden		82					82	11%
Taiwan	50						50	7%
Netherlands		63					63	8%
Turkey			35				35	5%
UK		17					17	2%
USA				36			36	5%
Venezuela						30	30	4%
Total	88	423	55	61	44	90	761	100%

The purpose of IMSS is to examine international practices and performance related to manufacturing strategy. It was in 1992 when the initial world-wide data gathering began, and at that time, 20 countries participated. Since then, the data gathering has taken place every four years. The data used in this research is IMSS-IV that included 761 manufacturing units in 24 countries around the world. Table 3.1.1 summarizes this descriptive statistics.

Table 3.1.2. ISIC Classification by Country

Country	Region	ISIC 28	ISIC 29	ISIC 30	ISIC 31	ISIC 32	ISIC 33	ISIC 34	ISIC 35	Others	Total
Argentina	SA	24	6	1	5	1	1	5	1	0	44
Australia	OC	10	4	0	0	0	0	0	0	0	14
Belgium	EU	16	4	0	4	4	0	1	3	0	32
Brazil	SA	5	3	0	0	1	0	5	1	1	16
Canada	NA	13	6	0	1	1	0	3	1	0	25
China	AS	7	10	2	13	2	1	3	0	0	38
Denmark	EU	10	8	1	7	2	5	1	1	1	36
Estonia	EU	6	4	3	6	1	0	1	0	0	21
Germany	EU	7	3	0	4	1	2	0	1	0	18
Greece	EU	6	1	0	1	1	0	1	1	2	13
Hungary	EU	22	9	0	4	6	1	9	3	0	54
Ireland	EU	2	2	1	4	4	2	0	0	0	15
Israel	ME	12	3	1	1	2	1	0	0	0	20
Italy	EU	8	19	0	4	7	1	2	4	0	45
New Zealand	OC	12	13	0	4	0	0	0	1	0	30
Norway	EU	10	3	0	2	0	1	1	0	0	17
Portugal	EU	7	1	0	1	0	0	1	0	0	10
Sweden	EU	26	20	0	9	4	5	12	5	1	82
Taiwan	AS	12	7	5	9	10	2	4	1	0	50
Netherlands	EU	20	13	4	13	0	5	3	5	0	63
Turkey	EU	5	13	0	2	1	0	9	5	0	35
UK	EU	9	1	0	3	0	2	1	1	0	17
USA	NA	13	0	3	1	1	2	4	8	4	36
Venezuela	SA	20	0	0	3	0	0	6	0	1	30
Total		282	153	21	101	49	31	72	42	10	761
Percentage		**37.1%**	**20.1%**	**2.8%**	**13.3%**	**6.4%**	**4.1%**	**9.5%**	**5.5%**	**1.3%**	**100.0%**

In 2005, national research groups within the global network collected the data using a standard questionnaire. Industries included nine manufacturing industries from ISIC code 28 to 36 (Table 3.1.2). The questionnaire was sent to plant managers or manufacturing executives in a sample of manufacturing units with more than 100 employees. Initially, firms were contacted for their willingness to participation, and the response rate varied across countries with the minimum response rate of 25%.

3.2. Sample Characteristics

Understanding sample characteristics helps us to grasp the context of the data and analysis. The survey in 2005 was conducted by full-time professors in operations management strategy areas, who acted as research coordinators in each of the countries. In countries that do not use English as the primary or common language, the research coordinators translated the survey. The mail survey was modeled after the total design method suggested by Dillman (1978). Works by Voss and Blackmon (1998), Frohlich and Westbrook (2002), da Silveira (2005), and Cagliano et al. (2005) present the credentials and detailed methods of IMSS research.

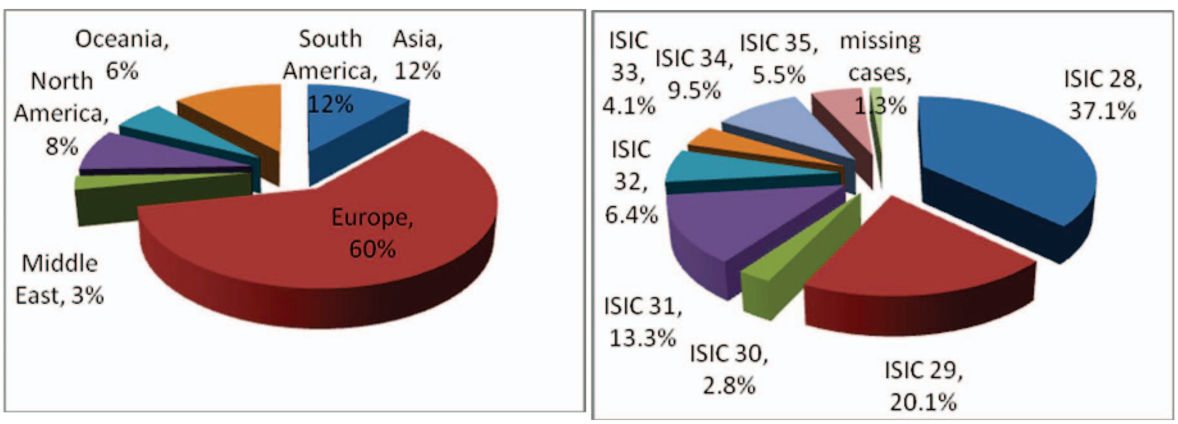


Figure 3.2.1. Sample by region and ISIC code

The responses are from 24 countries. Each country collected independently and the minimum of data sampel is 13 from Greece and the maximum is 82 from Sweden. Since the survey consisted of more than three hundred questions, it was difficult to get many responses from each country. The responses can be divided into six regions- Asia accounts for 12%, Europe for 60%, Middle East 3%, North America 8%, Oceania 6%, and South America 12%. The distribution according to the ISIC code is as follows: ISIC 28 (fabricated metal products, except machinery and equipment) 37.1%, ISIC 29 (machinery and equipment not elsewhere classified) 20.1%, ISIC 30 (office, accounting and computing machinery) 2.8%, ISIC 31 (electrical machinery and apparatus not elsewhere classified) 13.3%, ISIC 32 (radio, television and communication equipment and apparatus) 6.4%, ISIC 33 (medical, precision and optical instruments, watches and clocks) 4.1%, ISIC 34 (motor vehicles, trailers and semi-trailers) 9.5%, ISIC 35 (other transport equipment) 5.5%, and ISIC 36 (other miscellaneous products not listed) 1.3%. Figure 3.2.2 summarizes the sample by region, country, and industry.

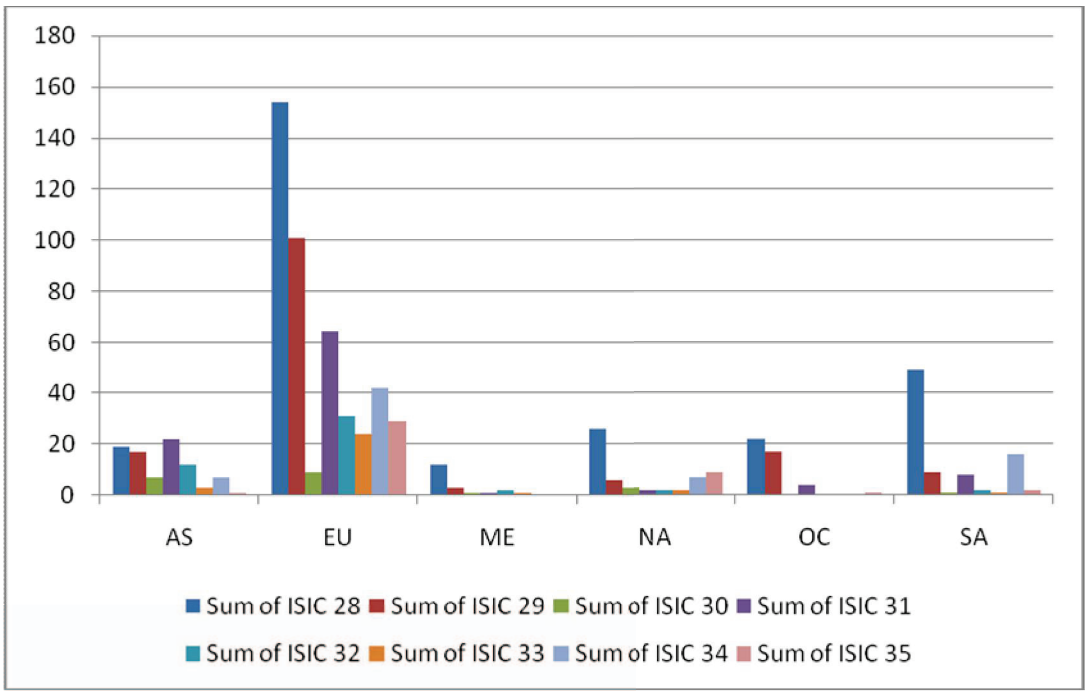


Figure 3.2.2. ISIC Classification by Region

The situation of the business units can be described as follows: 47% of business units were located at one site whereas the rest of the (53%) of business units were located at more than one site (refer to table 3.2.3.). Table 3.2.3. describes how the business unit situation relates to product development. More than half of the companies (52%) were operating product development at one site in its country. 22% of companies were running global product development programs (refer to table 3.2.1.).

Table 3.2.1. Business Unit Situation relating to Manufacturing

	Manufacturing Site		NPD Site	
Location of Business Unit	Number	Percent	Number	Percent
At one site	358	47%	400	52%
At more than one site in this country	133	17%	101	13%
At sites in a few countries in this continent	66	9%	81	11%
Globally, at sites in various continents	208	27%	171	22%

Table 3.2.2. captures the level of product customization. Only 9% of companies are not customizing its products but the 91% of companies are taking the customization strategy. 46 % of companies are customizing their products depending on the customer's orders (refer to Table 3.2.2.).

Table 3.2.2. Level of Product Customization

Level of Customization	Number	Percent
Standard products in only one version	68	9%
Modularized products based on a number of standard components	136	18%
Products with a product platform and a significant number of product-specific parts	199	27%
Customized products depending on the customer's order	168	22%
Products that are made entirely to the customer's specification	178	24%

3.3. Large-scale Instrument Assessment Methodology

Within the large IMSS survey, items that matched the constructs were chosen carefully at the author's discretion. Rigorous reliability and validity assessment followed the selection of relevant items. Purification, factor structure (initial validity), unidimensionality, and reliability ensure acquiring valid measurement. This process starts with item purification. Kerlinger (1978) suggests calculating the Corrected Item-Total Correlation (CITC) for each item. The instrument purification will be conducted by examining the corrected items total correlation (CITC). An item whose CITC is less than 0.5 should not be included in order to ensure scale reliability. Items that have less than 0.5 of CITC score will be cut off from each construct according to Kerlinger (1978)'s recommendation. If an item is deemed to constitute an important criterion for a construct, it should be retained, notwithstanding a CITC that is slightly lower than 0.5.

It is essential to test the unidimentionality of each construct. Cronbach's Alpha is a widely accepted method of assessing the internal consistency of a construct (Cronbach 1951). Typically, principle component factor analysis with varimax rotation and mean substitution ensures unidimentionality. The acceptable loading limits is be greater than 0.6 for exploratory study (Nunnally 1978), and Cronbach's Alphas should exceed 0.6 for scale consistency (Cronbach 1951).

Following the examination of CITC and Cronbach's Alpha, an explorative factor analysis (EFA) was employed, using SPSS 16 for Windows, to test the factor structure and the possible latent variance of the measure in each construct. Factor analysis serves to identify factor structure and to reduce the data (Hair et al. 1998). The first step scrutinizes the correlations among items. Detecting more than two correlations above 0.3 signifies the presence of underlying factors among items. The sample size plays an important role in factor analysis, and it is advised that the ratio between sample size and the number of items exceed a ten-to-one ratio (Hair et al. 1998). The sample size 761 used in this research, however, meets this condition sufficiently, for the total number of survey items used for analysis does not exceed 70. Principal Component analysis with Varimax rotation method is appropriate when a researcher intends to do further analysis with the results from factor analysis, and so this method were chosen for the factor analysis. This scrutiny sets 0.4 as the cutoff score of factor loadings in order to ensure finding a sound structure. Purification process finds its role in the incidence of items that exhibit cross-loadings of more than 0.4. This process allows for carefully observing the impact of eliminating one item to the measurement model.

The Kaiser-Meyer-Olkin (KMO) measure tests sampling adequacy. 0.5 serves as the cutoff value in the KMO test, and 0.8 is a very good value, while 0.9 is as an outstanding one. The KMO after factor analysis produced 0.859, which shows the adequacy of the sampling in this data analysis (Yoo 2006; Liao 2006).

3.4. Item Purification

Following the method described in section 3.3, this section examines the measurement purification via exploratory factor analysis and confirmatory factor analysis. Sections 3.4.1. through 3.4.4. present item purification results at the construct level. These analyses are twofold: (1) the initial items and dimension-level corrected item-total correlation (CITC) scores, and (2) exploratory factor analysis.

3.4.1. Strategic Level of Responsive Supply Chain

The strategic level of responsive supply chains consists of competition intensity and responsive business strategy. The purification process starts with the corrected item-total correlation (CITC) scores analysis provided by SPSS 16.0. Both items for Competition Intensity produced 0.46 for CITC, which is a little lower than 0.5. Since both items cover an important criterion of competition intensity, and the CITC scores are close to 0.5, these items were not discarded. For Responsive Business Strategy, one item displayed a CITC of 0.19, which is far below 0.5, and so the item was discarded to attain a better Cronbach's alpha.

Table 3.4.1 Purification for Strategic Level of Responsive Supply Chain

Coding		Construct Items	CITC-1	Alpha if deleted	CITC-2
IMSS	Model				
Competitive Market Environment: alpha=0.615 (initial)					
How would you describe the eternal environment?					
A4 e	MD1	Competition Intensity	0.46	N/A	
A4 f	MD2	Number of Competitors	0.46	N/A	
Responsive product strategy: alpha=0.698 (initial); 0.784 (final)					
Consider the importance of the following attributes to win orders from your major customers.					
A5e	RPS1	faster deliveries	0.18	0.79	-
A5g	RPS2	wider product range	0.58	0.58	0.58
A5h	RPS3	offer new products more frequently	0.65	0.51	0.71
A5i	RPS4	offer more innovative products	0.56	0.58	0.60

The exploratory factor analysis with principal component extraction and varimax rotation method yielded two factors with factor loading greater than 0.80. In addition, the two factors combined explain 71% of total variance, which goes beyond the recommended level of 60% variance. The Cronbach's alpha for Responsive Business Strategy is 0.70 and that for Competition Intensity is 0.62, which falls to an acceptable margin.

Table 3.4.2. Factor Loadings for Strategic Level of RSC

Item	F1- Responsive product strategy	F2- Competition Intensity	Alpha
A4 e		0.86	0.62
A4 f		0.85	
A5g	0.80		0.70
A5h	0.88		
A5i	0.81		
Eigenvalue	2.09	1.47	
% of variance	41.8	29.4	
Cumulative % of variance	41.8	71.2	

3.4.2. Coordination level of Responsive Supply Chain

The strategic level of responsive supply chains has both the supplier side and the customer side, and each aspect consists of three constructs: information sharing, coordination, and restructuring practices.

3.4.2.1. Distribution Chain Aspect

CITC analysis examines information sharing with customers, coordination with customers, and distribution chain restructuring. In regard to information sharing with customers, all five items exhibit CITCs above 0.5 and Cronbach's alpha of 0.87. These results indicate internal consistency of the five items in forming the construct, information sharing with customers. Similarly, three items for Coordination with Customers display CITCs above 0.5 and the initial Cronbach's alpha of 0.76. These results indicate internal consistency of the three items in forming the construct, coordination with customers. Two items form the distribution chain restructuring construct. Both CITCs are 0.49, which is very close to 0.5. Cronbach's alpha, 0.65, is also an acceptable one. These results support internal consistency of two items in forming the construct, distribution chain restructuring. Table 3.4.3 reports the results.

Table 3.4.3. Purification for Coordination level of RSC (Customers)

Coding		Items	CITC-1	Alpha if deleted	CITC-2
IMSS	Model				
Information Sharing with Customers: alpha=0.87 (initial)					
Indicate to what extent do you use electronic tools (Internet or EDI based) with your key/strategic customers? (1-no adoption, 5- high level of adoption)					
SC14 d	ISC1	Data analysis (audit and reporting)	0.72	0.84	
SC14 e	ISC2	Access to catalogues	0.53	0.89	
SC14 f	ISC3	Order management and tracking	0.72	0.84	
SC14 g	ISC4	content and knowledge management	0.78	0.83	
SC14 h	ISC5	collaboration support services	0.76	0.83	
Coordination with Customers: alpha=0.76 (initial)					
How do you coordinate planning decisions and flow of goods with your key/strategic customers?					
SC13 a	CCP1	Share inventory knowledge	0.61	0.67	
SC13 b	CCP2	Share production planning decisions and demand forecast knowledge	0.62	0.66	
SC13 g	CCP6	Collaborative Planning, Forecasting and Replenishment	0.56	0.72	
Distribution Chain Restructuring: *alpha=0.65 (initial)*					
Indicate degree of the following action programs undertaken over the last three years and planned efforts for the coming three years.					
SC15d	SCR4	Rethinking and restructuring distribution strategy in order to change the level of intermediation	0.49	-	
SC15e	SCR5	Increasing the level of coordination of planning decisions and flow of goods with customers including dedicated investments	0.49	-	

The exploratory factor analysis with principal component extraction and varimax rotation method further tests the convergent and discriminant validity of these three constructs. The analysis yielded three factors with most factor loading greater than 0.70. Factor loadings for SC14e and SC13g are 0.678 and 0.675, which fall to acceptable level. In addition, the three factors combined explain 69.6% of total variance, which goes beyond the recommended 60% variance. The KMO and Bartlett's test score, 0.874, shows excellent sampling adequacy, too. Considering all these together, these three factors show acceptable internal and external validities. Table 3.4.4. and 3.4.5. report the results for exploratory factor analysis and KMO test.

Table 3.4.4. Factor Loadings for Coordination level of RSC (Customers)

Item	F1- Information Sharing with Customers	F2- Coordination with Customers	F3-Distribution Chain Restructuring	Alpha
SC14 d	.781			0.87
SC14 e	.678			
SC14 f	.777			
SC14 g	.834			
SC14 h	.832			
SC13 a		.788		0.76
SC13 b		.848		
SC13 g		.675		
SC15d			.887	0.65
SC15e			.728	
Eigenvalue	3.297	2.165	1.501	
% of variance	32.970	21.647	15.010	
Cumulative % of variance	32.970	54.618	69.628	

Table 3.4.5. KMO and Bartlett's Test for Coordination level of RSC (Customers)

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.874
Bartlett's Test of Sphericity	Approx. Chi-Square	3244.974
	Df	45.000
	Sig.	.000

3.4.2.2. Supply Chain Aspect

CITC analysis scrutinizes internal consistency for three constructs: information sharing with suppliers, coordination with suppliers and supply chain restructuring. Information sharing with suppliers includes five items and all of them exhibit CITC above 0.5. These results indicate internal consistency of them in forming the construct, information sharing with suppliers. Similarly, two items for Coordination with Suppliers display CITC above 0.5. The factor loading for SC7h, 0.496, is very close to 0.5. Plus its initial Cronbach's alpha 0.72 shows sufficient validity. These results indicate internal consistency of three items in forming the construct, coordination with suppliers. Three items formed distribution chain restructuring construct. CITCs are well above 0.5 and Cronbach's alpha, 0.76, supports the consistency as well. These results promote internal consistency of these three items in forming the construct, supply chain restructuring. Table 3.4.6 reports the results.

Table 3.4.6. Purification for Coordination level of RSC (Suppliers)

Coding		Items	CITC-1	Alpha if deleted	CITC-2
IMSS	Model				
Information Sharing with Suppliers: alpha=0.874 (initial)					
Indicate to what extent do you use electronic tools (Internet or EDI based) with your key/strategic suppliers? (1-no adoption, 5- high level of adoption)					
SC8 d	ISS1	Data analysis (audit and reporting)	.651	.835	
SC8 e	ISS2	Access to catalogues	.543	.861	
SC8 f	ISS3	Order management and tracking	.700	.822	
SC8 g	ISS4	content and knowledge management	.745	.811	
SC8 h	ISS5	collaboration support services	.742	.812	
Coordination with Suppliers: alpha=0.72 (initial)					
How do you coordinate planning decisions and flow of goods with your key/strategic suppliers?					
SC7f	CCP1	Require supplier(s) to manage or hold inventories of materials at your site (e.g., Vendor Managed Inventory, Consignment Stock)	.584	.586	
SC7g	CCP2	Collaborative Planning, Forecasting and Replenishment	.559	.617	
SC7h	CCP3	Physical integration of the supplier into the plant	.496	.689	
Supply Chain Restructuring: *alpha=0.76 (initial)*					
Indicate degree of the following action programs undertaken over the last three years and planned efforts for the coming three years.					
SC15a	SCR1	Rethinking and restructuring supply strategy and the organization and management of suppliers portfolio	.570	.709	
SC15b	SCR2	Implementing supplier development and vendor rating programs	.618	.655	
SC15c	SCR3	Increasing the level of coordination of planning decisions and flow of goods with suppliers including dedicated investments	.595	.681	

The exploratory factor analysis with principal component extraction and varimax rotation method further tests the convergent and discriminant validity of these three constructs at the coordination level of the responsive supply chain. The analysis yielded three factors with all factor loadings greater than 0.70. Also, the three factors combined explain 65.7% of total variance, which goes beyond the recommended level of 60%

variance. The KMO, and the Bartlett's test score, 0.851, shows excellent sampling adequacy, too. Considering all these numbers together, these three factors show acceptable internal and external validities. Tables 3.4.7. and 3.4.8. report the results for the exploratory factor analysis and the KMO test.

Table 3.4.7. Factor Loadings for Coordination level of RSC (Suppliers)

Item	F1-Information Sharing with Suppliers	F2- Coordination with Suppliers	F3-Supply Chain Restructuring	Alpha
SC8 d	.741			0.86
SC8 e	.711			
SC8 f	.792			
SC8 g	.828			
SC8 h	.824			
SC7 g			.818	0.72
SC7 f			.779	
SC7h			.731	
SC15a		.795		0.76
SC15b		.827		
SC15c		.763		
Eigenvalue	3.177	2.061	1.990	
% of variance	28.880	18.739	18.095	
Cumulative % of variance	28.880	47.619	65.714	

Table 3.4.8. KMO and Bartlett's Test for Coordination level of RSC (Suppliers)

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.851
Bartlett's Test of Sphericity	Approx. Chi-Square	3088.779
	Df	55.000
	Sig.	.000

3.4.3. Intra-organization level of Responsive Supply Chain

The Intra-organization level of responsive supply chains comprises Advanced Manufacturing Technology (AMT), Commitments for Pull Production (CPP), and

Intergrated product development (IPD). The purification process starts with the corrected item-total correlation (CITC) scores analysis provided by SPSS 16.0. CITC scores greater than 0.5 provide evidence of internal consistency.

Table 3.4.9. Purification for Intra-organization level of Responsive Supply Chain

Coding		Items	CITC-1	Alpha if deleted	CITC-2
IMSS	Model				
Advanced Manufacturing Technology: alpha=0.751 (initial)					
To what extent is the operational activity in your plant performed using the following technologies: (1:no use; 5: high use)					
T1c	AMT1	Automated parts loading/unloading	0.52	0.74	
T1d	AMT2	Automated guided vehicles (AGVs)	0.59	0.63	
T1e	AMT3	Automated storage-retrieval systems (AS/RS)	0.61	0.60	
Pull Production: alpha=0.680 (initial); 0.694 (final)					
Indicate degree of the following action programmes undertaken over the last three years and planned efforts for the coming three years.					
PC6b	PP1	Restructuring manufacturing processes and layout for the last three years	0.40	0.70	-
PC6c	PP2	Undertaking actions to implement pull production (e.g. reducing batches, setup time, using kanban systems, etc.) for the last three years	0.63	0.39	0.53
PC6f	PP3	Undertaking actions to implement pull production (e.g. reducing batches, setup time, using kanban systems, etc.) for the next three years	0.46	0.63	0.53
Produce Development and Manufacturing Integration: alpha=0.756 (initial)					
Indicate the degree of the following action programs undertaken over the last three years					
PD6a	IPD1	Increasing performance of product development and manufacturing through e.g. platform design, standardization and modularization	.604	.647	
PD6b	IPD2	Increasing the organizational integration between product development and manufacturing through e.g. Quality Function Deployment, Design for manufacturing, Design for assembly, teamwork, job rotation and co-location, etc.	.616	.634	
PD6c	IPD3	Increasing the technological integration between product development and manufacturing through e.g. CAD-CAM	.532	.733	

Three items constitute AMT, and their CITC scores are all above 0.5. These results indicate internal consistency of these items in forming the construct, information sharing with suppliers. In regard to CPP, PC6b was discarded because its CITC is far below 0.5. CITC scores for the remaining two items rose to 0.53 and the Cronbach's alpha to 0.694, which justified the elimination of these items. IPD is comprised of three items, and their CITCs are all over 0.5 with the Cronbach's alpha of 0.75. These results indicate the internal consistency of these three constructs. Table 3.4.9 reports the results.

The exploratory factor analysis with principal component extraction and varimax rotation method further tests the convergent and discriminant validity of these three constructs in Intra-organization level of responsive supply chain. The analysis yielded three factors with all factor loadings greater than 0.70 and the three factors combined explain 69.8% of total variance, which goes beyond the recommended 60% variance. Considering all these together, these three factors demonstrate acceptable internal and external validities. Table 3.4.10. reports the results for exploratory factor analysis.

Table 3.4.10. Factor Loadings for Intra-organization level of RSC

Item	F1-Integrative Product Development	F2- Advanced Manufacturing Technology	F3- Pull Production	Alpha
T1c		.748		0.75
T1d		.815		
T1e		.840		
PC6c			.826	0.69
PC6f			.890	
PD3a	.816			0.76
PD3b	.830			
PD3c	.752			
Eigenvalue	2.042	2.008	1.534	
% of variance	25.529	25.095	19.180	
Cumulative % of variance	25.529	50.624	69.805	

3.4.4. Performance Level of Responsive Supply Chain

The performance level of the responsive supply chain consists of Market Responsiveness (MR) and Firm growth (FG). The purification process begins with the corrected item-total correlation (CITC) scores analysis. CITC scores greater than 0.5 provide evidence of internal consistency. Four items constitute MR, and their CITC scores are all above 0.5. These results indicate internal consistency of the items in forming the construct, MR. In regard to FG, both items exhibit CITCs above 0.5. These results indicate the internal consistency of these two constructs. Table 3.4.11 reports the results.

Table 3.4.11. Purification for Performance Level of Responsive Supply Chain

Coding		Items	CITC-1	Alpha if deleted	CITC-2
IMSS	Model				
Market Responsiveness: alpha=0.802 (initial)					
How has your operational performance changed over the last three years?					
B9af	MR1	Time to market	0.57	0.78	
B9ai	MR2	Delivery speed	0.73	0.70	
B9al	MR3	Delivery dependability	0.61	0.76	
B9an	MR4	Manufacturing lead time	0.57	0.77	
Firm growth: alpha=0.744 (initial)					
What is the current business unit performance?					
A6e	FG1	Sales	0.59	N/A	
A6f	FG2	Market share	0.59	N/A	

The exploratory factor analysis with principal component extraction and varimax rotation method further tests the convergent and discriminant validity of these two constructs in Intra-organization level of responsive supply chain. The analysis yielded three factors with all factor loadings greater than 0.70 and the three factors combined explain 68.6% of total variance, which goes beyond the recommended 60% variance.

Considering all these together, these two factors demonstrate acceptable internal and external validities. Table 3.4.12 reports the results for exploratory factor analysis.

Table 3.4.12. Factor Loadings for Performance Level of RSC

Item	F1-Market Responsiveness	F2-Firm growth	Alpha
B9af	0.73		0.76
B9ai	0.86		
B9al	0.78		
B9an	0.77		
A6e		0.89	0.74
A6f		0.88	
Eigenvalue	2.50	1.61	
% of variance	41.72	26.86	
Cumulative % of variance	41.72	68.58	

3.4.5. Exploratory Factor Analysis for Supply Chain

With ensuring unidimensionality through the factor analysis at the Intra-organization level, subjecting all items across all constructs to an exploratory factor analysis provides a more rigorous way of examining measurement items than just running an EFA separately. This is because processing the entire set of items together alone tests whether or not the measurement items meet both the internal and external rules of unidimensionality (Koufteros et al. 2007). The possibility of cross-loading makes it harder to achieve discriminant validity when all the items are under the scrutiny of EFA. An equamax, principal component analysis was used to conduct EFA. The equamax rotation method is a hybrid of the varimax and quartimax rotation methods that maximizes the weighted sum of the varimax and quartimax criteria. This method addresses the concern for simple structure within variables as well as within factors (Hair et al. 1998).

An equamax principal component analysis for the customer aspect of the responsive supply chain produced ten factors with most factor loadings greater than 0.70. Four items, i.e., SC 14e, SC 13g, SC 15e, and B9af show factor loadings less than 0.7, but they are acceptable since all of them are still greater than 0.60. The analysis found no cross-loadings that exceed 0.4. The result of the KMO test exceeds 0.80, and demonstrates the adequacy of sampling. Taken all together, these analyses show convergent and discriminant validity. Table 3.4.13. presents the results for EFA.

Table 3.4.13. Exploratory Factor Analysis (Customers)

	ISC	MR	CC	RPS	IPD	AMT	DCR	FG	CPP	CI
Item	1	2	3	4	5	6	7	8	9	10
A4e										0.85
A4f										0.84
A5ag				0.79						
A5ah				0.85						
A5ai				0.79						
SC14d	0.76									
SC14e	0.63									
SC14f	0.77									
SC14g	0.80									
SC14h	0.80									
SC13a			0.78							
SC13b			0.83							
SC13g			0.68							
SC15d							0.86			
SC15e							0.65			
T1c						0.73				
T1d						0.80				
T1e						0.83				
PC6c									0.82	
PC6f									0.88	
PD6a					0.74					
PD6b					0.77					
PD6c					0.75					
B9af		0.69								
B9ai		0.84								
B9al		0.77								
B9an		0.75								
A6e								0.89		
A6f								0.87		
Eigenvalue	3.02	2.48	2.20	2.15	2.06	2.05	1.66	1.66	1.62	1.53
% of Variance	10.41	8.55	7.59	7.40	7.11	7.08	5.73	5.72	5.60	5.27
% of Cumulative Variance	10.41	18.95	26.54	33.94	41.05	48.13	53.86	59.58	65.18	70.45

Extraction Method: Principal Component Analysis.
Rotation Method: Equamax with Kaiser Normalization.
a. Rotation converged in 7 iterations.

An equamax, the principal component analysis for the supplier aspect of the responsive supply chain also yielded ten factors with all factor loadings greater than 0.70, except for B9af. Even the factor loading for B9af, 0.69, is close to 0.70. The ten factors explain 69.12% of the total variance. The KMO test resulted in 0.839, which exceeds 0.80, and demonstrates the adequacy of sampling. Taken together, the EFA results show good internal and external validities of the measurement items. Tables 3.4.14. present the results for the EFA.

Table 3.4.14. Exploratory Factor Analysis (Suppliers)

	ISS	MR	RPS	SCR	AMT	IPD	CS	FG	PP	CME
	1	2	3	4	5	6	7	8	9	10
A4e										0.85
A4f										0.83
A5ag			0.77							
A5ah			0.85							
A5ai			0.80							
SC8d	0.71									
SC8e	0.71									
SC8f	0.76									
SC8g	0.79									
SC8h	0.78									
SC7f							0.79			
SC7g							0.75			
SC7h							0.73			
SC15a				0.76						
SC15b				0.80						
SC15c				0.70						
T1c					0.74					
T1d					0.80					
T1e					0.82					
PC6c									0.80	
PC6f									0.88	
PD6a						0.72				
PD6b						0.74				
PD6c						0.77				
B9af		0.69								
B9ai		0.85								
B9al		0.77								
B9an		0.74								
A6e								0.88		
A6f								0.87		
Eigenvalue	2.98	2.48	2.14	2.11	2.07	2.05	2.02	1.67	1.65	1.55
% of Variance	9.94	8.28	7.14	7.04	6.92	6.83	6.75	5.56	5.50	5.16
% of Cumulative Variance	9.94	18.22	25.36	32.40	39.32	46.15	52.89	58.46	63.96	69.12

Extraction Method: Principal Component Analysis.
Rotation Method: Equamax with Kaiser Normalization.
a. Rotation converged in 7 iterations.

3.4.6. Measurement and Structural Model Methods

Measurement model testing has gained popularity since Gerbing and Anderson (1988) suggested testing measurement models before proceeding to the structural equation modeling test. Running measurement model offers a more rigorous way of examining the convergent and the discriminant validity than traditional methods do (Anderson & Gerbing 1988).

To corroborate the validity of measurement items, the structural equation modeling (SEM) is used to perform the confirmatory factor analysis (CFA), i.e., measurement model test, because it takes the correlation of the error term into consideration. The purpose of the testing measurement models is to examine convergent and discriminant validities so that one can determine whether or not the measurement provides enough soundness to proceed to the structural equation modeling test. CFA provides the means to assess the convergent validity. model fit indices from CFA should demonstrate excellent fit of the model, factor loadings should be greater than 0.60, and the composite reliability should be greater than 0.6.

3.4.6.1. Model Indices

AMOS was chosen for the CFA and the SEM analysis. The results of the AMOS analysis for SEM offer a variety of indices to check the robustness of the constructs under examination. There are two categories for the fit of these indices: a model fit and an individual parameter fit. Model fits include the Chi-square fit ratio, the goodness of fit index (GFI), the adjusted goodness of fit index (AGFI), the comparative fit index (CFI) (Bentler 1990), the normed-fit index (NFI) (Bentler 1990), the root mean square residual

(RMR), and the root mean square error of approximation (RMSEA) (Steiger & J. C. Lind 1980). The ratio of Chi-square fit tests if an unconstrained model differs from a constrained model by checking the covariance and the correlations matrix (Wheaton et al. 1977). A ratio greater than 3.0 indicates the significance of the hypothesized model and that the unconstrained model also fits the covariance and correlation matrix (McIver & Carmines 1981). Since Chi-square tends to increase as the sample size gets larger, Chi-square relative to degrees of freedom better fits the data (Jöreskog & Sörbom 1993).

GFI and RMSEA gauge the overall suitability of the model under scrutiny. GFI ranges from 0 to 1.0, and a value higher than 0.9 signifies excellent fit, whereas a value greater than 0.8 suggests acceptable fit. The root mean square residual (RMR) serves as an indicator that specifies the average difference between the sample and the hypothesized correlation matrices (Byrne 2001). Varying from 0 to 1, a smaller value means that the model elaborates the correlations to within an average error of the value of the RMR (Hu & Bentler 1995).

GFI and AGFI are absolute indices of fit, for their calculation processes do not include comparisons between the hypothesized model and alternative models (Hu & Bentler 1995). Different from GFI, AGFI addresses the issue of parsimony by taking the degrees of freedom into consideration. It is, however, the parsimony goodness-of-fit (PGFI) that directly tackles how parsimonious a structural equation model is. It is not unusual that parsimony-based indices like PGFI are considerably lower than absolute indices of fit. Mulaik et. al (1989) found that researchers can expect observed values of PGFI to be in the 0.50s (Mulaik et al. 1989).

The normed fit index (NFI) and the comparative fit index (CFI) represent incremental or comparative indices of fit. Incremental indices differ from absolute ones in that they compare the hypothesized model against an independence model (Byrne 2001). NFI compares the proposed model against an independence model, and CFI complements NFI by considering the sample size. A value closer to 1.0 signifies a greater divergence between the proposed model and the independence model. Bentler recommended CFI as the index of choice because it takes the issue of parsimony into consideration (Bentler 1990). The incremental index of fit (IFI) also resolves the issue of parsimony with respect to degrees of freedom and sample size (Bollen 1986). The Tucker-Lewis index (TLI) is another index of good fit with values close to 0.95 being considered a superior fit (Tucker & Lewis 1973). Values between 0.80-0.89 in indices of GFI, AGFI, CFI, NFI, IFI, and TLI signify that the structural equation models being examined are reasonable fits while values greater than or equal to 0.9 indicates that the models fit the data very well.

With the appearance in Steiger and Lind's work in 1980 (Steiger & Lind 1980), the root mean square error of approximation (RMSEA) has lately drawn much attention from researchers. RMSEA rectifies the propensity of the chi-square statistic to reject a specified model a sample size is large. Hu and Bentler (1999) advocate RMSEA values below .06 as a criterion for good-fit model. Models with RMSEA greater than .10 have poor fits. A confidence interval for this index can be computed, and the narrower the interval, the better it is. The lower end value of the 90% confidence interval should approximate to zero, whereas the upper end value should be less than .08. The RMSEA tends to be misleading if the degrees of freedom and sample size are small. The large sample size in this study rules out this possibility.

Standardized root mean square residual (SRMR) comes from the average of the residuals between observed and expected input matrices. It is the standardized difference between the observed covariance and predicted covariance. Simply put, a value of zero points to a perfect fit, for it means that there is no difference between the observed and the predicted covariance. 0.08 usually serves as the cutoff value for good fit.

Once model fit indices indicate the good fit of the measurement model, the next step is to examine factor loadings. Factor loadings that exceed 0.60 indicate that the measured constructs exhibit convergent validity. Along with factor loadings, composite reliability provides a criterion to assess convergent validity. A composite reliability score greater than 0.60 suggests that there is a single common factor among a set of variables.

3.4.6.2. Convergent and Discriminant Validity

Strong factor loadings and t-test values of individual items, along with good overall fit indices, provide evidence of convergent validity in CFA. Simply put, model fit indices should meet the following criteria: χ^2/d.f.<3; NFI>0.90 and a CFI>0.90; and an RMSEA and an Standardized RMR <0.05 (Hu & Bentler 1995).

With good factor loadings and composite reliability comes the issue of discriminant validity. Discriminant validity essentially assesses if items for the construct gauge only the construct in question. Namely, it seeks to determine whether constructs differ from each other. There are various ways to test discriminant validity, but this analysis takes the measurement model approach that utilizes averaged variance extracted (AVE), and compares it with squared correlations of paired constructs. Not finding any squared correlation greater than the AVE indicates discriminant validity. Discriminant validity also requires AVEs to be greater than correlations between other constructs.

Reliability estimation comes after proving convergent and discriminant validity. Composite reliability weighs how much a set of latent construct indicators explains their measurement of a construct. 0.7 or higher serves as the threshold for composite reliability (Hair et al. 1998). Although different from composite reliability, AVE also attempts to measure the amount of common variance among indicators that gauge the latent construct (Hair et al. 1998), and its threshold value is 0.5. A construct yielding an AVE less than 0.5 means that the indicators of the construct accounts for less than half of the variance for the specified indicators (Hair et al. 1998). Table 3.4.15 summarizes the discussion regarding convergent and discriminant validity.

Table 3.4.15. Measurement Model Fit Guide

Statistic (range)	Recommended value	Description
SRMR (N/A)	<0.08 (Chau, 1997)	Standardized root mean square residual. Measure of overall fit. It is the average of the residuals between observed and estimated input matrices.
RMSEA (N/A)	<0.08 (reasonable fit) <0.05 (good fit) (Jöreskog & Sörbom 1993)	Root mean square error of approximation. Attempts to correct the tendency of the chi-square statistic to reject a specified model with a sufficiently large sample.
GFI (0 – 1)	>0.8 (reasonable fit) >0.9 (good fit) (Byrne 2001)	Goodness-of-fit. Measure of overall fit. Squared residual from prediction compared to actual data.
AGFI (0 – 1)	>0.8 (reasonable fit) >0.9 (good fit) (Byrne 2001)	Adjusted GFI. Parsimonious fit measure. Measures whether the measure has been over fitted with too many items. Adjusted by the ratio of degree of freedom for the current model to the degree of freedom for the Null model
NFI (0 – 1)	>0.8 (reasonable fit) >0.9 (good fit) (Jöreskog & Sörbom 1993)	Normed fit index. Relative comparison of the current model to the Null model.
CFI (0 – 1)	>0.8 (reasonable fit) >0.9 (good fit) (Byrne 2001)	Comparative fit index. Compares the fit of the current model to a baseline model, usually the Null model. It avoids the underestimation of fit in smaller samples compared to NFI (Bentler, 1990).
Chi-square/df (N/A)	<3.0 (Byrne 2001)	"provides information on the relative efficiency of competing modes in accounting for the data."
λ-coefficient (0 – 1)	0.6	
Composite Reliability	>0.8 (excellent fit) >0.7 (reasonable fit) (Hair et al. 1998)	Composite reliability weighs how much a set of latent construct indicators explain their measurement of a construct.
Average Variance Extracted	>0.5 (good fit) (Hair et al. 1998)	AVE also attempts to measure the amount of common variance among indicators that gauge a latent construct

3.4.7. Measurement Model Results

AMOS 5.0 for windows analyzed measurement model and Table 3.4.16 reports the results for customer model. Various fit indices supports the soundness of the model. GFI, AGFI, NFI, and CFI are well above 0.9 whilst chi-square per degree of freedom was below 2.0 and the RMSEA and the standardized RMR were well below 0.05. Most of factor loadings shown in Table 3.4.16 surpass 0.60 threshold except for SC14e and PC6f. Their factor loadings are 0.56, which is close to 0.60. Because those items were regarded to support criterion validity, they are kept in the model. Since the t-values corresponding with factor to item loadings far exceed 2.33, which is significant at the 0.01 level.

Table 3.4.16. Measurement model results (Customers)

Constructs	Item no.	Completely Std. Loading	t-Value
Competition Intensity	A4E	0.60	-
	A4F	0.77	6.20
Responsive product strategy	A5AH	0.88	-
	A5AG	0.66	16.25
	A5AI	0.69	16.67
Information Sharing with Customers	SC14D	0.77	-
	SC14E	0.56	15.23
	SC14F	0.78	22.08
	SC14G	0.87	24.97
	SC14H	0.85	24.36
Coordination with Customers	SC13A	0.72	-
	SC13B	0.72	16.03
	SC13G	0.72	16.04
Distribution Chain Restructuring	SC15D	0.64	-
	SC15E	0.76	13.80
Advanced Manufacturing Technology	T1C	0.62	-
	T1D	0.75	14.22
	T1E	0.94	14.24
Pull Production	PC6C	0.94	-
	PC6F	0.56	7.55
Integrative Product Development	PD6A	0.76	-
	PD6B	0.75	17.19
	PD6C	0.64	15.27
Market Responsiveness	B9AN	0.63	15.95
	B9AL	0.73	-
	B9AI	0.87	19.72
	B9AF	0.62	15.63
Firm growth	A6E	0.66	-
	A6F	0.90	6.83
Fit indices: χ^2 = 608.254 (332 d.f.), χ2/d.f.= 1.83, GFI=0.95, AGFI=0.93, NFI=0.92, CFI= 0.96, RMSEA=0.033, Standardized RMR=0.033			

Table 3.4.17 presents the descriptive statistics, composite reliabilities, AVE, and correlations among the constructs. The comparison between the squared correlation of two constructs and their individual AVE offers the basis for judging additional discriminant validity. Fornell and Larcker (1981) reported that constructs with AVE value greater than 0.5 and than squared correlation between constructs exhibit discriminant validity. AVEs are greater than 0.5 except for two constructs: competition intensity (0.48) and distribution chain restructuring (0.49). Nonetheless, all squared correlations are far below AVEs, giving the evidence of discriminant validity to other constructs. Reliability assessment comes after confirming the validity of the constructs. Composite reliabilities above 0.7 ensure acceptable reliability (Hair et al. 1998), and the AVEs for all constructs are greater than 0.7 except for competition intensity (0.64) and distribution chain restructuring (0.66).

Table 3.4.17. Descriptive Statistics, Correlations, Composite Reliability and Discriminant Validity (n=761) (Customers)

Constructs	No. of Items	Mean	S.D.	CI	RPS	ISC	CC	DCR	AMT	PP	IPD	MR	FG
Competition Intensity	2	7.68	1.74	**0.64[a], 0.48[b]**									
Responsive product strategy	3	10.17	2.68	0.32*, 0.10[c]	**0.79, 0.57**								
Information Sharing with Customers	5	13.87	5.04	0.20*, 0.04	0.20*, 0.04	**0.88, 0.60**							
Coordination with Customers	3	8.74	3.03	0.18*, 0.03	0.15*, 0.02	0.56*, 0.31	**0.76, 0.52**						
Demand Chain Restructuring	2	5.04	1.76	0.13**, 0.02	0.28*, 0.08	0.54*, 0.29	0.62*, 0.38	**0.66, 0.49**					
Advanced Manufacturing Technology	3	5.48	2.77	0.15*, 0.02	0.23*, 0.05	0.30*, 0.09	0.30*, 0.09	0.40*, 0.16	**0.76, 0.51**				
Pull Production	2	6.31	2.05	0.03, 0.00	0.20*, 0.04	0.16*, 0.03	0.22*, 0.05	0.34*, 0.12	0.27*, 0.07	**0.74, 0.60**			
Integrative Product Development	3	6.62	2.57	0.19*, 0.04	0.31*, 0.10	0.39*, 0.15	0.34*, 0.12	0.63*, 0.4	0.44*, 0.19	0.40*, 0.16	**0.76, 0.52**		
Market Responsiveness	4	11.68	2.81	0.12**, 0.01	0.22*, 0.05	0.26*, 0.07	0.26*, 0.07	0.24*, 0.06	0.24*, 0.06	0.21*, 0.04	0.32*, 0.10	**0.81, 0.52**	
Firm growth	2	5.54	1.67	-0.01, 0.00	0.07, 0.00	0.09**, 0.01	0.10*, 0.01	0.17*, 0.03	0.08, 0.01	0.15*, 0.02	0.18*, 0.03	0.30*, 0.09	**0.76, 0.62**

a Composite reliabilities are on the diagonal; b Average variances extracted are on the diagonal. c Squared correlation.

∗ Correlation is significant at 0.01 level; ∗∗ Correlation is significant at 0.05 level.

Table 3.4.18. Measurement model results (Suppliers)

Constructs	Item no.	Completely Std. Loading	t-Value
Competition Intensity	A4E	0.59	-
	A4F	0.78	6.64
Responsive Business Strategy	A5AH	0.88	-
	A5AG	0.67	16.33
	A5AI	0.69	16.73
Information Sharing with Suppliers	SC8D	0.70	-
	SC8E	0.56	14.42
	SC8F	0.75	18.98
	SC8G	0.84	20.96
	SC8H	0.84	20.91
Coordination with Suppliers	SC7G	0.71	-
	SC7F	0.72	14.63
	SC7H	0.63	13.64
Supply Chain Restructuring	SC15A	0.68	
	SC15B	0.72	15.98
	SC15C	0.75	16.33
Advanced Manufacturing Technology	T1C	0.61	-
	T1D	0.76	14.13
	T1E	0.77	14.14
Pull Production	PC6C	0.95	-
	PC6F	0.56	8.15
Integrative Product Development	PD6A	0.76	-
	PD6B	0.76	17.85
	PD6C	0.63	15.31
Market Responsiveness	B9AL	0.73	-
	B9AI	0.86	19.66
	B9AF	0.62	15.68
	B9AN	0.63	15.96
Firm growth	A6E	0.66	-
	A6F	0.90	6.91
Fit indices: χ^2 = 662.17 (360 d.f.), χ^2/d.f.= 1.84, GFI=0.94, AGFI=0.93, NFI=0.92, CFI= 0.96, RMSEA=0.033, RMR=0.04			

Table 3.4.18. reports the measurement model results for the supplier model. Various fit indices validate the soundness of the model. GFI, AGFI, NFI, and CFI are well above 0.9 while the Chi-square per degree of freedom is below 2.0, and the RMSEA and the standardized RMR are well below 0.05. Most of the factor loadings shown in Table 3.4.18 are greater than 0.60 except for A4e and SC8e. Their factor loadings are 0.59 and 0.56, which are close to 0.60. The t-values corresponding with factor-to-item loadings far exceed 2.33, which is significant at the 0.01 level.

Table 3.4.19 presents the descriptive statistics, composite reliabilities, AVE, and correlations among the constructs for the supplier's model. The comparison between the squared correlation of the two constructs and their individual AVEs offers the basis for judging additional discriminant validity. Fornell and Larcker (1981) reported that constructs with AVE values greater than 0.5 and also greater than the squared correlation between constructs meet requirements for discriminant validity. AVEs are greater than 0.5 except for two constructs: competition intensity (0.48) and coordination with suppliers (0.47). Nonetheless, all squared correlations are far below the AVEs, providing evidence of discriminant validities. Reliability assessment comes after confirming the validity of the constructs. Composite reliabilities above 0.7 signify acceptable reliability (Hair et al. 1998), and the AVEs for all constructs are greater than 0.7 except for competition intensity (0.64).

Table 3.4.19. Descriptive Statistics, Correlations, Composite Reliability and Discriminant Validity (n=751) (Suppliers)

Constructs	No. of Items	Mean	S.D.	CI	RPS	ISC	CC	DCR	AMT	PP	IPD	MR	FG
Competition Intensity	2	7.68	1.74	**0.64[a], 0.48[b]**									
Responsive product strategy	3	10.17	2.68	0.32*, 0.10[C]	**0.79, 0.56**								
Information Sharing with Suppliers	5	13.89	4.64	0.29*, 0.08	0.23*, 0.05	**0.86, 0.56**							
Coordination with Suppliers	3	7.28	2.72	0.22*, 0.05	0.30*, 0.09	0.43*, 0.19	**0.73, 0.47**						
Supply Chain Restructuring	3	6.02	2.45	0.13**, 0.02	0.23*, 0.05	0.43*, 0.19	0.51*, 0.26	**0.76, 0.52**					
Advanced Manufacturing Technology	3	5.48	2.77	0.15*, 0.02	0.23*, 0.05	0.33*, 0.11	0.36*, 0.13	0.38*, 0.14	**0.76, 0.51**				
Pull Production	2	6.31	2.05	0.03, 0.00	0.20*, 0.04	0.17*, 0.03	0.33*, 0.11	0.41*, 0.17	0.27*, 0.07	**0.74, 0.61**			
Integrative Product Development	3	6.62	2.57	0.19*, 0.04	0.31*, 0.10	0.42*, 0.18	0.44*, 0.19	0.69*, 0.48	0.44*, 0.19	0.39*, 0.15	**0.76, 0.52**		
Market Responsiveness	4	11.68	2.81	0.12**, 0.01	0.22*, 0.05	0.25*, 0.06	0.32*, 0.10	0.26*, 0.07	0.24*, 0.06	0.21*, 0.04	0.32*, 0.10	**0.81, 0.52**	
Firm growth	2	5.54	1.67	-0.01, 0.00	0.08, 0.01	0.11*, 0.01	0.14*, 0.02	0.08**, 0.01	0.08, 0.01	0.15*, 0.02	0.18*, 0.03	0.30*, 0.09	**0.73, 0.58**

a Composite reliabilities are on the diagonal; b Average variances extracted are on the diagonal. c Squared correlation.

∗ Correlation is significant at 0.01; ∗∗ Correlation is significant at 0.05.

CHAPTER 4: STRUCTURAL MODEL METHODS AND RESULTS

Before proceeding to structural model results for the whole model, the whole model will be broken into three sub-models that describe (1) the influence of responsive product strategy on market responsiveness, (2) the influence of operational practices on market responsiveness, (3) the influence of organizational practices on market responsiveness. The purpose of this sub model analysis is to see how organizational and operational practices are separately increasing market responsiveness. Later these results will be integrated into the whole research framework.

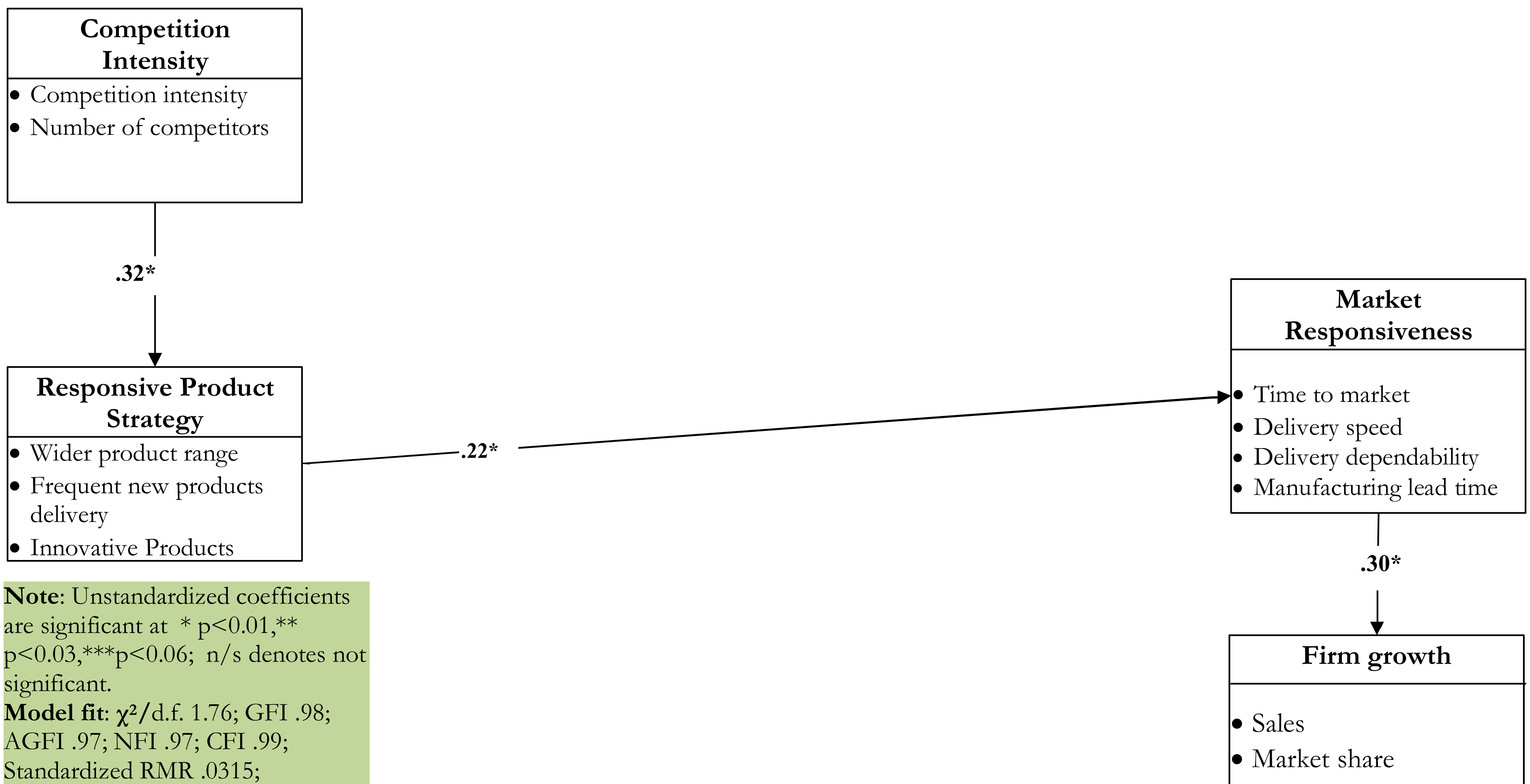
4.1. SEM Results for Breakup Analysis

4.1.1. SEM Results for Strategic Level

The measurement instrument with adequate validity and reliability is good to proceed to test the hypothesized structural model. A well fitting model produces excellent model fit indices such as χ^2/d.f., GFI, AGFI, NFI, CFI, SRMR and RMSEA along with loadings greater than 0.60. The assessment of the significance of the path coefficients offers the basis of judgment as to whether or not the hypothesized model supports the individual hypothesis (Jöreskog & Sörbom 1993).

Fit indices produced from Amos 5.0 for Windows indicate sufficiency of model-to-data fit. Absolute model fit, the chi-square to degree of freedom is 1.76, which is less than 3.0. Incremental indices for goodness of fit (GFI .98; AGFI .97; NFI .97; CFI .99) also show the sufficient validity of the model. Indices for badness of fit signify the adequacy of the model as well (SRMR 0.0315; RMSEA 0.032 with 90% confidence interval varying from 0.019 to 0.043). SRMR is far less than 0.08 and RMSEA is less than 0.05, which indicates very good fit of the model.

Figure 4.1.1 presents the results from the structural equation model and its coefficients with p-values. All standardized coefficients are significant at 0.01 level. As competition intensifies in a market, firms are strongly compelled to implement responsive product strategy (i.e., its coefficient is .32) by widening product range, delivering new products more frequently, and offering innovative features. This result confirms contingency theory that firms have to make the arrangement between the environment and its strategy (Hofer 1975; Van de Ven & Drazin 1984). This responsive product strategy increases market responsiveness but its magnitude is only 0.22. This result confirms the impact of strategy upon business performance such as market responsiveness (Gatignon & Xuereb 1997; Voss & Voss 2000). The positive coefficient of market responsiveness to firm growth (0.30) shows that market responsiveness helps firms to increase firm performance.



Note: Unstandardized coefficients are significant at * $p<0.01$,** $p<0.03$,***$p<0.06$; n/s denotes not significant.
Model fit: χ^2/d.f. 1.76; GFI .98; AGFI .97; NFI .97; CFI .99; Standardized RMR .0315; RMSEA .032 (.019,.043).

Figure 4.1.1. SEM Results for Strategic Level Sub-Model

4.1.2. SEM Results for Intra-organization level

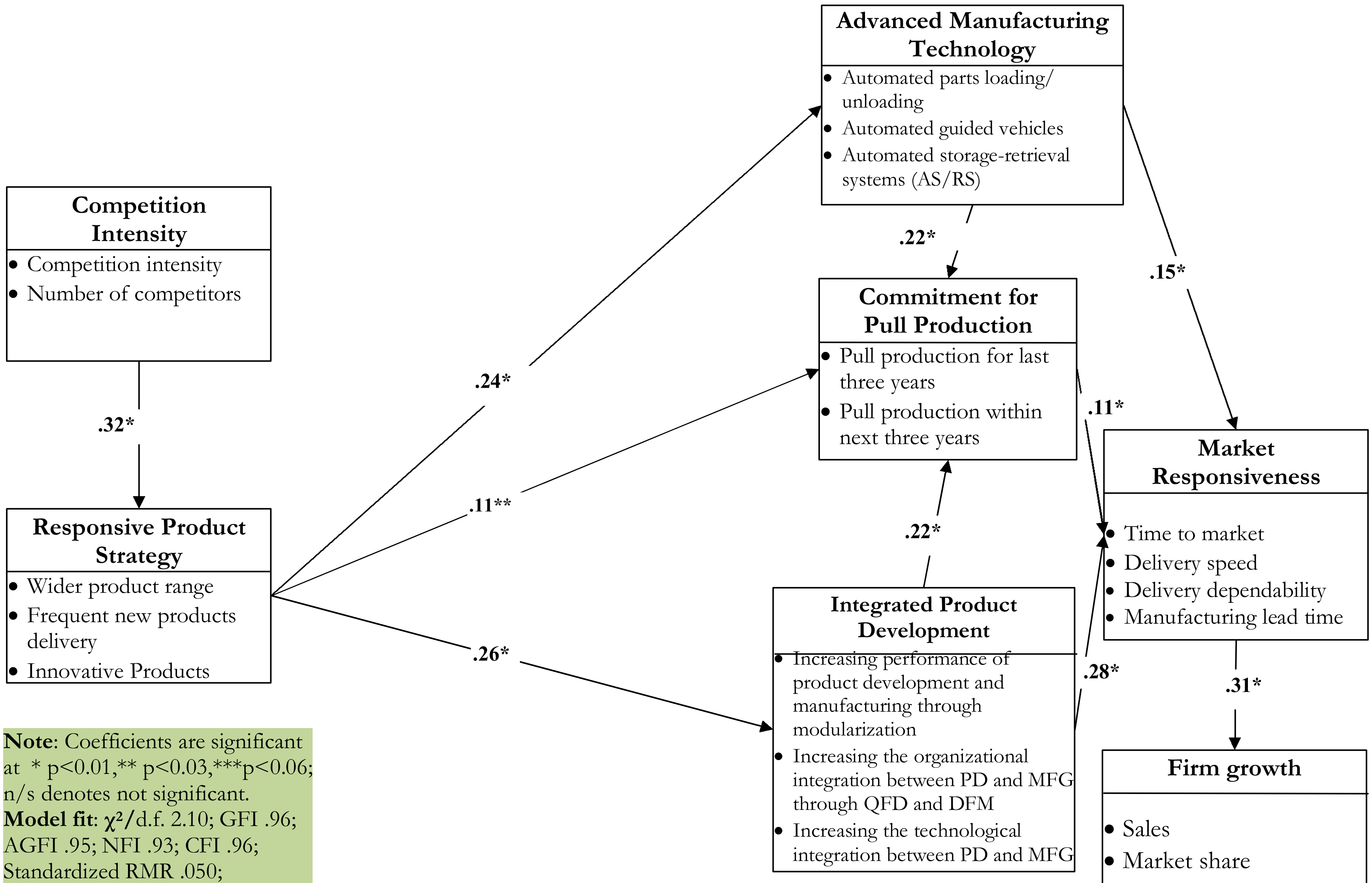
Intra-organization level of the model included three operational practices such as advanced manufacturing technology, commitment for pull production, and integrated product development. The model is more complicated than the strategic level model.

Absolute model fit, the chi-square to degree of freedom is 2.10, which is lower than 3.0. Incremental indices for goodness of fit (GFI .96; AGFI .95; NFI .93; CFI .96) also show the adequate validity of the model. Indices for badness of fit indicate the adequacy of the model as well (SRMR 0.050; RMSEA .038 with the 90% of confidence interval varying from 0.032 to 0.044). SRMR is far less than 0.08 and RMSEA is less than 0.05, which indicates very good fit of the model.

Figure 4.1.2 presents results from structural equation model and its coefficients with p-values. Except for the impact of responsive product strategy on commitment for pull production, all standardized coefficients are significant at 0.01 level. The coefficient from RPS to PP is significant at 0.03 level.

The influence of competition intensity is as strong as that exhibited in the strategic model (i.e., its coefficient is .32). Firms respond to competitive market environment by widening product range, delivering new products more frequently, and offering innovative features. This result again confirms contingency theory that firms have to make the fit between the environment and its strategy (Hofer 1975; Van de Ven & Drazin 1984). This responsive product strategy also leads firms to implement operational practices that help them to be responsive to the market. It strongly increases the firms commitment to implement advanced manufacturing technology (0.24), pull production (0.11), integrated product development (0.26). Utilization of AMT helps increase the pull production system (0.22) as well as integrated product development practices do (0.22).

Their coefficients are the same, showing that their influences on pull production are equally important. In regard to antecedents to market responsiveness, AMT, PP, and IPD are identified as strong factors and their influences proved to be strong. Among them, IPD exhibits the strongest influence on market responsiveness (0.28). IPD is a rather holistic approach to increasing market responsiveness. It takes all important aspects of product design into consideration and systematically accommodates different opinions from different functions such as marketing, engineering, and manufacturing. The positive coefficient of market responsiveness to firm growth (0.31) again shows that market responsiveness helps firms to increase firm performance.



Note: Coefficients are significant at * $p<0.01$,** $p<0.03$,*** $p<0.06$; n/s denotes not significant.
Model fit: χ^2/d.f. 2.10; GFI .96; AGFI .95; NFI .93; CFI .96; Standardized RMR .050; RMSEA .038 (.032,.044).

Figure 4.1.2. SEM Results for Operational Level

4.1.3. SEM Results for Coordination level (Customer Model)

Fit indices produced from Amos 5.0 for Windows indicate sufficiency of model-to-data fit. Absolute model fit, the chi-square to degree of freedom is 2.70, which is less than 3.0. Incremental indices for goodness of fit (GFI .94; AGFI .93; NFI .90; CFI .93) also show the sufficient validity of the model. Indices for badness of fit signify the adequacy of the model as well (SRMR 0.053; RMSEA .047 with the confidence interval varying from 0.042 to 0.052). SRMR is far less than 0.08 and RMSEA is less than 0.05. The 90% confidence interval for RMSEA varies little. Considered together, the structural equation model indicates a good model-to-data fit.

Figure 4.1.3 presents results from the structural equation model and its coefficients with p-values. All standardized coefficients are significant at the 0.01 level. The influence of competition intensity is as strong as that exhibited in both the strategic level model and the Intra-organization level model (i.e., its coefficient is .32).

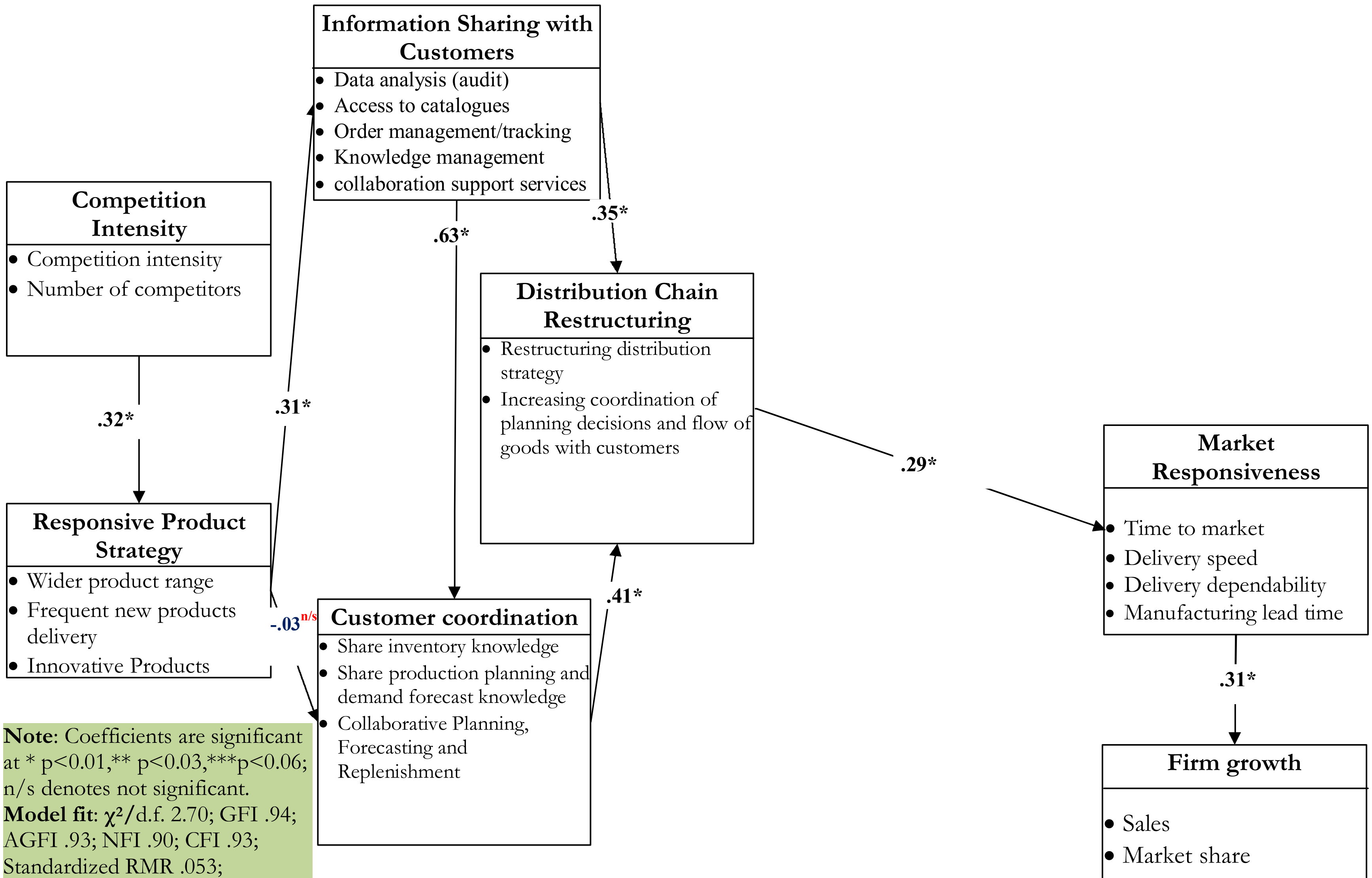


Figure 4.1.3. SEM Results for Organizational Level (Customers)

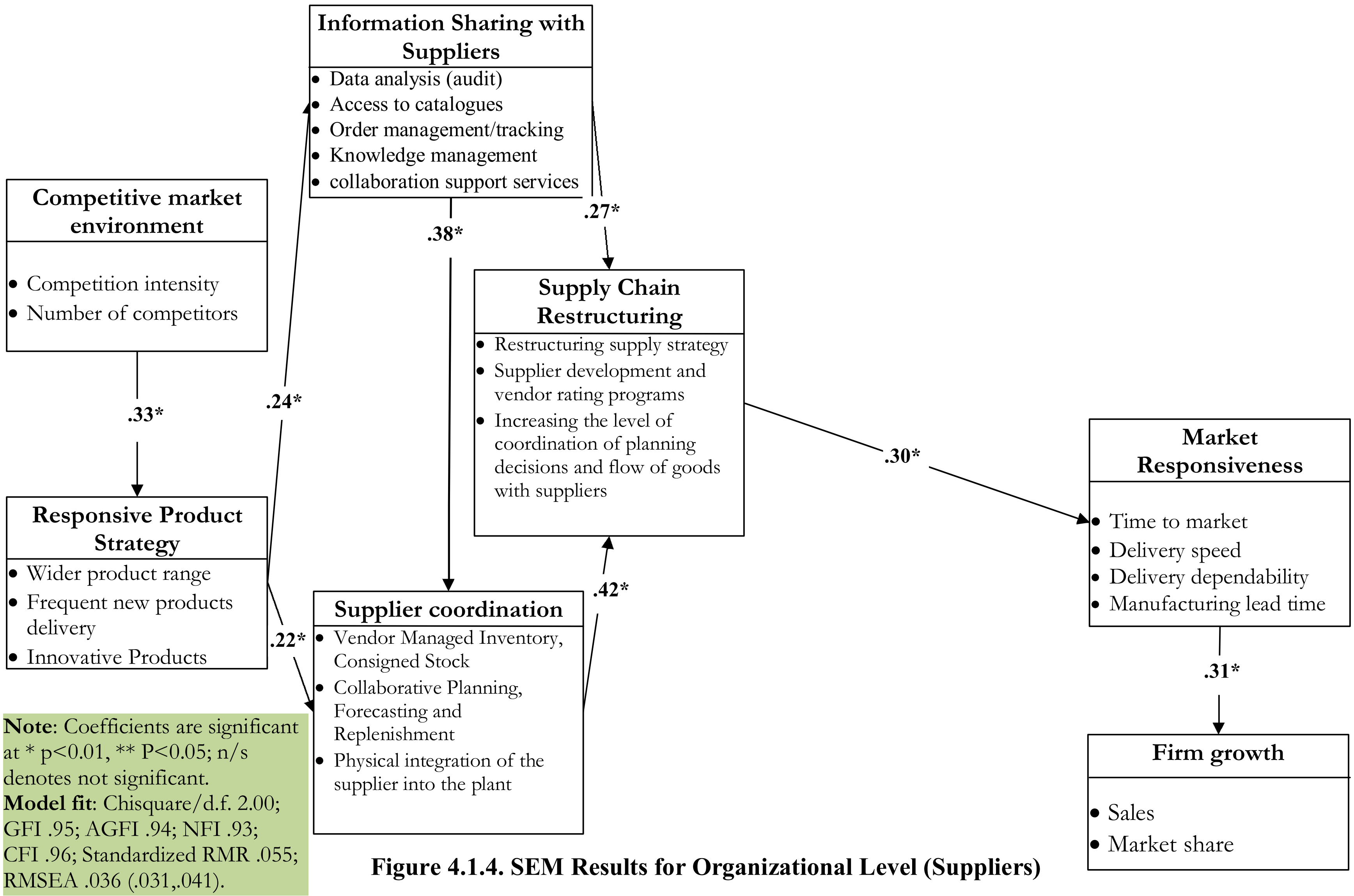
Firms respond to a competitive market environment by widening product range, delivering new products more frequently, and offering innovative features. This result again confirms contingency theory that firms have to make adjustments between the environment and its strategy (Hofer 1975; Van de Ven & Drazin 1984). This responsive product strategy also leads firms to implement coordination level practices that help firms to be responsive to the market. Practices at the coordination level are comprised of information sharing with customers, collaboration with customers, and demand chain restructuring. It turns out that RPS does not have a statistically significant influence on collaboration with customers. Nonetheless, it has an indirect impact on collaborating with customers through information sharing (0.63). In fact, this is the largest coefficient in the model. This means that in collaborating with customers, information technology takes a significant role in fostering customer coordination mechanisms such as inventory knowledge, production planning and demand forecasting, and collaborative planning, forecasting and replenishment.

ISC and CC are strong drivers for demand chain restructuring (i.e., their coefficients are 0.35 and 0.41, respectively. Restructuring of the distribution chain starts with strategy reconsideration and increasing coordination of decisions with customers. This effort results in enhancing market responsiveness (0.29). The result also shows that restructuring the supply chain directly influences a firm's market responsiveness. However, it is also important to recognize that the coefficient, 0.29 is relatively small magnitude in influencing market responsiveness, which suggests the presence of some links between coordination level practices and operational practices.

4.1.4. SEM Results for Coordination level (Supplier Model)

This section examines the SEM results for the organizational model from the supplier's perspective. Fit indices produced from Amos 5.0 for Windows indicate sufficiency of model-to-data fit. Absolute model fit, the chi-square to degree of freedom is 2.00, which is less than 3.0. Incremental indices for goodness of fit (GFI .95; AGFI .94; NFI .93; CFI .96) also show the sufficient validity of the model. Indices for badness of fit signify the adequacy of the model as well (SRMR 0.055; RMSEA .036 with the 90% of confidence interval varying from 0.031 to 0.041). SRMR is far less than 0.08 and RMSEA is less than 0.05. The 90% confidence interval for RMSEA varies little and is below 0.05. Considered together, the structural equation model indicates good model-to-data fit.

Figure 4.1.4 presents results from the structural equation model and its coefficients with p-values. All standardized coefficients are significant at 0.01 level. The influence of competition intensity is as strong as that exhibited in both the strategic level model and the Intra-organization level model (i.e., its coefficient is .33).



Note: Coefficients are significant at * p<0.01, ** P<0.05; n/s denotes not significant.
Model fit: Chisquare/d.f. 2.00; GFI .95; AGFI .94; NFI .93; CFI .96; Standardized RMR .055; RMSEA .036 (.031,.041).

Figure 4.1.4. SEM Results for Organizational Level (Suppliers)

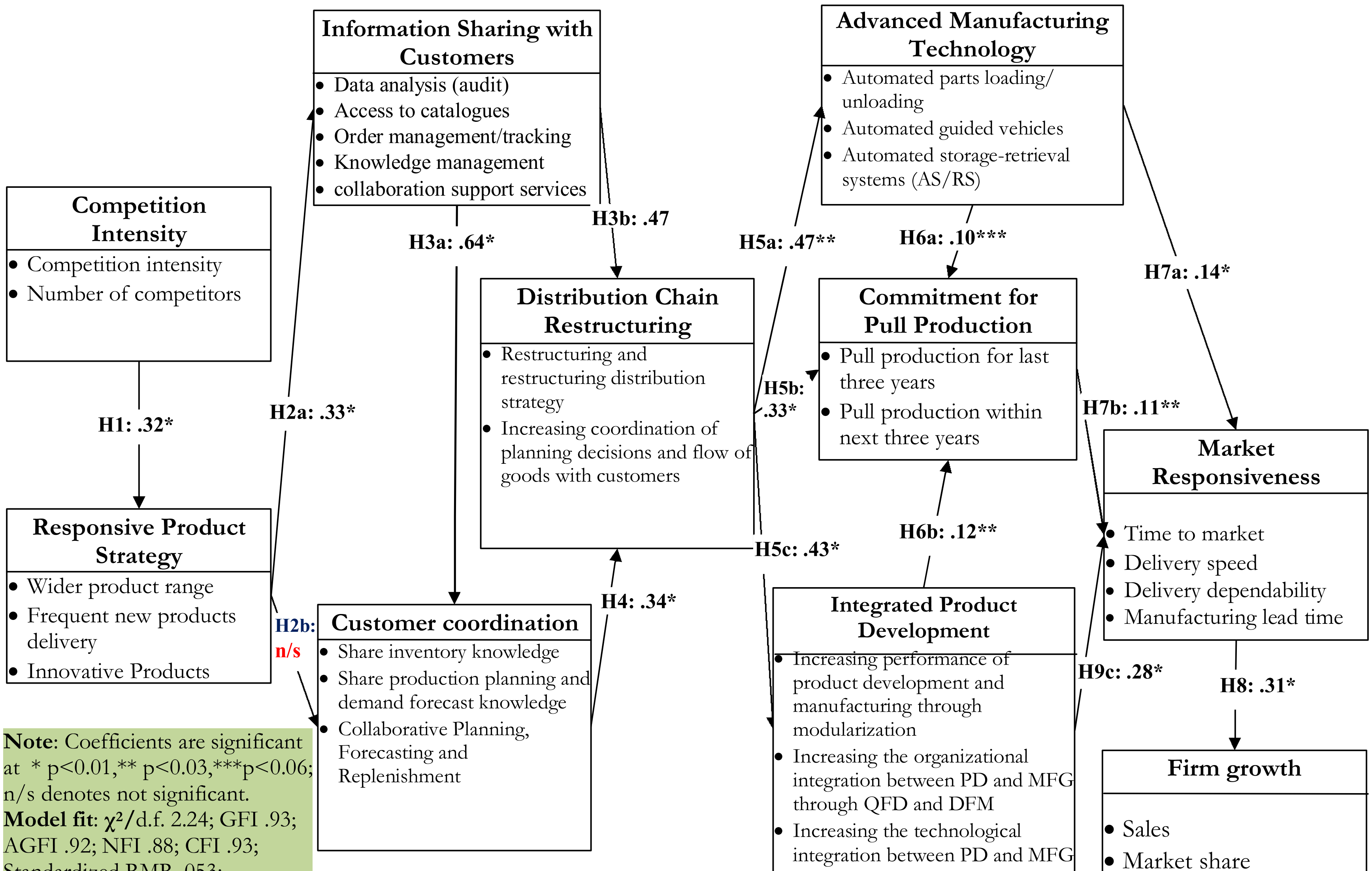
Firms respond to competitive market environment by widening product range, delivering new products more frequently, and offering innovative features. This result again confirms contingency theory that firms have to make adjustments between the environment and its strategy (Hofer 1975; Van de Ven & Drazin 1984). This responsive product strategy also leads firms to implement coordination level practices that help firms to be responsive to the market. Practices at the coordination level from the supplier's perspective are comprised of information sharing with suppliers, collaboration with suppliers, and supply chain restructuring. In contrast to the customer model results (section 4.1.3), it turns out that RPS has a direct impact on collaboration with suppliers (0.22). This result suggests that RPS influence is stronger for suppliers. This might be because suppliers usually are more within the control of manufacturing firms and therefore its strategy would have a stronger impact on suppliers. Information technology plays a strong role in mediating the impact of RPS on supply chain restructuring. The coefficient for supplier coordination is 0.38 while that for supply chain restructuring is 0.27. ISS and SC are strong drivers for supply chain restructuring (i.e., their coefficients are 0.27 and 0.42, respectively). SCR is influenced by supplier coordination more strongly than by information sharing with suppliers (i.e. 0.42 vs. 0.27). This was true of the customer model, too, suggesting that collaboration with suppliers and customers has a strong impact on supply chain and demand chain restructuring. Restructuring the supply chain starts with strategy reconsideration, an increase in coordination of decisions with suppliers, and supplier development programs. This effort results in enhancing market responsiveness (0.30). However, it is also important to recognize that the coefficient

(0.30) is relatively small, which suggests the presence of some links between coordination level practices and operational practices.

4.2. SEM Results for Research Framework for Customer (Whole Model)

This section shows the results from the whole model which includes strategic, operational, and supply chain level practices of responsive supply chain. The measurement instrument showed adequate validity and reliability, which was shown in Chapter 3. Thus, the whole model can undergo structural equation model testing. Fit indices produced from Amos 5.0 for Windows indicate satisfactory model-to-data fit. Absolute model fit, the chi-square to degree of freedom is 2.24, which is less than 3.0. Incremental indices for goodness of fit (GFI .93; AGFI .92; NFI .88; CFI .93) also show the sufficient validity of the model being tested. Indices for badness of fit signify the adequacy of the model as well (SRMR 0.053; RMSEA .04) with the confidence interval varying from 0.037 to 0.044.

Figure 4.2.1 and Table 4.2.1 present the coefficients of the path results in structural equation model with p-values. Except for the impact of responsive product strategy on coordination with customers, all standardized coefficients are significant at 0.06 level.



Note: Coefficients are significant at * p<0.01,** p<0.03,***p<0.06; n/s denotes not significant.
Model fit: χ^2/d.f. 2.24; GFI .93; AGFI .92; NFI .88; CFI .93; Standardized RMR .053; RMSEA .04 (.037,.044).

Figure 4.2.1. SEM Results for Research Framework (Customers)

Table 4.2.1. Structural model results (Customers)

Path (from-to)			Standardized coefficients	t-Value	P-Value
CME	→	RPS	0.32	6.07	0.00
RPS	→	ISC	0.33	6.82	0.00
RPS	→	CC	-0.04	-0.94	0.35
ISC	→	CC	0.64	10.47	0.00
ISC	→	DCR	0.47	6.60	0.00
CC	→	DCR	0.34	5.09	0.00
DCR	→	AMT	0.47	8.10	0.00
DCR	→	IPD	0.43	7.76	0.00
DCR	→	PP	0.33	4.99	0.00
AMT	→	PP	0.10	1.89	0.06
IPD	→	PP	0.12	2.33	0.02
AMT	→	MR	0.14	3.02	0.00
PP	→	MR	0.12	2.36	0.02
IPD	→	MR	0.28	5.58	0.00
MR	→	FG	0.31	5.16	0.00
Fit indices: χ^2/d.f=2.24; GFI .93; AGFI .92; NFI .88; CFI .93; Standardized RMR .053; RMSEA .04 (.037,.044).					

The first hypothesis predicted that the higher the level of competition intensity, the higher the level of responsive product strategy. The impact of competition intensity on responsive product strategy proved significant (γ = .32, t = 6.07, p = 0.00). This result indicates the positive relationship between competition intensity and responsive product strategy. As intensified competition compels firms to respond to market changes and customer preferences more speedily, firms will reconsider their strategy and strive to make their products have wider range, more innovativeness, and deliver them more frequently to the market. This result confirms contingency theory that firms have to make adjustments between the environment and its strategy (Hofer 1975; Van de Ven & Drazin 1984).

Hypothesis 2a anticipated that a firm with a high level of responsive product strategy would need to acquire a higher level of information technology in order to share production, demand data and knowledge management data with customers. The relationship turned out to be significant (β = .33, t = 6.82, p = 0.00). Firms that demand the responsive supply chain needs to scan how the competitive landscape in the market is changing. It is an imperative task for firms to increase the means of sharing information and knowledge with customers by implementing information systems.

Hypothesis 2b predicted that a firm with a high level of responsive product strategy would strive to obtain a high level of coordination with customers. Implementing responsive product strategy necessitates a higher level of coordination with customers in terms of sharing inventory knowledge, production planning, demand forecast knowledge, and collaborative planning and forecasting. Surprisingly, however, the relationship turned out to be statistically insignificant (β = -.04, t = -.94, p = 0.35). It turns out that RPS has an indirect impact on customer coordination through information technology. Customers are scattered in a market and it is hard to reach them directly. By establishing effective information systems with customers, firms can foster collaboration. The examples of information sharing are data analysis (audit), access to catalogues, order management/tracking, knowledge management, and collaboration support service. Through these sharing practices, firms can extend collaboration network to customers.

Hypothesis 3a predicted that a higher level of information sharing technology execution will help to enhance coordination with customers. This relationship proved to be very strong (β = .64, t = 10.47, p = 0.00). Information technology plays a key role in fostering coordination with customers. With the advent of the internet and other electronic communication tools, firms are empowered to further synchronize production and demand data with customers.

Hypothesis 3b anticipated that a higher level of information sharing technology execution will help to cultivate distribution chain restructuring. This impact proved to be significant ($\beta = .47$, $t = 6.60$, $p = 0.00$). Information and data drawn from information technology implementation with customers helps firms to scan the needs for restructuring the distribution chain. Information technology relates strongly to distribution chain restructuring.

Hypothesis 4 posited that coordination with customers would have a positive influence on supply chain restructuring. As hypothesized, the relationship appeared significant ($\beta = .34$, $t = 5.09$, $p = 0.00$). Sharing knowledge on inventory, demand information, collaborative efforts with customers helps firms to reconsider distribution strategy and to increase coordination of planning decisions and flow of goods with customers.

Hypothesis 5a speculated the positive influence of distribution chain restructuring on implementing advanced manufacturing technology. The structural equation model results demonstrate its strong relationship ($\beta = .47$, $t = 6.60$, $p = 0.00$). Restructuring the distribution chain espouses the adoption and usage of advanced manufacturing technology. Restructuring in distribution will enable firms to see the frontend of the market situation and customer demand variations and to proactively respond to the changes. Therefore, a manufacturing firm needs to acquire the capacity to tackle the changing realities. Advanced manufacturing technology facilitates firms to promptly accommodate changing needs of customers for products.

Hypothesis 5b predicted a positive effect of distribution chain restructuring on commitment for pull production. The result confirmed this relationship (β = .33, t = 4.99, p = 0.00). The higher the level of distribution chain restructuring, the higher the commitment for pull production. Pull production is the culmination of the efforts to reflect changing customer's needs and competitive market environment effectively and efficiently. Distribution restructuring will make pull production easier.

Hypothesis 5c presented the causal relationship between distribution chain restructuring and integration between product development and manufacturing. This relationship turned out to be strong (β = .43, t = 7.76, p = 0.00). In the stream of reframing distribution structure, firms realize the needs to compress the product development cycle. Experience and realization gained from the restructuring process lead them to endeavor to integrate as many functions into the product development process as possible. Firms will make every effort to increase product development performance by implementing modularization, platform usage design for manufacturing, quality function deployment, technological integration and so forth.

Hypothesis 6a conjectured the underlying association between advanced manufacturing technology and commitment for pull production. This relationship also proved to be significant (β = .10, t = 1.89, p = 0.06). Pull production necessitates advanced production technology that supports a firm's system. Advanced manufacturing technology helps firms to commit themselves to pull production. However, this impact was not as significant as other hypothesis. It was significant at the 0.06 level. This was quite surprising because it was expected that AMT would have a very strong influence on pull production. This result is unexpected. Technology seemed important but in this study the impact does not support it. Sociotechnical system theory (Clegg 2005; Kaghan & Bowker 2001; Walker et al. 2008) might be the explanation for this outcome. Pull production is a system that requires orchestration of functions. Although important, technology might not be the most important factor that aids pull production systems. For instance, Koufteros (1999) reports that preventive maintenance and setup improvements are important antecedents that enhance pull production. Koufteros et al. (2007) also report that level of communication is another important driver that affects pull production implementation. This means that the significance of technology should be complemented by other factors. In this sense, sociotechnical system theory perspective offers a sensible explanation for the surprising result. According to the theory, technology itself may not bring desired and anticipated outcomes to a firm. When socio-system supports and is compatible with socio-system such as employee training, organizational culture, flexible organizational design, the system could yield to anticipated results.

Hypothesis 6b surmised the contributory connection of functional, organizational, and technological integration of product development to commitment for pull production. Pull production is supported by the level of integration and this relationship was significant ($\beta = .12$, $t = 2.33$, $p = 0.02$). This evidence highlights the integral role of product development that supports pull production capability.

Hypothesis 7a theorized the positive influence of advanced manufacturing technology on market responsiveness. Market responsiveness attempts to measure how speedily a firm tackles variations and challenges rising from competitive markets. This relationship was robust ($\beta = .14$, $t = 3.02$, $p = 0.00$). Advanced manufacturing technology apparently serves to buttress market responsiveness. The capability to absorb unstable demand variation gives latitude for firms to take risky opportunities to thrive in today's competitive landscape.

Hypothesis 7c inferred the positive impact of commitment for pull production on market responsiveness. This supposition materialized significant ($\beta = .28$, $t = 5.58$, $p = 0.02$). With purpose to adapt to changing market situation, pull production contributes to augment market responsiveness.

Hypothesis 7c predicted that functional, organizational and technological integration of product development will shore up market responsiveness. This relationship was robust ($\beta = .14$, $t = 3.02$, $p = 0.00$). It is noteworthy that this relationship appeared the strongest amongst other antecedents to market responsiveness, i.e., pull production and advanced manufacturing technologies. This finding gives an important insight. While expanding advanced manufacturing technology and committing to pull production, firms need not to neglect to address more deep-seated problems that reside in the organization. One of the active ways to outwit the problem that slows down a firm's responsiveness to market stems from taking possible problems into consideration and tackling them at the product design stage. For instance, Anderson (2004) reports that the production design phase determines 80 to 90 percent of total committed costs of a product. The finding that three dimensional integration in production development affects positively on market responsiveness corroborates this known notion.

Hypothesis 8 posited that the higher the level of market responsiveness, the higher the level of firm growth of a firm. This hypothesis emerged significant. ($\beta = .31$, $t = 5.16$, $p = 0.00$). There could be many aspects that influence profitability. Market responsiveness under high competition intensity comes into sight as a significant antecedent to profitability, suggesting that market responsiveness deserves attention from management.

Table 4.2.2. Indirect Effects of the Research Framework (Customers)

Effect / Cause	ISC	CC	DCR	AMT	IPD	PP	MR	FG
CI	0.11	0.05	0.07	0.03	0.03	0.03	0.02	0.01
RPS		0.21	0.21	0.10	0.09	0.09	0.05	0.02
ISC			0.22	0.32	0.30	0.30	0.16	0.05
CC				0.16	0.15	0.14	0.08	0.03
DCR						0.10	0.24	0.07
AMT							0.01	0.05
IPD							0.01	0.09
PP								0.04

Table 4.2.2 reports the indirect effects of the research framework for the customer model from the structural equation model. Such indirect effects, though not hypothesized, can shed light on relationships among variables in the research framework. For instance, competition intensity seems to have a strong impact on information sharing with customers (0.11) and also distribution chain restructuring (0.07). Responsive product strategy also carries significant indirect effects on coordination with customers (0.21), distribution restructuring (0.21) and advanced manufacturing technology (0.10). In particular, information sharing with customers has the strongest indirect influence on distribution chain restructuring (0.22), advanced manufacturing technology (0.32), Integrative Product Development (0.30), commitment for pull production (0.30), and market responsiveness (0.16). This viable but oblique impact of information sharing with customers suggests its essential role that information technology poses in distribution chain management. Coordination with customers conveys strong indirect effects on advanced manufacturing technology (0.16), three dimensional integration (0.15), and pull

production (0.14) as well. Distribution restructuring has a sturdy indirect effect on market responsiveness (0.24). It is also notable that there seems no robust indirect impact found for firm growth. This means that market responsiveness solely accounts for the direct impact on profitability. It is the strongest precursor in increasing profitability under intense competition.

4.3. SEM Results for Research Framework for Suppliers (Whole Model)

Fit indices produced from the research framework for suppliers signify sufficiency of model-to-data fit. Absolute model fit, the ratio of chi-square to degree of freedom is 2.05, which is close to 2.0. Incremental indices for goodness of fit (GFI .93; AGFI .92; NFI .90; CFI .95) also demonstrate the sufficient validity of the model being tested, for all of them exceed 0.90. Indices for badness of fit suggest the adequacy of the model as well (SRMR 0.055; RMSEA .037 with the confidence intervals ranging from 0.034 to 0.041).

Figure 4.3.1 and Table 4.3.1 present fit indices and coefficients of the path results from the structural equation model and their corresponding t-values and p-values. Except for the impact of advanced manufacturing technology on commitment for pull production, all standardized coefficients are significant at 0.05 level.

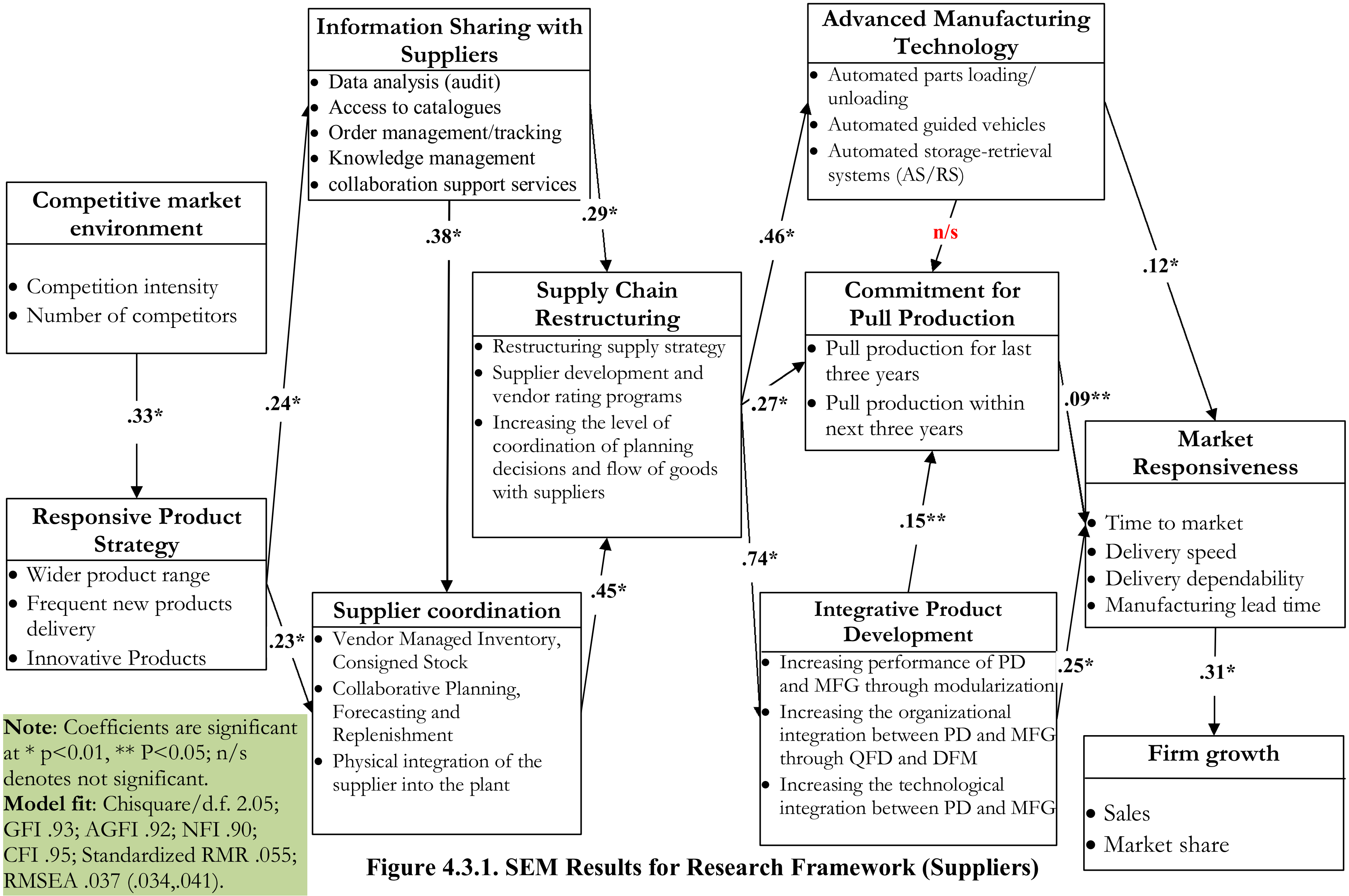


Figure 4.3.1. SEM Results for Research Framework (Suppliers)

Table 4.3.1. Structural model results (Suppliers)

Path (from-to)			Standardized coefficients	t-value	P-value
CME	→	RPS	0.33	6.24	0.00
RPS	→	ISS	0.24	5.60	0.00
RPS	→	SC	0.23	4.96	0.00
ISS	→	SC	0.38	7.68	0.00
ISS	→	SCR	0.29	6.19	0.00
SC	→	SCR	0.45	8.09	0.00
SCR	→	AMT	0.46	8.82	0.00
SCR	→	IPD	0.74	14.16	0.00
SCR	→	PP	0.27	3.50	0.00
AMT	→	PP	0.07	1.46	0.14
IPD	→	PP	0.15	2.08	0.04
AMT	→	MR	0.12	2.52	0.01
PP	→	MR	0.09	1.94	0.05
IPD	→	MR	0.25	4.90	0.00
MR	→	FG	0.31	5.14	0.00
Model fit: χ^2/d.f.=2.05; GFI .93; AGFI .92; NFI .90; CFI .95; RMR .061; RMSEA .037 (.034,.041).					

The first hypothesis predicted that the higher the level of competition intensity, the higher the level of responsive product strategy. The impact of competition intensity on responsive product strategy held significant ($\gamma = .33$, $t = 6.24$, $p = 0.00$). This result, almost identical to that in the customer model, indicates the positive relationship between competition intensity and responsive product strategy.

Hypothesis 2a anticipated that a firm with a high level of responsive product strategy would demand it to acquire a higher level of information technology in order to share production, demand data and knowledge management with suppliers. The relationship turned out to be significant ($\beta = .24$, $t = 5.60$, $p = 0.00$). The impact lessened in degree compared to 0.33 in the customer model. Firms need to scrutinize how the competitive landscape in the market is changing. It is an imperative task for firms to increase the means of sharing information and knowledge with suppliers. One way is to adopt and implement information systems. The lesser effect on information sharing technology with suppliers may come from the fact that suppliers often cannot afford the financial resources to launch quality information sharing technology. In many cases, however, customers monitor the demand variation and share with the producer more often and consistently by using information technologies.

Hypothesis 2b predicted that a firm with a high level of responsive product strategy would strive to obtain a higher level of coordination with suppliers. Implementing responsive product strategy necessitates a higher level of coordination with suppliers in such areas as inventory knowledge, production planning and demand forecast knowledge and collaborative planning and forecasting. The link turned out to be statistically significant ($\beta = .23$, $t = 4.96$, $p = 0.00$). This result contrasts with that from the customer model. The results from the research framework in the customer model did not support this relationship at all. Namely, while responsive product strategy does not have much impact on coordination with customers, it does have a considerable effect on coordination with suppliers. Why would this be the case? One interpretation is that it is easier for manufacturers to control suppliers than customers. Another possible interpretation is that supplier coordination is recognized as more crucial than customer coordination. In order to implement responsive product strategy, firms need to collaborate with suppliers more than with customers.

Hypothesis 3a predicted that there is a positive relationship between the level of information sharing with suppliers and the level of coordination with suppliers. This relationship proved to be strong (β = .38, t = 7.68, p = 0.00). Information sharing using technology plays a key role in fostering coordination with suppliers. In the customer model, the coefficient of information sharing with customers on coordination with customers were strongest one (0.68) but in supplier model it is 0.38. Although significant, the coefficient is not as strong as that in the customer model. The reason might be that manufacturers sometimes share information with suppliers through direct contact other than information technology. They invite suppliers and train them and share knowledge and practices together. For example, Toyota actively implements supplier development programs and does not depend on information sharing technology alone in collaborating with suppliers (Langfield-Smith & Greenwood 1998).

Hypothesis 3b predicted that there is a positive relationship between information sharing technology execution and supply chain restructuring. This impact appears significant (β = .29, t = 6.19, p = 0.00). Information and data drawn from information technology implementation with suppliers helps firms to scrutinize the needs for restructuring the supply chain. Information technology relates strongly to distribution chain restructuring. The impact of information sharing with customers on distribution chain restructuring was 0.47, which is stronger than 0.29. Information sharing technology plays a less important role in promoting supply chain restructuring. One reason lies in the fact that the supply chain is more stable than the distribution chain. Another reason is that technology has been implemented in the supply chain and it does not drive supply chain restructuring in the same degree as in the case of customers.

Hypothesis 4 posited positive influence of coordination with suppliers on supply chain restructuring. As hypothesized, the relationship appeared significant (β = .45, t =

8.09, p = 0.00). .34 Sharing knowledge on inventory and demand information with suppliers and collaborative efforts with suppliers to plan, forecast and replenish help firms to reconsider supply strategy and increase coordination of planning decisions and flow of goods with suppliers. In comparison to the result from customer model (0.34), this result is much stronger. Notice that the impact is more significant than that of information sharing with suppliers (0.29). In suppliers case, the level of coordinating with suppliers is more important than information sharing with suppliers. In other words, without sharing information in too much detail, a manufacturing firm manages to increase coordination level and foster supply chain restructuring.

Hypothesis 5a speculated the positive influence of supply chain restructuring plan on implementing advanced manufacturing technology. The structural equation model result demonstrate its strong relationship ($\beta = .46$, $t = 8.82$, $p = 0.00$). Restructuring supply chain espouses the adoption and usage of advanced manufacturing technology. Restructuring in supply chain will enable firms to see the frontend of market situation and customer demand variations and to proactively respond to the volatile changes. Therefore a manufacturing firm needs to acquire the capacity to tackle the changing realities. Advanced manufacturing technology facilitates firms to promptly accommodate changing demand through resilient production capability. This is a comparable result with that in customer model.

Hypothesis 5b described the positive effect of supply chain restructuring on commitment for pull production. The result confirmed this relationship ($\beta = .27$, $t = 3.50$, $p = 0.00$). The higher the level of supply chain restructuring, the higher the commitment for pull production. Pull production is the culmination of the efforts to reflect changing customer's needs and competitive market environment. Supply chain restructuring will result in shorter and more responsive supply chain structure, which requires production capability to rapidly manufacture a variety of products. This result is also comparable to that from customer model.

Hypothesis 5c presented the causal relationship between supply chain restructuring and Integrative Product Development. This relationship came out very strong ($\beta = .74$, $t = 14.16$, $p = 0.00$). In an effort to reframe supply chain structure, firms realize the needs to compress product development cycle and broaden the scope of product development integration with other functions. Experience and realization gained from restructuring process lead them to endeavor to integrate production development as many functions as possible. Firms will make every effort to increase product development performance by implementing modularization, platform usage design for manufacturing, quality function deployment, technological integration and so forth. Compared against customer model (0.43), 0.74 is much bigger than that. Amongst H5a, H5b, and H5c, H5c has the strongest impact. In customer model, H5a was the strongest one, putting more weight on advanced manufacturing technology. However, in supplier model, the integrative product development is far important than advanced manufacturing technology and pull production. Restructuring supply chain results in reconsidering product development process and enlarging the scope of integration from functions to organization to technology.

Hypothesis 6a conjectured the underlying association between advanced manufacturing technology and commitment for pull production. This relationship held less significant in the results ($\beta = .07$, $t = 1.46$, $p = 0.14$). Pull production necessitates advanced production technology that supports its system. Advanced manufacturing technology helps firms to incessantly be committed to pull production. However, this impact was not as significant as other hypothesis. It is significant at 0.14 level. Despite the importance of this relationship, technology itself does not drive firms to commit to pull production. This relationship was significant in customer model but not in supplier model, which is surprising. Advanced manufacturing technology may not induce commitment for pull production.

Hypothesis 6b surmised the contributory connection of functional, organizational, and technological integration of product development to commitment for pull production. Pull production is supported by the level of integration and this relationship proved to be significant ($\beta = .15$, $t = 2.08$, $p = 0.04$). This evidence highlights the integral role of product development that supports pull production capability. Given that H6a is insignificant, one can infer that it is integrative product development that encourages the commitment for pull production. In addition, supply chain restructuring display stronger impact on commitment for pull production than three dimensional integration.

Hypothesis 7a theorized the positive influence of advanced manufacturing technology on market responsiveness. Market responsiveness attempts to measure how speedily a firm tackles variations and challenges rising from competitive market. This relationship emerged robust ($\beta = .12$, $t = 2.52$, $p = 0.01$). Advanced manufacturing technology apparently serves to buttress market responsiveness. The capability to absorb unstable demand variation gives latitude for firms to make risks opportunities to thrive in today's competitive landscape.

Hypothesis 7b inferred the positive impact of commitment for pull production on market responsiveness. This supposition materialized significant (β = .09, t = 1.94, p = 0.05). With purpose to adapt to changing market situation, pull production contribute to augment market responsiveness. Compared to the coefficient in customer model (0.28), the coefficient is smaller.

Hypothesis 7c construed that functional, organizational and technological integration of product development will shore up market responsiveness. This relationship surfaced robust (β = .25, t = 4.90, p = 0.00). It is noteworthy that this relationship protruded the strongest amongst antecedents to market responsiveness. This finding gives an important insight. While expanding advanced manufacturing technology and committing to pull production, firms need not to neglect to address more deep-seated problem that resides in organization. One of active ways to outwit problems that slow down a firm's responsiveness to market stems from taking possible problems into consideration and tackling them at the product design stage.

Hypothesis 8 posited that the higher the level of market responsiveness, the higher the level of firm growth of a firm. This hypothesis emerged significant. (β = .31, t = 5.14, p = 0.00). There could be many aspects that influence profitability. Market responsiveness under high competition intensity come into sight as a significant antecedent to profitability, suggesting that market responsiveness deserves efforts for enhancement. Figure 4.2 and Table 4.3 summarize the discussion.

Table 4.3.2. Indirect Effects of the Research Framework (Suppliers)

Effect / Cause	ISS	CS	SCR	AMT	IPD	PP	MR	FG
CI	0.13	0.13	0.10	0.05	0.08	0.06	0.03	0.01
RPS		0.06	0.15	0.08	0.12	0.10	0.04	0.01
ISS			0.15	0.21	0.32	0.26	0.10	0.03
CS				0.26	0.39	0.32	0.13	0.04
SCR						0.22	0.26	0.08
AMT							0.01	0.03
IPD							0.01	0.07
PP								0.02

Table 4.3.2 reports the indirect effects of the research framework for supplier model from structural equation model. Such indirect effects, though not hypothesized, can shed light on relationships among variables in the research framework. For instance, competition intensity seems to have a strong impact on information sharing with customers (0.13), coordination with suppliers (0.13) and supply chain restructuring (0.10). Responsive product strategy also carries a significant indirect effect on supply chain restructuring (0.15) and integrated product development practices (0.12). In particular, information sharing with suppliers bear strong indirect influence on supply chain restructuring (0.15), advanced manufacturing technology (0.21), integrative product development (0.32), and commitment for pull production (0.26). This viable but oblique impact of information sharing with supplier suggests the essential role that information technology poses in distribution chain management. Coordination with customers conveys strong indirect effects on advanced manufacturing technology (0.16), three dimensional integration (0.15), and pull production (0.14) as well. Supply chain restructuring causes sturdy indirect effect on commitment for full production (0.22) and market responsiveness (0.26). It is also notable that there seems no robust indirect impact found for firm growth. This means that market responsiveness solely accounts for the

direct impact on profitability. It is the strongest precursor in increasing profitability under intense competition.

4.4. Comparison between Customer Model and Supplier Model

Table 4.4.1 compares SEM results from the customer model to those from the supplier model. Five findings stand out from the results. First, responsive product strategy influences the coordination with suppliers significantly while not influencing the coordination with customers. This is an interesting result that deserves more discussion. It seems that the responsive product strategy affects coordination with customers through information sharing with customers, which at most produces a strong indirect effect (0.21). For the suppliers' side, however, the responsive product strategy has a direct impact on coordination with suppliers (0.23) at the level of 0.01% significance.

Table 4.4.1. Structural Model Results Comparison (Customers vs. Suppliers)

Customers				Suppliers			
Path (from-to)	Std. Coefficients	t-Value	P-Value	Path (from-to)	Std. Coefficients	t-Value	P-Value
CME → RPS	0.32	6.07	0.00	CME → RPS	0.33	6.24	0.00
RPS → ISC	0.33	6.82	0.00	RPS → ISS	0.24	5.60	0.00
RPS → CC	-0.04	-0.94	0.35	RPS → CS	0.23	4.96	0.00
ISC → CC	0.64	10.47	0.00	ISS → CS	0.38	7.68	0.00
ISC → DCR	0.47	6.60	0.00	ISS → SCR	0.29	6.19	0.00
CC → DCR	0.34	5.09	0.00	CS → SCR	0.45	8.09	0.00
DCR → AMT	0.47	8.10	0.00	SCR → AMT	0.46	8.82	0.00
DCR → IPD	0.43	7.76	0.00	SCR → IPD	0.74	14.16	0.00
DCR → PP	0.33	4.99	0.00	SCR → PP	0.27	3.50	0.00
AMT → PP	0.10	1.89	0.06	AMT → PP	0.07	1.46	0.14
IPD → PP	0.12	2.33	0.02	IPD → PP	0.15	2.08	0.04
AMT → MR	0.14	3.02	0.00	AMT →MR	0.12	2.52	0.01
PP → MR	0.12	2.36	0.02	PP → MR	0.09	1.94	0.05
IPD → MR	0.28	5.58	0.00	IPD →MR	0.25	4.90	0.00
MR → FG	0.31	5.16	0.00	MR → FG	0.31	5.14	0.00
Fit indices: χ^2/d.f=2.24; GFI .93; AGFI .92; CFI .93; Standardized RMR .053; RMSEA .04 (.037,.044).				Fit indices: χ^2/d.f.=2.05; GFI .93; AGFI .92; CFI .95; Standardized RMR .055; RMSEA .037 (.034,.041).			

Second, information sharing with customers leads to a more significant impact on coordination with customers than information sharing with suppliers does on the coordination with suppliers. In the suppliers' case, there are other means of sharing knowledge, such as communicating with each other on the phone or in an actual meeting. Since customer information constantly changes, however, information sharing with customers plays a more important role in coordinating with customers.

Third, information sharing with customers has a stronger impact on restructuring the distribution chain than information sharing with suppliers does. The coefficient of the causal relationship between the ISC and the DCR is 0.47 whereas that between the ISS and the SCR is 0.29. In both research frameworks, sharing information with customers and with suppliers play an important role in rethinking and reconsidering the supply chain and the distribution chain.

Fourth, the results highlight the importance of restructuring the supply chain and the distribution chain. The best facilitator for restructuring both the upstream and downstream of the supply chain is information sharing with customers and suppliers. Reframing the supply and distribution chains has a three-fold impact on market responsiveness. It first increases the usage of advanced manufacturing technology, then the commitment for pull production, and finally the integration between product development and manufacturing. Among these three results, restructuring the supply chain has the most prominent influence on the three-dimensional integration between product development and manufacturing. It exhibited the strongest standing on the Integrative Product Development and manufacturing with a coefficient of 0.74, and a t-value of 14.16. The results suggest that restructuring the supply chain allows the functional, technological, and organizational integration of the product development process with manufacturing. In particular, restructuring the supply chain has a greater effect on integrated product development practices than restructuring the distribution chain. This finding can be explained by the fact that suppliers focus on the product development process, and that they can be directly alerted of the changes that take place in the supply chain to take the appropriate actions.

Fifth, the effect of advanced manufacturing technology differs in the customer model from the effect in the supplier model. In the research framework for customers, advanced manufacturing technology displayed a significant influence on the commitment for pull production. The results from the supplier model were the exact opposite; AMT did not enhance the commitment for pull production.

Despite these differences, the research results bring up largely similar results pattern from both customer and supplier models for the research framework. The empirical results illustrates overall how a firm approaches market responsiveness. It starts from pondering the situation and setting up a responsive product strategy. The strategy compels a firm to work with suppliers and customers by enhancing information sharing and coordination on the supply chain level. Doing so will restructure the supply chain. Such results influences manufacturing practices from the technology level to the production development level, and allows for pull production to take place. Eventually, these practices result in market responsiveness and firm growth.

4.5. Split-Half Analysis

This section reports split-half analysis of the data. Split-half analysis serves to validate discriminant validity and reliability of the sample used in this research (Anderson & Gerbing 1988; Hair et al. 1998; Bagozzi & Yi 1988; Hong et al. 2005). The sample was randomly divided into two using SPSS 16 and structural equations modeling was examined using those two samples. Table 4.5.1 reports the results from customer models. No significantly different results between split-half 1 sample and split-half 2 sample, confirming the discriminate validity of the measurement.

Table 4.5.1. Split-Half Analysis (Customers)

Split-Half 1 (n=379)				Split-Half 2 (n=383)		
Path (from-to)	Unstd. Coefficients	t-Value	P-Value	Unstd. Coefficients	t-Value	P-Value
CME → RPS	0.59	4.224	0.00	0.617	4.322	0.00
RPS → ISC	0.198	4.225	0.00	0.281	5.594	0.00
RPS → CC	-0.033	-0.621	0.535	-0.041	-0.678	0.498
ISC → CC	0.743	6.842	0.00	0.866	7.933	0.00
ISC → DCR	0.438	4.706	0.00	0.395	4.507	0.00
CC → DCR	0.219	3.234	0.001	0.238	3.634	0.00
DCR → AMT	0.591	5.156	0.00	0.613	6.164	0.00
DCR → IPD	0.47	4.875	0.00	0.554	6.178	0.00
DCR → PP	0.569	3.895	0.00	0.513	3.394	0.00
AMT → PP	0.112	1.285	0.199	0.136	1.42	0.00
IPD → PP	0.138	1.44	0.15	0.148	1.343	0.179
AMT → MR	0.132	2.462	0.014	0.093	1.742	0.081
PP → MR	0.054	1.267	0.205	0.101	2.117	0.034
IPD → MR	0.215	3.447	0.00	0.289	4.422	0.00
MR → FG	0.312	3.459	0.00	0.303	3.663	0.00
Fit indices: χ^2/d.f=1.62; IFI .92; TLI .91; CFI .92 RMSEA .04 (.034, .046)				Fit indices: χ^2/d.f.=1.67; IFI .93; TLI .92; CFI 0.93; RMSEA .042 (.036, .048).		

Table 4.5.2 reports the results from supplier models. No significantly different results between split-half 1 sample and split-half 2 sample were found, confirming the discriminate validity of the measurement.

Table 4.5.2. Split-Half Analysis (Suppliers)

	Split-Half 1 (n=379)			Split-Half 2 (n=383)		
Path (from-to)	Unstd. Coefficients	t-Value	P-Value	Unstd. Coefficients	t-Value	P-Value
CME → RPS	0.605	4.349	0.000	0.635	4.429	0.000
RPS → ISC	0.124	2.526	0.012	0.258	5.308	0.000
RPS → CC	0.145	3.15	0.002	0.168	4.154	0.000
ISC → CC	0.265	4.599	0.000	0.33	5.868	0.000
ISC → DCR	0.278	5.087	0.000	0.188	3.096	0.002
CC → DCR	0.382	5.25	0.000	0.633	6.402	0.000
DCR → AMT	0.516	5.669	0.000	0.535	6.797	0.000
DCR → IPD	0.845	9.774	0.000	0.772	10.468	0.000
DCR → PP	0.444	2.437	0.015	0.4	2.315	0.021
AMT → PP	0.103	1.208	0.227	0.086	0.906	0.365
IPD → PP	0.2	1.319	0.187	0.272	1.791	0.073
AMT → MR	0.124	2.211	0.027	0.077	1.401	0.161
PP → MR	0.038	1.083	0.279	0.065	1.642	0.101
IPD → MR	0.177	2.838	0.005	0.25	3.9	0.000
MR → FG	0.31	3.427	0.000	0.301	3.647	0.000
Fit indices: χ^2/d.f=1.58; IFI .94; IFI .94; CFI .94; RMSEA .039 (.033, .045) *negative variance for e33 (-.076)				Fit indices: χ^2/d.f.=1.57; IFI .95; TLI .94; CFI .95; RMSEA .039 (.033, .044).		

CHAPTER 5: CONTEXTUAL ANALYSIS

This chapter reports various contextual analyses results. The sample was divided into a few different categories such as region, plant size, degree of globalization, ISIC code, production schedule, production system, maintenance method, degree of product customization, number of coordination levels, proportion of cross-functional teams, proportion of multi-skilled workforce, degree of job rotation, extent of workforce autonomy, degree of just-in-time, number of suppliers, customer types, and number of customers. These contextual analyses shed light on what differences various contexts what differences various context bring in to responsive supply chain practices.

One note is that contextual analyses encountered negative variances in several occasions, which precluded the contextual analysis from comparison. In the presence of negative variances, data analyses results may be arbitrary in error terms. The main culprit for the presence of negative variances is high multicollinearity (Chen et al., 2001). Amos results suggested the presence of negative variances for two constructs: commitment for pull production and firm growth. Both constructs consist of two items and careful consideration led to eliminating one of them for both constructs. It was decided to eliminate PC6f (planned efforts for pull productions within next 3 years) for commitment for full production because PC6c (degree of use of pull production program for the last 3 years) deemed more important to represent commitment for pull production construct. Similarly, it was decided to remove A6f (market share) from firm growth because A6e (sales) deemed more important than market share because it represents firm growth of a firm. Another note is that unstandardized coefficients were used in this section for they allow the researchers to compare the differences in various contexts. Unstandardized coefficient serves comparison purpose better than standardized coefficient.

Eight contexts are provided in this section: region, plant size, globalization, industries according ISIC code classification, days of frozen production schedule, the proportion of multi-skilled workforce, the number of suppliers, and the degree of just-in-time practices with suppliers and customers.

5.1. International Comparison

This section reports international comparisons of the research framework. Descriptive statistics is reported in Table 5.1.1 and Figure 5.1.1 The sample was divided to four major regions that include Europe (n=458), Asia and Oceania (n=132), and North and Latin America (n=151) and Asia only (n=88). European data accounts for more than 60%. This breakup analysis aims at finding any regional difference, which can be interpreted as cultural or regional differences. According to international culture studies, culture plays important role in business practices and this section explores possible differences.

Region	Frequency	Relative Frequency
Asia	88	12%
Asia&Oceania	132	17%
Europe	458	60%
North&Latin America	151	20%
Total Sample	761	

Table 5.1.1. Regional Distribution

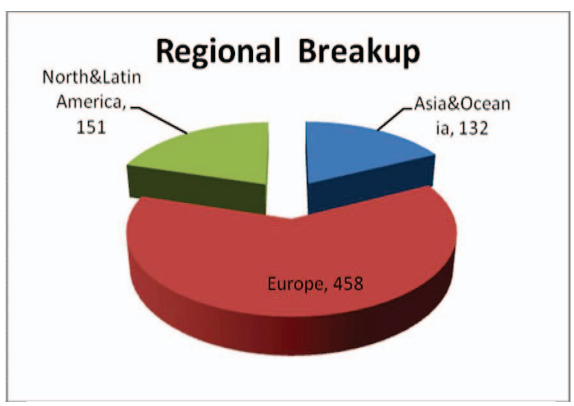


Figure 5.1.1. Regional Distribution

5.1.1. Customer Model

Table 5.1.2 reports structural model results for customer model from Europe, Asia and Oceania, and North and Latin America samples. For European countries, two noticeable things are observed. First, customer coordination is playing an important role in fostering demand chain restructuring. The coefficient of CC to DCR is 0.332 for European firms while 0.06 and 0.181 for other regions. While information sharing with customers is also having a significant impact on DCR, customer coordination is the strongest factor. This result suggests that in restructuring demand chain European companies utilize information technology less than other regions, in particular, Asia and Oceania, whose coefficient from ISC to DCR is 0.724. Second, in European countries, advanced manufacturing technologies and integrated product development are statistically significant in increasing pull production practices while in the other regions thee are not the significant factors. It seems that AMT and IPD are being utilized in Europe. It may be because European firms have more resources to automate production process using advanced technologies. The reason for using IPD more actively in European firms is that it is more oriented toward long-term solution in increasing pull production systems.

Table 5.1.2. Regional Comparison for Customer Model

Customer Model			Whole Sample (n=761)		Europe (n=458)		Asia&Oceania (n=132)		North&Latin America (n=151)	
Path (from-to)			Unstd. Coefficients	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value
CME	→	RPS	0.624	0	0.497	0	0.726	0	0.781	0
RPS	→	ISC	0.234	0	0.162	0	0.356	0	0.33	0
RPS	→	CC	-0.038	0.346	-0.006	0.913	-0.022	0.844	-0.044	0.844
ISC	→	CC	0.817	0	0.726	0	0.822	0	0.877	0
ISC	→	DCR	0.419	0	0.217	0.002	0.724	0	0.474	0
CC	→	DCR	0.234	0	0.332	0	0.06	0.439	0.181	0.439
DCR	→	AMT	0.61	0	0.46	0	0.897	0	0.582	0
DCR	→	IPD	0.506	0	0.498	0	0.521	0	0.396	0
DCR	→	PP	0.513	0	0.492	0	0.85	0	0.239	0
AMT	→	PP	0.122	0.058	0.237	0.004	-0.047	0.686	-0.005	0.686
IPD	→	PP	0.167	0.02	0.213	0.011	-0.09	0.532	0.493	0.532
AMT	→	MR	0.114	0.003	0.062	0.187	0.056	0.412	0.264	0.412
PP	→	MR	0.076	0.018	0.065	0.1	0.21	0.011	0.032	0.011
IPD	→	MR	0.251	0	0.262	0	0.252	0.011	0.233	0.011
MR	→	FG	0.317	0	0.25	0.004	0.597	0	0.21	0
Fit Indices			χ2/d.f=2.24; GFI .93; AGFI .92; NFI .88; CFI .93; SRMR .053; RMSEA .04 (.037,.044).		χ2/d.f=1.81; GFI .91; IFI .90; TLI .90; CFI .91; SRMR .060; RMSEA .042 (.037,.047).		χ2/d.f=1.52; IFI .89; TLI .87; CFI .89; SRMR .089; RMSEA .063 (.052,.074).		χ2/d.f=1.29; IFI .93; TLI .92; CFI .93; SRMR .078; RMSEA .044 (.031,.055).	

A few important observations are made as follows: First, competitive market environment influences firms strongly to implement responsive product strategy, which strongly influences them to implement information sharing practices with customers. Compared to European firms, Asian and Oceania firms are more susceptible to competitive environment because they are usually exporters to the world rather than importer and the market size in their continents are smaller than European market.

Second, information sharing with customers helps in restructuring demand chain more than coordination with customers does. Asian companies, in particular, are known for its swift adoption of technologies.

Third, in Asian and Oceania companies the influence of demand chain restructuring is playing the strongest impact on AMT, IPD, and PP. In particular, the effort to restructure demand chain lead firms to adopt AMT (i.e., its coefficient is 0.897) and increase commitment for PP (i.e., its coefficient is 0.85). Particularly, PP is enhanced by DCR only in Asia & Oceania companies. These results suggest that DCR is taking place in Asia more actively than other places. Asian and Oceania business environment is more dynamic than other regions and the effort to agriculture demand chain is powerfully penetrating into internal manufacturing practices.

Fourth, in increasing market responsiveness, companies in Asia and Oceania take advantage of pull production systems and integrated product development practices more than advanced manufacturing technologies. Asia and Oceania are more affluent in human resources than in capital resources. Through concerted training and effort in conducting pull production system and integrated product development management, the firms increases market responsiveness.

Lastly, increase in market responsiveness results in increasing firm growth in Asia and Oceania firms. The coefficient (0.597) is two times greater than those from firms in Europe and North and Latin America. Asian and Oceanian companies focuse on increasing market responsiveness and this increases their firm growth. The results suggest that this region is taking advantage of market responsiveness the most.

With respect to North and Latin America, the results exhibit similar patterns to those from Asia and Oceania. Competitive market environment influences firms strongly to implement RPS, which strongly influences them to adopt information sharing practices with customers. Strongest impact of information sharing with customers came up in the model. The coefficient, 0.877, is the largest, suggesting that information sharing with customers is strongly helping firms in America to collaborate with customers. However, surprisingly, collaboration with customers are not helping firms in America to restructure its demand chain but ISC. In companies in North and Latin America, DCR enhances PP. However, surprisingly AMT and IPD does not have statistically significant impact on pull production. PP and IPD play important role in increasing MR, which helps increasing firm growth.

5.1.2. Supplier Model

Table 5.1.3. summarizes structural model results for supplier model from Europe, Asia and Oceania, and North and Latin America samples. For European countries, two noticeable things are observed. First, supplier coordination is playing an important role in fostering supply chain restructuring. The coefficient of SC to SCR is 0.702 for European firms while that is 0.434 for companies in Asia and Oceania and 0.525 for companies in North and Latin America. While information sharing with suppliers also exhibits a significant impact on SCR, supplier coordination is the strongest factor that triggers SCR. This result suggests that in restructuring supply chain European companies utilize information technology less than other regions, in particular, North and Latin America, whose coefficient from ISS to SCR is 0.367. Second, in European countries, advanced manufacturing technologies and integrated product development are statistically significant in increasing pull production practices while in the other regions these are not the significant factors. It seems that AMT and IPD are being utilized in Europe in order to increase pull production systems. It may be because European firms have more resources to automate production process using advanced technologies. The reason for using IPD more actively in European firms is that it is more oriented toward long-term solution in increasing pull production systems.

Table 5.1.3. Regional Comparison for Supplier Model

Supplier Model			Whole Model (n=761)		Europe (n=458)		Asia&Oceania (n=132)		North&Latin America (n=151)	
Path (from-to)			Unstd. Coefficients	P-Value	Unstd. Coefficients	P-Value	Unstd. Coefficients	P-Value	Unstd. Coefficients	P-Value
CME	→	RPS	0.641	0	0.512	0	0.731	0	0.79	0
RPS	→	ISS	0.197	0	0.149	0.001	0.245	0.008	0.266	0
RPS	→	SC	0.15	0	0.067	0.011	0.341	0	0.177	0.009
ISS	→	SC	0.304	0	0.195	0	0.461	0	0.136	0.102
ISS	→	SCR	0.252	0	0.232	0	0.198	0.015	0.367	0
SC	→	SCR	0.49	0	0.702	0	0.434	0	0.525	0
SCR	→	AMT	0.523	0	0.391	0	0.917	0	0.402	0
SCR	→	IPD	0.79	0	0.723	0	1.044	0	0.777	0
SCR	→	PP	0.429	0	0.224	0.162	1.081	0	0.443	0.074
AMT	→	PP	0.093	0.144	0.2	0.018	-0.049	0.664	-0.049	0.772
IPD	→	PP	0.22	0.037	0.413	0.009	-0.159	0.418	0.165	0.458
AMT	→	MR	0.099	0.012	0.059	0.216	0.111	0.145	0.188	0.124
PP	→	MR	0.05	0.052	0.042	0.161	0.179	0.022	0.006	0.935
IPD	→	MR	0.218	0	0.249	0	0.022	0.807	0.301	0.007
MR	→	FG	0.316	0	0.241	0.005	0.597	0	0.211	0.048
Fit Indices			χ2/d.f.=2.05; GFI .93; AGFI .92; NFI .90; CFI .95; SRMR .055; RMSEA .037 (.034,.041).		χ2/d.f.=1.69; GFI .91; AGFI .90; IFI .93; TLI .92; CFI .93; SRMR .057; RMSEA .039 (.034,.044). *negative variances		χ2/d.f.=1.45; IFI .91; TLI .90; CFI .91; SRMR .090; RMSEA .059 (.048,.069).		χ2/d.f.=1.18; IFI .96; TLI .96; CFI .96; SRMR .079.; RMSEA .035 (.019,.047).	

Noticeable observations from the results from firms in Asia and Oceania are as follows. Firstly, competitive market environment influences firms strongly to implement responsive product strategy, which strongly influences them to implement information sharing practices with suppliers. Compared to European firms, Asian and Oceania firms are more susceptible to competitive environment because they are usually exporters to the world rather than importer and because the market size in their continents are smaller than European market. Secondly, coordination with suppliers helps firms in restructuring supply chain more than information sharing with suppliers does. This result reveals that close collaboration with suppliers is more effective in restructuring supply chain. Notice, though, that information sharing with suppliers has larger magnitude of coefficient (0.232) than Asia and Oceania (0.198). This is the same case for firms in North and Latin America (i.e., its coefficient is 0.367). This difference might be explained that close collaboration is more preferred in European countries but in Asia and Oceania are more technology oriented. Thirdly, in Asian and Oceania companies the influence of supply chain restructuring exhibit the strongest influences on AMT, IPD, and PP. The efforts to restructure supply chain lead firms to adopt AMT (i.e., its coefficient is 0.917), increase commitment for pull production (i.e., its coefficient is 1.081), and enhance integrated product development practices (i.e., its coefficient is 1.044). Particularly, pull production is enhanced by supply chain restructuring only in Asia and Oceania companies. These results suggest that restructuration in supply chain is taking place in Asia more than other regions. Asian and Oceania business environment is more dynamic than other regions and the effort to agriculture demand chain is powerfully penetrating into internal manufacturing practices. Fourthly, in increasing market responsiveness, companies in

Asia and Oceania take advantage of pull production systems and integrated product development practices more than advanced manufacturing technologies. Asia and Oceania are more affluent in human resources than in capital resources. Through concerted training and effort in conducting pull production system and integrated product development management, the firms increase market responsiveness. Lastly, increasing market responsiveness results in increasing firm growth in Asia and Oceania firms. The coefficient (0.597) is two times greater than those from firms in Europe and North and Latin America. Asian and Oceania companies focus on increasing market responsiveness and this increases their firm growth. The results suggest that this region is taking advantage of market responsiveness the most.

With respect to North and Latin America, the results exhibit similar patterns to those from Asia and Oceania. Competitive market environment influences firms strongly to implement responsive product strategy, which strongly influences them to adopt information sharing practices with suppliers. Strongest impact of information sharing with suppliers on demand chain restructuring is observed; the coefficient, 0.367, is the largest among three coefficients, suggesting that information sharing with suppliers is strongly helping firms in America to restructure supply chain. In companies in North and Latin America, supply chain restructuring enhances pull production. However, surprisingly AMT and IPD do not have statistically significant impact on pull production. Moreover, pull production and AMT do not exhibit statistically significant impact on increasing market responsiveness. IPD is the only one that improves market responsiveness.

5.2. Plant Size

Three categories serve to divide firms into three classes. According to Small and Medium Sized firms, small firms means employing less than 100 employees, whereas medium size means between 100 and 500 employees and large size more than 500. Table 5.2 and Figure 5.2 present descriptive statistics of the sample according to plant size. Small firms and large firms account for 25 percent of total sample, respectively. The majority of the plants belong to small-medium-enterprises.

# of employees	Frequency	Relative Frequency
Small (0-100)	189	25%
Medium (101-500)	380	50%
Large (>500)	185	25%
Total	754	100%

Table 5.2 Plant Size

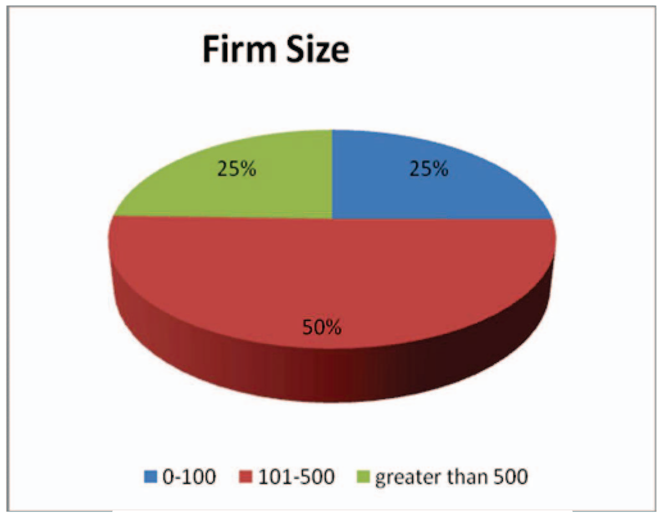


Figure 5.2 Plant Size

5.2.1. Customer Model

Table 5.2.1 shows the effect of plant size for customer models. Competitive market environment strongly influences large firms to implement responsive product strategy. Its coefficient, 0.812 is larger than the other two. It seems that RPS affects large firms to share information with customers. Its coefficient, 0.299 is greater than the other two. Large firms are more sensitive to the changes in competitive market environment. They also have more resources to respond to it by implementing responsive product strategy.

Table 5.2.1 The effects of firm size (Customers)

Customer Model			Whole Sample (n=761)		Small Enterprises (size<101;n=189)		Medium E. (100 < size=<500; n=380)		Large E. (Size>500; n=185)	
Path (from-to)			Unstd. Coefficients	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value
CME	→	RPS	0.624	0.000	0.455	0.009	0.624	0.000	0.812	0.000
RPS	→	ISC	0.234	0.000	0.205	0.002	0.177	0.000	0.299	0.000
RPS	→	CC	-0.038	0.348	-0.091	0.181	-0.102	0.059	0.174	0.106
ISC	→	CC	0.816	0.000	0.972	0.000	0.759	0.000	0.703	0.000
ISC	→	DCR	0.417	0.000	0.342	0.029	0.354	0.000	0.613	0.000
CC	→	DCR	0.235	0.000	0.285	0.025	0.26	0.00	0.129	0.187
DCR	→	AMT	0.608	0.000	0.376	0.000	0.56	0.000	0.459	0.000
DCR	→	IPD	0.505	0.000	0.4	0.000	0.514	0.000	0.28	0.019
DCR	→	PP	0.526	0.000	0.31	0.045	0.611	0.000	0.523	0.003
AMT	→	PP	0.121	0.066	0.213	0.151	0.103	0.381	0.145	0.216
IPD	→	PP	0.146	0.046	0.257	0.083	0.09	0.415	0.113	0.345
AMT	→	MR	0.118	0.001	0.179	0.064	0.16	0.008	0.138	0.076
PP	→	MR	0.059	0.012	-0.004	0.944	0.079	0.009	0.084	0.11
IPD	→	MR	0.257	0.000	0.347	0.000	0.235	0.000	0.199	0.02
MR	→	FG	0.316	0.000	0.178	0.07	0.331	0.000	0.43	0.000
Fit Indices			χ^2/d.f=2.24; GFI .93; AGFI .92; TLI .93; CFI .94; SRMR .055; RMSEA .042 (.037,.044).		χ^2/d.f=1.31; GFI .87; AGFI .84; TLI .93; CFI .94; SRMR .074; RMSEA .040 (.028,.051).		χ^2/d.f=1.63; GFI .91; AGFI .89; TLI .91; CFI .92; SRMR .061; RMSEA .041 (.034,.047).		χ^2/d.f=1.30; GFI .87; AGFI .84; TLI .92; CFI .93; SRMR .066; RMSEA .040 (.028,.051).	

The influence of information sharing with customers (ISC) on customer coordination (CC) and distribution chain restructuring (DCR) produced interesting results. Its impact on customer coordination turned out to be the strongest for small enterprises (0.972) and the impact gradually decreases as the organizational plant size increases (i.e., 0.759 for medium enterprises and 0.703 for large enterprises). In contrast, the impact of ISC on DCR turns out to be the strongest for large enterprises (0.613) and it gradually decreases as plant size decreases (i.e., 0.354 for medium enterprises and 0.342 for small enterprises). These contrasting results suggest that small-size plants are utilizing ISC to collaborate with customers more than to restructure distribution chain. Large plants take advantage of ISC more to re-streamline their distribution chains than to collaborate with customers.

In regard to the influence of customer coordination (CC), it stands out that CC does not have statistically significant impact on DCR for large firms while it plays significant role in restructuring demand chain for small-and-medium sized plants. This result implies that the small-and-medium-sized enterprises are getting more information through the usage of information sharing with customers.

Significant impacts of DCR on integrative practices of intra-organizations: advanced manufacturing technology (AMT), integrated product development (IPD), and commitment for pull production (PP). All coefficients are significant and strong across plant size, which means that the effort to restructure distribution chain strongly influences focal companies to integrate AMT, PP, and IPD on intra-organizational level. As mentioned in theory development section, DCR serves as a link that connects coordination mechanisms to intra-organizational integration. Notice that DCR tends to exhibit strong effects on pull production for medium and large firms. Simplifying and flattening distribution chains are effective for larger firms. Small firms need to rather focus on organizing resources within the plant. Little has been known about how distribution chain activities are influencing focal companies and this research finds that firms' endeavor to restructure distribution chains integrate AMT, PP and IPD.

With respect to the influences on PP, it turns out that AMT is not significant factor as it was shown in the general model. This result confirms that technology itself may not help increasing the level of pull production, which suggests the presence of socio-technical factors that would influence pull production systems. This part will be examined through contextual analysis on human resource component such as the level of multi-skilled workforce.

It was striking that IPD turned out to be insignificant in increasing the level of PP for customer. The coefficient of IPD on PP is significant at 0.05 level for the whole sample but it turned out to be insignificant for medium and large enterprises. It is statistically significant for small enterprises at the 0.083 level. IPD seems to be used for small enterprises to increase pull production. Small plants have agility to absorb changing market realities. The proposition of this research was that IPD costs large resources to pursue organizational and technological integration. But the analyses show that small firms are implementing IPD actively.

Factors that increase market responsiveness (MR) differ depending on plant size. AMT, PP, and IPD had significant effects in the whole model. For small enterprises, however, PP was found having no significant impact on MR. AMT and IPD are playing important roles for small firms to increase market responsiveness, but IPD has particularly strong impact on MR. For medium enterprises, AMT, PP, and IPD are all important with IPD being the strongest factor. For large enterprises, PP is not significant factor but AMT and IPD prove to have robust impact on MR.

These results suggest that PP might not be the most important factor that increases MR, which was assumed thus far in this research. It seems that IPD exhibited the strongest impact on MR. IPD comprehends market changes and helps firms to proactively cope with market changes. AMT is more important to small-and-medium enterprises than to large enterprises. This might be due to the fact that small-and-medium enterprises can drastically improve production volume and process by adopting AMT.

Lastly, MR increases firm growth regardless of plant size. However, the magnitude of the impact is less strong in the sample of small enterprises.

5.2.2 Supplier Model

Table 5.2.2 summarizes how plant size differently affects responsive supply chain in the case of supplier model. CME has also significant impact on RPS. It strongly influences small firms to implement RPS; however, for medium and large firms, CME does not have significant impact on RPS.

RPS shows similar pattern shown in customer model. For large firms, RPS has the strongest effect on implementing information sharing with suppliers (ISS) and coordination with suppliers (CS). The coefficient from RPS to ISS (0.429) is much bigger than the other two, so is the coefficient from RPS to SC (0.348) for large firms. The influence of ISS on SC was the strongest for large companies (its coefficient is 0.403). This result confirms coordination theory that goals drive the selection of coordination mechanisms, which is mediated by information technology.

Table 5.2.2. The effect of firm size (Suppliers)

Supplier Model			Whole Sample (n=761)		Small Enterprises (size<101;n=189)		Medium E. (100 < size=<500; n=380)		Large E. (Size>500; n=185)	
Path (from-to)			Unstd. Coefficients	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value
CME	→	RPS	0.641	0.000	0.467	0.007	0.638	0.17	0.843	0.217
RPS	→	ISS	0.197	0.000	0.068	0.248	0.149	0.045	0.429	0.093
RPS	→	SC	0.15	0.000	0.124	0.019	0.07	0.036	0.348	0.098
ISS	→	SC	0.304	0.000	0.238	0.003	0.272	0.054	0.403	0.097
ISS	→	SCR	0.252	0.000	0.164	0.049	0.277	0.056	0.256	0.088
SC	→	SCR	0.49	0.000	0.536	0.000	0.457	0.088	0.249	0.104
SCR	→	AMT	0.523	0.000	0.341	0.002	0.404	0.079	0.58	0.14
SCR	→	IPD	0.79	0.000	0.611	0.000	0.827	0.088	0.766	0.13
SCR	→	PP	0.429	0.000	0.434	0.014	0.605	0.208	0.059	0.249
AMT	→	PP	0.092	0.147	0.195	0.157	0.084	0.115	0.122	0.118
IPD	→	PP	0.221	0.037	0.191	0.237	0.06	0.175	0.593	0.214
AMT	→	MR	0.099	0.012	0.177	0.069	0.135	0.065	0.107	0.08
PP	→	MR	0.048	0.047	0.011	0.839	0.063	0.03	0.055	0.058
IPD	→	MR	0.217	0.000	0.229	0.013	0.23	0.06	0.206	0.109
MR	→	FG	0.316	0.000	0.174	0.077	0.333	0.098	0.427	0.128
Fit Indices			χ^2/d.f=2.17; GFI .93; AGFI .92; TLI .94; CFI .94; SRMR .056; RMSEA .039 (.035,.043).		χ^2/d.f=1.41; GFI .86; AGFI .83; TLI .91; CFI .92; SRMR .076; RMSEA .047 (.036,.056).		χ^2/d.f=1.57; GFI .91; AGFI .89; TLI .93; CFI .94; SRMR .057; RMSEA .039 (.032,.045).		χ^2/d.f=1.34; GFI .86; AGFI .83; TLI .92; CFI .93; SRMR .067; RMSEA .043 (.032,.053).	

Under turbulence in market, larger firms tend to invest more resources in moving toward more knowledge-intensive and collaboration-friendly coordination mechanisms. Implementing ISS and increasing CS play key roles in accommodating competitive market environment.

The influence of Information sharing with suppliers (ISS) on coordination with suppliers (CS) and supply chain restructuring (SCR) shows that information technology has direct impact on SCR while it facilitates coordination mechanisms with suppliers. The impacts of ISS on SC and SCR increase as the firm size increases. However, in small firms, SC has a larger impact on SCR in small enterprises.

Different from results from customer model, the impact of SCR is significant only in small enterprises case. For medium and large enterprises, its impacts on AMT, IPD, and PP are statistically insignificant. This is surprising because SCR was expected to have strong influences in medium and large firms. The result could be interpreted that AMT, PP, and IPD are already all well established in large firms. In addition large firms usually have command and control power to their suppliers. Thus, SCR does not have a large impact on their internal manufacturing systems. SCR has a more impact in small firms because their internal production systems are more flexible to changes. This finding can be extended to PP and MR. In large companies, none of coefficients are significant except for the influence of PP on MR.

5.3. Globalization

The context analysis of globalization is reported in this section. Business unit's situation and product development sites measured the extent of Globalization. The questionnaire asked, "Where are the business unit's products produced?" and the choices are (1) at one site in this country, (2) At more than one site in this country, (3) at sites in a few countries in this continent, and (4) globally, at sites in various continents. For analysis purpose, responses for (1) and (2) were classified into one group and responses for (3) and (4) into the other group. Table 5.3 and Figure 5.3 report the descriptive statistics of this classification. Regional manufacturers account for 64% of the total sample. Overall, globalized firms are less than 36% of the total sample. This descriptive statistics suggest that the world is being more globalized in manufacturing and new product development is taking place in a multiple regions.

Table 5.3 Extent of Globalization

	Manufacturing site		Product Development site	
	Frequency	Relative Frequency	Frequency	Relative Frequency
Within the country	490	64%	501	66%
More than two countries or globally	274	36%	250	33%

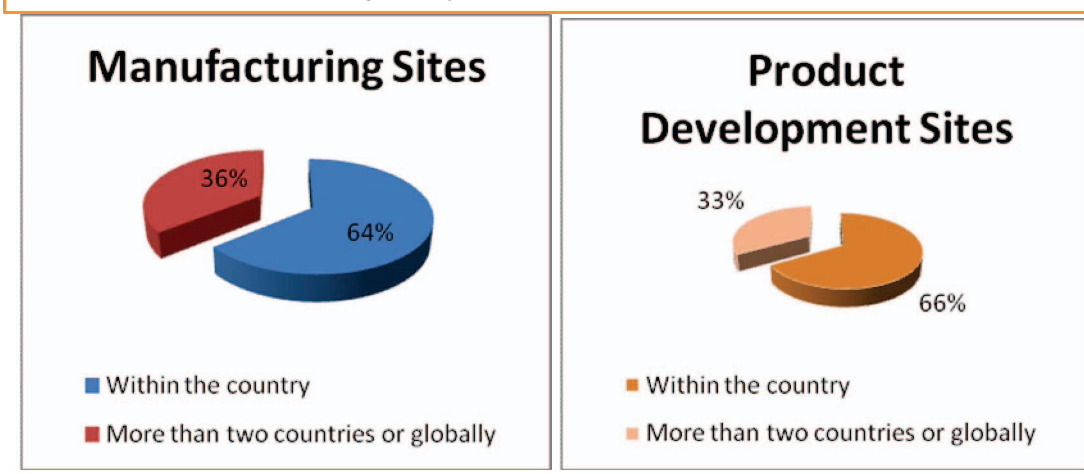


Figure 5.3 Extent of Globalization

5.3.1 Customer Model

Table 5.3.1 summarizes the results. Several observations are made. First, global manufacturing firms are more susceptive to competitive market environment than regional manufacturers are (0.724 vs. 0.564). RPS does not have a significant impact on coordination with customers.

Second, in regional manufacturing firms, responsive product strategy negatively influences customer coordination. For global manufacturing firms, RPS does not significantly influence customer coordination. CC is not driven by RPS in global manufacturing companies. Third, ISC is a significant factor that fosters CC and DCR for both global and regional manufacturers. But it has a stronger impact for the regional manufacturers than for global manufacturers. ISC was expected to have a more important to global manufacturers since they have to sense what is going on in the world with others. But this is not the case. Fourth, ISC has a greater impact on demand chain restructuring for regional manufacturers than for global firms. In contrast, CC has great impact on DCR for global manufacturers than regional manufacturers (.211 vs. .256). Fifth, DCR impacts AMT adoption, PP and IPD greater for global manufacturers than for regional manufacturers (0.715, 0.643, 0.638 vs. 0.457, 0.402, 0.424). Coefficients pattern between manufacturing site and product development site is similar to each other except that DCR's influences are great in magnitude. Sixth, for NPD globalization, the impact of DCR on PP and IPD are smaller for global manufacturers than for regional manufacturers (0.425, 0.234 vs. 0.519, 0.576).

Table 5.3.1. The effect of globalization (Customers)

Customer Model			Whole Sample (n=761)		Manufacturing within the country (n=490)		Manufacturing globally (n=274)		NPD Within the country (n=501)		NPD Globally (n=250)	
Path (from-to)			Unstd. Coefficients	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value
CME	→	RPS	0.624	0.000	0.564	0.000	0.724	0.000	0.577	0.000	0.747	0.000
RPS	→	ISC	0.234	0.000	0.234	0.000	0.152	0.012	0.234	0.000	0.181	0.002
RPS	→	CC	-0.038	0.348	-0.105	0.021	0.11	0.136	-0.099	0.049	0.065	0.336
ISC	→	CC	0.816	0.000	0.834	0.000	0.695	0.000	0.861	0.000	0.661	0.000
ISC	→	DCR	0.417	0.000	0.483	0.000	0.242	0.001	0.466	0.000	0.279	0.002
CC	→	DCR	0.235	0.000	0.211	0.003	0.256	0.000	0.217	0.000	0.269	0.000
DCR	→	AMT	0.608	0.000	0.457	0.000	0.715	0.000	0.532	0.000	0.568	0.000
DCR	→	IPD	0.505	0.000	0.402	0.000	0.643	0.000	0.519	0.000	0.425	0.000
DCR	→	PP	0.526	0.000	0.424	0.000	0.638	0.001	0.576	0.000	0.234	0.158
AMT	→	PP	0.121	0.066	0.177	0.032	0.066	0.532	0.174	0.062	0.1	0.291
IPD	→	PP	0.146	0.046	0.234	0.01	-0.027	0.82	0.159	0.056	0.039	0.781
AMT	→	MR	0.118	0.001	0.102	0.039	0.154	0.01	0.105	0.054	0.139	0.014
PP	→	MR	0.059	0.012	0.033	0.28	0.097	0.013	0.033	0.273	0.096	0.019
IPD	→	MR	0.257	0.000	0.301	0.000	0.195	0.003	0.260	0.000	0.272	0.001
MR	→	Sales	0.316	0.000	0.237	0.003	0.445	0.000	0.314	0.000	0.332	0.001
Fit Indices			χ^2/d.f=2.24; GFI .93; AGFI .92; TLI .93; CFI .94; SRMR .055; RMSEA .042 (.037,.044).		χ2/d.f=1.72; GFI .92; AGFI .91; TLI .92; CFI .93; SRMR .053; RMSEA .038 (.033,.044).		χ2/d.f=1.72; GFI .87; AGFI .85; TLI .88; CFI .90; SRMR .081; RMSEA .051 (.044,.059).		χ2/d.f=1.81; GFI .92; AGFI .91; TLI .92; CFI .93; SRMR .055; RMSEA .040 (.035,.046).		χ2/d.f=1.52; GFI .88; AGFI .85; TLI .89; CFI .91 SRMR .055; RMSEA .040 (.035,.046).	

Seventh, the direct impact on PP comes from DCR. AMT and IPD seem to have little influences on PP. The coefficient from DCR to PP is greater in global manufacturers than in regional manufacturers (0.638 vs. 0.424). However, AMT and IPD have statistically significant impact on PP in the case of regional manufacturers (0.177 and 0.234, respectively). When it comes to global manufactures, they do not affect PP through AMT and IPD. Eighth, it is noteworthy that PP does not influence MR in the case of regional manufacturers whereas it does in the case of global manufacturers.

5.3.2 Supplier Model

Table 5.3.2 reports the analysis results. Several observations are made. First, global manufacturing firms are more susceptive to competitive market environment than regional manufacturers are (0.736 vs. 0.580). RPS does not have a significant impact on customer coordination: this trend is consistent in both customer and supplier model.

Second, in regional manufacturing firms, RPS influences CS. But RPS does not have statistically significant impact on CS. This is consistent result both in customer and supplier model. SC is not driven by RPS in global manufacturing companies. There might be other factors that influence SC. Regardless of implementation of RPS, CS is being implemented.

Third, information sharing with suppliers (ISS) is a significant factor that fosters CS and SCR for both global and regional manufacturers. This is a consistent pattern found in customer model. This result confirms that ISS plays significant roles in enhancing communication between suppliers and focal companies, which supports coordination theory.

Table 5.3.2. The effect of globalization (Suppliers)

Supplier Model			Whole Sample (n=761)		Manufacturing within the country (n=490)		Manufacturing globally (n=274)		NPD Within the country (n=501)		NPD Globally (n=250)	
Path (from-to)			Unstd. Coefficients	P-Value	Unstd. Coefficients	P-Value	Unstd. Coefficients	P-Value	Unstd. Coefficients	P-Value	Unstd. Coefficients	P-Value
CME	→	RPS	0.641	0.000	0.580	0.000	0.736	0.000	0.601	0.000	0.741	0.000
RPS	→	ISS	0.197	0.000	0.141	0.000	0.289	0.000	0.155	0.000	0.271	0.000
RPS	→	SC	0.150	0.000	0.158	0.000	0.059	0.255	0.131	0.000	0.171	0.001
ISS	→	SC	0.304	0.000	0.309	0.000	0.311	0.000	0.389	0.000	0.169	0.005
ISS	→	SCR	0.252	0.000	0.254	0.000	0.245	0.000	0.282	0.000	0.234	0.000
SC	→	SCR	0.490	0.000	0.468	0.000	0.423	0.000	0.418	0.000	0.453	0.000
SCR	→	AMT	0.523	0.000	0.467	0.000	0.548	0.000	0.466	0.000	0.573	0.000
SCR	→	IPD	0.790	0.000	0.743	0.000	0.867	0.000	0.745	0.000	0.868	0.000
SCR	→	PP	0.429	0.000	0.318	0.030	0.594	0.010	0.340	0.016	0.400	0.137
AMT	→	PP	0.092	0.147	0.137	0.102	0.024	0.806	0.188	0.041	-0.009	0.927
IPD	→	PP	0.221	0.037	0.274	0.039	0.122	0.502	0.254	0.045	0.197	0.366
AMT	→	MR	0.099	0.012	0.091	0.082	0.104	0.085	0.105	0.070	0.081	0.163
PP	→	MR	0.048	0.047	0.042	0.177	0.052	0.199	0.039	0.210	0.050	0.233
IPD	→	MR	0.217	0.000	0.183	0.001	0.299	0.000	0.168	0.003	0.334	0.000
MR	→	Sales	0.316	0.000	0.236	0.003	0.446	0.000	0.313	0.000	0.324	0.002
Fit Indices			χ^2/d.f=2.17; GFI .93; AGFI .92; TLI .94; CFI .94; SRMR .056; RMSEA .039 (.035,.043).		χ2/d.f.=1.76; GFI .92; AGFI .90; TLI .93; CFI .94; SRMR .057; RMSEA .039 (.034,.045). *negative variances		χ2/d.f.=1.58; GFI .88; AGFI .86; TLI .92; CFI .92; SRMR .072; RMSEA .046 (.039,.063).		χ2/d.f.=1.79; GFI .92; AGFI .90; TLI .93; CFI .94; SRMR .059; RMSEA .040 (.034,.045).		χ2/d.f.=1.53; GFI .87; AGFI .85; TLI .91; CFI .92; SRMR .069; RMSEA .046 (.038,.054).	

Fourth, compared to ISS, CS has almost twice strong impact on SCR. The coefficient of impact from ISS on SCR is 0.254 while that from SC on SCR is 0.468. This result implies that SC is more important factor than ISS in triggering SCR. This is consistent pattern in regional and global manufacturers.

Fifth, SCR affects AMT adoption, PP and IPD significantly for both global manufacturers and regional manufacturers. However, the magnitude of impacts are greater for global manufactures than for regional manufacturers (0.548, 0.867, 0.594 vs. 0.467, 0.743, 0.318, respectively). This pattern is consistent in both manufacturing and NPD sites.

Sixth, direct impact on PP comes from SCR and IPD. AMT seem to have a little influence (This is a consistent pattern that was found from customer model). The coefficient of SCR on PP is greater in global manufacturers than in regional ones (0.594 vs. 0.318), which is consistent pattern found in customer model. SCR is the most powerful factor that increases PP. However, IPD exhibited having a significant impact on PP in the case of regional manufacturers (0.274) at the 0.04 of significance level. When it comes to global manufactures, IPD has not significance impact on PP.

Seventh, PP has no significant impact on MR, but AMT and IPD do. AMT did not have a significant impact on PP, but it does have an influence on MR (0.091 and 0.104 for regional and global manufacturers, respectively). This result suggests that AMT is more related to swiftly manufacturing products in accordance with market changes than increasing the level of PP. IPD increases MR significantly (0.183 for regional manufacturers and 0. 299 for global manufacturers). In terms of increasing MR, implementing IPD is important than adoption of AMT or PP system.

5.4. Classification by ISIC Code

The context of ISIC classification is reported in this section. ISIC code consists of from 28 to 36. Three industries, i.e., fabricated metal, machinery/equipment, electrical machinery account for 70% of the total sample. Other machineries (ISIC 30, 32, and 33) are combined into one sample for analysis purpose as well as motor and transport vehicles (ISIC 34, 35). Table 5.4 and Figure 5.4 report the descriptive statistics of this classification.

Table 5.4. Classification by ISIC Code

ISIC	Description	Freq.	%	ISIC	Freq.	%
28	Fabricated metal	283	37%	28	283	37%
29	Machinery/Equipment	154	20%	29	154	20%
30	Computing machinery	21	3%	30, 32, 33	101	13%
31	Electrical machinery	101	13%	31	101	13%
32	Radio, TV, communication	49	6%	34, 35	114	15%
33	Medical instruments	31	4%			
34	Motor vehicles	72	9%			
35	Transport equipment	42	6%			
36	Miscellaneous	8	1%			
Total		761	100%			

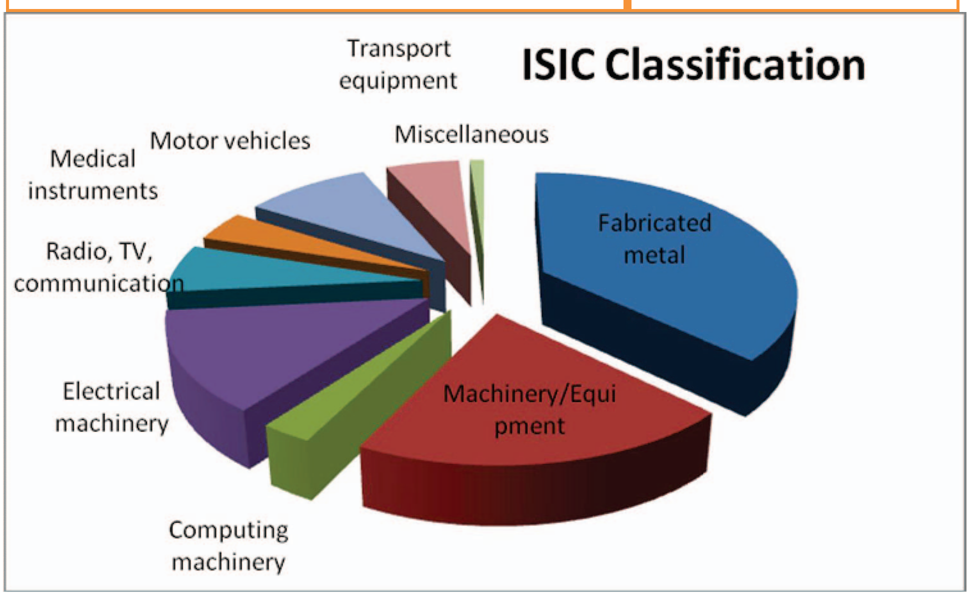


Figure 5.4. ISIC Classification

5.4.1. Customer Model

Table 5.4.1 reports the results of structural equation model for customers. Computing/communication/medical machinery (ISIC 30, 32, 33), electrical machinery (ISIC 31) and motor/transport equipment (ISIC 34, 35) exhibited a poor fit for the structural equation model. Only fabricated metal yielded a set of good fits worthy of comparison with the whole model. Comparison analysis shows that there is no significant difference between the whole model and the fabricated metal. All hypotheses are supported except for two relationships: the one between RPS and CC and the other between AMT and PP. IPD exhibited has a impact on PP stronger in fabricated metal sample than in the whole sample (0.277 vs. 0.146).

Table 5.4.1.SEM results for ISIC Classification (Customer Model)

Customer Model	Whole Sample (n=761)		Fabricated Metal (n=283)		Machinery/ Equipment (n=154)		Computing/ Communication/ Medical (n=101)		Electrical Machinery (n=101)		Motor/ Transport (n=114)	
Path (from-to)	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value
CME → RPS	0.624	0	0.576	0.000	0.619	0.005	0.195	0.378	0.758	0.005	1.306	0.001
RPS → ISC	0.234	0	0.123	0.027	0.220	0.001	0.441	0.001	0.295	0.006	0.323	0.000
RPS → CC	-0.038	0.348	-0.015	0.795	-0.061	0.345	-0.236	0.177	-0.022	0.856	0.212	0.105
ISC → CC	0.816	0	0.695	0.000	1.061	0.000	1.066	0.000	0.518	0.012	0.224	0.248
ISC → DCR	0.417	0	0.241	0.004	0.419	0.054	0.622	0.004	0.423	0.005	0.374	0.010
CC → DCR	0.235	0	0.263	0.000	0.420	0.018	0.007	0.955	0.299	0.006	0.246	0.030
DCR → AMT	0.608	0	0.507	0.000	0.598	0.000	0.523	0.008	0.840	0.003	0.854	0.002
DCR → IPD	0.505	0	0.486	0.000	0.455	0.000	0.839	0.001	0.186	0.411	0.586	0.006
DCR → PP	0.526	0	0.533	0.003	0.322	0.078	0.210	0.498	0.990	0.006	1.223	0.008
AMT → PP	0.121	0.066	-0.018	0.866	0.251	0.036	0.395	0.131	-0.026	0.893	-0.128	0.480
IPD → PP	0.146	0.046	0.277	0.038	0.218	0.301	0.052	0.704	0.084	0.512	-0.006	0.975
AMT → MR	0.118	0.001	0.157	0.012	0.133	0.025	0.113	0.308	0.295	0.018	-0.045	0.642
PP → MR	0.059	0.012	0.060	0.114	-0.010	0.814	0.202	0.000	0.005	0.951	0.046	0.501
IPD → MR	0.257	0	0.222	0.005	0.362	0.000	0.064	0.287	0.372	0.002	0.331	0.008
MR → Sales	0.316	0	0.321	0.001	0.139	0.426	0.698	0.005	0.479	0.002	0.145	0.217
Fit Indices	χ^2/d.f=2.24; GFI .93; AGFI .92; TLI .93; CFI .94; SRMR .055; RMSEA .042 (.037,.044).		χ2/d.f=1.49; GFI .89; AGFI .86; TLI .92; CFI .93; SRMR .064; RMSEA .041 (.033,.049).		χ2/d.f=1.41; GFI .84; AGFI .80; TLI .89; CFI .90; SRMR .082; RMSEA .052 (.040,.063).		χ2/d.f=1.49; GFI .76; AGFI .70; TLI .77; CFI .80; SRMR .094; RMSEA .070 (.056,.083).		χ2/d.f=1.29; GFI .79; AGFI .74; TLI .85; CFI .87 SRMR .055; RMSEA .086 (.037,.069).		χ2/d.f=1.28; GFI .81; AGFI .77; TLI .88; CFI .90 SRMR .087; RMSEA .050 (.034,.064).	

5.4.2. Supplier Model

Table 5.4.2 summarizes the results of structural equation model for suppliers. Similar to customer model, the model fits are poor. However, comparison between the whole model and fabricated machinery produced interesting results. First of all, RPS does not have a significant impact on implementing ISS. ISS is not affected by the RPS. But RPS does have a strong influence on CS. In the whole sample, the relationship from RPS to CS was insignificant but it was in the case of fabricated machinery sample, which implies that in fabricated machinery sample, RPS has a stronger influence on CS.

CS has strong a impact on SCR. It is twice as strong as it is in the whole sample (0.531 vs. 0.235). In regard to the influence of SCR, the strongest impact on IPD (0.985) was observed. This result indicates that SCR is happening through IPD practices. However, AMT and IPD do not have significant influence on implementation of PP.

Table 5.4.2 SEM Results for ISIC Classification (Supplier Model)

Supplier Model	Whole Sample (n=761)		Fabricated Metal (n=283)		Machinery/ Equipment (n=154)		Computing/ Communication/ Medical (n=101)		Electrical Machinery (n=101)		Motor/ Transport (n=114)	
Path (from-to)	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value
CME → RPS	0.641	0.000	0.582	0.000	0.623	0.004	0.212	0.350	0.766	0.005	1.362	0.000
RPS → ISS	0.197	0.000	0.050	0.338	0.167	0.025	0.134	0.137	0.316	0.007	0.472	0.000
RPS → SC	0.150	0.000	0.085	0.036	0.129	0.016	0.148	0.132	0.235	0.023	0.281	0.018
ISS → SC	0.304	0.000	0.194	0.000	0.441	0.000	0.461	0.004	0.105	0.285	0.359	0.006
ISS → SCR	0.252	0.000	0.181	0.000	0.299	0.008	0.303	0.035	0.140	0.106	0.364	0.007
SC → SCR	0.490	0.000	0.531	0.000	0.377	0.019	0.591	0.000	0.610	0.000	0.210	0.159
SCR → AMT	0.523	0.000	0.433	0.000	0.615	0.000	0.321	0.007	0.750	0.000	0.587	0.000
SCR → IPD	0.790	0.000	0.985	0.000	0.512	0.000	0.741	0.000	0.775	0.000	0.818	0.000
SCR → PP	0.429	0.000	0.670	0.009	0.099	0.615	0.363	0.143	1.245	0.010	0.161	0.576
AMT → PP	0.092	0.147	0.000	0.998	0.262	0.029	0.226	0.333	0.042	0.843	-0.105	0.468
IPD → PP	0.221	0.037	0.075	0.688	0.460	0.053	0.164	0.448	-0.751	0.053	0.676	0.005
AMT → MR	0.099	0.012	0.157	0.017	0.125	0.040	0.092	0.417	0.051	0.713	-0.089	0.391
PP → MR	0.048	0.047	0.063	0.102	0.000	0.992	0.185	0.002	0.047	0.541	-0.010	0.902
IPD → MR	0.217	0.000	0.149	0.021	0.259	0.012	0.114	0.154	0.621	0.000	0.287	0.035
MR → Sales	0.316	0.000	0.318	0.001	0.131	0.445	0.731	0.004	0.477	0.002	0.138	0.240
Fit Indices	χ^2/d.f=2.24; GFI .93; AGFI .92; TLI .93; CFI .94; SRMR .055; RMSEA .042 (.037,.044).		χ2/d.f=1.48; GFI .89; AGFI .87; TLI .93; CFI .94; SRMR .062; RMSEA .041 (.034,.049).		χ2/d.f=1.55; GFI .81; AGFI .77; TLI .87; CFI .88; SRMR .091; RMSEA .06 (.050,.070)		χ2/d.f=1.39; GFI .77; AGFI .64; TLI .83; CFI .85; SRMR .098; RMSEA .063 (.049,.076).		χ2/d.f=1.28; GFI .79; AGFI .74; TLI .88; CFI .89; SRMR .087; RMSEA .053 (.037,.067).		χ2/d.f=1.28; GFI .80; AGFI .76; TLI .91; CFI .92 SRMR .087; RMSEA .050 (.035,.063).	

5.5. Frozen Production Schedule

The question used for production flexibility is "How far ahead is your production schedule frozen?" This question was answered as work days and descriptive statistics for this question is found in Table 5.5.1 and Figure 5.5.1

Frozen Production Schedule		
N	Valid	714.0
	Missing	47.0
Mean		17.3
Median		7.0
Mode		5.0
Std. Deviation		42.2
Skewness		9.5
Frozen days	**Frequency**	**Relative Frequency**
0-7 days	410	54%
8-720 days	304	40%

Table 5.5.1 Frozen Production Schedule

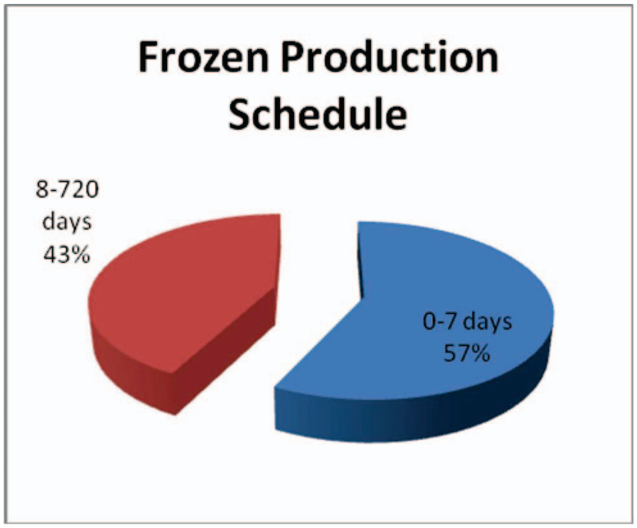


Figure 5.5.1 Frozen Production Schedule

The production schedule for 57 % of the sample was frozen 7 days ahead of the actual production day whereas 43% of the sample had longer production plan, meaning that the majority of firms have rather flexible production schedule. The longer the production schedule is frozen, the more rigid the production system is. It is anticipated that RPS model produces better results in the sample of flexible production schedule. With this in mind, structural equation model was performed and the results are reported in Table 5.5.2.

Table 5.5.2 SEM Results for Frozen Production Schedule (Customer and Supplier Models)

Customer/ Supplier Model	Whole Sample (n=761)		Frozen 0-7 days (n=410)		Frozen 8-720 days (n=304)		Supplier Model Whole Sample (n=761)		Frozen 0-7 days (n=410)		Frozen 8-720 days (n=304)	
Path (from-to)	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value
CME → RPS	0.624	0	0.691	0.000	0.605	0.000	0.641	0.000	0.705	0.000	0.627	0.000
RPS → ISC	0.234	0	0.210	0.000	0.264	0.000	0.197	0.000	0.217	0.000	0.203	0.001
RPS → CC	-0.038	0.348	-0.027	0.609	-0.112	0.082	0.150	0.000	0.137	0.000	0.132	0.011
ISC → CC	0.816	0	0.914	0.000	0.731	0.000	0.304	0.000	0.259	0.000	0.418	0.000
ISC → DCR	0.417	0	0.407	0.000	0.420	0.000	0.252	0.000	0.262	0.000	0.276	0.000
CC → DCR	0.235	0	0.230	0.000	0.234	0.010	0.490	0.000	0.589	0.000	0.362	0.000
DCR → AMT	0.608	0	0.629	0.000	0.647	0.000	0.523	0.000	0.496	0.000	0.552	0.000
DCR → IPD	0.505	0	0.545	0.000	0.432	0.000	0.790	0.000	0.830	0.000	0.729	0.000
DCR → PP	0.526	0	0.698	0.000	0.407	0.005	0.429	0.000	0.701	0.000	0.231	0.208
AMT → PP	0.121	0.066	0.148	0.116	0.053	0.608	0.092	0.147	0.121	0.171	0.038	0.715
IPD → PP	0.146	0.046	0.116	0.231	0.147	0.200	0.221	0.037	0.046	0.756	0.307	0.073
AMT → MR	0.118	0.001	0.096	0.057	0.116	0.040	0.099	0.012	0.083	0.113	0.071	0.255
PP → MR	0.059	0.012	0.075	0.013	0.039	0.311	0.048	0.047	0.067	0.035	0.022	0.574
IPD → MR	0.257	0	0.255	0.000	0.310	0.000	0.217	0.000	0.198	0.000	0.303	0.000
MR → Sales	0.316	0	0.338	0.000	0.285	0.006	0.316	0.000	0.336	0.000	0.287	0.006
Fit Indices	χ^2/d.f=2.24; GFI .93; AGFI .92; TLI .93; CFI .94; SRMR .055; RMSEA .042 (.037,.044).		χ2/d.f=1.98; GFI .90; AGFI .88; TLI .89; CFI .90; SRMR .068; RMSEA .049 (.043,.055).		χ2/d.f=1.50; GFI .90; AGFI .88; TLI .92; CFI .93; SRMR .060; RMSEA .041 (.033,.048).		χ2/d.f=1.49; GFI .76; AGFI .70; TLI .77; CFI .80; SRMR .061; RMSEA .070 (.056,.083).		χ2/d.f=1.88; GFI .90; AGFI .88; TLI .92; CFI .92; SRMR .069; RMSEA .046 (.041,.052).		χ2/d.f=1.44; GFI .90; AGFI .88; TLI .94; CFI .95; SRMR .059; RMSEA .038 (.030,.045).	

In the results from customer model and supplier model, all coefficients show a similar pattern, but three things stand out. First, the influence of ISC on CC is stronger in flexible production schedule than in rigid production schedule (0.914 vs. 0.731). This is because firms that plans production flexibly need to collaborate with customers more closely than firms with less flexible production schedule. For example, the production schedule of Japanese automotive companies is frozen no more than 7 days. Toyota's production schedule is flexible up to three days before the production day, Nissan for four to six days, and Mitsubishi for five days (Tomino et al. 2008). To make this flexible production plan possible, these three Japanese automakers work closely with their national sales offices and dealers by implementing inter-organizational information systems such as online order system (Tomino et al. 2008). Strong impact of ISC on CC in a firm with flexible production schedule, therefore, confirms the findings in the literature. However, in supplier model, the result comes out different. ISS on SC is less strong in firms with flexible production schedule plan than in firms with rigid production schedule (0.259 vs. 0.418). In fact, these coefficients are quite less than that from the whole sample (0.816). This would be due to the fact that production schedule has more to do with customers than suppliers. ISS is not as much important as ISC in the context of flexible production schedule. Another angle to interpret this result is that to make production schedule longer, a manufacturing company has to secure parts and component suppliers committed to the production plan. This process demands firms with longer and rigid production schedule to share information with suppliers actively.

Second, the impacts of DCR and SCR are more significant for the firms with flexible production schedule. As shown in other contextual analyses, DCR and SCR are playing critical role in increasing the level of AMT adoption, commitment to PP, and IPD. IPD is more of a long-term decision than AMT is. It seems that firms with flexible production schedule consistently restructure their distribution and supply chains and systematically improve their PP and IPD practices. AMT is effective only when PP system and IPD are effectively managed. In addition, among AMT and IPD, SCR and DCR are the factors that increase the commitment to PP, which confirms the significance of SCR.

Third, the impact of pull production on market responsiveness is significant only for firms with flexible production schedule. This result consistently appears for both customer and supplier models. It is more difficult for firms with longer production schedule to implement PP than ones with shorter schedule. PP aids firms to increase MR. This finding confirms the original hypothesis that the higher the level of PP, the higher the level of MR.

5.6. The Level of Multi-Skilled Workforce

Implement responsive supply chain requires multi-skilled workforce. This is because accommodating various demands and changes makes it necessary for employees to acquire multi-skills. It is anticipated that firms with highly multi-skilled workforce are to enhance MR better than workforce with lower level of multi-skills. The question to offer the context of multi-skilled workforce is “How many of your production workers do you consider being multi-skilled?” The response was taken as the percentage of total number of production workers. Table 5.6.1 and Figure 5.6.1 summarize descriptive statistics for this question.

Out of 761 sample, 735 firms answered this question. The mean was 17% and median was 7 percent, and its skewness is 9.5, suggesting that the distribution is skewed severely to the right. The relative frequency for 51 % of the sample said that less than half workforce is multi-skilled while 46% firms said that more than 51% of their workforce is multi-skilled.

Multi-skilledness of Workforce		
N	Valid	735.0
	Missing	26.0
Mean		17.3
Median		7.0
Mode		5.0
Std. Deviation		42.2
Skewness		9.5
Multi-skilledness	Frequency	Relative Frequency
0-50 %	387	51%
51-100 %	348	46%

Table 5.6.1. Multi-skilled workforce

Figure 5.6.1. Multi-skilled workforce

The results from customer model and supplier model in Table 5.6.2 are surprising because they contradict the anticipation. Results from firms with multi-skilled workers are not much different from results from firms with less multi-skilled workers. Contrary to anticipated relationship, level of workforce does not have statistically different impact under this responsive supply chain framework.

However, this result provides a strong evidence of socio-technical theory. The influence of AMT on PP is significant only in the sample of multi-skilled case of customer model. The coefficient is 0.206 with p-value of 0.035. Note that other contextual effects showed that AMT did not have any significant impact. This result validates that technology is useful when socio-factors are present in a plant.

Table 5.6.2. SEM results for Multi-skilled Workforce

Customer Model		Whole Sample (n=761)		51 - 100 % (n=348)		0 – 50 % (n=387)		Supplier Model Whole Sample (n=761)		51 - 100 % (n=348)		0 – 50 % (n=387)	
Path (from-to)		Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value
CME →	RPS	0.624	0	0.719	0.000	0.523	0.000	0.641	0.000	0.748	0.000	0.627	0.000
RPS →	ISC	0.234	0	0.231	0.000	0.236	0.000	0.197	0.000	0.213	0.000	0.203	0.001
RPS →	CC	-0.038	0.348	-0.009	0.884	-0.091	0.106	0.150	0.000	0.105	0.012	0.132	0.011
ISC →	CC	0.816	0	0.788	0.000	0.846	0.000	0.304	0.000	0.323	0.000	0.418	0.000
ISC →	DCR	0.417	0	0.258	0.011	0.541	0.000	0.252	0.000	0.265	0.000	0.276	0.000
CC →	DCR	0.235	0	0.373	0.000	0.161	0.002	0.490	0.000	0.464	0.000	0.362	0.000
DCR →	AMT	0.608	0	0.477	0.000	0.730	0.000	0.523	0.000	0.466	0.000	0.552	0.000
DCR →	IPD	0.505	0	0.354	0.000	0.676	0.000	0.790	0.000	0.752	0.000	0.729	0.000
DCR →	PP	0.526	0	0.413	0.001	0.567	0.000	0.429	0.000	0.314	0.082	0.231	0.208
AMT →	PP	0.121	0.066	0.206	0.035	0.088	0.331	0.092	0.147	0.144	0.130	0.038	0.715
IPD →	PP	0.146	0.046	0.131	0.243	0.128	0.199	0.221	0.037	0.309	0.078	0.307	0.073
AMT →	MR	0.118	0.001	0.067	0.192	0.141	0.008	0.099	0.012	0.025	0.634	0.071	0.255
PP →	MR	0.059	0.012	0.054	0.087	0.077	0.029	0.048	0.047	0.023	0.494	0.022	0.574
IPD →	MR	0.257	0	0.290	0.000	0.201	0.000	0.217	0.000	0.294	0.000	0.303	0.000
MR →	Sales	0.316	0	0.260	0.003	0.364	0.000	0.316	0.000	0.258	0.004	0.287	0.006
Fit Indices		χ^2/d.f=2.24; GFI .93; AGFI .92; TLI .93; CFI .94; SRMR .055; RMSEA .042 (.037,.044).		χ2/d.f=1.66; GFI .90; AGFI .88; TLI .90; CFI .91; SRMR .064; RMSEA .044 (.037,.050).		χ2/d.f=1.76; GFI .91; AGFI .89; TLI .91; CFI .92; SRMR .060; RMSEA .044 (.038,.050).		χ2/d.f=1.49; GFI .76; AGFI .70; TLI .77; CFI .80; SRMR .061; RMSEA .070 (.056,.083).		χ2/d.f=1.63; GFI .90; AGFI .88; TLI .92; CFI .93; SRMR .065; RMSEA .043 (.036,.049).		χ2/d.f=1.44; GFI .90; AGFI .88; TLI .94; CFI .95; SRMR .059; RMSEA .038 (.030,.045).	

5.7. Number of Customers and Suppliers

The number of suppliers offers another good context to responsive supply chain framework. It is expected that the more suppliers firms work with, the more difficult firms to enhance market responsiveness. The question to offer the context of multi-skilled workforce is "Total number of suppliers (figure for 2004)." Table 5.7.1 and Figure 5.7.1 report descriptive statistics for the number of suppliers.

Number of Suppliers		
N	Valid	648
	Missing	113
Mean		252.4
Median		100.0
Mode		200.0
Std. Deviation		615.4
Skewness		9.5
Number of Suppliers	Frequency	Relative Frequency
0-50	214	28.1%
51-200	255	33.5%
> 200	179	23.5%

Table 5.7.1. Number of Suppliers

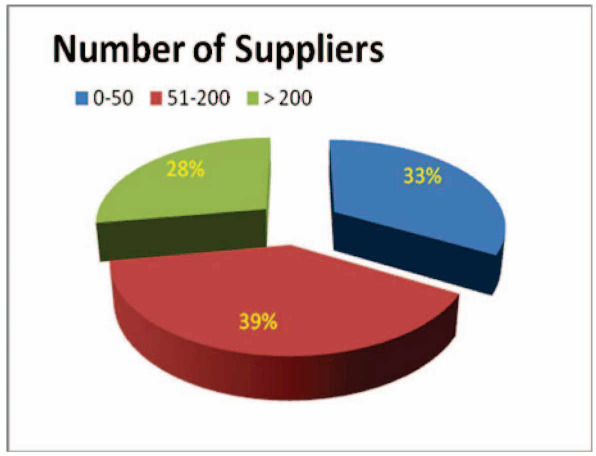


Figure 5.7.1. Number of Suppliers

Out of 761 sample, 648 firms answered this question. The mean was 252.4 suppliers and median was 100 suppliers, and its skewness is 9.5, suggesting that the distribution is skewed severely to the right. In fact, the largest number of suppliers was 10000, which makes the data extrembely skewed right. 28.1% of samples have 0-50 suppliers, 33.5% 51-200 suppliers and 23.5% more than 200 suppliers, which breaks up the sample into three subsamples.

Table 5.7.2.SEM results for Number of Suppliers

Customer/ Supplier Model	Up to 50 Suppliers (n=214)		51 – 200 Suppliers (n=255)		More than 200 Suppliers (n=179)		Up to 50 Suppliers (n=214)		51 – 200 Suppliers (n=255)		More than 200 Suppliers (n=179)	
	Customer Model						Supplier Model					
Path (from-to)	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value
CME → RPS	0.473	0.132	0.689	0.000	0.449	0.016	0.527	0.1	0.692	0.000	0.489	0.007
RPS → ISC	0.318	0.000	0.221	0.000	0.145	0.09	0.159	0.011	0.162	0.005	0.371	0.000
RPS → CC	-0.178	0.017	-0.036	0.574	0.109	0.262	0.192	0.002	0.115	0.005	0.061	0.423
ISC → CC	0.892	0.000	0.737	0.000	0.81	0.000	0.318	0.000	0.289	0.000	0.358	0.000
ISC → DCR	0.727	0.000	0.269	0.003	0.156	0.287	0.188	0.005	0.349	0.000	0.222	0.031
CC → DCR	-0.026	0.755	0.345	0.000	0.473	0.000	0.496	0.000	0.464	0.000	0.623	0.000
DCR → AMT	0.556	0.000	0.826	0.000	0.488	0.000	0.522	0.000	0.585	0.000	0.582	0.000
DCR → IPD	0.673	0.000	0.733	0.000	0.367	0.000	1.02	0.000	0.703	0.000	0.656	0.000
DCR → PP	0.471	0.036	0.666	0.005	0.247	0.148	0.629	0.011	0.344	0.086	0.522	0.055
AMT → PP	0.053	0.677	0.121	0.238	0.168	0.297	-0.047	0.704	0.101	0.308	0.005	0.976
IPD → PP	0.183	0.331	0.037	0.782	0.348	0.033	0.132	0.42	0.249	0.205	0.219	0.385
AMT → MR	0.126	0.061	0.14	0.014	0.052	0.514	0.133	0.056	0.122	0.038	-0.006	0.946
PP → MR	0.006	0.889	0.124	0.002	-0.005	0.912	0.015	0.725	0.104	0.011	-0.014	0.756
IPD → MR	0.229	0.007	0.243	0.000	0.324	0.000	0.099	0.1	0.264	0.001	0.369	0.000
MR → Sales	0.446	0.000	0.193	0.081	0.334	0.013	0.446	0.000	0.196	0.076	0.313	0.019
Fit Indices	χ^2/d.f=1.63; IFI .90; TLI .88; CFI .89; SRMR .071; RMSEA .054 (.046,.063).		χ2/d.f=1.43; IFI .93; TLI .92; CFI .93; SRMR .061; RMSEA .041 (.032,.049).		χ2/d.f=1.39; IFI .89; TLI .88; CFI .89; SRMR .075; RMSEA .047 (.036,.057).		χ2/d.f=1.41; IFI .94; TLI .93; CFI .94; SRMR .070; RMSEA .044 (.034,.053).		χ2/d.f=1.44; IFI .94; TLI .93; CFI .94; SRMR .065; RMSEA .042 (.033,.050).		χ2/d.f=1.27; IFI .93; TLI .92; CFI .93; SRMR .070; RMSEA .039 (.026,.050).	

The structural model results reported in Table 5.7.2 exhibit one important thing. The impact of RPS on CS decreases as the number of suppliers increases. In both customer and supplier model, the coefficients tend to decrease from 0.192 to 0.115 to 0.061 as the number of suppliers increases. This result confirms the difficulties of collaborating with suppliers as the number increases. A large number of suppliers is a barrier for CS. However, information sharing with suppliers offers a means to overcome the barrier. Where there are more than 200 suppliers, information sharing with suppliers increases the level of supplier coordination strongly (i.e., its coefficients, 0.358, are greater than the others). The impact of CS on SCR is the strongest (0.623) when there are more than 200 suppliers. This result paradoxically shows that supplier coordination is a hard task when there are many suppliers, and because it is hard, CS has a strong impact on SCR when it is implemented. Transaction cost economics perspective justifies this view. Since the number of suppliers causes a higher coordination cost, firms try to minimize it by implementing information technology, and this attempt helps firms to increase supplier coordination (Williamson 1979; Dedrick et al. 2008).

5.8. Extent of Just-In-Time Application

The extent of JIT was asked in the following question: "What proportion of your raw materials and components are delivered to you Just-In-Time?" This question was asked in the context of customers and suppliers. It is expected that the more the firms implement JIT, the more efforts the firms make to implement market responsiveness. The descriptive statistics are shown in Table 5.8.1. and Figure 5.8.1. as follows:

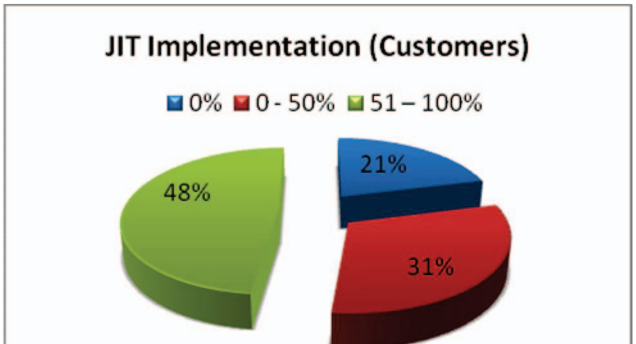


Figure 5.8.1.Percent of JIT Implementation for Suppliers

% of JIT	Frequency	Relative Frequency
0%	147	21.06%
0 - 50%	215	30.80%
5 - 100%	336	48.14%

Table 5.8.1. JIT Implementation

The descriptive statistics for JIT extent with suppliers are shown in Table 5.8.2 and figure 5.8.2. Out of 761 sample, 686 firms answered this question. The mean was 37.7% and the median was 25% and the mode was 0. This means that despite firms are implementing JIT to some degree, many firms are not taking advantage of JIT practices. Its skewness is 0.4, suggesting that the data is close to normal distribution. 31% of firms said that they are implanting JIT to purchase raw materials and components. About 20% of firms said that they are not utilizing JIT at all.

% of JIT Implementation for Suppliers		
N	Valid	686
	Missing	75
Mean		37.7
Median		25.0
Mode		0.0
Std. Deviation		34.6
Skewness		0.4
% of JIT	**Frequency**	**Relative Frequency**
0%	142	18.7%
0 - 50%	305	40.1%
51 – 100%	239	31.4%

Table 5.8.2. JIT Implementation

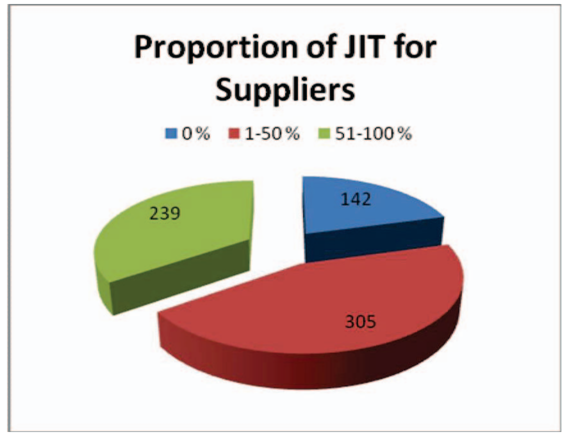


Figure 5.8.2.Percent of JIT Implementation for Suppliers

The structural model results reported in Table 5.8.3 exhibit two things. First, information sharing with customers and suppliers has the strongest impact on coordination with customers and suppliers when firms utilized JIT more than 50%. This result supports that JIT requires intensive information sharing with both suppliers and customers. Second, for supplier model, the results produced inadmissible solutions for the sample that utilizes no JIT method. This result also supports that responsive supply chain is not working for the sample that does not implement JIT. This is an evidence that pull production is a crucial component of responsive supply chain.

Table 5.8.3. SEM results for Number of Customers Suppliers

Customer/ Supplier Model	No JIT Customers (n=147)		1-50 Customers (n=215)		51-100 Customers (n=336)		No JIT (n=142)		0 - 50 % Suppliers (n=305)		51 – 100 % Suppliers (n=239)	
Path (from-to)	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value	Unstd. Coeff.	P-Value
CME → RPS	0.674	0.002	0.641	0.001	0.621	***			0.785	***	0.77	***
RPS → ISC	0.295	***	0.297	***	0.174	***			0.242	***	0.191	0.002
RPS → CC	-0.049	0.629	-0.028	0.749	-0.051	0.361			0.201	***	0.149	0.007
ISC → CC	0.701	***	0.755	***	0.994	***			0.279	***	0.413	***
ISC → DCR	0.594	***	0.434	***	0.308	0.003			0.324	***	0.191	0.015
CC → DCR	0.202	0.014	0.152	0.107	0.247	0.001			0.521	***	0.460	***
DCR → AMT	0.743	***	0.513	***	0.687	***			0.610	***	0.504	***
DCR → IPD	0.383	0.001	0.637	***	0.483	***			0.786	***	0.618	***
DCR → PP	0.541	0.025	0.68	0.003	0.549	0.001			0.104	0.584	0.611	***
AMT → PP	-0.204	0.208	0.254	0.106	0.147	0.111			0.151	0.131	0.064	0.538
IPD → PP	0.046	0.805	0.079	0.559	0.168	0.13			0.509	0.002	0.048	0.758
AMT → MR	-0.017	0.836	0.121	0.226	0.14	0.005			0.138	0.03	0.114	0.067
PP → MR	0.057	0.309	-0.007	0.898	0.052	0.117			0.003	0.938	0.061	0.14
IPD → MR	0.28	0.024	0.328	***	0.226	***			0.216	0.004	0.191	0.012
MR → Sales	0.343	0.014	0.4	***	0.248	0.011			0.381	***	0.232	0.039
Fit Indices	χ^2/d.f=1.31; IFI .91; TLI .90; CFI .91; SRMR .075; RMSEA .046 (.032,.058).		χ2/d.f=1.60; IFI .88; TLI .86; CFI .87; SRMR .072; RMSEA .053 (.044,.061).		χ2/d.f=1.71; IFI .91; TLI .90; CFI .91; SRMR .065; RMSEA .046 (.039,.053).		Not admissible solutions		χ2/d.f=1.43; IFI .95; TLI .94; CFI .95; SRMR .057; RMSEA .038 (.030,.045).		χ2/d.f=1.54; IFI .93; TLI .92; CFI .92; SRMR .079; RMSEA .048	

CHAPTER 6: DISCUSSION

6.1. Theoretical Implications

This research based its framework on several theories: coordination theory, order winner and order qualifier, and value chain framework. The primary thesis of this study is that coordination mechanism plays a central role in enhancing market responsiveness through supply chain restructuring that integrates internal practices such as implementations of advanced manufacturing technologies, pull production systems, and integrated product development practices. This research found several interesting theoretical implications.

First, this research found the integral role that coordination plays in the supply chain. Contingency theory suggests that a firm produces better firm growth when environment and strategy are aligned (Hofer 1975; Van de Ven & Drazin 1984). Integral operational practices such as advanced manufacturing technology, pull production, and integrated product development have long been known for increasing market responsiveness. However, it was unclear what is between strategy and operational practices when supply chain comes in. This study posited coordination mechanisms as the linkage that connects strategy to intra-organization level of practices. Supply chain management involves managing dependencies among participants, which requires coordination mechanisms (Malone & Crowston 1994).

Now coordination revolves around three things. Firstly, coordination seeks to meet a set of goals. In other words, goals drive firms to select coordination mechanisms. Goals are expressed as priorities and values that firms seek to achieve. Goals, therefore, can be translated to strategy. Since this study pursued responsive supply chain, the goals reflect strategy that represents increasing market responsiveness. In this context, responsive product strategy was defined as a set of order winners that aim to increase market responsiveness by mirroring customers' needs for innovative product features, wider product range and frequent products delivery. To reflect responsive supply chain, coordination mechanisms in supply chain were determined as vendor managed inventory, collaboration planning and forecasting and replenishment (CPFR), physical integration of suppliers into plant, and share inventory knowledge.

Another point that coordination suggests is that the adoption of coordination mechanisms leads to restructuring (Malone 1987; Crowston 1997; Lewis & Talalayevsky 1997). Change in coordination entails change in the supply chain. An example is vendor managed inventory system. Proctor and Gamble used to receive orders from Wal-Mart but Wal-Mart adopted VMI as a method to manage inventory dependencies with Proctor and Gamble. This change in coordination mechanism resulted in restructuring in supply chain. Before the change, Wal-Mart had power over suppliers. After the change, however, VMI changed the structure that now Proctor and Gamble suppliers had the control on their products on retailers' shelves. Likewise, adopting a mechanism changes the existing structure. In the supply chain context, adopting the coordination mechanisms that aim to increase market responsiveness lead to supply chain restructuring.

The other point that coordination theory suggest is that information technology mediates the impact of coordination in supply chain. Information technology helps firms to lower the coordination costs by connecting the participants in the chain to each other at a lower cost ever. A manufacturer can coordinate with suppliers and customers even in overseas via the Internet. The advancements of technology make it easier for firms to choose and implement coordination mechanisms. In addition, information technology aides to bring supply chain restructuring to firms. Implementation of information technology entails restructuring information technology (Grant 2005). The restructuring could result from coordination mechanism and information technology, since technology can eliminate the need of having intermediary layers of management (Croom 2001; van Hoek et al. 1999). Thus, information technology is another important factor that facilitates restructuring in the supply chain.

This study confirms that coordination theoretical framework is valid and strong in the supply chain context. The validity was found in several ways. First of all, breakup analyses in section 4.1 show the research framework can be broke up to three components and test the soundness of coordination mechanisms in the responsive supply chain context. The first component showed that responsive product strategy has a direct impact on market responsiveness. Second component showed that firms put integral practices into action. Third component showed that coordination mechanisms are strongly influencing market responsiveness. For customer model, it turned out that firms are utilizing information technology strongly. RPS does not have a direct impact on coordination with customers, but it influences through information technology. Coordination with customers has a strong influence on distribution chain restructuring (i.e., its coefficient is 0.41) and information sharing with customers has also a strong influence on it (0.35). The similar pattern to the results from customer model appeared in the results from supplier model. All the coefficients were significant, showing that coordination mechanisms are working strong. The second way to show the validity of coordination mechanism was to examine the whole research model in section 4.2. In the model, coordination mechanism was proven to be strong in both customer and supplier model. To my best knowledge, this is the first empirical study that applied coordination theory to the supply chain level.

Second, this research extended coordination theory to its application level by examining the influence of restructuring, a result of coordination. Although coordination theory suggests the sequential links among goals, coordination mechanism and restructuring, it does not mention much about the impact of restructuring. This study attempted to explicate the impact of restructuring from a manufacturing perspective. Supply chain restructuring is the link that connects supply chain activities to internal operational practices. Supply chain restructuring means significant reassignment roles and responsibilities among supply chain entities such as readjustment of tasks between tiers, redistribution of inventory between tiers, and warehouse structure changes (Kopczak 2005). The changes in supply chain structure bring a significant change to internal operational practices of a manufacturing firm.

For example, Christman (1999) reported that EMI Music Distribution (EMD) invested $10 million in an attempt to restructure its supply chain in 1998 when it found inefficiency of having manufacturing plant and distribution warehouse separately. Before restructuring, products had to be shipped from manufacturing plant to distribution warehouse for shipment to customers. The buildings were located in Jacksonville, 100 yard apart. EMD found that this production and distribution approach increased inventory level and slowed down market responsiveness. Thus, EMD decided to integrate distribution center into the manufacturing building and automate shipment process by adopting 'automated pick, pack, and ship equipment.' Richard Cottrell, CEO of EMD, said that the integration of automated shipment equipment eliminated the process of transferring products to distribution center via trucks while it cut down inventory level and shortened response time for catalog titles. Furthermore, this restructuring helped EMD to develop specialty labels and flexibility to satisfy the needs of each accounts. Cottrell said, "Our goal is to be more responsive, efficient, and to develop the ability to have shelf-ready product to stores by year's end." This case epitomizes the research framework and, in particular, the impact of supply chain restructuring on internal operation systems. EMD wanted to be more responsive, and so the CEO set the goal. The goal was reflected to restructure its distribution chain by integrating warehouse into the factory. This decision drove the firm to adopt automated shipment technology, which improved pull production system and market responsiveness. This example demonstrated how restructuring decisions affect internal operational practices.

Another example comes from Proctor & Gamble. Proctor & Gamble undertook an arduous effort to restructure its supply chain for its variety of products and saved over $200 million by cutting the number of North American plants in 1993 (Camm et al. 1997). The decision to reduce the number of plants led it to adopt new advanced manufacturing technology to increases efficiency and flexibility of manufacturing. The restructuring decision drove P&G to adopt advanced manufacturing technologies and conduct integrated product development practices more.

The influences of supply chain restructuring on internal operation practices were examined in hypothesis 6a (advanced manufacturing technology), 6b (pull production systems), and 6c (integrated product development practices). These relationships were found significant, supporting the argument that restructuring decisions in supply chain affect internal operation practices. Theoretically, choice of coordination mechanisms driven by a set of goals led firms to make supply chain restructuring decisions. Supply chain restructuring, in turn, influences internal operational practices decision, including advanced manufacturing technology. To the best of my knowledge, this link is empirically studied for the first time in this research.

Third, this research also confirms the theory of responsive supply chains by incorporating order winner framework by Hill (2000). Lambert et al. (1998) introduced the general framework for the supply chain that consists of various flows from information to order fulfillment. This research paid close attention to information flow, product development flow, and supplier and customer relationship management flow. The results of this research framework presented that all these flows are essential in increasing the market responsiveness and the profitability of the firm. It especially showed that managing the information flows with customers and suppliers foster the supply chain restructuring and the supply chain collaboration. The coordination level of the responsive supply chain bridges the responsive product strategy to the operational implementation of the responsive supply chain. In particular, supply chain restructuring exhibited a powerful influence on the integration of product development and manufacturing, and the commitment for pull production and advanced manufacturing technology. This finding shows that involving the supply chain and streamlining the structure play a critical role in enhancing the operational implementation of the responsive supply chain.

Fourth, this research corroborates the impact of strategy on market responsiveness (Porter 1979; Grinyer et al. 1980; Park & Mason 1990) . As indicated by Voss (1995), strategy formulation is one of many steps towards changing the course of the direction of competition, and it has to be implemented through a set of practices. This research showed that strategy begins to influence coordination mechanism and affects the information flow, the supply chain structure, and the supply chain collaboration practices. It also influences advanced manufacturing technology, pull production, and integrative product development practices. The research model comprehensively illuminated how a firm's strategy could result in market responsiveness from a strategy standpoint.

Fifth, this research shows that the competitive market environment affects firms to formulate their manufacturing strategy. Organizational theories and other studies strongly suggest that the environment impacts the strategy formulation process. This research confirmed the relationship in hypothesis 1. Competition intensity and the number of competitors force the firm to seek a unique competitive edge in the market. This pressure leads them to develop a responsive product strategy. The manufacturer sets the standard on the supply and distribution chain strategies, which influences the suppliers and the customers to change their behaviors. The change in the suppliers' and customers' perceptions and behaviors then influences the manufacturer to continue or alter its practices and expectations. Responsive business strategy strongly affected information sharing practices with both suppliers and customers. It also greatly affected the supplier coordination, although it did not have a significant impact on the customer coordination. The impact on information sharing practices and collaboration eventually leads to restructuring the supply chain and the distribution chain. The adjustment will also reinforce manufacturer's expectations on its operational practices in advanced manufacturing technology, pull production, and product and manufacturing integration. This will eventually result in the overall improvement of performance.

Sixth, this research framework extended the theory of production competence. The theory was applied at the intra-organization level to include manufacturing capabilities and practices. This research not only validated the theory at the Intra-organization level but also extended the theory to the supply chain level. According to Day (1994)'s framework, there is a strong relationship between market orientation and firm performance. This research shows that the relationship was present. The study results demonstrate that the appropriate operational practices resulted in production competence. Furthermore, the research explored how involving suppliers and customers in sharing information and collaboration increases market responsiveness. Beyond intra-organization level, this research sees the production competence from a broader angle that includes suppliers and customers. Collaboration with suppliers and customers increases the market responsiveness. Engaging suppliers and customers plays an important role in increasing market responsiveness, because it makes it easier for a manufacturer to implement pull production, effective technology deployment, and product development integration.

6.2. Managerial Implications

This research provides valuable managerial implications to managers. First, firms might consider implementing a responsive supply chain by offering a wider product range and frequently delivering new products with innovative features. Responsiveness is not just about making the production process quick and swift, but about delivering the products that are in demand. In a fast-changing market landscape, firms should consider formulating a more responsive product strategy. Kodak film and Apple computer are contrasting examples. Kodak used to be promising company until digital technology took over analog technology. The company regressed as the competitive market turned to digital technology. Kodak did not turn to digital technology and compete as quickly as it did in the analog market. As a result of not formulating a responsive product strategy, the firm growth of the firm plummeted. Their products ranged around analog technology. On the contrary, Apple computer broadened its product strategy to offer a wider range of more innovative products. Epitomized by the invention of iTune, iPod, and iPhone, the company caught the customer's attention by capturing their needs and increasing market responsiveness.

Second, the research presents the significance of involving suppliers and customers in increasing the market responsiveness. The research results show that advanced manufacturing technology, commitment for pull production, and integrative product development practices increase market responsiveness. But market responsiveness is also enhanced by the supply chain level practices such as information sharing, supplier and customer coordination, and supply chain restructuring. Improving marketing responsiveness requires a concerted effort. It involves not only the manufacturer but also the supplier and the customer. Increasing the flow of information and collaborating with suppliers and customers lead to supply chain restructuring, which in turn affects operational practices.

Third, the research also gives managers insights as to why to take supply chain restructuring into consideration. Restructuring the supply chain significantly increases the likelihood of implementing advanced manufacturing technology, pull production, and integrative product development practices. It even has a direct impact on market responsiveness. Competitive market environment increases the level of uncertainty, in which firms have to constantly rethink their supply and distribution chain strategies. Depending on the situation, firms should try to optimize or to decouple supply chain from manufacturing or distribution. Notably, restructuring the supply chain has a significant effect on the integrative product development. Integrative product development has usually been regarded as a part that cross-functional integration has much to do with. However, this research reveals that restructuring the supply chain plays an important role in increasing the likelihood/success of integrative product development practices. Shortening and customizing the supply chain helps a manufacturer to better see the needs of suppliers and customers. In return, restructuring enhances technological integration and modularization in the supply chain.

Fourth, this research explored various contexts of coordination mechanisms and responsive supply chain framework. The contexts are region, plant size, globalization, ISIC code classification, days of frozen production schedule, the proportion of multi-skilled workforce, the number of suppliers, and the degree of just-in-time practices with suppliers and customers.

Regional comparison showed differences in Europe, Asia and Oceania, and North and Latin America. In Europe, customer coordination was found to be used stronger than information technology in resulting in supply restructuring. AMT and IPD were being utilized more in Europe than other regions. Asia and Oceania found to be influenced by competition intensity in the market. Information technology is strongly influencing supply chain restructuring and coordination in supply chain. In addition, sample from Asia and Oceania exhibited the strongest influence of supply chain restructuring on AMT, PP, and IPD. These results suggest that restructuration in supply chain was taking place in Asia and Oceania. The results also suggest that companies in Asia and Oceania were taking advantage of pull production systems more than of AMT. The region is affluent in human resources and taking the direction to organize labor force more effectively. Companies in North and Latin America showed results similar pattern to those from companies in Asia and Oceania.

Plant size often gives important information about firms. The impact of demand chain restructuring was significant regardless of plant size. Information technology influenced coordination with customers and demand chain restructuring strongly at the size of firms increases. This result confirms that information technology requires much resource, which large firms have the most. AMT turned out to be not having a significant impact on PP across plant size. For small firms, IPD is the significant factor on MR while for large firms, AMT and IPD are factors that increase MR.

In regard to globalization, globalized firms were more sensitive to competition intensity. Information technology played more important role than coordination in supply chain. To globalized companies, customers are spread around the world and demand chain restructuring takes place through information technology rather than close coordination with customers.

The context of frozen production schedule provided how much a firm is flexible in dealing with customers and suppliers. It was expected that firms with longer frozen production schedule can implement responsive supply chain to a less degree. Firms with a flexible production schedule exhibited using information sharing technology more and information technology helps such firms to closely coordinate with customers. In less flexible firms, this result did not appear. As shown in Japanese automotive firms, firms with flexible production system utilized information system more than firms with rigid production systems so that they could communicate information regarding demand and production process better (Tomino et al. 2008).

The multi-skilled workforce plays a crucial role in realizing the potential of advanced manufacturing technologies. The influence of AMT on PP was in significant throughout the research result except for the once case: the presence of multi-skilled workforce. This result validates that AMT itself may not be a aid to PP but when there is workforce that handles PP system, AMT is effective. This finding support sociotechnical system view.

The number of suppliers and customers show that when there are a large number of suppliers and customers, it is difficult for firms to coordinate them. Perspective from transaction cost economics provides justification for this result. Larger number of suppliers and customers cause a higher coordination costs, and firms try to minimize this cost by implementing information technology (Dedrick et al. 2008). These various contextual analyses provides for managers to take various factors into consideration when implementing the responsive supply chains.

CHAPTER 7: CONCLUSION, LIMITATIONS AND FUTURE RESEARCH

Fundamental changes in external environments demand fundamental changes in internal environments (Hammer & Champy 2003). The dynamic nature of customer values requires firms to consider not only the current customers but also the factors that drive the changing perception of value over time, and ultimately, the values of future customers (Flint et al. 1997). In terms of the supply chain, firms have responded to these dynamics in two ways. The first reaction has been to eliminate waste from production to delivery, and to reinforce the price competition (Womack & Jones 2003; Womack et al. 1990). The central concept of these supply chain management strategies is increasing efficiency. The efficiency-oriented and supply-central approach, however, poses considerable limitations on the supply chain in three ways: limited improvements, failure to synchronize processes with customer changes, and circumscribed innovation potential.

The responsive supply chain framework offers an alternative paradigm to tackle these limitations. Different from traditional supply chains, the responsive supply chain emphasizes continually connecting all the constituents in the supply chain to information about the demand in order to proactively respond to customer changes. The responsive supply chain aims at enhancing the firms' profitability by strategically and operationally aligning upstream with sales channels, retailers, and distributors (Jüttner et al. 2007), and by managing downstream with agility in a cost-effective manner.

Several compelling rationales provide the justification for the responsive supply chain management framework. The first reason is the need to extend the concept of market orientation across the supply chain level. Researchers have placed an emphasis on market orientation since the 1960s, but the concept has yet been extended to the supply chain level. It is still unknown how to connect market orientation to supply chains. The Deloitte Research (2002) reports that 49 out of 288 firms performed better in the market by distinguishing their products and services on a customer-by-customer basis.

The second compelling reason for the using the responsive supply chain framework is that firms need to direct their attention to where profits could be found. Dell computer, for example, has created competitive edge by focusing on business users and accommodating to their needs. Companies have to go beyond efficiency and attain effectiveness by quickly responding to the customers' needs.

The third reason for using the responsive supply chain framework stems from the volatility of the market. Intense global competition, rapid technological advancements, and innovative managerial practices (Champlin & Olson 1999) have made it necessary for firms to transform continuously, and to be more sensitive to customers than ever before.

With these rationales in mind, this study aimed at developing the framework for a responsive supply chain from a focal company's perspective, and attempted to answer the following set of research questions: (1) What is responsive supply chain? In other words, what are critical practices to implement responsive supply chain? (2) What are interrelationships among key practices for responsive supply chain? (3) What are outcomes of responsive supply chain? What are managerial and theoretical implications of the responsive supply chain?

The development of the research framework and the empirical test of the framework addressed the abovementioned research questions. The first question was addressed in the literature review part. Responsive supply chain was defined as a type of supply chains that aims to rapidly adapt to changes of customer needs and market volatility through collaborative and knowledge sharing coordination. A few critical practices were chosen to appropriately describe the responsive supply chains. Responsive product strategy is the first construct of this study's interest because any business starts from strategy.

Also, coordination in the supply chain was chosen as a critical practice for the change of supply chain philosophy results in choosing different coordination mechanisms. The corollary of changed coordination mechanism is supply chain restructuring as suggested by coordination theory. Supply chain restructuring constantly takes place and makes the supply chain structure flatter and simpler. This change will help a focal manufacturing company to implement higher level of advanced manufacturing technologies, pull production, and integrated product development practices. These three internal practices increase market responsiveness. From the value chain framework by Lambert and Cooper (2000), information flows, product flows, and technology flows, and product design flows were chosen and discussed in the model.

The second research question, "What are interrelationships among key practices for responsive supply chain?" purported to see the interrelationships among critical flows and practices in the responsive supply chain. In response to the competitive market environment, firms formulate responsive product strategies that emphasize frequent delivery of a wider range of products with innovative features. Being responsive to customers means delivering the products that the customers need. This research has found that there is a significant relationship between the competitive market environment and the responsive product strategy, confirming the influence of the environment on strategy formulation.

Another causal linkage pursued internal integration in the responsive supply chain. Based on Lambert's framework (1998), the research framework identified three critical internal programs at the Intra-organization level: advanced manufacturing technology, pull production, and integrative product development programs. These three practices are critical in compressing the manufacturing time, reducing procurement and manufacturing lead time, and increasing the speed of product delivery to customers. In particular, integrative product development practices exhibited the strongest influence on enhancing the market responsiveness.

In the coordination level of responsive supply chain practices, the research called attention to three important practices: information sharing, collaboration, and supply chain restructuring. Being responsive to customers and markets implies an excellent interfunctional coordination (Kohli & Jaworski 1990). However, interfunctional coordination has to be extended to the supply chain level. This expansion takes place when information sharing and collaboration within the constituents of the supply chain increase. The improvement in information sharing and collaborative practices within the supply chain would expose to the firms the sources of efficiency and the areas that require changes. Firms then consider restructuring the supply chain and the distribution chain, and in particular, compressing the supply chain in terms of length and numbers.

Still another causal relationship found in this study was the linkage between coordination and organizational integration. This study found that while internal integration practices increase market responsiveness significantly, coordinating practices provide the link between responsive product strategy and integrative practices. It was also discovered how intra-integrative practices precedes operational practices, and how the two are related to each other. In particular, the results showed that restructuring the supply chain plays an especially salient role in operational practices. Restructuring the supply chain influences firms to widely adopt advanced manufacturing technology, to commit more to pull production, and to integrate product development with manufacturing and engineering more extensively. These practices eventually result in the improved performance measures such as in market responsiveness and firm growth.

The last research question examined the impact of responsive supply chain practices on performance. Market responsiveness summarizes the operational performance aspect of the responsive supply chain. Time to market, delivery speed, delivery dependability, and manufacturing lead time served as indicators of market responsiveness. It is important to note that an increase in market responsiveness directly affects profitability. Firm growth such as sales and market share increased to a significant extent when market responsiveness increased.

This research contributes to the existing body of literature by presenting an integrated responsive supply chain framework and validating it with international data.

Another important contribution is clarifying the responsive supply chain deployment process. Pull production and integrative product development process are key practices that increase the market responsiveness. Time-based competition competence comes true when firms integrate their operational practices with their suppliers and customers through collaborative coordination and information systems. This study, in particular, illuminates the precursors of pull production and integral product design programs. Although pull production summarizes a firm's efficiency and effectiveness, few researchers have shown the integral relationships between product design and collaborative supply chain practices. In order to create innovative products while increasing time-based competition competence, a manufacturing firm has to pursue internal and external integration. Namely it needs to constantly restructure its supply chain through knowledge- and collaboration-friend mechanisms. It also needs to integrate intra-organizational practices to enhance market responsiveness.

This research is not free of limitations. First, this research framework is built from a focal company's perspective, and so generalizing findings from this research to other contexts needs careful attention. Although a focal company perspective is useful, it will be interesting to see how to extend the research framework to general supply network level. Future research can classify supply networks into a few types and find important practices that will enhance market responsiveness in the specific supply chain. Second, this study based its data analysis on cross-sectional data. Since the research framework examined structural relationships, a longitudinal study or an experimental design would be used to confirm or re-scrutinize the relationships. Third, over 50% of responses are from ISIC 28 and 29. Also more than 50% of responses are from European countries. This means that there is a possibility that the data are focused on fabricated metal products and machinery and equipment in European countries. One should be aware of this propensity. Future research should attempt to conduct a longitudinal study in replicating and extending the research framework. The ongoing survey of IMSS V should allow for the possibility of conducting a longitudinal study in the future.

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APPENDIX

Appendix A. Definition of Constructs

Construct	Definition	Reference
Competitive market environment	Degree of turbulence in a market on account of intensity of competition and number of competitors	Emery & Trist 1965; Vonderembse et al. 1997; Cyert & March 2007; Milliken 1987
Responsive Product Strategy	A set of order winners that aim to increase market responsiveness by mirroring customers' needs for innovative product features, wider product range and frequent products delivery	Calori & Ardisson, 1988; Porter, 1979; Porter, 1996; Hill, 2000; Hayes et. al, 2005
Information Sharing in Supply Chain	Information sharing in supply chain refers to the usage of information technology by a manufacturer with the purpose of enhancing communication with suppliers and customers in areas such as order tracking, knowledge management, and collaboration services.	Cline & Guynes, 2001; Coates, 2000; Da Silveira et al. 2001; Goldman et al., 1995; Gunasekaran, 1998; Hoek et al., 2001; Keen, 1991; Teo & King, 1997
Coordination in Supply Chain	The mechanisms to manage dependencies among manufacturers and suppliers and customers in sharing planning decisions, demand, and delivery knowledge in order to increase collaboration	(Barratt 2004); (Chan et al. 2004); Holweg et al., 2005; Malone & Crowston 1994; Olson et al. 2001; Lewis & Talalayevsky 1997
Supply Chain Restructuring	The extent of implementing action programs that will bring significant changes in the supply chain, including the suppliers'/ customers' portfolio, the supplier/customer development, and the coordination of flow of goods.	O'Laughlin et al. 1993; Camm et al. 1997; Christman 1999; van Hoek et al. 1999; Voordijk 1999; Croom 2001; Grant 2005; Kopczak 2005
Advanced Manufacturing Technology	A group of technologies that enables firms to produce a variety of products at lower cost and with higher speed.	Lei et al., 1996; (Dean et al. 1992); (Lowe 1995); (Small & I. J. Chen 1995)
Commitment for Pull Production	The degree of commitment to a production system to which the production is triggered by the previous operations and by the system downstream and eventually actual customer demands	Koufteros et al., 1998; Siha, 1994; Spearman & Zazanis, 1992; Koufteros et al., 2007.
Integrative Product Development Practices	The degree of implementing action programs that were designed to increase product development performance through integration among manufacturing, product development, and technology.	Bralla, 1986; Brown & Eisenhardt, 1995; Gerwin & Barrowman, 2002; Koufteros et al., 2002; Hong 2000; Hong et al. 2005

Market Responsiveness	Market responsiveness is defined as the extent to produce products that meet customer expectation and deliver them to customers promptly and accurately by compressing time in production and delivery processes	Handfield & Pannesi, 1995; Holmberg, 2000; Koufteros et al., 1998; Reichhart & Holweg, 2007; Stalk, 1988
Customization Capability	The ability of a firm to incorporate customers' needs and wants by producing a variety of customized products.	(White 1996); (Pine et al. 1993); (Shawnee Vickery et al. 1999); (Richard Klein 2007)
Firm growth	The extent to which a firm increases sales or market share	Stock et al., 2000; Yamin et al., 1999; Koufteros et al., 2007

Appendix B. Measurement Items for Constructs

Coding		Construct Items	CITC-1	Alpha if deleted	CITC-2
IMSS	Model				
Competitive Market Environment: alpha=0.615 (initial)					
How would you describe the eternal environment?					
A4 e	Competition Intensity		0.46	N/A	
A4 f	Number of Competitors		0.46	N/A	
Responsive product strategy: alpha=0.698 (initial); 0.784 (final)					
Consider the importance of the following attributes to win orders from your major customers.					
A5e	faster deliveries		0.18	0.79	-
A5g	wider product range		0.58	0.58	0.58
A5h	offer new products more frequently		0.65	0.51	0.71
A5i	Offer more innovative products		0.56	0.58	0.60
Information Sharing with Customers: alpha=0.87 (initial)					
Indicate to what extent do you use electronic tools (Internet or EDI based) with your key/strategic customers? (1-no adoption, 5- high level of adoption)					
SC14 d	Data analysis (audit and reporting)		0.72	0.84	
SC14 e	Access to catalogues		0.53	0.89	
SC14 f	Order management and tracking		0.72	0.84	
SC14 g	content and knowledge management		0.78	0.83	
SC14 h	Collaboration support services		0.76	0.83	
Coordination with Customers: alpha=0.76 (initial)					
How do you coordinate planning decisions and flow of goods with your key/strategic customers?					
SC13 a	Share inventory knowledge		0.61	0.67	
SC13 b	Share production planning decisions and demand forecast knowledge		0.62	0.66	
SC13 g	Collaborative Planning, Forecasting and Replenishment		0.56	0.72	
Distribution Chain Restructuring: *alpha=0.65 (initial)*					
Indicate degree of the following action programs undertaken over the last three years and planned efforts for the coming three years.					
SC15d	Rethinking and restructuring distribution strategy in order to change the level of intermediation		0.49	-	
SC15e	Increasing the level of coordination of planning decisions and flow of goods with customers including dedicated investments		0.49	-	

Information Sharing with Suppliers: alpha=0.874 (initial)				
Indicate to what extent do you use electronic tools (Internet or EDI based) with your key/strategic suppliers? (1-no adoption, 5- high level of adoption)				
SC8 d	Data analysis (audit and reporting)	.651	.835	
SC8 e	Access to catalogues	.543	.861	
SC8 f	Order management and tracking	.700	.822	
SC8 g	content and knowledge management	.745	.811	
SC8 h	collaboration support services	.742	.812	
Coordination with Suppliers: alpha=0.72 (initial)				
How do you coordinate planning decisions and flow of goods with your key/strategic suppliers?				
SC7f	Require supplier(s) to manage or hold inventories of materials at your site (e.g., Vendor Managed Inventory, Consignment Stock)	.584	.586	
SC7g	Collaborative Planning, Forecasting and Replenishment	.559	.617	
SC7h	Physical integration of the supplier into the plant	.496	.689	
Supply Chain Restructuring: *alpha=0.76 (initial)*				
Indicate degree of the following action programs undertaken over the last three years and planned efforts for the coming three years.				
SC15a	Rethinking and restructuring supply strategy and the organization and management of suppliers portfolio	.570	.709	
SC15b	Implementing supplier development and vendor rating programs	.618	.655	
SC15c	Increasing the level of coordination of planning decisions and flow of goods with suppliers including dedicated investments	.595	.681	
Advanced Manufacturing Technology: alpha=0.751 (initial)				
To what extent is the operational activity in your plant performed using the following technologies: (1:no use; 5: high use)				
T1c	Automated parts loading/unloading	0.52	0.74	
T1d	Automated guided vehicles (AGVs)	0.59	0.63	
T1e	Automated storage-retrieval systems (AS/RS)	0.61	0.60	
Pull Production: alpha=0.680 (initial); 0.694 (final)				
Indicate degree of the following action programmes undertaken over the last three years and planned efforts for the coming three years.				
PC6b	Restructuring manufacturing processes and layout for the last three years	0.40	0.70	-
PC6c	Undertaking actions to implement pull production (e.g. reducing batches, setup time, using kanban systems, etc.) for the last three years	0.63	0.39	0.53
PC6f	Undertaking actions to implement pull production (e.g. reducing batches, setup time, using kanban systems, etc.) for the next three years	0.46	0.63	0.53

Integrated Produce Development: alpha=0.756 (initial)				
Indicate the degree of the following action programs undertaken over the last three years				
PD6a	Increasing performance of product development and manufacturing through e.g. platform design, standardization and modularization	.604	.647	
PD6b	Increasing the organizational integration between product development and manufacturing through e.g. Quality Function Deployment, Design for manufacturing, Design for assembly, teamwork, job rotation and co-location, etc.	.616	.634	
PD6c	Increasing the technological integration between product development and manufacturing through e.g. CAD-CAM	.532	.733	
Market Responsiveness: alpha=0.802 (initial)				
How has your operational performance changed over the last three years?				
B9af	Time to market	0.57	0.78	
B9ai	Delivery speed	0.73	0.70	
B9al	Delivery dependability	0.61	0.76	
B9an	Manufacturing lead time	0.57	0.77	
Firm growth: alpha=0.744 (initial)				
What is the current business unit performance?				
A6e	Sales	0.59	N/A	
A6f	Market share	0.59	N/A	

Appendix C. Results and Rationales of Hypothesis

Hypo-thesis	Hypothesis and Results	Rationale and Explanation
H1	Firms operating in a competitive market environment will formulate a higher level of responsive product strategy than firms operating in a less competitive market environment. (Supported)	(1) Strategic fit between environment and firm strategy. (2) Competitive market environment drives firms to offer innovative products more frequently.
H2a	The higher the extent of responsive product strategy, the higher the information sharing in the supply chain. (Supported)	Increase in innovativeness and compression of product development cycle requires seamless information flows and close coordination with customers and suppliers
H2b	The higher the extent of responsive product strategy, the higher the level of coordination in the supply chain. (Not Supported)	The advancement of information technology made firms dependent on using IT in implementing coordination mechanisms. RPS fosters coordination mechanism indirectly via information sharing technologies.
H3a **H3b**	The higher the level of information sharing in the supply chain, the higher the level of supply chain restructuring. (Supported) The higher the level of information sharing in the supply chain, the higher the level of coordination in the supply chain. (Supported)	Coordination theory suggests (1) information technology enhances information sharing significantly by reducing coordination costs; (2) Information technology fosters coordination between entities in the supply chain; (3) Information sharing results in supply chain restructuring by making it flatter and simpler.
H4	The higher the level of coordination in the supply chain, the higher the level of supply chain restructuring. (Supported)	Changes in coordination bring changes in structure.
H5a	The higher the level of supply chain restructuring a firm achieves, the higher the firm will implement advanced manufacturing technology. (Supported)	Implementing advanced manufacturing technology requires implementing flexible organizational system. As a firm restructures its supply chain, supply chain becomes simpler and flatter, which supports the implementation of advanced manufacturing technologies, pull production, and integrated product development in the firm.
H5b	The higher the level of supply chain restructuring a firm achieves, the higher commitment for pull production the firm will achieve. (Supported)	
H5c	The higher the level of supply chain restructuring a firm achieves, the higher integrated product design the firm will achieve. (Supported)	

H6a	The higher the level of advanced manufacturing technology a firm implements, the higher level of pull production the firm will achieve. (Not Supported)	Sociotechnical system theory (Clegg 2005; Kaghan & Bowker 2001; Walker et al. 2008) suggests that technology might not be the most important factor that aids pull production systems. This means that the significance of technology should be complemented by other factors. When socio-system supports and is compatible with socio-system such as employee training, organizational culture, flexible organizational design, the system could yield to anticipated results.
H6b	The higher the level of integrated product development programs a firm implements, the higher level of pull production the firm will achieve. (Supported)	Implementing pull production assumes that production system speedily processes customer demands and supplier coordination. Advanced manufacturing technology helps firms to resolve trade-offs among variety, speed and cost. Integrated product design addresses meeting customer's expectation and simplifying product architecture and production process.
H7a	The higher the level of advanced manufacturing technology implementation, the higher level of market responsiveness the firm will achieve. (Supported)	Market responsiveness can be increased mainly in two ways: speed of order fulfillment and meeting or exceeding customer expectation. Pull production satisfies these two aspects because the pull-production-oriented system aims to manufacture and deliver what is ordered. Advanced manufacturing directly increases production speed and aids pull production. In addition, integrated product design embeds flexibility and modularity in product through integration in organization and technology. Therefore, advanced manufacturing technology, pull production, and integrated product development help firms to increase market responsiveness.
H7b	The higher the level of commitment for pull production, the higher level of market responsiveness the firm will achieve. (Supported)	
H7c	The higher the level of integrated product development practices, the higher level of market responsiveness the firm will achieve. (Supported)	
H8	The higher market responsiveness a firm achieves, the higher level of firm growth it will achieve. (Supported)	Market responsiveness means to satisfy customer's needs speedily. When firms meets and surpasses customer expectation, their sales increases and market share expands.