Impact Of SCM Practices Of A Firm On Supply Chain Responsiveness And Competitive Advantage Of A Firm

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ABSTRACT

Today's supply chains are expected to respond rapidly, effectively, and efficiently to changes in the marketplace to sustain, succeed and create competitive advantage in this increasingly global marketplace by focusing on time, flexibility, and speed of response. The focus of this study is the supply chain responsiveness construct and a firm's practices to respond to customer's demands and constantly changing market conditions to create competitive advantage.

This research conceptualizes three dimensions of supply chain responsiveness and develops a reliable and valid instrument for measuring this construct. The study further tests the relationships between supply chain management (SCM) practices, supply chain responsiveness, and competitive advantage using structural equation modeling based on 294 responses from industry professionals in the manufacturing and supply chain area. Research findings point out that higher level of SCM practices can lead to improved supply chain responsiveness and enhanced competitive advantage of a firm. Also supply chain responsiveness can have a direct positive impact on competitive advantage of a firm.

Keywords: Supply Chain Responsiveness; Supply Chain Management (SCM); Competitive Advantage; Structural Equation Modeling

1. INTRODUCTION

The environment in which today's manufacturing firms operate is characterized by growing world competition and increasingly demanding customers (Rich and Hines, 1997). The new competitive environment is more global, technologically oriented and customer driven, with shrinking product life cycles, ever faster times to market, and customers continually demanding low cost, faster response, and higher quality products and services (Yang and Burns, 2003; D' Souza, 2002). Today's firms consider cost and quality as market entry qualifiers, while responsiveness and lean manufacturing are considered as order winners (Narasimhan and Das, 1999). Sabath (1998) argues that supply chains need to be managed in a way that enables quick response to cope with volatile demand.

With increasingly sophisticated customer demand, and recent events of supply disruptions (Lee, 2004; Christopher and Peck, 2004; Gosain et al., 2004; Germain, 1989; Lee, 2004; Christopher and Peck, 2004), supply chains are required to respond rapidly and perform in an increasingly changing business environment (Towill, 1996; Duclos et al., 2003; Gerwin, 1987; Huber, 1984; Narasimhan and Das, 1999; Ward et al., 1998), in order to create competitive advantage on various dimensions (Henke et al., 1993; Aquilano et al., 1995; Vokurka and Fliedner, 1998; Stalk and Hout, 1990; Vokurka and O'Leary-Kelly, 2000; D' Souza and Williams, 2000; Suarez et al., 1995; Duclos et al., 2003; Gattorna, 1998; Pine, 1993; Goldman et al., 1995; Christopher, 1998). It is incumbent on managers and researchers to strive for a better understanding of the responsiveness construct at the inter-organizational level.

Supply chain responsiveness literature is highly normative and conceptual with research studies primarily being based on case studies (Holweg, 2005; Storey et al., 2005). The literature lacks thorough empirical investigation of the supply chain responsiveness construct. Recent studies (Swafford et al., 2006a; Swafford et al., 2006b) however attempt operationalizing the supply chain agility of a firm as a first-order construct. This research adds to the same research pool by operationalizing the supply chain responsiveness construct using different measures than those used in prior empirical studies and further explores the existence of underlying first-order constructs and their measures. It would be interesting to managers and researchers alike, to understand what practices are required to achieve supply chain responsiveness. This study aims at filling this gap in literature by empirically testing the effects of various SCM practices on supply chain responsiveness. This paper develops and validates the supply chain responsiveness construct based on prior literature in - manufacturing and supply chain - flexibility and agility, and customer responsiveness. Further, since today's organizations strive to achieve competitive advantage to survive and thrive in a fast paced business environment, this study also assesses the impact of supply chain responsiveness on competitive advantage of a firm.

The relationships among the constructs are tested empirically, using data collected from 294 respondents to a survey questionnaire. Structural equation modeling is used to test the hypothesized relationships. The remainder of the paper is organized as follows. Section 2 presents the research framework, provides definitions and theory underlying each dimension of supply chain responsiveness, SCM practices, and competitive advantage, and develops the hypothesized relationships. The research methodology is described in section 3. Sections 4 and 5 discuss the results of construct development and hypothesis testing respectively. Implications of findings are presented in section 6 and limitations of the study and directions for future research are discussed in section 7.

2. CONSTRUCTS AND RESEARCH FRAMEWORK

The research framework is shown in Figure 1. We propose that SCM practices have an impact on competitive advantage both directly and indirectly through supply chain responsiveness. SCM practices and competitive advantage are constructs operationalized in earlier research (Li et al., 2005; Li et al., 2006; Koufteros et al., 1997). Supply chain responsiveness is operationalized by conceptualizing it as a three-dimensional construct. The three dimensions are operations system responsiveness, logistics process responsiveness, and supplier network responsiveness. A detailed description of the development of the supply chain responsiveness construct is provided first, and later SCM practices and competitive advantage constructs are discussed based on prior literature. Later in this section, the expected relationships among SCM practices, supply chain responsiveness, and competitive advantage are discussed with supporting literature review. Hypotheses relating these variables are then developed.

2.1 Supply chain responsiveness

Supply chain responsiveness is defined as the capability of promptness and the degree to which a supply chain can address changes in customer demand (Holweg, 2005; Prater et al., 2001; Lummus et al., 2003; Duclos et al., 2003). This responsiveness is aggregate of the operations system, logistics process, and supplier network responsiveness. In a rapidly changing competitive world, there is a need to develop organizations and supply chains that are significantly more flexible and responsive than existing ones (Gould 1997, James-Moore, 1996). Although it would be interesting to study supply chain responsiveness from the supply disruption perspective, the current study focuses on customer demand perspective. The following paragraphs discuss the pertinent supply chain responsiveness literature.

Supply chain responsiveness is the ability of the supply chain to rapidly address changes and requests in the marketplace (Holweg, 2005), which implies that speed and flexibility combined forms responsiveness. Prater et al. (2001) maintain that as the levels of speed and flexibility in a supply chain increase, the level of supply chain responsiveness increases. Thus, a responsive system is also flexible (Swafford et al., 2006). The current study focuses on the speed of response aspect in addition to the flexibility and which is popularly termed as responsiveness (Holweg, 2005; Fisher, 1997; Lee, 2002; Olhager, 1993; D' Souza and Williams, 2000; Holweg and Pil, 2001; Meehan and Dawson, 2002; Williamson, 1991; Prater et al., 2001; Towill and Christopher, 2002; Christopher and Peck, 2004; Gunasekaran and Yusuf, 2002; Christopher, 2000), in a supply chain context. Based on literature (Prater et al., 2001; Duclos et al., 2003; Lummus et al., 2003), we identify three dimensions of supply chain responsiveness, namely: operations system responsiveness, logistics process responsiveness, and supplier network responsiveness.

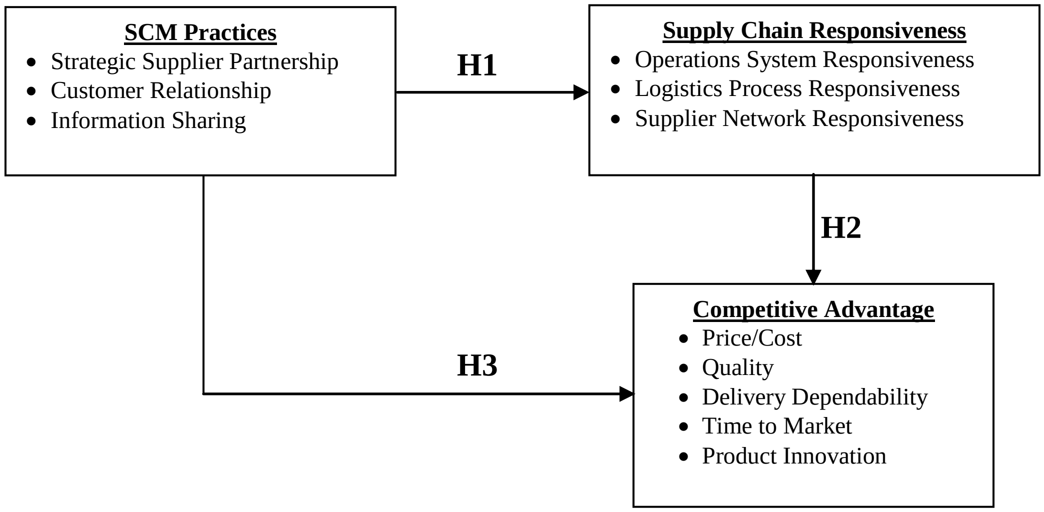

Figure 1. Research framework

Gupta and Goyal (1989), contend that being responsive is normally considered as an adaptive response to the environmental uncertainty. Bowersox et al. (1999) advocate the need for organizations to be responsive when the penalties associated with uncertainty are higher. These penalties for an organization could include cost of stock outs or carrying the wrong inventory and which can be mitigated through a responsive system, by adopting effective SCM practices as indicated and proposed in this study. Table 1 lists the sub-constructs for supply chain responsiveness, along with their definitions and supporting literature. A detailed discussion of these dimensions is provided below.

Table 1
List of sub-constructs for supply chain responsiveness

Sub-constructs	Definitions	Literature
Operations system responsiveness	The ability of a firm's manufacturing system to address changes in customer demand	Prater et al., 2001; Lummus et al., 2003; Duclos et al., 2003; Anderson and Lee, 2000; Radjou, 2000; Allnoch, 1997
Logistics process responsiveness	The ability of a firm's outbound transportation, distribution, and warehousing system (including 3PL/4PL) to address changes in customer demand	Prater et al., 2001; Lummus et al., 2003; Duclos et al., 2003; Bradley, 1997; Fuller et al., 1993; Richardson, 1998; Huppertz, 1999; Doherty, 1998; Swaminathan, 2001; Van Hoek, 2000
Supplier network responsiveness	The ability of a firm's major suppliers to address changes in the firm's demand	Prater et al., 2001; Lummus et al., 2003; Duclos et al., 2003; Jordan and Michel, 2000; Rich and Hines, 1997; Burt and Soukup, 1985; McGinnis and Vallorpa, 1999; Fisher et al., 2000; Bensaou, 1999; Mason et al., 2002; Cooper and Gardner, 1993; Choi and Hartley, 1996

Operations system responsiveness (OSR): OSR is defined as the ability of a firm's manufacturing system to address changes in customer demand (Thatte et al., 2012). OSR includes both manufacturing and service operations. It would also include the ability to rapidly configure or reconfigure assets and operations of a manufacturing system to cope with consumer trends (Wu, 2001; Lummus et al., 2003), respond rapidly to changes in product volume, and effectively expedite emergency customer orders. As a supply chain responds to customer demand, the constituent organizations may be required to move quickly from producing one product to another, or quickly change production levels for a given product. From a manufacturing standpoint, the responsiveness of an operations system would be an ability of the manufacturing or production function to respond rapidly to unexpected events, and an ability to swiftly accommodate special or non-routine customer requests. Operations responsiveness at each node in a supply chain is an integral component of SCR, since each entity in a supply chain is required to deliver the product or service in a timely and reliable manner, to satisfy customer demand (Duclos et al., 2003; Lummus et al., 2003).

The items under this category measure the responsiveness associated with a specific node or firm in a supply chain (Duclos et al., 2003; Lummus et al., 2003). This firm could be a supplier, manufacturer, or customer, or distributor. Anderson and Lee (2000) identify operations responsiveness as a valuable component of a successful supply chain strategy. Flexibility and speed of response are essential ingredients of a firm's manufacturing system (Holweg 2005; Holweg and Pil, 2001; Meehan and Dawson, 2002; Williamson, 1991). Measures used to operationalize the OSR construct are: operations system's ability to – respond rapidly to changes in product volume demanded by customers, effectively expedite emergency customer orders, rapidly reconfigure equipment to address demand changes, rapidly reallocate people to address demand changes, and rapidly adjust capacity to address demand changes.

Logistics process responsiveness (LPR): LPR is defined as the ability of a firm's outbound transportation, distribution, and warehousing system (including 3PL/4PL) to address changes in customer demand. Logistics and distribution management includes the activities of transportation of goods from suppliers to manufacturer to distribution centers to final points of consumption (Ricker and Kalakota, 1999; Duclos et al., 2003; Lummus et al., 2003). These activities include warehousing, packaging and shipping, transportation planning and management, inventory management, reverse logistics, and order tracking and delivery. This study focuses on the outbound logistics of the focal firm. Fuller et al. (1993) suggest that a firm's logistics system is instrumental in creating value for its customers. This value creation implies ensuring logistics flexibility (Duclos et al., 2003; Lummus et al., 2003) and speed within the supply chain to serve each distinct customer's needs. A typical response to uncertainty is to build flexibility into the supply chain (Simchi-Levi et al., 2008). Organizations can minimize risk and stay competitive (Simchi-Levi et al., 2008) if flexibility can be supplemented by an increased velocity of sensing and responding. This responsiveness in the logistic processes is a vital component in the success of a responsive supply chain strategy (Fawcett, 1992).

The responsiveness components in the logistics system include - selecting logistics components that: accommodate and respond to wide swings in demand over short periods, adjust warehouse capacity to address demand changes, handle a wide range of products, vary transportation carriers, have the ability to pack product-in-transit to suit discreet customers' requirements, and have the ability to customize products close to the customer. It is vital that a firm has easy access to and is able to utilize different modes of transportation to be logistically responsive (Prater et al., 2001). Hise (1995) states that companies need a capability and flexibility to adjust logistic systems quickly to respond to changes in market needs, and the necessitated product assortment. Lummus et al. (2003) put forth some of the critical logistics process flexibility aspects of a supply chain, which are vital for supply chain responsiveness. These criteria are adapted for the logistics process responsiveness dimension in this study, and are as follows: logistics system's ability to - rapidly respond to unexpected demand changes, rapidly adjust warehouse capacity to address demand changes, rapidly vary transportation carriers to address demand changes, accommodate special or non-routine customer requests, and effectively deliver expedited shipments.

Supplier network responsiveness (SNR): SNR is defined as the ability of a firm's major suppliers to address changes in the firm's demand. A key to responsiveness is the presence of responsive partners upstream and downstream of the focal firm (Christopher and Peck, 2004). Reichhart and Holweg (2007) argue that suppliers' manufacturing systems' responsiveness can be treated as the supply chain's responsiveness. The ability of a firm to react quickly to customer demand is much dependent on the reaction time of its suppliers to address the firm's demand. Thus, responsive firms should be able to select suppliers who can add new products and make desired changes, quickly. Supply chains should be capable and ready to address ripple effects caused by new technologies, terrorist threats (Walker, 2005) or increased competition. Slack (1991) argues that supplier networks are the essential building blocks of a flexible system. Some interviews with operations managers conducted at the European vehicle assembly plants of Volvo revealed that the lack of supplier network flexibility hampered the company's responsiveness (Holweg, 2005). Supplier network flexibility (Slack, 1991) and thus supplier network responsiveness is an important part of supply chain responsiveness. Holweg and Pil (2001) argue that flexibility in the supplier network is an important ingredient of being responsive to changes in customer demand.

It is well known that responsive suppliers are a vital resource of a firm when design (McGinnis and Vallopra, 1999; Burt and Soukup, 1985) and manufacturing of outsourced products are involved. Fisher et al. (2000) found that for short lifecycle products, such as fashion apparel, retailers are most successful if they can work with suppliers who can provide initial shipments of products based on forecasts, but then rapidly increase production to the right style, color, size, etc. based on actual sales. They note that fast supply chains can produce products as they sell rather than worrying about accurate forecasts. These studies suggest that supplier selection based on product development capabilities and rapid deployment capabilities, positively impact delivery time for new products. Choi and Hartley (1996) found that the capability of suppliers to make product volume changes to be a significant factor in supplier selection in the automotive industry. In the electronics industry, for example, demand volatility poses a unique challenge to suppliers to vary output in line with demand. The increases or decreases in demand may come at a short notice and may need to be sustained over some time period. Some of the measures of supplier network responsiveness identified in this study are: major suppliers' ability to - change product volume in a relatively short time, change product mix in a relatively short time, consistently accommodate the customer-firm's requests, provide quick inbound logistics to its customer-firms, have excellent on-time delivery record, and effectively expedite emergency orders.

2.2 SCM practices

'SCM practices' is defined as "the set of activities undertaken by an organization to promote effective management of its supply chain" (Li et al., 2006, p. 109). Li et al. (2005, 2006) propose 'SCM practices' as a multi-dimensional construct that includes both upstream and downstream sides of the supply chain. The literature identifies various practices as dimensions of this construct: outsourcing, strategic supplier partnership, information sharing, continuous process flow, quality, purchasing, customer relationships, inter-organizational system use, core competencies, postponement, supply chain integration, geographic proximity, JIT capability, product modularity, and cross-functional teams (Alvarado and Kotzab, 2001; Donlon, 1996; Tan et al., 1998; Tan et al., 2002; Lee, 2004; Chen and Paulraj, 2004; Min and Mentzer, 2004). Consolidating prior literature, Li et al. (2005, 2006) identified strategic supplier partnership, customer relationship, and information sharing as key SCM practices. Other factors identified in literature although of great interest, are not included in this study due to length of survey concerns and measurement instrument's parsimony. The present study, therefore, adopts from Li et al. (2005, 2006), strategic supplier partnership, customer relationship, and information sharing as the three dimensions of SCM practices. A brief discussion of these dimensions is provided below.

Strategic supplier partnership (SSP): SSP is defined as "the long term relationship between the organization and its suppliers. It is designed to leverage the strategic and operational capabilities of individual participating organizations to help them achieve significant ongoing benefits" (Li et al., 2006, p. 109). In the past two decades there has been a growing trend in long term collaborative relationships by organizations with a few trusted suppliers, instead of the traditional approach of a onetime cost based supplier relationship (Anderson et al., 1994; Wilkinson and Young, 1995; Ford, 1990; Sheth, 1996; Sheth and Sharma, 1997; Kalwani and Narayandas, 1995; Dwyer et al., 1987; Spekman, 1988). Some of the key advantages of long term relationships with suppliers identified in prior literature include: shared benefits and ongoing collaboration in key strategic areas like technology, products, and markets (Yoshino and Rangan, 1995), cost effective design alternatives, selection of better components and technologies, improved design assessment (Tan et al., 2002), enhanced coordination in operations, R & D, and product launching between partners (Fulconis and Paché, 2005; Burt and Soukup, 1985; Clark and Fujimoto, 1991; Helper, 1991; Hakansson and Eriksson, 1993; Lamming, 1993; Hines, 1994; Ragatz et al., 1997; Dowlatshahi, 1998; 2000; Swink, 1999; Shin et al., 2000), stronger competitive position in the marketplace through mutual co-operation (Porter, 1980), effective management of supply, manufacturing, logistics, and supply chain (Mentzer et al., 2001; Tyndall et al., 1998; Boddy et al., 2000; Ellram and Cooper, 1990), creation of competitive advantage (Sheth and Sharma, 1997; Ballou et al., 2000).

Customer relationship (CR): CR is defined as "the entire array of practices that are employed for the purpose of managing customer complaints, building long-term relationships with customers, and improving customer satisfaction" (Li et al., 2006, p. 109). Customer relationship is considered as an important component of SCM practices (Noble, 1997; Tan et al.,1998; Croxton et al., 2001). Literature highlights several benefits of customer relationships: success of an organization in SCM efforts as well as its performance (Scott and Westbrook, 1991;

Ellram, 1991; Turner, 1993; Moberg et al., 2002), increased sales and profits (Bommer et al., 2001), product differentiation from competitors, sustaining customer loyalty, and greater value provided to customers (Magretta, 1998).

Information sharing (IS): IS refers to "the extent to which critical and proprietary information is communicated to one's supply chain partner" (Li et al., 2006, p. 110). It refers to the access to private data between trading partners that enables them to monitor the progress of products and orders as they pass through various processes in the supply chain (Simatupang and Sridharan, 2002). Shared information can vary from strategic to tactical in nature and could pertain to logistics, customer orders, forecasts, schedules, markets, or more (Mentzer et al., 2000). Some of the elements that comprise information sharing include: data acquisition, processing, storage, presentation, retrieval, and broadcasting of demand and forecast data, inventory status and locations, order status, cost-related data, and performance status (Simatupang and Sridharan, 2005). Information sharing pertaining key performance metrics and process data, improves supply chain visibility, enabling effective decision making by firms. Information shared in a supply chain is of use only if it is relevant, accurate, timely, and reliable (Simatupang and Sridharan, 2005). The bullwhip effect can be minimized or eliminated by sharing information with trading partners (Yu et al., 2001). Through information sharing, the demand information flows upstream from the point of sale, while product availability information flows downstream (Lee and Whang, 2001; Yu et al., 2001) in a systematic manner. Moreover, information sharing ensures that the right information is available for the right trading partner in the right place and at the right time (Liu and Kumar, 2003). Information sharing with trading partners enables better decisions making by organizations, on the basis of greater visibility (Davenport et al., 2001), making firms and supply chains competitive (Lummus and Vokurka, 1999; Lalonde, 1998).

2.3 Competitive advantage

Competitive advantage is defined as the "capability of an organization to create a defensible position over its competitors" (Li et al., 2006, p. 111). Tracey et al. (1999) argues that competitive advantage comprises of distinctive competencies that sets an organization apart from competitors, thus giving them an edge in the marketplace. Porter's approach to competitive advantage centers on a firm's ability to be a low cost producer in its industry, or to be unique in its industry in some aspects that are popularly valued by customers (Porter, 1991). Most managers agree that cost and quality will continue to remain the competitive advantage dimensions of a firm (D' Souza and Williams, 2000). Wheelwright (1978) suggests cost, quality, dependability and speed of delivery as some of the critical competitive priorities for manufacturing. There is widespread acceptance of time to market as a source of competitive advantage (Holweg, 2005). Price/cost, quality, delivery dependability, and time to market have been consistently identified as important competitive capabilities (Vokurka et al., 2002; Fawcett and Smith, 1995; White, 1996; Skinner, 1985; Roth and Miller, 1990; Tracey et al., 1999). 'Time' has been argued to be a dimension of competitive advantage in other research contributions (viz: Stalk, 1988; Vesey, 1991; Handfield and Pannesi; 1995, Kessler and Chakrabarti, 1996; Zhang, 2001). In a research framework, Koufteros et al. (1997) describe the following five dimensions of competitive capabilities: competitive pricing, premium pricing, value-to-customer quality, dependable delivery, and product innovation. These dimensions were further described and utilized in other contributions as well (Koufteros et al., 2002; Tracey et al., 1999; Rondeau et al., 2000; Roth and Miller, 1990; Cleveland et al., 1989; Safizadeh et al., 1996; Vickery et al., 1999, Li et al. 2006). Based on these studies, the five dimensions of competitive advantage construct used in this study are price/cost, quality, delivery dependability, product innovation, and time to market.

2.4 Research hypotheses

There exists evidence that firms are achieving flexibility (Tully, 1994), and thus responsiveness, through the use of SCM practices. SCM practices directly impact the operational flexibility, and firms should use SCM practices to excel in attaining responsiveness (Narasimhan and Das, 1999). Successful SCM can result in lower system inventories, a network of firms that respond more quickly to market changes, and products that more closely match customer expectations. Thus, firms pursuing either a differentiation or a cost leadership or a quick response strategy, or a combination of these, can all find benefits from supply chain management (Porter, 1985).

Strategic supplier partnerships including working closely with suppliers to design or redesign products and processes, solve problems, as well as prepare back-up plans is critical in attaining supply chain responsiveness (Storey et al., 2005; Liu and Kumar, 2003; Martin and Grbac, 2003; Gunasekaran and Yusuf, 2002; Sheth and Sharma, 1997; Tan et al., 1998; Araujo et al., 1999; Ghosh et al., 1997; Ellinger, 2000; Lambert and Cooper, 2000; Turner et al., 2000; Harris, 2005; Yusuf et al., 2004; Lee, 2004; Power et al., 2001; Narasimhan and Das, 2000; Martin and Grbac, 2003). Liu and Kumar (2003) observed that collaborative practices such as 3PL, VMI, and CPFR between supply chain partners led to increased supply chain responsiveness. In a special report of logistics and transport (2003), information sharing and strategic supplier partnership practices have been highlighted as the critical steps to being responsive. Close relationship with suppliers, has been empirically found to positively affect the volume flexibility, mix flexibility and new product flexibility dimensions of manufacturing flexibility (Suarez et al., 1995). Numerous studies emphasize the importance of integrating suppliers, manufacturers, and customers in order to achieve supply chain responsiveness (Frohlich and Westbrook, 2001; Clinton and Closs, 1997; Fulconis and Pache, 2005; Van Hoek et al., 2001; Herrmann et al., 1995; Christopher, 2000; Smith and Barclay, 1997; Handfield and Nichols, 2002; Handfield et al., 1998). The case of Dell (Magretta, 1998), Wal-Mart (Parks, 2001), and Toyota are excellent examples of building strategic supplier partnerships resulting in mutual benefits including fast response to customers.

Customer relationship is essential for attaining supply chain wide responsiveness (Storey et al., 2005; Mitchell, 1997; Christine, 1997; Martin and Grbac, 2003; Sheth and Sharma, 1997; Tan et al., 1998; Araujo et al., 1999; Van Hoek et al., 2001; Christopher, 2000; Harris, 2005). For instance, Taiwan Semiconductor Manufacturing Company (TSMC), the world's largest semiconductor foundry, gives suppliers and customers proprietary tools, data, and models so they can execute design and engineering changes quickly and accurately. In a similar fashion instead of carrying excess inventory, General Electric (GE) collaborated with its retailers to better respond to customer demand (Treacy and Wiersema, 1993).

Information sharing plays an important role in constructing a responsive supply chain network (Lau and Lee, 2000). A great amount of visibility is required through the supply chain in order to attain supply chain responsiveness (Storey et al., 2005). This would, it is argued, enable all the players in the supply chain "to see from one end of the pipeline to another, in as close to real time as possible" (Storey et al., 2005, p. 244). Information sharing practice in a supply chain increases responsiveness to customers needs (Martin and Grbac, 2003, Sheth and Sharma, 1997; Tan et al., 1998; Araujo et al., 1999; Van Hoek et al., 2001; Christopher, 2000). Lambert and Cooper (2000) argue and Thatte et al. (2009) find that a higher level of information sharing practices will lead to a higher level of supplier network responsiveness. Close relationship and open communication can lead to supplier responsiveness (Liker and Choi, 2004; Handfield and Bechtel, 2002; Treleven and Schweikhart, 1988). The examples of Dell and Cisco demonstrate that information sharing with suppliers improves customer service and supply chain responsiveness (Zhou and Benton, 2007). Open sharing of information such as inventory levels, forecasts, sales promotion strategies, and marketing strategies reduces the uncertainty between supply chain partners (Andel, 1997; Lewis and Talalayevsky, 1997; Lusch and Brown, 1996; Salcedo and Grackin, 2000) thus enabling firms to respond rapidly to unexpected events on either customer or supply side (Martin and Grbac, 2003; Handfield and Nichols, 2002; Hult et al., 1996; Gosain et al., 2004; Tan et al., 1998). Based on the above arguments we state:

Hypothesis 1: The higher the levels of SCM practices of a firm, the higher the levels of supply chain responsiveness.

Aquilano et al. (1995, p. 447) contend that low cost, high quality and improved responsiveness (both delivery time and flexibility of product delivery), are the three main strategic imperatives to stay competitive (as cited in Duclos et al., 2003). Supply chain agility is considered a key element of a firm's competitive strategy (Goldman et al., 1994; Teece et al., 1997). Goldman et al. (1994) state that an agile organization has the potential to achieve competitive advantage. The improvement of flexibility and speed of response has become increasingly important as a method to achieve competitive advantage (Upton, 1997; Martin and Grbac, 2003 Lau and Hurley, 2001). Responsiveness to customers is critical to gaining competitive advantage (Williamson, 1991; Martin and Grbac, 2003; Ellinger, 2000; Christopher, 2000). Lummus et al. (2003) argue that in the future, as supply chains compete with other supply chains, organizations must understand that responsive supply chains will outperform those that are less responsive. Firms with more responsive supply chains will be more adaptive to demand fluctuations and will handle this uncertainty at a lower cost due to the shorter lead time (Randall et al., 2003)..

Effective engineering of cycle time reduction can lead to significant improvements in manufacturing and inventory cost savings and productivity (Towill, 1996). He further argues that reduction in lead times is a necessary condition for a responsive supply chain and which further reduces the time to market. Allnoch (1997), in a study of 225 manufacturers found that average companies require much more time to respond to changes in customer demand than do leading manufacturers. The study also found that while leading manufacturers required two weeks to meet increased production requirements per customer demand, average companies required four weeks to four months. These leading companies thus outperformed their peers and realized huge cost savings and other competitive advantages. Thus, supply chain responsiveness enables firms to respond effectively and quickly to business uncertainties, thereby allowing it achieve superior competitive position in a global marketplace (Swafford et al., 2006).

Being operationally responsive will enable organizations to compete based on cost (due to first mover advantage), time to market, and delivery dependability. Responsiveness of a firm's logistics (transportation and distribution) process will enable it to introduce new products faster than competitors (i.e. lowering time to market), and also lead to greater ability of a firm to provide on time the type and volume of product required by customers (i.e. improving delivery dependability). If a firm is endowed with responsive suppliers this can improve its ability to: rapidly introduce new products and features in the market place (i.e. compete based on product innovation), reduce time to market for new products (Thatte et al., 2008), provide on time delivery (Thatte et al., 2009). A supply chain characterized by quick responsiveness to customers will also be competitive in terms of time and quality (Li, 2002). The above arguments lead to:

Hypothesis 2: The higher the levels of supply chain responsiveness, the higher the levels of competitive advantage of a firm.

SCM practices have empirically been found to positively impact competitive advantage by Li et al. (2006). The current study aims to test if supply chain responsiveness plays a key role in this relationship. Christopher (1992) states that, the greater the collaboration, at all levels, between supplier and customer, the greater the likelihood that competitive advantage can be gained by organizations. Extensive coordination and involvement with suppliers in the new product development process has been known to reduce time to market (Vonderembse and White, 2004). Supplier integration can reduce material costs and improve quality (Ragatz et al., 2002; McGinnis and Vallopra, 1999; Ragatz et al., 1997), reduce product development time and cost (Kessler, 2000; Clark, 1989), and reduce manufacturing cost while improving functionality. A long-term relationship with the supplier will have a lasting effect on the competitiveness of the entire supply chain (Choi and Hartley, 1996; Noble, 1997; Kotabe et al., 2003).

Sharing information (and data) with other parties within the supply chain can be used as a source of competitive advantage (Jones, 1998; Novack et al., 1995). Armistead and Mapes (1993) suggest that firms can improve product quality through information sharing with trading partners. Furthermore, Tompkins and Ang (1999) consider the effective use of pertinent, timely, and accurate information by supply chain members as a key competitive factor. Information sharing with suppliers has given Dell Corp. the benefits of faster cycle times (implying lower time to market), reduced inventory (implying reduced costs), and improved forecasts. Customers, for their part, have benefited by getting a higher-quality product at a lower price (Magretta, 1998; Stein and Sweat, 1998). The above arguments lead to:

Hypothesis 3: Firms with high levels of SCM practices will have high levels of competitive advantage.

3. RESEARCH METHODOLOGY

Research methodology is described for the instrument development and data collection in this section. The instrument development methodology for supply chain responsiveness includes four stages: (1) item generation, (2) pre-pilot study, (3) pilot study, and (4) large-scale data collection. Instruments for SCM practices (Li et al., 2005; Li et al., 2006) and competitive advantage (Zhang, 2001; Koufteros et al., 1997) are adopted from respective literatures. The items for these instruments are listed in Appendix A. The unit of analysis in this study is a firm, since SCM practices and responsiveness are dependent on the individual operating firms within a supply chain. Past studies (ex: Swafford et al., 2006a) have used similar unit of analysis. Also a study that encompasses the entire supply chain domain, from raw materials through production/assembly at multiple stages/organizations, through delivery via diverse distribution channels, would be complex, time consuming, and costly.

3.1 Item generation, pre-pilot, and pilot study

As per Churchill (1979), the content validity is enhanced if steps are taken to ensure that the domain of the construct is covered. In accordance with Churchill (1979), in the item generation stage, potential items were generated through a literature review and from construct definitions. The items for supply chain responsiveness (operations systems responsiveness, logistics process responsiveness, and supplier network responsiveness) were generated through supply chain flexibility, manufacturing flexibility, supply chain agility, agile manufacturing, and customer responsiveness literatures (Prater et al., 2001; Lummus et al., 2003; Duclos et al., 2003; Van Hoek, 2000; Fawcett, 1992; Fawcett et al., 1996; Fawcett and Smith, 1995; Lau, 1999; Emerson and Grimm, 1998; Martin and Grbac, 2003).

In the pre-pilot study, these items were reviewed by six academicians and a doctoral student, and further re-evaluated through a structured interview with one high level executive. The focus was to check the relevance of each construct's definition and clarity of wordings of sample questionnaire items. Based on the feedback from the academicians and practitioners, redundant and ambiguous items were either modified or eliminated. New items were added wherever deemed necessary. Definitions were also modified to ensure that the domain of the construct is covered and thus strengthen the content validity.

For the pilot study phase, the Q-sort method was used to pre-assess convergent and discriminant validity of the scales. Purchasing/materials/supply chain/operations vice presidents and managers were requested to act as judges and sort the items into the three dimensions of supply chain responsiveness, based on similarities and differences among items. An indicator of construct validity was the convergence and divergence of items within the categories. If an item was consistently placed within a particular category, then it was considered to demonstrate convergent validity with the related construct, and discriminant validity with the others. The reliability of the sorting conducted by the judges was assessed using three different measures: the inter-judge raw agreement scores, Cohen's Kappa (Cohen, 1960), and item placement ratios (or Moore and Benbasat's (1991) "Hit Ratio"). The inter-judge raw agreement scores were calculated by counting the number of items both judges agreed to place in a certain category. An item was considered as an item with agreement, though the category in which the item was sorted together by both judges may not be the originally intended category. Further, Cohen's Kappa was used to eliminate any chance agreements, thereby evaluating the true agreement score between two judges. Finally, item placement ratios were calculated by counting all the items that were correctly sorted into the target category by the judges for each round and dividing them by twice the total number of items.

In the first round, the inter-judge raw agreement scores averaged 0.83, the Cohen's Kappa score averaged 0.74, and the initial overall placement ratio of items within the target constructs was 0.91. Several studies have considered scores greater than 0.65 to be acceptable (e.x. Vessey, 1984; Jarvenpaa, 1989). As per the guidelines laid down by Landis and Koch (1977) for interpreting Cohen's Kappa, a score of 0.74 is considered as a good degree of agreement beyond chance, between the judges. To further improve the Cohen's Kappa measure of agreement, an examination of the off-diagonal entries in the placement matrix was conducted.

Analysis of inter-judge disagreements about item placement identified both bad items, as well as weakness in the original definitions of constructs. Based on the misplacements made by the judges the items were identified and inappropriately worded or ambiguous items were either reworded or eliminated. Further, feedback from both judges was obtained on each item and incorporated into the modification of items. Further the definitions of logistics process responsiveness and supplier network responsiveness were slightly modified based on the feedback from judges.

The reworded items were then entered into the second round. In the second round, the inter-judge raw agreement scores averaged 1.0, the initial overall placement ratio of items within the target constructs was 1.0, and the Cohen's Kappa score averaged 1.0. A Kappa score of 1.0 indicates an excellent level of agreement for the judges in the second round. Also, the overall placement ratio of items within the target constructs (1.0) is excellent in the second round, indicating a high degree of construct validity. Feedback from the judges in round two led to the replacement of one item and slight modification of four items.

The third sorting round was used to re-validate the constructs. The results of the third round were similar to those obtained in the second sorting round, thereby indicating consistency of results between the second and third round. At this stage, the results suggested an excellent level of inter-judge agreement, indicating a high level of reliability and construct validity at the pilot testing stage.

3.2 Large-scale methods and data collection

Since this study has a supply chain management focus, the target respondents were the operations / manufacturing / purchasing / logistics / materials / supply chain – vice presidents, directors and managers as these personnel were deemed to have the best knowledge in the supply chain area. The respondents were asked to refer to their major suppliers or customers when answering the questionnaire. E-mail lists were purchased from three different sources. These were the Council of Supply Chain Management (CSCMP), Rsateleservices.com, and Lead411.com. Seven SIC codes are covered in the study: 22 “Textile Mill products”, 23 “Apparel and other Textile Products”, 25 “Furniture and Fixtures”, 34 “Fabricated Metal Products”, 35 “Industrial Machinery and Equipment”, 36 “Electrical and Electronic Equipment”, and 37 “Transportation Equipment”. The lists were limited to organizations with more than 100 employees as these organizations are most likely to engage in SCM initiatives.

The survey was web-based, based on methods of Dillman (2000). The final version of the questionnaire was administered by e-mail to 5498 target respondents. To ensure a reasonable response rate, the survey was e-mailed in three waves. In the first e-mail, the questionnaire with the cover letter indicating the purpose and significance of the study was emailed to target respondents. In the cover letter, the respondents were given three options to send their response: 1) online completion and submission: a web link (survey hosted on university website) was given so that they could complete the questionnaire online; 2) download the hard copy online: a link to the questionnaire in .pdf file was given and respondents could send it by fax or ask for a self-addressed stamped envelope; 3) request the hard copy by sending an email: they received in their regular mail a copy of the questionnaire along with a self-addressed stamped envelope. Using this approach data was gathered during June-July 2006.

The response rate was calculated based on the number of click-through’s the emailing generated and total number that was converted to a completed survey. After three waves of emailing a total of 714 click-throughs were generated and 294 completes were obtained to provide a good response rate of 41.18%. Response rate based on the click-through’s may represent a better measure for email surveys, since bulk emails sent out in this manner are treated as spam by respondents’ organizations’ email program and may never be retrieved or viewed by the target respondent. Since it is highly difficult to track this information accurately, a more appropriate measure would be to base the analysis on the number of people who have visited the site and have had an opportunity to review the request and purpose of this study, and then may have declined to complete the survey based on any number of reasons. 11% of the respondents are CEO/President, 45% are Vice Presidents, 25% are Directors, and 19% are titled as Managers. Thus 81% of the respondents (CEOs, VPs, and Directors) are high level executives, implying a high reliability of the responses received, as these executives have a wider domain (job responsibility) and administrative knowledge. This is consistent with past survey-based research studies in SCM (ex: Frohlich and Westbrook, 2002). The areas of expertise were 11% executives (CEOs/Presidents), 12% purchasing, 22% SCM, 18% distribution/transportation/logistics, 20% manufacturing/production, 10% materials, and 7% belong to other category such as sales. Thus the respondents’ domains cover all key functions across the supply chain ranging from purchasing, to manufacturing, to sales, to distribution. Also, since 33% of the respondents have been with the organization over 10 years, 21% have been at the organization between 6-10years, implies that majority of the respondents have a comprehensive view of the supply chain program of their organization.

This research did not investigate non-response bias directly since the email lists had only names and email addresses of individuals without organizational details. This research compares those subjects who responded after the first e-mailing wave and those who responded to the second/third wave. The succeeding waves of survey were considered to be representative of non-respondents (Lambert and Harrington, 1990; Armstrong and Overton, 1977).

Similar methodology has also been used in prior SCM empirical research (Li et al., 2005; Chen and Paulraj, 2004; Handfield and Bechtel, 2002). Chi-square tests (χ^2 statistic) were used to make the comparisons. No significant difference in industry type (based on SIC), employment size, and respondent's job title was found between these two groups (i.e. $p > 0.1$, when testing the null hypotheses: there is no significant difference in distribution of responses across SIC codes/employment size/job title between groups). Further, Chi-square tests of independence were also performed to observe if the distribution of responses across SIC codes, employment size, and respondent's job title is independent of the three waves when considered independently. No significant difference in industry type (based on SIC), employment size, and respondent's job title was found between each of the three groups / waves.

4. MEASUREMENT MODEL

In order to effectively test the structural model, it is essential to demonstrate that the instruments for the various constructs used in the study are valid and reliable. Convergent validity, discriminant validity, and reliability are important for construct validity (Ahire et al., 1996; Ragunathan and Ragunathan, 1994). Also, as per the guidelines of Bagozzi (1980) and Bagozzi and Phillips (1982), the important properties for measurement to be reliable and valid include content validity, construct validity (convergent and discriminant validity), reliability (internal consistency or scale consistency of operationalization), validation of second-order construct (analysis of fit statistics of second order model), and predictive validity (we use the construct level correlation analysis). Structural equation modeling (using AMOS software) was used for convergent (measurement model) and discriminant (two factors at a time) validity. Reliability estimation is performed after convergent and discriminant validity because in the absence of a valid construct, reliability may not be relevant (Koufteros, 1999). Following are the discussions of content validity, convergent validity, discriminant validity, reliability analysis, and construct level correlation analysis (for predictive validity).

4.1. Convergent validity

Instrument assessment is an important step in testing the research model. AMOS software is used to perform CFA (confirmatory factor analysis) for the measurement models, which is then followed by the structural model displaying the hypothesized relationships. It was decided to first test the measurement model and then the structural model, to avoid any interactions between the measurement and the structural model, and as proposed by Gerbing and Anderson (1988). The purification of the measurement models was done only to the supply chain responsiveness construct. Model-data fit was evaluated based on multiple fit indices. The overall model fit indices include goodness of fit index (GFI), adjusted goodness of fit index (AGFI), and root mean square error of approximation (RMSEA). GFI indicates the relative amount of variance and covariance jointly explained by the model. AGFI differs from GFI in that it adjusts for the number of degrees of freedom in the model. A GFI and AGFI score in the range of 0.8 to 0.89 is considered as representing a reasonable fit; a score of 0.9 or higher is considered as evidence of good fit (Joreskog and Sorbom, 1989). The RMSEA takes into account the error of approximation and is expressed per degree of freedom, thus making the index sensitive to the number of estimated parameters in the model; a value of less than 0.05 indicates a good fit, a value as high as 0.08 represents reasonable errors of approximation in the population (Browne and Cudeck, 1993), a value ranging from 0.08 to 0.10 indicates mediocre fit, and values greater than 0.10 indicate poor fit (MacCallum et al., 1996). If the fit indices are not satisfactory, the modification indices are observed to check for any error term correlation. Those items, whose error terms are highly correlated with the error terms of other items measuring that variable, are further studied for logic and theoretical support for deletion. Items are deleted one at a time if there was a reason to do so, based on the criteria for model fit. Otherwise the item remained in the model. This process of purification of the measurement model was continued until an acceptable model fit was obtained.

The instrument for supply chain responsiveness that emerged from the pilot study is given in Table 2. The supply chain responsiveness construct is represented by three dimensions and 18 items, including operations system responsiveness (OSR) (7 items), logistics process responsiveness (LPR) (5 items), and supplier network responsiveness (SNR) (6 items). These 18 items were submitted to a measurement model analysis to check model fit indices for each sub-construct to further refine the scale

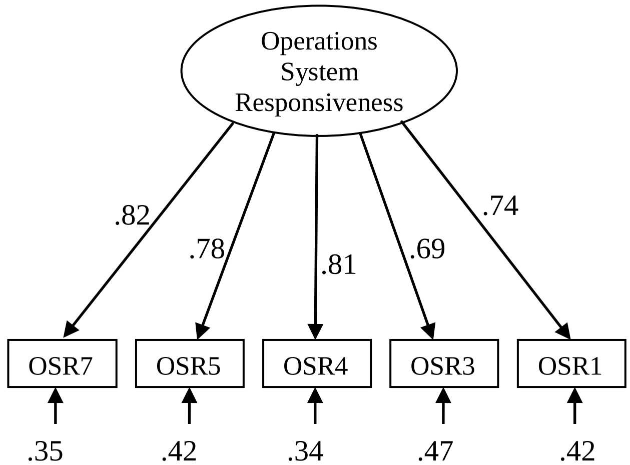

Figure 2. Final measurement model for operations system responsiveness (OSR)

The initial model fit indices for OSR consist of GFI = 0.866, AGFI = 0.732, and RMSEA = 0.182. These indices show nowhere near a reasonable fit; therefore further model modification was carried out based on modification indices (MI). MI represents both measurement error correlations and item correlations (multicollinearity). MI shows evidence of misfit between the default model and the hypothesized model. MI is conceptualized as a chi-square statistic with one degree of freedom (Joreskog and Sorbom, 1989). Therefore, the threshold of MI is 4 chi-square statistics at a 0.05 significance level. High MI represents error covariances meaning that one item might share variance explained with another item (commonality) and thus they are redundant. The remedial action for error covariances is to delete such an item which has high error variance. Based on the modification indices, two items (OSR2 and OSR6) were dropped one at a time. Although the λ coefficients were satisfactory (above 0.69), RMSEA (0.182) is higher and AGFI (0.732) is lower than recommended. Modification indices indicated high error correlation between OSR2 and other items (OSR1, OSR5, OSR6, and OSR7). Therefore OSR2 was dropped. In the next iteration, RMSEA (0.099) is slightly high and modification indices indicated high error correlation between OSR6 and other items (OSR1, OSR3, and OSR 5). Item OSR6 was thus dropped from the model. The new model fit indices improved significantly to GFI = 0.989, AGFI = 0.968, and RMSEA = 0.045. The final measurement model for OSR is shown in Fig.2.

Table 2
Model Fit Indices for Supply Chain Responsiveness

Coding	Items	Initial Model Fit	Final Model Fit
	Operations System Responsiveness (OSR)		
OSR1	Our operations system responds rapidly to changes in product volume demanded by customers.		
OSR2	Our operations system responds rapidly to changes in product mix demanded by customers. *	GFI = 0.866	GFI = 0.989
OSR3	Our operations system effectively expedites emergency customer orders.	AGFI = 0.732	AGFI = 0.968
OSR4	Our operations system rapidly reconfigures equipment to address demand changes.		
OSR5	Our operations system rapidly reallocates people to address demand changes.	RMSEA = 0.182	RMSEA = 0.045
OSR6	Our operations system rapidly changes manufacturing processes to address demand changes. *		
OSR7	Our operations system rapidly adjusts capacity to address demand changes.		
	Logistics Process Responsiveness (LPR)		
LPR1	Our logistics system responds rapidly to unexpected demand change.		
LPR2	Our logistics system rapidly adjusts warehouse capacity to address demand changes.	GFI = 0.926	GFI = 0.996
LPR3	Our logistics system rapidly varies transportation carriers to address demand changes.	AGFI = 0.777	AGFI = 0.98
LPR4	Our logistics system rapidly accommodates special or non-routine customer requests. *		
LPR5	Our logistics system effectively delivers expedited shipments.	RMSEA = 0.181	RMSEA = 0.025
	Supplier Network Responsiveness (SNR)		
SNR1	Our major suppliers change product volume in a relatively short time. *		
SNR2	Our major suppliers change product mix in a relatively short time.	GFI = 0.822	GFI = 0.993
SNR3	Our major suppliers consistently accommodate our requests.	AGFI = 0.584	AGFI = 0.963
SNR4	Our major suppliers provide quick inbound logistics to us.		
SNR5	Our major suppliers have outstanding on-time delivery record with us. *	RMSEA = 0.272	RMSEA = 0.064
SNR6	Our major suppliers effectively expedite our emergency orders.		

* Items were dropped from the initial model

The initial model fit indices for LPR consist of GFI = 0.926, AGFI = 0.777, and RMSEA = 0.181. Based on the modification indices, one item (LPR4) was dropped. The concept of LPR4 – logistics system rapidly accommodates special or non-routine customer requests, is already partially captured by LPR5 - logistics system effectively delivers expedited shipments, and partially by LPR1 - logistics system responds rapidly to unexpected demand change, and therefore LPR4 was dropped. The new model fit indices improved significantly to GFI = 0.996, AGFI = 0.98, and RMSEA = 0.025. The final measurement model for LPR is shown in Fig. 3.

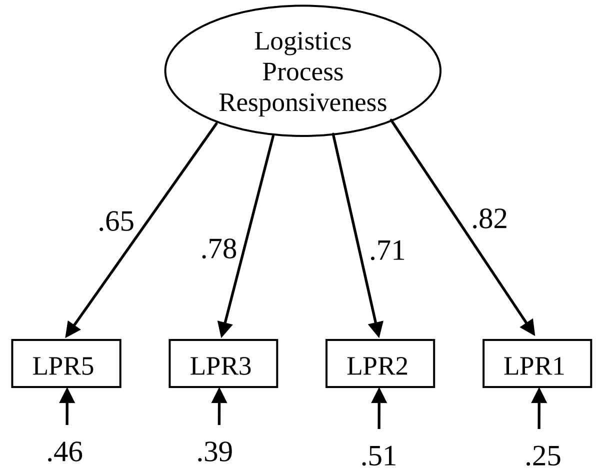

Figure 3. Final measurement model for logistics process responsiveness (LPR)

The initial model fit indices for SNR consist of GFI = 0.822, AGFI = 0.584, and RMSEA = 0.272. These indices show unreasonable fit; therefore further model modification was carried out to improve model fit indices. Based on the modification indices two items (SNR1 and SNR5) were dropped one at a time. It appeared that SNR1 – major suppliers quickly change product volume could be constructed as part of SNR3 – major suppliers consistently accommodate requests, and therefore SNR1 was dropped. Also in the next iteration, the modification indices indicated high error correlation between SNR5 and SNR6. Further, the λ coefficient for SNR5 (0.72) was lower than that for SNR6 (0.81). Item SNR5 was thus dropped for the next iteration.

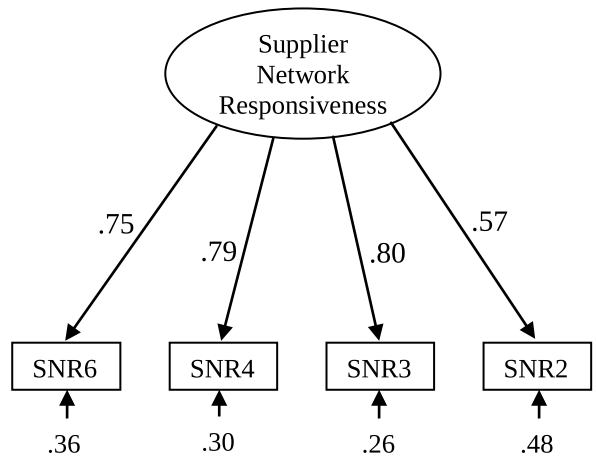

Figure 4. Final measurement model for supplier network responsiveness (SNR)

The new model fit indices improved significantly to GFI = 0.993, AGFI = 0.963, and RMSEA = 0.064. The final measurement model for SNR is shown in Fig. 4. Although the loading of SNR2 is relatively low, it was decided to keep the item as the overall model fit is good, with no error correlation between the items. Table 2 provides a summary of results for the measurement model for supply chain responsiveness dimensions.

4.2. Discriminant validity

Discriminant validity refers to the independence of the dimensions (Bagozzi and Phillips, 1982) or factors measuring one construct. It can be assessed using structural equation modeling methodology (Bagozzi and Phillips, 1982). In AMOS, it can be done by taking two factors (i.e. variables) at a time at one instance, and then having all items of the two constructs inserted into one single factor in the second instance (see Fig. 5).

The chi-square values of running each instance thus obtained are noted. The difference between the chi-square value (df =1) of the two models must be greater than or equal to 3.84 for significance at $p < 0.05$ level so as to indicate support for the discriminant validity criterion (Joreskog, 1971). The constructs are considered to be distinct if the hypothesis that the two constructs together form a single construct is rejected. Table 3 provides discriminant validity results for supply chain responsiveness construct. The differences between chi-square values of all pairs and the corresponding single factors are statistically significant at $p< 0.0001$ level thus indicating high degree of discriminant validity among various dimensions of supply chain responsiveness.

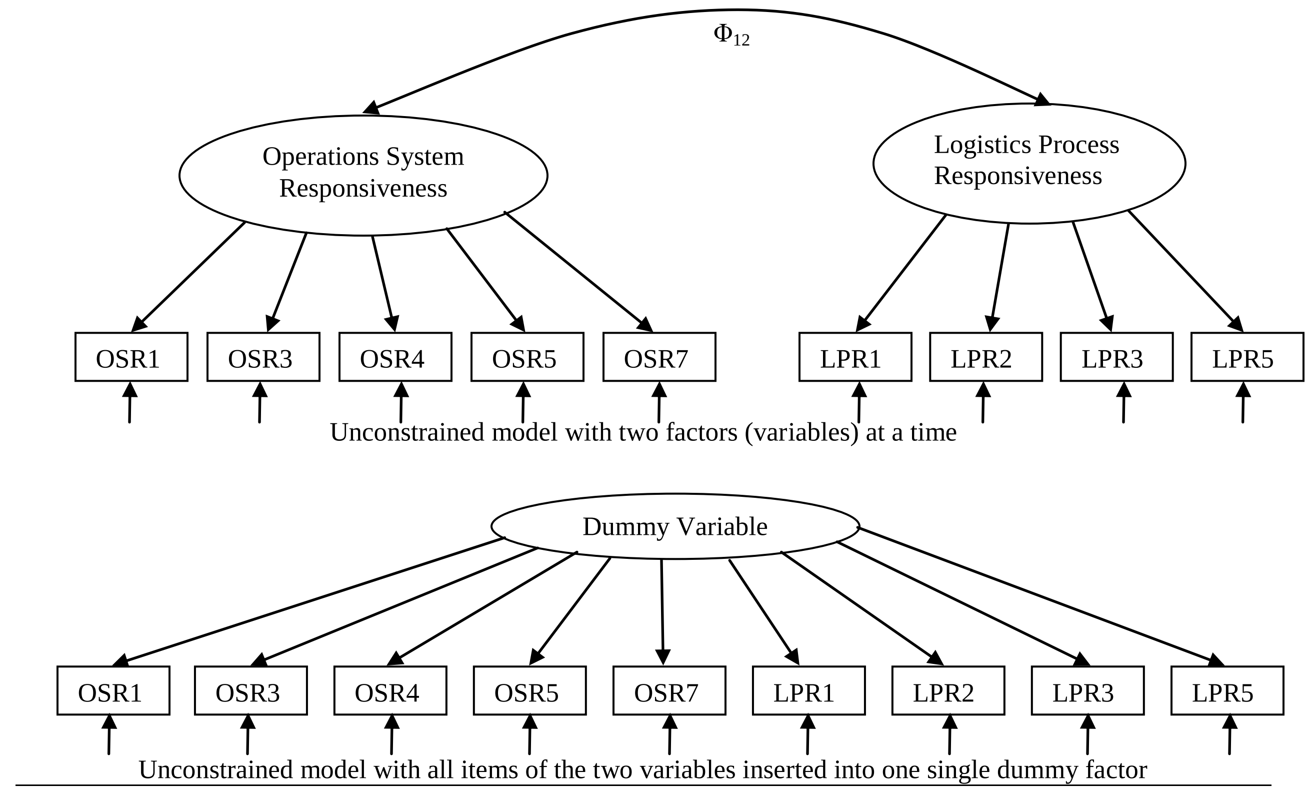

Figure 5. Illustrative example of measurement model testing discriminant validity

Table 3
Discriminant validity - pair-wise/single-factor comparison of chi-square values for supply chain responsiveness

	OSR (χ^2)			LPR (χ^2)		
Construct	Pair-wise	Single-factor	Dif.	Pair-wise	Single-factor	Dif.
OSR						
LPR	50.9	310.4	**259.5**			
SNR	41.6	321.8	**280.2**	26.3	330.8	**304.5**

All χ^2 differences are statistically significant at $p< 0.0001$ level

4.3 Assessing Reliability

The reliabilities of supply chain responsiveness, SCM practices, and competitive advantage were assessed with Cronbach's (1951) alpha. A commonly used value for acceptable reliability is 0.70 (Hair et al., 1998; Nunnally, 1978). Tables 4a-c report means, standard deviations, correlations, and reliabilities for each of the constructs. The reliability values for supply chain responsiveness are greater than 0.80, which is considered to be good. Reliabilities for other constructs are greater than 0.74, which are considered acceptable.

Table 4
Means, standard deviations, correlations, and reliabilities of (a) SCM practices, (b) supply chain responsiveness, and (c) competitive advantage

Variables	Mean	S.D.	SCMP	SCR	CA	1	2	3	4	5	Reliability
(a) *SCM practice (SCMP)*	*3.62*	*.57*	-								-
1. Strategic supplier partnership	3.67	.73				-					.82
2. Customer relationship	3.94	.74				.38**	-				.83
3. Information sharing	3.25	.72				.45**	.46**	-			.90
(b) *Supply chain responsiveness (SCR)*	*3.42*	*.60*	*.44***	-							-
1. Operations system responsiveness	3.32	.82				-					.88
2. Logistics process responsiveness	3.60	.77				.48**	-				.83
3. Supplier network responsiveness	3.33	.70				.43**	.36**	-			.82
(c) *Competitive advantage (CA)*	*3.91*	*.43*	*.44***	*.43***	-						-
1. Price	3.45	.91				-					.79
2. Quality	4.52	.56				.18**	-				.88
3. Delivery dependability	4.24	.70				.22**	.21**	-			.91
4. Time to market	3.20	.83				.21**	.08	.23**	-		.74
5. Product innovation	3.88	.85				.69	.11	.03	.24**	-	.82

**Correlation is significant at 0.01 level (two-tailed).

4.4 Validation of second-order constructs

Supply chain responsiveness is conceptualized as a second-order construct comprising of three dimensions, operations system responsiveness, logistics process responsiveness, and supplier network responsiveness. In the case of three correlated first-order factors, a second-order model has the same degrees of freedom and chi-square as that of the first-order model, thus the target coefficient (T-coefficient) value equals 1.0, which has no meaning (Doll et al., 1995). In this situation, we look at the standardized coefficient (γ) for each sub-construct. If all of them are statistically significant, a second-order construct can be considered. The fit statistics for the second-order model were $\chi^2 = 98.217$; df = 62; $\chi^2/df = 1.584$, $P = 0.002$, GFI =0.95, AGFI = 0.93 and RMSEA = 0.045, indicating a very good model-data fit. Furthermore, the γ coefficients for the three sub-constructs are 0.80 for OSR, 0.68 for LPR, and 0.61 for SNR, and are all statistically significant at $P < 0.01$. Thus, there is a strong evidence of existence of a higher-order supply chain responsiveness (SCR) construct. SCM practices and competitive advantage constructs have already been validated as second-order constructs (Li et al., 2006).

4.5 Predictive Validity

In order for the measurement to be generalized, predictive validity or criterion-related validity may be performed by comparing the second order factor models with one or more external variables (criterion) known or believed to measure the attribute. Criterion-related validity is characterized by prediction to an outside criterion and by checking a measuring instrument, against some outcome or measure (Kerlinger, 1986). In this study, the criterion used to test the predictive validity is dependent variable. Construct level correlation analysis was performed between the second order constructs to check for preliminary statistical validity of the hypotheses. Each construct was represented by a composite score. Each second-order construct is measured by multiple first-order constructs and each first-order construct contains multiple items. An average score of the items measuring each first-order construct was treated as the score for the corresponding first-order construct. Further, the average score of all first-order constructs that comprised the second-order construct was calculated and this score was treated as the composite score for the second-order construct. Pearson correlation was then run between these higher order constructs. Table 4 provides the results of the correlation analyses for the second-order constructs. All correlations were statistically significant at 0.01 level. Thus all three hypothesized relationships are statistically supported by the Pearson correlation. Further hypotheses testing using structural equation modeling (using AMOS) is discussed in the next section.

5. STRUCTURAL MODEL

AMOS structural modeling method was used to test the hypothesized relationships among variables SCM practices, supply chain responsiveness, and competitive advantage. Fig. 6 displays the path analysis resulting from the AMOS structural modeling analysis. The composite scores for the corresponding dimensions were used as input to the structural model. The results are presented in Table 5. The χ^2 measure is often criticized for its over-sensitivity to sample size hence caution is recommended when making inferences pertaining to model fit based on chi-square values alone (Hair et al., 1998). The standardized structural coefficient (or effect size) between two constructs is commonly used to complement structural equation modeling (SEM). The effect size helps researchers differentiate between statistical significance and practical significance, when the test of a relationship deals with a large-sample size. An effect size of 0.371 (indicating 13.8% of variance in the dependent variable that is accounted by the independent variable) or above is considered large, between 0.100 and 0.371 is considered medium, and 0.1 and below is considered small (Cohen, 1988; 1990). The results exhibit that all measurements have significant loadings to their corresponding second-order construct. Overall the model has good fit with $\chi^2 = 76.99$, df = 41, $P = 0.001$, GFI = 0.96, AGFI = 0.93, and CFI = 0.93. The RMSEA is 0.055 which is within the recommended range of acceptability (<0.05 to 0.08).

Hypotheses 1 (t-value = 6.46) and 2 (t-value = 3.38), were significant at $P < 0.001$ level. Hypothesis 3 (t-value = 3.10) was significant at 0.01 level. Therefore all research hypotheses are supported by the AMOS structural modeling results. All three relationships have a large effect size (standardized coefficient, $\beta > 0.37$), confirming that the supported relationships have both statistical and practical significance, which is crucial in providing theoretical and managerial implications.

Hypothesis 1, which states that organizations with higher levels of SCM practices will have higher levels of supply chain responsiveness is strongly supported ($\beta = 0.62$, $P < 0.001$, t = 6.46). Hypothesis 1 confirms that a well-managed and a well-executed supply chain reduces uncertainty and lead-time, and leads to improved supply chain responsiveness. The implementation of SCM may directly improve an organization's ability to address any changes in the business environment.

The supported Hypothesis 2, indicates that supply chain responsiveness has a direct positive impact on competitive advantage of a firm ($\beta = 0.49$, $P < 0.001$, t = 3.38). The finding empirically confirms the assertion in the literature that a responsive supply chain in terms of an organization's operations systems, logistics and distribution processes, and suppliers could provide the organization with competitive advantage on dimensions such as cost, quality, delivery dependability, product innovation, and time-to-market.

The results strongly support hypothesis 3 ($\beta = 0.44$, $P < 0.01$, t = 3.10), concurring with and confirming the finding of Li et al. (2006) that SCM practices directly and positively impact competitive advantage, asserting the argument that implementation of various SCM practices, such as strategic supplier partnership, customer relationship, and information sharing, may provide the organization a competitive advantage on cost, quality, delivery dependability, time to market, and product innovation.

Based on the standardized structural coefficients of the three hypotheses displayed in Table 5 , SCM practice may have a greater direct impact on supply chain responsiveness ($\beta = 0.62$) than on competitive advantage ($\beta = 0.44$). This supports the argument that competitive advantage is an outcome of numerous practices within (such as various manufacturing and management practices) and between organizations and not an outcome of just one factor, such as SCM practices.

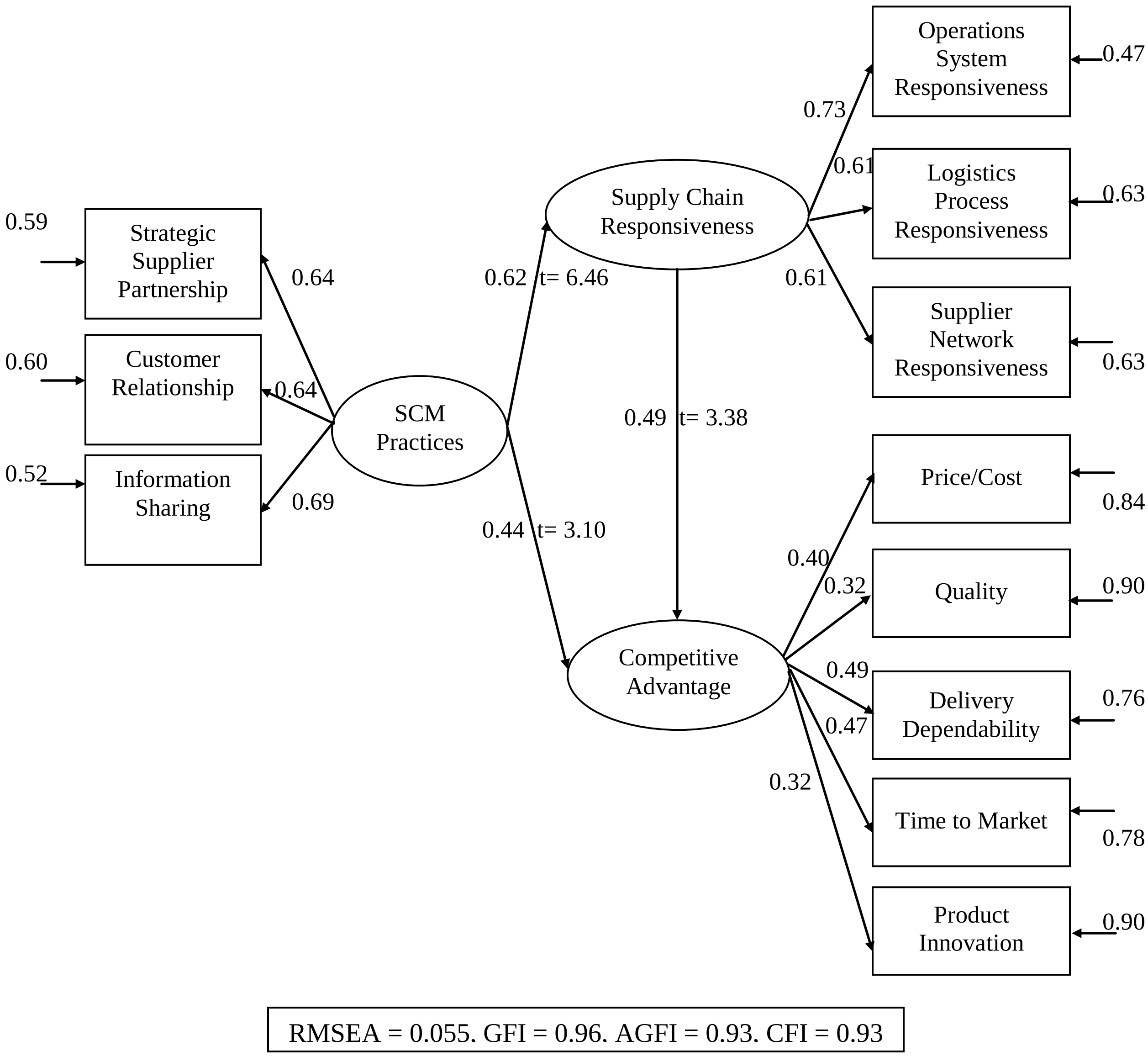

Figure 6. AMOS structural model of SCM practices, supply chain responsiveness, and competitive advantage

Table 5
Results for structural model

Hypothesis	**Relationship**	**Total effects** ***β*** **(t-value)**	**Direct effects** ***β*** **(t-value)**	**Indirect effects** ***β*** **(t-value)**	**Hypothesis**
H1	SCMP → SCR	0.62***(6.46)	0.62***(6.46)		Supported
H2	SCR → CA	0.49***(3.38)	0.49***(3.38)		Supported
H3	SCMP → CA	0.75***(5.24)	0.44**(3.10)	0.31*(2.14)	Supported

*** Significant at $P < 0.001$ level
** Significant at $P < 0.01$ level
* Significant at $P < 0.05$ level

Interestingly the results also indicate that competitive advantage is influenced by SCM practices indirectly via supply chain responsiveness (β of indirect effect of SCM practice on competitive advantage is 0.31, $P < 0.05$).

This implies that SCM practices lead to responsiveness in the supply chain in the first place, and this responsiveness in supply chain in turn produces competitive advantage for the organization on various dimensions. The findings of this research thus indicate the presence of an intermediate factor in terms of supply chain responsiveness between the relationship of SCM practices and competitive advantage, thereby supplementing prior literature (ex: Ragatz et al., 2002; Moberg et al., 2002; Li et al., 2006) and providing food for thought.

6. RESEARCH FINDINGS AND IMPLICATIONS

A major contribution of the study is the development of the supply chain responsiveness construct and the validation of the measurement instrument. The scale has been tested through rigorous statistical methodologies including pretest, pilot-test using Q-sort method, confirmatory factor analysis, unidimensionality, reliability, and validation of second-order construct. The scale is shown to meet the requirements for reliability and validity and thus, can be used in future research. Such a valid and reliable scale has been otherwise lacking in the literature. The development of these measurements will greatly stimulate and facilitate the theory development in this field.

The results of this study have several important implications for researchers. First, the study provides inferences made from an instrument that is valid and reliable for the current study's context for evaluating the level of supply chain responsiveness, and tests the construct with an outcome (competitive advantage) of relevance and interest to a firm. Although several previous studies discuss the responsiveness of firms, they are oriented toward customer responsiveness at a firm level. The instrument developed in this research captures three important aspects and first-order constructs of supply chain responsiveness – operations system responsiveness, logistics process responsiveness, and supplier network responsiveness. This study adds to the empirical investigation of supply chain responsiveness and the studies of Swafford et al. (2006a, 2006b) and Braunscheidel and Suresh (2009), offering additional valid and reliable measures of the supply chain construct. Further, since practices are designed to achieve efficiency and responsiveness, the new instrument shall provide better guideline for researchers in the SCM area, and thus, can be considered as a strategic management tool.

Second, the study takes a look at supply chain responsiveness at the firm level, by measuring the extent of a firm's ability on various dimensions to address changes in customer demand. The concept of supply chain responsiveness is difficult to measure; however, the degree to which demand changes are addressed at various nodes of a firm (viz: upstream, within the firm, and downstream) can be used as an indirect measure of this concept. This measure is useful to researchers who are interested in measuring supply chain responsiveness but cannot specify a sampling frame for the supply chain. Measuring supply chain responsiveness at the firm level provides an alternate way to study supply chain outcomes.

Third, this study provides supporting evidences to the conceptual and prescriptive literature about previously untested statements regarding the relationship between SCM practices and supply chain responsiveness. The study provides a research framework that identifies positive and significant relationships between SCM practices, supply chain responsiveness, and competitive advantage. The results demonstrate that a higher level of SCM practices will lead to a higher level of supply chain responsiveness on an aggregate basis. This finding supports Feitzinger and Lee's (1997) case study based argument that effective SCM practices are essential and vital for attaining cost effective responsiveness. Further, this study also provides supporting evidences to the literature on the relationships between SCM practices and competitive advantage (Li et al., 2006; Moberg et al., 2002) as well as supply chain responsiveness and competitive advantage (Lummus et al., 2003). The results demonstrate that a higher level of SCM practices and supply chain responsiveness will lead to a higher level of competitive advantage for a firm. This framework provides a foundation and insight for future researchers in the area of supply chain responsiveness.

The results of this study have several important implications for practitioners. First, as today's competition is moving from between organizations to between supply chains, more and more organizations are increasingly adopting SCM practices, in the hope for securing competitive advantage. 36% of the respondents (106 / 294) indicated that their firm has not embarked upon a program aimed specially at implementing supply chain management. Of the remaining 64% of the respondents, over 55% (97/178)) indicated that their firm has embarked on a supply chain management program for just three years or less. The findings of this research assure the practitioners that SCM is an effective way of competing, and the implementation of SCM practices does have a strong impact on supply chain responsiveness and competitive advantage of the firm. Second, the study provides statistical and theoretical evidence to practitioners that can encourage adoption of specific SCM practices to improve responsiveness and in-turn strengthen their competitive position in the marketplace. Supply chain responsiveness has been poorly defined and there is a high degree of variability (ranging from flexibility to agility) in people's mind about its meaning. The findings demonstrate to the practitioners the vital components of responsiveness. Third, the study provides practitioners with measures that can be used to evaluate, benchmark, and compare responsiveness at different nodes in a supply chain (viz. raw material/component supplier, assembler, sub-assembler, manufacturer, wholesaler, and retailer) and further helps identify the immediate outcomes of it. These measures can also be used by firms to understand impacts on organizational performance.

7. LIMITATIONS AND FUTURE RESEARCH

This research has extended past research in several ways, by building on past theoretical and empirical studies. Although this research has significant contributions from both theoretical and practical point of views, it also has some limitations, which are described below. The examination of those limitations will assist future researchers to work around them.

First, due to the limited number of observations (294), the revalidation of constructs was not carried out in this research. Confirmatory research strengthens the validity and thus the confidence in using the instrument. This needs to be addressed in future research. Second, in this research, individual respondents (high level executives from purchasing, operations, materials, and logistics functions) in an organization were asked to respond to complex SCM issues dealing with the participants along the supply chain, including upstream suppliers and downstream customers. However, no person in an organization is in charge of the entire supply chain: for example, purchasing managers are mainly responsible for purchasing and supply side, and may be not in an appropriate position to answer the customer-related questions; the main area of manufacturing managers is production and they may not have enough knowledge of their suppliers and customers; similarly materials managers are mainly responsible for inventory management, and they may not have enough knowledge of their customer. Even though we have a majority of the responses (81%) from high level executives (CEOs, VPs, and directors) who may at least have an idea of how the various process in an organization work, the use of single respondent may generate some measurement inaccuracy. Third, as noted by Li et al. (2006) that "SCM practices may be influenced by contextual factors" (p. 119), like a firm's position in the supply chain, industry type, and organization size, also applies to this research. The study is limited to the industries (SIC codes – 22, 23, 25, 34, 35, 36, 37) used for this research. This could limit generalizability of results to other industry types. Future research may extend / replicate the study for other industry types to enhance generalizability. Recommendations for future research follow.

This framework provides a foundation for future research. Although the findings demonstrate to the practitioners the hypothesized relationships on an aggregate basis as well as the vital components of responsiveness, it would be desirable that the research brings forth the ways of achieving them. Thus it is desired that future study provide predominant and specific SCM practices that impact one or more supply chain responsiveness dimensions. This can be achieved through detailed dimension and item level analyses to understand the intricate relationships between various specific SCM practices and supply chain responsiveness and competitive advantage dimensions.

In the future, new constructs may be added to provide an in-depth understanding of supply chain responsiveness theory. Future research should revalidate measurement scales developed in this research by using similar reference populations. Such a validation shall confirm our measurement instrument and create generalizability for it. Later studies may apply multiple methods of obtaining data. Once a construct is measured with multiple methods, random error and method variance may be assessed using a multitrait-multimethod approach. The use of single respondent to represent what are supposed to be intra/inter-organization wide variables may generate some inaccuracy, more than the usual amount of random error (Koufteros, 1995). To enhance the reliability of research findings, future research may seek to utilize multiple respondents from each participating organization. Future research can study SCM issues at the supply chain level and investigate the various mechanisms that govern it. Complete supply chains can be compared to better understand differences in SCM practices across supply chains operating in different industries (ex: electronic and computer, heavy industrial equipment, fashion and apparel, and consumer goods). Such comparisons can identify strengths and weaknesses of each supply chain and the best common SCM practices. Further recommendations can thus be made to improve both, the overall responsiveness of specific supply chains, as well as the competitive position of firms. In addition, future research may expand the current theoretical framework by integrating new constructs from within and outside the field. Future studies may test the hypothesized relationships across countries, for identification and comparison of country specific SCM issues. Finally, it would be interesting to explore other dimensions of supply chain responsiveness, not considered in this research, such as assembly responsiveness and inbound logistics responsiveness among others.

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APPENDIX A. INSTRUMENT FOR SCM PRACTICES, SUPPLY CHAIN RESPONSIVENESS, AND COMPETITIVE ADVANTAGE

SCM Practices

Please circle the number that accurately reflects the extent of your firm's current level of SCM practices.

Strategic supplier partnership (SSP)

SSP1	We consider quality as our number one criterion in selecting suppliers
SSP2	We regularly solve problems jointly with our suppliers
SSP3	We have helped our suppliers to improve their product quality
SSP4	We have continuous improvement programs that include our key suppliers
SSP5	We include our key suppliers in our planning and goal- setting activities
SSP6	We actively involve our key suppliers in new product development processes

Customer relationship(CR)

CR1	We frequently interact with customers to set reliability, responsiveness, and other standards for us
CR2	We frequently measure and evaluate customer satisfaction
CR3	We frequently determine future customer expectations
CR4	We facilitate customers' ability to seek assistance from us
CR5	We periodically evaluate the importance of our relationship with our customers

Information sharing (IS)

IS1	We inform trading partners in advance of changing needs
IS2	Our trading partners share proprietary information with us
IS3	Our trading partners keep us fully informed about issues that affect our business
IS4	Our trading partners share business knowledge of core business processes with us
IS5	We and our trading partners exchange information that helps establishment of business planning
IS6	We and our trading partners keep each other informed about events or changes that may affect the other partners

Supply Chain Responsiveness

Please circle the number that accurately reflects the extent of your supply chain's current level of responsiveness.

Operations system responsiveness (OSR)

OSR1	Our operations system responds rapidly to changes in product volume demanded by customers
OSR2*	Our operations system responds rapidly to changes in product mix demanded by customers
OSR3	Our operations system effectively expedites emergency customer orders
OSR4	Our operations system rapidly reconfigures equipment to address demand changes
OSR5	Our operations system rapidly reallocates people to address demand changes
OSR6*	Our operations system rapidly changes manufacturing processes to address demand changes
OSR7	Our operations system rapidly adjusts capacity to address demand changes

Logistics process responsiveness (LPR)

LPR1	Our logistics system responds rapidly to unexpected demand change
LPR2	Our logistics system rapidly adjusts warehouse capacity to address demand changes
LPR3	Our logistics system rapidly varies transportation carriers to address demand changes
LPR4*	Our logistics system rapidly accommodates special or non-routine customer requests
LPR5	Our logistics system effectively delivers expedited shipments

Supplier network responsiveness (SNR)

SNR1*	Our major suppliers change product volume in a relatively short time
SNR2	Our major suppliers change product mix in a relatively short time
SNR3	Our major suppliers consistently accommodate our requests
SNR4	Our major suppliers provide quick inbound logistics to us
SNR5*	Our major suppliers have outstanding on-time delivery record with us
SNR6	Our major suppliers effectively expedite our emergency orders

Competitive Advantage

Please select the number that accurately reflects the extent of your firm's competitive advantage on each of the following.

Price/Cost (PC)

PC1	We offer competitive prices
PC2	We are able to offer prices as low or lower than our competitors

Quality (QL)

QL1	We are able to compete based on quality
QL2	We offer products that are highly reliable
QL3	We offer products that are very durable
QL4	We offer high quality products to our customers

Delivery dependability (DD)

DD1	We deliver customer orders on time
DD2	We provide dependable delivery

Time to market (TTM)

TM1	We are first in the market in introducing new products
TM2	We have time-to-market lower than industry average
TM3	We have fast product development

Product innovation (PI)

PI1	We provide customized products
PI2	We alter our product offerings to meet client needs
PI3	We cater to customer needs for "new" features

* Items were dropped in the final instrument

APPENDIX B. DEMOGRAPHIC DATA OF RESPONDENTS (SAMPLE SIZE 294)

Variables	Total Responses	First-wave	Second and third wave
	Frequency (%)	Frequency (%)	Frequency (%)
Industry - SIC (278)			
SIC 22	0 (0.0%)	0 (0.0%)	0 (0.0%)
SIC 23	4 (1.4%)	2 (2.3%)	2 (1.1%)
SIC 25	7 (2.5%)	2 (2.3%)	5 (2.6%)
SIC 34	29 (10.4%)	9 (10.3%)	20 (10.5%)
SIC 35	28 (10.1%)	7 (8.1%)	21 (11.0%)
SIC 36	110 (39.6%)	36 (41.4%)	74 (38.7%)
SIC 37	26 (9.4%)	8 (9.2%)	18 (9.4%)
Other	74 (26.6%)	23 (26.4%)	51 (26.7%)
Number of employees (291)			
1-50	12 (4.1%)	4 (4.4%)	8 (4.0%)
51-100	20 (6.9%)	6 (6.6%)	14 (7.0%)
100-250	35 (12.0%)	9 (9.9%)	26 (13.0%)
251-500	36 (12.4%)	10 (11%)	26 (13.0%)
501-1000	25 (8.6%)	7 (7.7%)	18 (9.0%)
Over 1000	163 (56.0%)	55 (60.4%)	108 (54.0%)
Job title (290)			
CEO/President	31 (10.7%)	11 (12.0%)	20 (10.1%)
Vice President	130 (44.8%)	37 (40.2%)	93 (47.0%)
Director	73 (25.2%)	23 (25.0%)	50 (25.3%)
Manager	56 (19.3%)	21 (22.8%)	35 (17.7%)