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Towards a theory of supply chain management: the constructs and measurements

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Abstract

Rising international cooperation, vertical disintegration, along with a focus on core activities have led to the notion that firms are links in a networked supply chain. This novel perspective has created the challenge of designing and managing a network of interdependent relationships developed and fostered through strategic collaboration. Although research interests in supply chain management (SCM) are growing, no research has been directed towards a systematic development of SCM instruments.

This study identifies and consolidates various supply chain initiatives and factors to develop key SCM constructs conducive to advancing the field. To this end, we analyzed over 400 articles and synthesized the large, fragmented body of work dispersed across many disciplines. The result of this study, through successive stages of measurement analysis and refinement, is a set of reliable, valid, and unidimensional measurements that can be subsequently used in different contexts to refine or extend conceptualization and measurements or to test various theoretical models, paving the way for theory building in SCM.

Keywords: Supply chain management; Constructs; Instrument development

1. Introduction

The origin of the supply chain concept has been inspired by many fields including (1) the quality revolution (Dale et al., 1994), (2) notions of materials management and integrated logistics (Carter and Price, 1993; Forrester, 1961), (3) a growing interest in industrial markets and networks (Ford, 1990; Jarillo, 1993), (4) the notion of increased focus (Porter, 1987; Snow et al., 1992), and (5) influential industry-specific studies (Womack et al., 1990; Lamming, 1993). Researchers thus find themselves inundated with terminologies such as "supply chains", "demand pipelines" (Farmer and Van Amstel, 1991), "value streams" (Womack and Jones, 1994), "support chains", and many others. The term supply chain management (SCM) was originally introduced by consultants in the early 1980s (Oliver and Webber, 1992) and has subsequently gained tremendous attention (La Londe, 1998). Analytically, a typical supply chain as shown in Fig. 1 is a network of materials, information, and services processing links with the characteristics of supply, transformation, and demand.

The term SCM has been used to explain the planning and control of materials and information flows as well as the logistics activities not only internally

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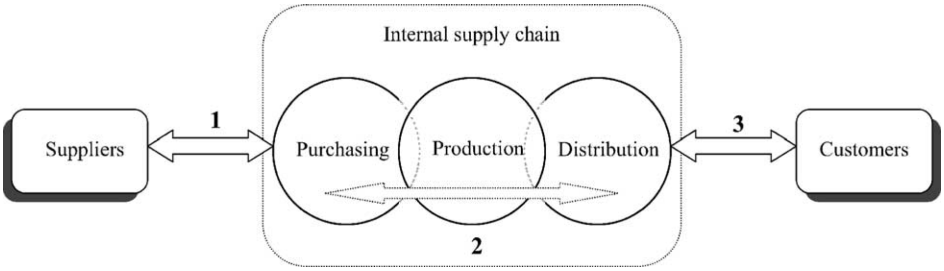

Fig. 1. An illustration of a company's supply chain.

within a company but also externally between companies (Cooper et al., 1997b; Fisher, 1997). Researchers have also used it to describe strategic, inter-organizational issues (Harland et al., 1999), to discuss an alternative organizational form to vertical integration (Thorelli, 1986; Hakansson and Snehota, 1995), to identify and describe the relationship a company develops with its suppliers (e.g., Helper, 1991; Hines, 1994; Narus and Anderson, 1995), and to address the purchasing and supply perspective (e.g., Morgan and Monczka, 1996; Farmer, 1997).

A number of fields such as purchasing and supply, logistics and transportation, operations management, marketing, organizational theory, management information systems, and strategic management have contributed to the explosion of SCM literature. From the myriad of research, it can be seen that a great deal of progress has been made toward understanding the essence of SCM. The new orthodox of supply chain management, however, is in danger of collapsing into a discredited management fad unless a reliable conceptual base is developed (New, 1996), and many authors have highlighted the pressing need for clearly defined constructs and conceptual frameworks to advance the field (Saunders, 1995; Cooper et al., 1997a; Babbar and Prasad, 1998; Saunders, 1998).

Recognizing that construct measurement development is at the core of theory building (Venkatraman, 1989), we intend to contribute to the development of SCM constructs with an initial set of operational measurements that exhibit sound psychometric properties. Towards the journey of developing theoretical constructs in SCM, we examine over 400 articles from the diverse disciplines noted above. Thus, this study may be the most comprehensive analysis of the multidisciplinary, wide-ranging research on SCM. While the contributions from various works exist in isolation, they, when taken together, have many of the critical elements necessary for successful management of supply chains. We first consolidate relevant findings and integrate them into a tractable, meaningful research framework, as depicted in Fig. 2. Through successive stages of measurement analysis and refinement, the result of this study is a set of reliable, valid, and unidimensional measurements that can be subsequently used in different contexts to extend or refine conceptualization and the operational measures. Such an exercise would reflect a cumulative theory-building perspective where progress is made by successively testing the efficacy of the measures in varying theoretical networks (Cronbach, 1971). Thus, this study represents a response to a call for theory building in operations management (Melnyk and Handfield, 1998; Meredith, 1998). The conceptual framework and the instrument developed herein can help researchers better understand the scope of both the problems and the opportunities associated with supply chain management. It will also allow researchers to test different theoretical SCM models with varying foci, including the relationships among the various constructs, along with their individual or collective impact on supply chain performance. It will be of value, therefore, not only to readers who desire to expand their research into this exciting area, but also to those who have already investigated this topic but in isolation or with limited scope. The rest of this article is organized in the following order. Section 2 presents the foundation and conceptualization of the proposed SCM constructs. Then, the research design including data collection is presented, followed by a section describing measurement development process and the test of the measures along with their psychometric

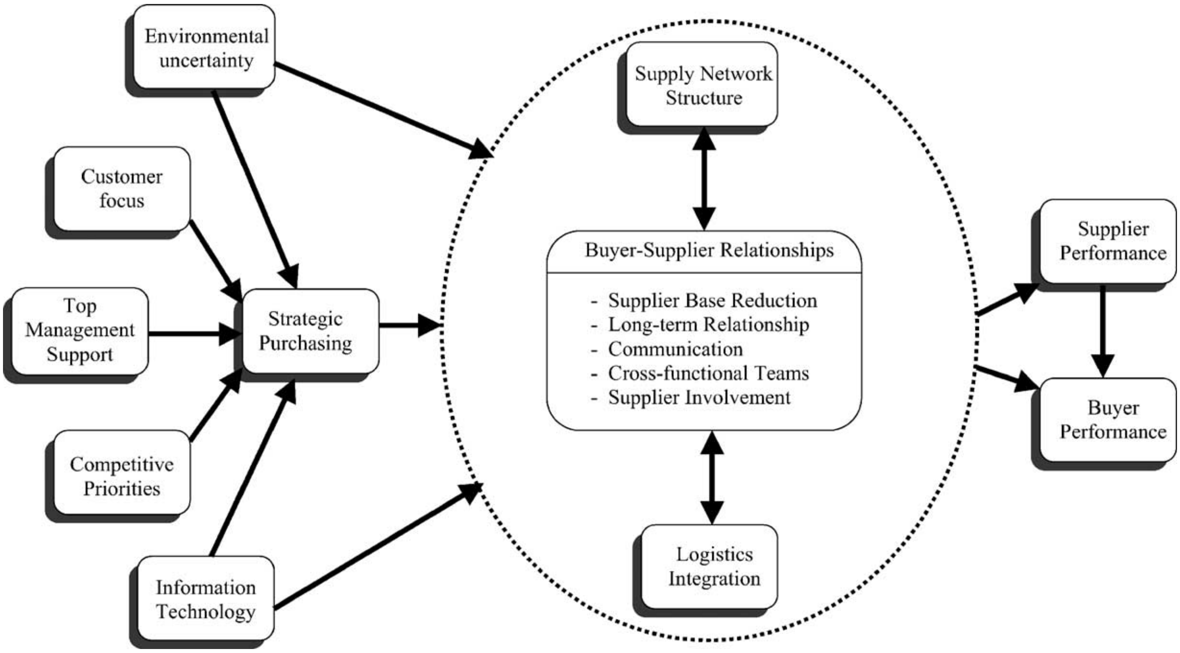

Fig. 2. A research framework of supply chain management.

properties. Section 5 discusses limitations and directions for future research. Finally, the paper concludes with a summary and implications of the research.

2. Theoretical foundation and construct development

Drawing on a prodigious body of knowledge in cross-enterprise and interdisciplinary literature, this section presents constructs significant to SCM within the conceptual framework depicted in Fig. 2. This framework is grounded on a paradigm of strategic management theory that emphasizes the development of “collaborative advantage” (e.g., Contractor and Lorange, 1988; Nielsen, 1988; Kanter, 1994; Dyer, 2000), as opposed to “competitive advantage” (e.g., Porter, 1985). Within the collaborative paradigm, the business world is composed of a network of interdependent relationships developed and fostered through strategic collaboration with the goal of deriving mutual benefits (Miles and Snow, 1986; Thorelli, 1986; Borys and Jemison, 1989; Lado et al., 1997; Madhok and Tallman, 1998; Ahuja, 2000; Chen and Paulraj, 2004). The framework also draws on the “relational view” of interorganizational competitive advantage (Dyer and Singh, 1998) in contrast to the “resource-based view” (RBV) of the firm (e.g., Barney, 1991, Teece et al., 1997). Although complementary to the RBV, the relational view considers the dyad/network instead of individual firms as the unit of analysis and thus provides a more coherent support for our view of supply chain management.

In identifying the numerous theoretical determinants of supply chain management, we have directed our attention to the buyer–supplier dyadic relationship. The buyer–supplier dyad, represented by link 1 in Fig. 1, is of paramount importance to the effective management of the supply chain (Anderson et al., 1994; Anderson and Narus, 1990). The relationship aspect of this dyad is a widely recognized area that has generated abundant scholarly works (e.g., Carr and Pearson, 1999; Choi and Hartley, 1996; De Toni and Nassimbeni, 1999; Hahn et al., 1986; Heidi and John, 1990). Based on an extensive review of the literature, this framework incorporates some key aspects of the buyer–supplier relationship including supply base reduction, long-term relationships, communication, cross-functional teams, and supplier involvement.

Fostering and maintaining a superior relationship between the dyadic members is a daunting task. Various forces play critical roles in making this a challenging business practice. The proposed framework includes some of the key driving forces that have been identified from diverse literature. As environmental uncertainty appears to be a fundamental problem for both simple and complex organizations (Thompson, 1967), it is included as a critical antecedent to supply chain management. Strategy and structure have also been postulated as key forces to the success of any manufacturing initiative (Hayes and Wheelwright, 1979; Porter, 1990; Skinner, 1969; Thorelli, 1986; Ward et al., 1994; Williamson, 1985, 1994). In a similar spirit, we believe that they are also crucial to the successful management of supply chains. It is imperative that the buying firms take strategic initiatives that foster superior relationships and provide mutual benefits (Gadde and Hakansson, 1994; Hahn et al., 1990; Hakansson and Snehota, 1995; Krause and Ellram, 1997; Monczka et al., 1993; Ward et al., 1994). Recognizing this need, the framework includes constructs such as competitive priorities, top management support, and strategic purchasing to examine their effect on the effective management of the supply chain. Keeping in mind that a supply chain does not focus on a single firm, the framework takes on a theoretical definition of structure that focuses on the dyad. This construct, supply network structure, reflects a decentralized, horizontal and non-power based structural link among the supply chain members.

As articulated by many researchers, supply chain management is an integrative function (Ellram and Carr, 1994; Freeman and Cavinato, 1990; Gadde and Hakansson, 1994). Integration could occur, among others, in terms of material and information. Turning our attention to Fig. 1, integration of materials and information is not limited to link 1 alone. It encompasses all three links identified (Stock et al., 1998). In the proposed framework, a single construct of logistics integration is included to study the integration of information and materials along the supply chain. As information could replace inventory and foster superior performance (Min and Galle, 1999; Radstaak and Ketelaar, 1998), an information technology construct has also been included to study the extent of information integration. Furthermore, since it is a well-known fact that satisfying customer needs is the central purpose of any business (Doyle, 1994), this framework reflects the notion that customer focus, in terms of satisfying needs and providing timely service, is a key driving force of effective supply chain management.

Supply chain management seeks improved performance through better use of internal and external capabilities in order to create a seamlessly coordinated supply chain, thus elevating inter-company competition to inter-supply chain competition (Anderson and Katz, 1998; Birou et al., 1998; Christopher, 1996; Lummus et al., 1998; Morgan and Monczka, 1996). Therefore, in the context of SCM, performance is no longer affected by a single firm. Rather, performance of all members involved contributes to the overall performance of the entire supply chain. With this in mind, our framework includes both supplier performance and buyer performance. In particular, both operational (i.e., non-financial) and financial indicators are considered.

As defined by The Supply Chain Council (2002), a supply chain encompasses every effort involved in producing and delivering a final product from the supplier's supplier to the customer's customer. We recognize that the conceptual framework, though extensive, may not cover all the facets of supply chain management. Since it is not developed as a research model, instead of providing a detailed literature support for each link, the links in the framework are justified by the references contained in a cross-sectional table (Appendix A). It should be pointed out that some of the references provide indirect instead of direct support for the links among the underlying constructs. To further elucidate the development of the framework, key factors and supply chain initiatives addressed in this paper as well as the theoretical foundation of the constructs is briefly described in the following subsections. Due to the length of this article, however, a detailed analysis of literature is omitted.

2.1. *Environmental uncertainty*

Uncertainty has been an important construct in a number of fields, including organization theory, marketing, and strategic management. Davis (1993) suggests that there are three different sources of uncertainty that plague supply chains: supplier uncertainty, arising from on-time performance, average lateness, and degree of inconsistency; manufacturing uncertainty, arising from process performance, machine breakdown, supply chain performance, etc; and customer or demand uncertainty, arising from forecasting errors, irregular orders, etc. The extant supplier development literature further proposes that increased competition in the marketplace and the increased pace of technological innovation are two primary factors driving companies' needs for world-class suppliers and for supplier development (Hahn et al., 1990). In this study, we consider uncertainty in the forms of supply, demand and technology. Supply uncertainty includes indicators that represent quality, timeliness and the inspection requirements of the suppliers. Demand uncertainty is measured in terms of fluctuations and variations in demand. Technology uncertainty measures the extent of technological changes evident within the industry. These constructs are operationalized based on prior research (e.g., Miller, 1991; Handfield, 1993; St. John and Heriot, 1993; Stuart, 1993; Van Hoek, 1998; Krause, 1999).

2.2. Customer focus

Despite the use of the latest process improvement techniques and capable management, a firm's neglect of its customers may lead to disaster (Kordupleski et al., 1993). In fact, the pressure to revitalize manufacturing over the last decade has been rooted in customers' demand for a greater variety of reliable products with short lead times (Draaijer, 1992). As customer expectations are dynamic in nature (Shepetuk, 1991), organizations need to assess them regularly and adjust their operations accordingly (Takeuchi and Quelch, 1983). Doyle (1994) writes that satisfying customer needs is the central purpose of any business and Dibb et al. (1994) describe customer satisfaction as the major aim of marketing. The clear message is that the more attention a company pays to researching its customer base in order to identify customer needs, the more rewarding the exchange transaction in the supply chain will be for that company (Carson et al., 1998). Organizations can outperform their competition by exceeding, not just satisfying, the needs of their customers. Since customers are the central element of this strategy, this theoretical construct is formulated based on the importance given to customers in the execution of strategic planning, quality initiatives, product customization, and responsiveness (Stalk et al., 1992; Ahire et al., 1996; Carson et al., 1998; Tan et al., 1999).

2.3. Top management support

The important role of top management has been greatly emphasized in the supply chain literature (Hahn et al., 1990; Monczka et al., 1993; Ward et al., 1994; Krause, 1999). Top-level managers have a better understanding of the needs of supply chain management because they are the most cognizant of the firm's strategic imperatives to remain competitive in the market place (Hahn et al., 1990). Monczka et al. (1993) noted that top management must commit the time, personnel and financial resources to support the suppliers who are willing to be a long-term partner of the company through supplier development. One of the major functions of top management executives is to influence the setting of organizational values and develop suitable management styles to improve the firm's performance. Prior research has noted that top management must be aware of the competitive benefits that can be derived from the impact of strategic purchasing and information technology on effective supply relationships. In this study, the construct of top management support is characterized in terms of time and resources contributed by the top management to strategic purchasing, supplier relationship development and adoption of advanced information technology (Hahn et al., 1990; Monczka et al., 1993; Krause and Ellram, 1997; Krause, 1999).

2.4. Supply strategy

Supply strategy is inherently broader than manufacturing strategy, because it incorporates interactions among various supply chain members. Each focal organization has its own unique network that comprises a unique set of actors, resources, and activities, which together constitute its identity (Gadde and Hakansson, 1993). It also takes a position in comparison with other organizations and networks; the position of a company with respect to others reflects its capacity to provide values to others (productiveness, innovativeness, competence) (Hakansson and Snehota, 1995).

2.4.1. Competitive priorities

Consistent with the literature, the term competitive priorities is used to describe manufacturers' choice of manufacturing tasks or key competitive capabilities, which are broadly expressed in terms of low cost, flexibility, quality, and delivery (Skinner, 1969; Hayes and Wheelwright, 1984; Berry et al., 1991; Ward et al., 1995). The list has since been growing with the additions of innovativeness, time, delivery speed, and delivery reliability (Corbett and Van Wassenhove, 1993; Miller and Roth, 1994). These lists are closely related to the idea of generic strategies from the business strategy literature (Porter, 1990). Therefore, extant research has noted that supply chain strategy should not be based on cost alone, but rather on the issues of quality, flexibility, innovation, speed, time, and dependability. This theoretical construct of competitive priority is derived based on these initiatives and the indicators are formulated accordingly (Corbett and Van Wassenhove, 1993; Miller and Roth, 1994; Stock et al., 1998; Kathuria, 2000; Santos, 2000).

2.4.2. Strategic purchasing

Historically, purchasing was considered to have a passive role in the business organization (Fearon, 1989). In the 1980s, purchasing began to be involved in the corporate strategic planning process (Spekman and Hill, 1980; Carlisle and Parker, 1989). By the 1990s, both academics and managers had given unprecedented attention to strategic purchasing (Freeman and Cavinato, 1990; Watts et al., 1992; Gadde and Hakansson, 1993; Lamming, 1993; Ellram and Carr, 1994). The ability of purchasing to influence strategic planning has increased in a number of firms due to the rapidly changing competitive environment (Carr and Pearson, 2002; Spekman et al., 1994; Carter and Narasimhan, 1996), and evidence reveals that purchasing is increasingly seen as a strategic weapon to establish cooperative supplier relationships to enhance a firm's competitive stance (Carr and Smeltzer, 1999). Thus, contemporary purchasing is now best recognized as a fundamental unit of SCM (Gadde and Hakansson, 1994; Fung, 1999), and the theoretical construct of strategic purchasing is conceptualized by its proactive as well as long-term focus, its contributions to the firm's success, and strategically managed supplier relationships (Reck and Long, 1988; Carter and Narasimhan, 1993; Van Weele and Rozemeijer, 1996; Carr and Smeltzer, 1997, 1999).

2.5. Information technology

More than ever before, today's information technology is permeating the supply chain at every point, transforming the way exchange-related activities are performed and the nature of the linkages between them (Palmer and Griffith, 1998). A more recent perspective on linkages within the supply chain considers the role of inter-organizational systems, which are sophisticated information systems connecting separate organizations (Kumar and van Dissel, 1996). The strength of inter-organizational systems has been particularly crucial with respect to enabling the process transformation needed to create effective networks (Holland et al., 1994; Venkatraman, 1994; Holland, 1995; Teng et al., 1996; Kumar and van Dissel, 1996; Greis and Kasarda, 1997; Christiaanse and Kumar, 2000). Information technology also enhances supply chain efficiency by providing real-time information regarding product availability, inventory level, shipment status, and production requirements (Radstaak and Ketelaar, 1998). It has a vast potential to facilitate collaborative planning among supply chain partners by sharing information on demand forecasts and production schedules that dictate supply chain activities (Karoway, 1997). In particular, the goal of these systems is to replace inventory with perfect information. Thus, the indicators of this construct are conceptualized to denote the presence of electronic transactions and communication in various forms between the supply chain partners (Greis and Kasarda, 1997; Carr and Pearson, 1999).

2.6. Supply network structure

Traditionally, structure has been studied within a single firm or organization. In the context of SCM, the structure refers to a group of firms: a firm plus its suppliers and customers. Therefore, the topics of interest are the task, authority, and coordination mechanisms across distinct firms or organizational units that enhance supply chain performance. Williamson (1985) characterizes two extremes of governance forms: perfectly competitive markets and vertically integrated hierarchies. An intermediate form of governance is the network. A network structure is a difficult concept to define precisely, although the idea is relatively easy to grasp intuitively. Network firms are characterized by strong linkages between supply chain members with low levels of vertical integration. In addition, the lack of influence or power, personified in terms of interdependence, is also seen as a key determinant of effective supply network structure (Thorelli, 1986). Recently, there has been a move away from what might be termed power-based relationships in which there is some hierarchical dependence, towards more of a network model in which there is a sense of mutual development within a partnership (Bessant, 1990). While studies in organizational structure in general have not been lacking, research addressing the network structure conducive to supply chain performance has been very limited. It is encouraging to note that several recent studies have just set the groundwork for further research in this area (e.g., Dyer and Nobeoka, 2000; Harland and Knight, 2001). In line with existing research, this study characterizes supply network structure to emphasize non-power based relationships and inter-firm coordination as well as the informal social systems that are linked through a network of relations (Miles and Snow, 1986; Snow et al., 1992; Alter and Hage, 1993; Jones et al., 1997; Stock et al., 1998, 2000; Harland et al., 1999; Lambert and Cooper, 2000; Croom, 2001).

2.7. Managing buyer–supplier relationships

2.7.1. Supplier base reduction

In the past, firms commonly contracted with a large number of suppliers. Recently, a significant shift has occurred from the traditional adversarial buyer–seller relationships to the use of a limited number of qualified suppliers (Burt, 1989; Helper, 1991). Many firms are reducing the number of primary suppliers and allocating a majority of the purchased material to a single source (Manoocheri, 1984; Hahn et al., 1986; Pilling and Zhang, 1992; Kekre et al., 1995). This action provides multiple benefits including: (1) fewer suppliers to contact in case of orders given on short notice, (2) reduced inventory management costs (Trevelen, 1987), (3) volume consolidation and quantity discounts, (4) increased economies of scale based on order volume and the learning curve effect (Hahn et al., 1986), (5) reduced lead times due to dedicated capacity and work-in-process inventory from the suppliers, (6) reduced logistical costs (Bozarth et al., 1998), (7) coordinated replenishment (Russell and Krajewski, 1992), (8) an improved buyer–supplier product design relationship (De Toni and Nassimbeni, 1999), (9) improved trust due to communication, (10) improved performance (Shin et al., 2000), and (11) better customer service and market penetration (St. John and Heriot, 1993). This study follows prior research in characterizing supplier base reduction as a required element of contemporary supply chain management. The construct of supply base reduction includes indicators measuring the domain of reduced numbers of suppliers, contractual agreements and supplier retention policies utilized by the buying firm (Handfield, 1993; Kekre et al., 1995; Bozarth et al., 1998; Shin et al., 2000).

2.7.2. Long-term relationships

Supplier contracts have increasingly become long-term, and more and more suppliers must provide customers with information regarding their processes, quality performance, and even cost structure (Helper, 1991; Helper and Sako, 1995). Through close relationships, supply chain partners are more willing to (1) share risks and reward and (2) maintain the relationship over a longer period of time (Landeros and Monczka, 1989; Cooper and Ellram, 1993; Stuart, 1993). Hahn et al. (1983) provided useful insights to compare the potential costs associated with different sourcing strategies; they suggested that companies would gain benefits by placing a larger volume of business with fewer suppliers using long-term contracts. De Toni and Nassimbeni (1999) also found that a long-term perspective between the buyer and supplier increases the intensity of buyer–supplier coordination. Carr and Pearson (1999) discovered that strategically managed long-term relationships with key suppliers have a positive impact on a firm’s supplier performance. Moreover, through a long-term relationship, the supplier will become part of a well-managed chain and will have a lasting effect on the competitiveness of the entire supply chain (Choi and Hartley, 1996; Kotabe et al., 2003). Following the suggestions of existing research, the theoretical construct is operationalized to involve the initiatives taken by the buying firm to encourage long-term relationships with their suppliers (Krause and Ellram, 1997; Shin et al., 2000).

2.7.3. Communication

Extant research has demonstrated the necessity of two-way interorganizational communication for successful supplier relationship (Lascelles and Dale, 1989; Ansari and Modarress, 1990; Hahn et al., 1990; Newman and Rhee, 1990; Galt and Dale, 1991; Krause, 1999). Effective inter-organizational communication can be characterized as frequent, genuine, and involving personal contacts between buying and selling personnel. In order to jointly find solutions to material problems and design issues, buyers and suppliers must commit a greater amount of information and be willing to share sensitive design information (Giunipero, 1990; Carr and Pearson, 1999). Carter and Miller (1989) found that when communication occurs among other functions between the buyer and supplier firms in addition to the purchasing-sales interface, the supplier's quality performance is superior to that experienced when only the buying firm's purchasing department and supplier's sales department act as the inter-firm information conduit. In their case study, Newman and Rhee (1990) found that many supplier product problems were due to poor communication. Lascelles and Dale (1989) also noted that poor communication was a fundamental weakness in the interface between a buying firm and its supplier, and that this undermines the buying firm's efforts to achieve increased levels of supplier performance. Therefore, this theoretical construct is conceptualized to involve two-way communication and interaction with suppliers (Hahn et al., 1990; Morgan and Zimmerman, 1990; Krause and Ellram, 1997; Carr and Pearson, 1999; Carr and Smeltzer, 1999; Krause, 1999).

2.7.4. Cross-functional teams

Managing long-term relationships with customers using cross-functional teams is becoming a common practice in supply chains (Smith and Barclay, 1993; Moon and Armstrong, 1994; Deeter-Schmelz and Ramsey, 1995; Narus and Anderson, 1995; Helfert and Vith, 1999). In particular, cross-functional teams have been identified as important contributors to the success of such efforts as supplier selection and product design (Burt, 1989). Expertise is required from various functions within and outside a firm in order to address the wide range of product and process related problems (Hines, 1994; Narus and Anderson, 1995; Krause and Ellram, 1997; Helfert and Gemunden, 1998). Cross-functional teams dedicated for strategic purposes have been organized either around the material being purchased or according to the supplier's needs so team members can interact with their supplier counterparts (Hahn et al., 1990). This construct is operationalized to define the efforts taken to encourage as well as to use such supplier-involved teams (Hahn et al., 1990; Ellram and Pearson, 1993; Krause and Ellram, 1997; Santos, 2000).

2.7.5. Supplier involvement

A considerable amount has been written documenting the integration of suppliers in the new product development process (Burt and Soukup, 1985; Clark and Fujimoto, 1991; Helper, 1991; Hakansson and Eriksson, 1993; Lamming, 1993; Hines, 1994; Swink, 1999; Shin et al., 2000). The involvement may range from giving minor design suggestions to being responsible for the complete development, design and engineering of a specific part of assembly (Wynstra and ten Pierick, 2000). This practice can be attributed to the fact that suppliers account for approximately 30% of quality problems and 80% of product lead-time problems (Burton, 1988). Extensive research has documented the benefits of integrating suppliers in the new product development process as well as business and strategic planning (e.g., Primo and Amundson, 2002; Ragatz et al., 1997, 2002). Therefore, this theoretical construct is based on the involvement of the suppliers in crucial project and planning processes (Ragatz et al., 1997; Swink, 1999; Shin et al., 2000; Croom, 2001).

2.8. Logistics integration

Logistics provides industrial firms with time and space utilities (Caputo and Mininno, 1998). A more recent interpretation calls for logistics to guarantee that the necessary quantity of goods is in the right place at the right time (La Londe, 1983). The reduction of organizational slack, of which inventory is a typical example, requires an intensive and closely co-ordinated exchange of information between the supply chain partners (Caputo, 1996; Vollman et al., 1997). The current trend of using strategic partnerships and cooperative agreements among firms forces the logistics integration to extend outside the boundaries of the individual firm (Langley and Holcomb, 1992). It reflects an extension of the manufacturing enterprise to encompass the entire supply chain, not just an individual company, as the competitive unit (Greis and Kasarda, 1997). Higher levels of integration are characterized by increased logistics-related communication, greater coordination of the firm's logistics activities with those of its suppliers and customers, and more blurred organizational distinctions between the logistics activities of the firm and those of its suppliers and customers (Stock et al., 2000). Prior research has indicated that collaboration and logistics integration need to be achieved across enterprise boundaries, linking external suppliers, carrier partners, and customers. Grounded on earlier research, the theoretical construct of logistic integration is derived to include the seamless integration of the logistics function of the various supply chain partners (Stock et al., 1998, 2000).

2.9. Supply chain performance measurement

2.9.1. Supplier performance

Suppliers play a more direct role in an organization's quality performance than is often recognized (Lascelles and Dale, 1989). Poor quality of incoming parts adds significantly to buyer's cost in terms of inspection, rework and returns, purchasing, and overproduction. Therefore, quality-oriented organizations maintain a few reliable, competent, and cooperative suppliers on a long-term basis (Garvin, 1987; Giunipero and Brewer, 1993). The supplier quality management strategies, however, must result in good supplier performance in terms of reliability, competence, and cooperation (Ahire et al., 1996). This performance, in turn, affects the final product quality. Thus, supplier quality, flexibility, delivery, and cost performance are intermediate outcomes of the implementation of an appropriate supply chain strategy. In this study, the supplier performance construct is measured in terms of quality, cost, flexibility, delivery, and prompt response. The indicators for this construct are integrated from prior research (e.g., Ahire et al., 1996; Tan et al., 1998, 1999; Jayaram et al., 1999; Kathuria, 2000; Shin et al., 2000).

2.9.2. Buyer performance

Financial performance measures are more likely to reflect the assessment of a firm by factors outside of the firm's boundaries. These measures would include conventional indicators of business performance such as market share, return on investment, present value of the firm, firm's net income, and after-sales profit. Operational performance measures, on the other hand, provide a relatively direct indication of the effects of the relationship between the various supply chain constructs. Many researchers have recently considered different aspects of time-based performance in various stages of the overall value delivery cycle and proposed several measures to evaluate them (Jayaram et al., 1999). The key dimensions of time-based performance include delivery speed (Handfield and Pannesi, 1992), new product development time (Vickery et al., 1995), delivery reliability/dependability (Roth and Miller, 1990; Handfield, 1995), new product introduction (Safizadeh et al., 1996) and manufacturing lead-time (Handfield and Pannesi, 1995). In addition, customer responsiveness has also been recognized in the agility literature as a key aspect of time-based performance (Hendrick, 1994). Keeping the various limitations in mind, the buyer performance in this study is measured using indicators of operational performance in addition to financial indicators such as return on investment, profit, present value, and net income (Vickery et al., 1995; Beamon, 1999; Jayaram et al., 1999; Neely, 1999; Kathuria, 2000; Medori and Steeple, 2000).

3. Research design

3.1. Unit of analysis

Supplier management initiatives and relationships form the core of supply chain management. These initiatives focus on the relationship between the buyer and the supplier firms, hence, the dyadic relationship. Although the theoretical constructs identified in this study were mainly related to the buying firm, they reflect the strategic initiatives taken by these firms and the nature of the relationship they maintain with their suppliers. Thus, while the theoretical constructs revolve around the buying firm, their conceptualization ultimately studies the dyadic relationship. The unit of analysis in this study, therefore, is the dyadic relationship between the buyer and supplier. Since the departments of purchasing, materials management, and supply management are some of the most important links in this dyadic relationship, and the constructs spanned relationships as well as the firm's strategic initiatives, high-ranking professionals from these departments were found to be the most appropriate respondents. The approach of surveying the buying firms' top purchasing and supply management executives to study the buyer–supplier relationship has been widely practiced in the field of operations management (Bozarth et al., 1998; Carr and Pearson, 1999; Carter et al., 1996; Hartley et al., 1997; Krause, 1999; Shin et al., 2000; Tan et al., 2002).

3.2. Data collection

A four-page questionnaire was used to measure the theoretical constructs of supply chain management. A cross-sectional mail survey in the United States was utilized for data collection. The target sample frame consisted of members of the Institute for Supply Management (ISM) drawn from firms covered under the two-digit SIC codes between 34 and 39. The title of the specific respondent being sought was typically vice president of purchasing, materials management, and supply chain management or director/manager of purchasing, material management. A seven-point Likert scale with end points of "strongly disagree" and "strongly agree" was used to measure the items. The buyer and supplier performance were measured using seven-point Likert scale with end points of "decreased significantly" and "increased significantly". In an effort to increase the response rate, a modified version of Dillman's total design method was followed (Dillman, 1978). All mailings, including a cover letter, the survey, and a postage-paid return envelope, were sent via first-class mail. Two weeks after the initial mailing, reminder postcards were sent to all potential respondents. For those who did not respond, a second mailing of surveys, cover letters, and postage-paid return envelopes were mailed approximately 28 days after the initial mailing. Of the 1000 surveys mailed, 46 were returned due to address discrepancies. From the resulting sample size of 954, 232 responses were received, resulting in a response rate of 24.3%. A total of 11 were discarded due to incomplete information, resulting in an effective response rate of 23.2% (221/954). The final sample included 35 presidents/vice presidents (16%), 138 directors (62%), 33 purchasing managers (15%), and 15 others (7%). The respondents worked primarily for medium and large firms with nearly 36% working for firms employing more than 1000 employees. Nearly 60% of the firms had a gross income of greater than US$ 100 million. With respect to the annual sales volume, the respondents were evenly distributed among various groups. The respondents were also distributed evenly among the six SIC codes selected. Respondent profile and company profile are presented in Tables 1 and 2.

Table 1
Respondent profile

Title	Count	Percent
President/vice president	35	15.8
Supply chain management	8	
Materials management	8	
Purchasing	17	
Director	138	62.5
Purchasing	85	
Procurement	9	
Materials management	24	
Supply management	17	
Operations	3	
Manager	33	14.9
Purchasing	29	
Supplier development	3	
Operations	1	
Others	15	6.8
Purchasing supervisors	10	
Purchasing agents	3	
Senior buyers	2	

Table 2
Company profile

Number of employees	Count	Percent
Less than 25	9	4.1
25–100	29	13.1
101–250	29	13.1
251–500	38	17.2
501–1000	34	15.4
More than 1000	80	36.2
No response	2	0.9
Annual sales volume (in millions)		
Less than $1	4	1.8
$1–$49	56	25.3
$50–$99	28	12.7
$100–$499	62	28.1
Over $500	66	29.9
No response	5	2.3

3.3. Non-response bias

Non-response bias is the difference between the answers of respondents and non-respondents (Lambert and Harrington, 1990). In this study, non-response bias was assessed using two approaches. As a convention, the responses of early and late waves of returned surveys were compared to provide support of non-response bias (Krause et al., 2001; Narasimhan and Das, 2001; Stanley and Wisner, 2001; Lambert and Harrington, 1990; Armstrong and Overton, 1977). Along with the 10 demographic variables, 30 other randomly selected variables were also included in this analysis. The final sample was spilt into two, depending on the dates they were received. The early wave group consisted of 123 responses while the late wave group consisted of 98 responses. The *t*-tests performed on the responses of these two groups yielded no statistically significant differences (at 99% confidence interval). In addition, we further randomly selected 250 companies from the list that did not respond and collected the size information (i.e., number of employees as well as sales volume). This information was combined with the responding firms to represent the population mean value. The sample and the population means of demographic variables were compared for any significant difference. The *t*-tests performed yielded no statistically significant differences (at 99% confidence interval) between the sample and population. These results suggest that non-response does not appear to be a problem.

4. Measurement development and assessment

4.1. Procedure

The instrument development process illustrated in Fig. 3 was used to develop an instrument that satisfies the requirements of reliability, validity and unidimensionality. The three-stage continuous improvement cycle, which lies at the heart of the instrument development process, employs the confirmatory factor analysis that is more applicable for assessing the construct validity and unidimensionality of an instrument (Ahire et al., 1996; O'Leary-Kelly and Vokurka, 1998). Prior to data collection, the content validity of the instrument was established by grounding it strongly in existing literature and conducting pre-tests. In the first stage of the instrument development process, a Cronbach's alpha value was generated for each construct. The three-step approach presented by Flynn et al. (1994) was adopted in selecting constructs after the calculation of Cronbach's alpha. First, the constructs were accepted if the Cronbach's alpha value was greater than 0.7. Second, the constructs with an acceptable Cronbach alpha of at least 0.6 were further evaluated for the possibility of improvement. Items that contributed least to the overall internal consistency were the first to be considered for exclusion. The item inter-correlation matrix was utilized in determining the items that contributed the least and thus were the best candidates for deletion. The items that negatively correlated to other items within a scale were first discarded. Also, items with a correlation value below 0.10 were discarded. The cut-off value of 0.30 as given by Flynn et al. (1994) was not used to delete the items, but to mark them for possible deletion. Third, a similar elimination procedure was performed on the constructs that failed to achieve the minimum alpha value of 0.60. If a construct still failed to achieve the target value of Cronbach alpha, it would have been discarded. Since all the constructs achieved the target value, the analysis moved on the next stage of instrument development.

The second stage of the development process involved exploratory factor analysis (EFA) using principal component analysis. The commonly recommended method of varimax rotation with Kaiser normalization was used to clarify the factors (Loehlin, 1998). Since the number of constructs was determined prior to the analysis, the exact number of factors to be extracted was provided in this analysis. Indicator items were discarded after comparing their loading on the construct they were intended to measure to their loading on other scales. Furthermore, nuisance items, those that did not load on the factor they intended to measure, but on factors they did not intend to measure, were deleted from consideration. The final stage involved confirmatory factor analysis (CFA) in evaluating construct validity and unidimensionality. Due to the existence of a large number of indicators and constructs, as well as the limitation on sample size, four different LISREL measurement models were evaluated (Atuahene-Gima and Evangelista, 2000; Moorman, 1995). In this stage, indicator items

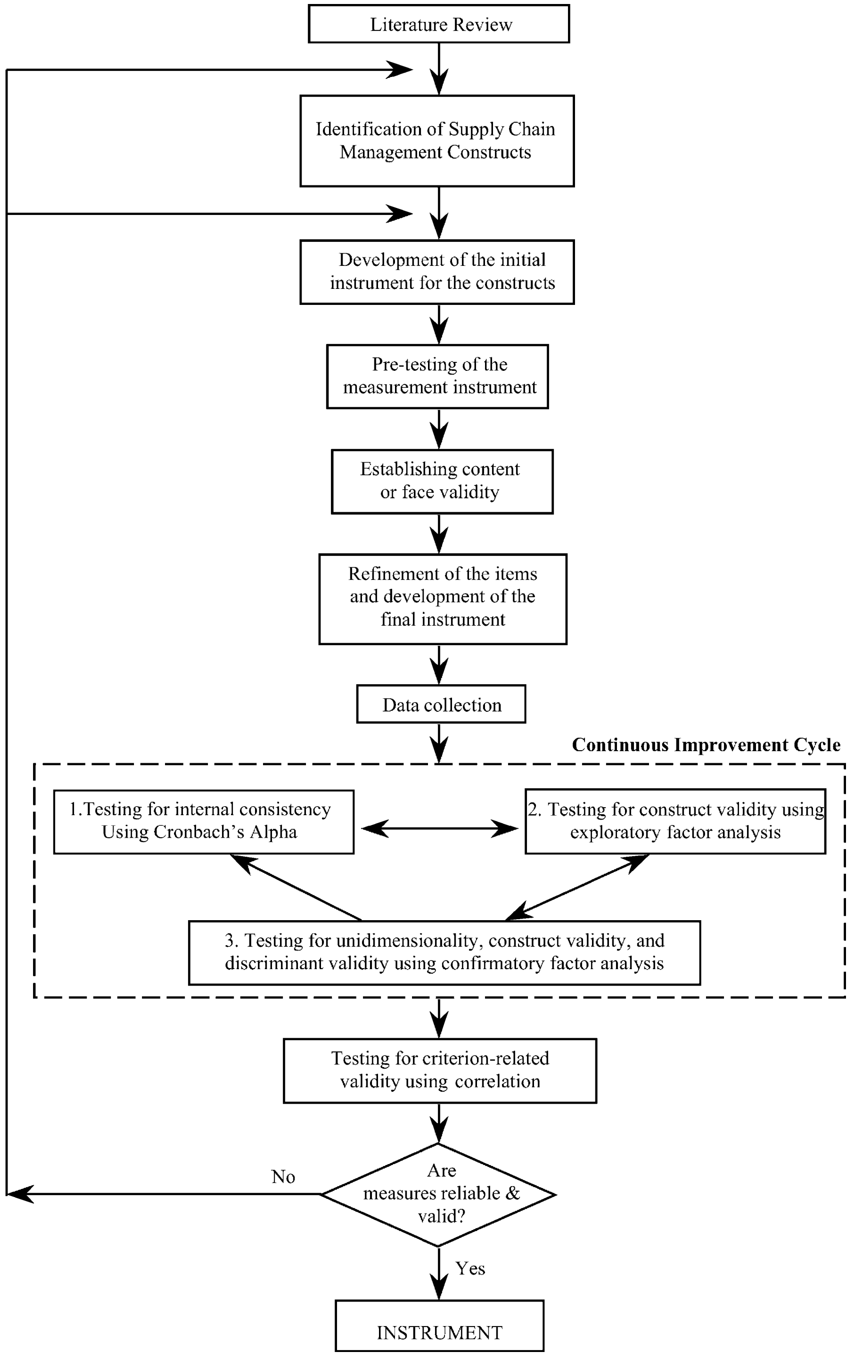

Fig. 3. The instrument development process.

were eliminated from further consideration if their proportion of variance (R^2) value was less than 0.30. Five different goodness-of-fit indices were used to evaluate the tenability of the models. The three-stage continuous improvement cycle was reiterated until the theoretical constructs exhibited acceptable levels of reliability, validity, and unidimensionality. The final measurement instrument is presented in Appendix B. A more detailed explanation and the results of the various analyses are presented in the following sections.

4.2. Reliability analysis

Reliability was operationalized using the internal consistency method that is estimated using Cronbach's alpha (Cronbach, 1951; Nunnally, 1978; Hull and Nie, 1981). Typically, reliability coefficients of 0.70 or higher are considered adequate (Cronbach, 1951; Nunnally, 1978). Nunnally (1978) further states that permissible alpha values can be slightly lower (0.60) for newer scales. The constructs developed in this study are new even though they are strongly grounded in the literature. Therefore, an alpha value of 0.60 was considered as the cut-off value. As can be seen from Appendix B, Cronbach's alpha values of the factors were well above the cut-off value and ranged from 0.65 to 0.95 with only one value below 0.70. These results suggest that the theoretical constructs exhibit good psychometric properties.

4.3. Content validity

The content validity of an instrument is the extent to which it provides adequate coverage for the construct domain or essence of the domain being measured (Churchill, 1979). The determination of content validity is not numerical, but subjective and judgmental (Emory, 1980). Prior to data collection, the content validity of the instrument was established by grounding it in existing literature including over 400 articles. Pre-testing the measurement instrument before the collection of data further validated it. Researchers as well as purchasing executives affiliated with ISM were involved in the pre-testing process. These experts were asked to review the questionnaire for structure, readability, ambiguity, and completeness (Dillman, 1978). The final survey instrument incorporated minor changes to remove a few ambiguities that were discovered during this validation process. These tests indicated that the resulting measurement instrument represented the content of the supply chain management factors.

4.4. Unidimensionality

Assessing unidimensionality means determining whether or not a set of indicators reflect one, as opposed to more than one, underlying factor (Gerbing and Anderson, 1988; Droge, 1997). There are two implicit conditions for establishing unidimensionality. First, an empirical item must be significantly associated with the empirical representation of a construct and, second, it must be associated with one and only one construct (Anderson and Gerbing, 1982; Phillips and Bagozzi, 1986; Hair et al., 1995). A measure must satisfy both of these conditions in order to be considered unidimensional. In this study, unidimensionality was established using CFA. Due to the existence of a large number of indicators and constructs as well as the limitation on sample size, four different LISREL measurement models were evaluated (Atuahene-Gima and Evangelista, 2000; Moorman, 1995). The environmental uncertainty measurement model includes factors of demand, supply, and technology uncertainties, while the driving forces measurement model contains factors of customer focus, top management support, competitive priorities, strategic purchasing, and information technology. The supply chain measurement model includes supply network structure, long-term relationship, supply base reduction, communication, cross-functional teams, supplier involvement, and logistics integration. Finally, the supply chain performance model includes supplier operational performance, buyer operational performance, and buyer financial performance. Unidimensionality was established by assessing the overall model fit of these models. Appendix B presents the results of the assessment of unidimensionality. As recommended by researchers, multiple fit criteria were utilized to assess the tenability of the measurement models (Bollen and Long, 1993; Tanaka, 1993). An indication of acceptable fit is the ratio of the chi-square statistic to the degrees of freedom. More recent research suggests the use of ratios of less than two as an indication of good fit (Koufteros, 1999). The other measures of model fit used in this study include adjusted goodness of fit [AGFI] (Joreskog and Sorbom, 1999), root mean square residual [RMR] (Joreskog and Sorbom, 1999), the Bentler and Bonnet non-normed fit index [NNFI] (Bentler and Bonett, 1980), and the Bentler comparative fit index [CFI] (Bentler, 1986). Adequate fit is suggested for models exhibiting AGFI indices greater than 0.80 and models exhibiting NNFI and CFI indices greater than 0.90. Though values for RMR of less than 0.05 are generally considered to be very good, values between 0.05 and 0.10 are acceptable by many investigators (e.g., Rupp and Segal, 1989). It can be seen from Appendix B that all the measurement models have acceptable fit indices, and consequently signify the unidimensionality of the constructs. Moreover, the convergent and discriminant validities established in the following section, further solidifies the extent of unidimensionality of the constructs.

4.5. Construct validity

Construct validity is the extent to which the items in a scale measure the abstract or theoretical construct (Carmines and Zeller, 1979; Churchill, 1987). Testing of construct validity concentrates not only on finding out whether or not an item loads significantly on the factor it is measuring—convergent—but also on ensuring that it measures no other factors—discriminant (Campbell and Fiske, 1959).

Convergent validity measures the similarity or convergence between the individual items measuring the same construct. In this study, convergent validity is assessed using both EFA and CFA. Due to existence of many constructs as well as the limitation on sample size, four different LISREL measurement models were evaluated (Atuahene-Gima and Evangelista, 2000; Moorman, 1995). In EFA, a construct is considered to have convergent validity if its eigen value exceeds 1.0 (Hair et al., 1995). In addition, all the factor loadings must exceed the minimum value of 0.30. Appendix B presents the final factor loading of the retained items on their underlying factors. It can be seen that all the loadings are quite high and their eigen values exceed the minimum criterion. In CFA, convergent validity can be assessed by testing whether or not each individual item's coefficient is greater than twice its standard error (Anderson and Gerbing, 1988). Bollen (1989) states that the larger the *t*-values or the relationship, the stronger the evidence that the individual items represent the underlying factors. Furthermore, the proportion of variance (R^2) in the observed variables, accounted for by the theoretical constructs influencing them, can be used to estimate the reliability of an indicator. In previous studies, R^2 values above 0.30 were considered acceptable (e.g., Carr and Pearson, 1999). Examination of the above conditions in Appendix B indicates that all indicators are significantly related to their underlying theoretical constructs.

Discriminant validity measures the extent to which the individual items of a construct are unique and do not measure any other constructs. In this study, discriminant validity is established using CFA. Models were constructed for all possible pairs of latent constructs. These models were run on each selected pair, (1) allowing for correlation between the two constructs, and (2) fixing the correlation between the constructs at 1.0. A significant difference in chi-square values for the fixed and free solutions indicates the distinctiveness of the two constructs (Bagozzi and Phillips, 1982; Bagozzi et al., 1991). The chi-square difference was tested for statistical significance at $P < 0.001$ confidence level. This approach of establishing discriminant validity has been reported by numerous research articles in the field of operations management (e.g., Carr and Pearson, 1999; Koufteros, 1999; Krause, 1999; Krause et al., 2001; Nahm et al., 2003). For the 15 constructs excluding the supply chain performance factors, a total of 105 different discriminant validity checks were conducted. As can be seen in Table 3, all the differences between the fixed and free solutions in chi-square are significant. This result provides a strong evidence of discriminant validity among the theoretical constructs.

4.6. Criterion-related validity

Criterion-related validity is a measure of how well the scales representing various constructs, included in Appendix B, represent the measures of performance. To establish criterion-related validity of the various constructs, the scales were correlated with buyer's operational performance measure. Table 4 presents the buyer performance indicators that were included in the outcome performance measure used for the analysis. Pearson's correlation coefficient was used to test the relationships between the constructs and the outcome variable. Table 5 presents the correlations and their

Table 3
Assessment of discriminant validity: chi-square differences between fixed and free models

Factors	SU	DU	TU	CF	CP	SP	TM	IT	SS	LR	SR	CO	CT	SI	LI
Supply uncertainty (SU)	–														
Demand uncertainty (DU)	135.19	–													
Technology uncertainty (TU)	164.66	266.88	–												
Customer focus (CF)	140.46	259.13	372.35	–											
Competitive priorities (CP)	142.07	272.85	399.87	490.92	–										
Strategic purchasing (SP)	136.33	502.51	389.76	374.14	494.24	–									
Top management support (TM)	139.38	269.91	382.29	770.59	521.14	112.56	–								
Information technology (IT)	135.63	269.14	370.07	642.89	524.03	440.99	676.37	–							
Supply network structure (SS)	138.17	270.43	384.84	268.35	329.96	314.79	315.18	366.83	–						
Long-term relationship (LR)	135.43	267.06	380.71	402.00	445.94	432.38	420.74	466.12	208.39	–					
Supply base reduction (SR)	50.31	58.92	56.83	51.78	48.09	54.85	50.18	50.45	41.60	41.61	–				
Communication (CO)	136.52	265.75	373.79	722.30	483.17	459.15	619.30	540.66	253.99	234.57	32.63	–			
Cross-functional teams (CT)	135.12	264.00	358.28	739.48	534.15	380.63	869.61	472.69	347.91	429.65	47.08	460.75	–		
Supplier involvement (SI)	142.78	266.32	363.03	442.89	513.34	380.59	389.86	420.35	332.02	444.27	49.86	307.69	284.02	–	
Logistics integration (LI)	151.57	264.26	377.61	808.96	514.61	380.66	1270.17	535.06	345.69	464.63	52.75	633.25	832.42	396.08	–

All chi-square differences were significant at the 0.001 level (for 1 d.f.).

Table 4
Outcome measure for criterion-related validity

Buyer operational performance ($\alpha = 0.95$)	
Flexibility	
BP5	Volume flexibility
Delivery	
BP6	Delivery speed
BP7	Delivery reliability/dependability
Quality	
BP8	Product conformance to specifications
Cost	
BP9	Cost
Customer responsiveness	
BP10	Rapid confirmation of customer orders
BP11	Rapid handling of customer complaints
Customer satisfaction	
BP12	Customer satisfaction

statistical significance at $P < 0.01$. It can be seen that none of the three environmental uncertainties significantly correlated to the outcome variable. Researchers have noted that when increased uncertainty and a lack of better alternatives are experienced, organizations in the value chain are likely to engage in collective action in order to stabilize their environment (Pfeffer and Salancik, 1978; Ouchi, 1980). Therefore, it appears that the actions taken by the firms may eventually attenuate the effects that uncertainties could have on performance. All other correlations were significant at $P < 0.01$ level. Based on the results of the correlation analysis, we conclude that the theoretical constructs developed have an acceptable criterion-related validity.

Table 5
Assessment of criterion-related validity: Pearson's correlation coefficient

Factors	Buyer operational performance
Supply uncertainty	0.08
Demand uncertainty	0.04
Technology uncertainty	0.02
Customer focus	0.28*
Competitive priorities	0.21*
Strategic purchasing	0.22*
Top management support	0.25*
Information technology	0.23*
Supply network structure	0.25*
Long-term relationship	0.25*
Supply base reduction	0.19*
Communication	0.28*
Cross-functional teams	0.20*
Supplier involvement	0.28*
Logistics integration	0.26*

* Significant at $P < 0.01$ level.

5. Discussion and limitations

This study intends to identify and validate key constructs underlying supply chain management research. The constructs were identified based on a thorough review of literature across diverse disciplines. The result of the iterative instrument development and purification process is a set of reliable, valid, and unidimensional constructs. During the purification process, 20 items were deleted in order to improve the reliability and validity of their underlying theoretical constructs. Though one or two indicators were removed from the original constructs of supply uncertainty, demand uncertainty, customer focus, competitive priorities, supply network structure, long-term relationships, communication, cross-functional teams, and supplier involvement, the underlying theoretical domain of these constructs was not significantly affected. The construct of top management support was characterized in terms of time and resources contributed by the top management to support strategic purchasing, supplier relationship development and the adoption of advanced information technology. The indicator related to the adoption of advanced information technology was deleted from the final construct. Therefore, this construct at its present state cannot be used to study the impact of top management support on the adoption of advanced information systems. Nevertheless, this construct still represents the key theoretical domain in top management's support for strategic purchasing and supplier relationship development practices. Strategic purchasing includes indicators that denote the purchasing function's proactive and long-term focus, its contributions to the firm's success, and strategically managed supplier relationship. Two indicators relating to the long-term focus of the purchasing function were deleted from the final instrument. Therefore, the final construct did not include the aspect of long-term focus. Future studies should extend this construct by including appropriate measures on this aspect. The construct of supply base reduction was operationalized to include the domain of reduced numbers of suppliers as well as the contractual agreements and supplier retention policies utilized by the buying firm. The final construct, however, included only the indicators representing a reduced number of suppliers. We encourage future research to focus on developing a more concrete measure for supply base reduction spanning the various intriguing facets of this theoretical construct. In summary, all the constructs are made up of three or more items except for supply uncertainty and supply base reduction, which include only two indicators. Though these two constructs have decent psychometric properties, future research should be directed to refine them by adding new indicators to ensure that all the dimensions of these two constructs are better represented.

The most crucial problem in defining supply chain phenomenon is in identifying what can be included within the orbit of supply chain management (New, 1996). As defined by The Supply Chain Council (2002), the supply chain encompasses every effort involved in producing and delivering a final product, from the supplier's supplier to the customer's customer. It is clear that the entire domain of this concept is very extensive and cannot be covered in just one study. Though very extensive in nature, the conceptual framework developed herein does not cover every facet of supply chain management. Moreover, measurement instrument development is an ongoing process and the instrument can be strengthened only through a series of further refinement and tests across different populations and settings (Hensley, 1999). Thus, this study could be considered as a first comprehensive step towards the identification of the theoretical domain of SCM. Future research should be directed not only to refining and strengthening the constructs identified in this study, but also to expanding the domain by considering additional factors. A few suggestions are provided on the inclusion of additional factors for future research efforts. As a result of an extensive literature review in the initial phase of this study, relevant factors such as manufacturing uncertainty (Davis, 1993), competitive environment (Hahn et al., 1990; Sutcliffe and Zaheer, 1998), trust and commitment (Kanter, 1994; Spekman and Sawhney, 1995), supplier selection (Choi and Hartley, 1996; Croom, 2001), supplier certification (Carr and Ittner, 1992; Ellram and Siferd, 1998), internal logistics integration (Kahn and Mentzer, 1996; Ballou et al., 2000; Ellinger, 2000), leaness (Naylor et al., 1999; Christopher and Towill, 2000), and agility (Fliedner and Vokurka, 1997; Billington and Amaral, 1999) were also identified. Though these factors are of great interest, they were removed from this study due to the length of the survey instrument and concerns regarding response rate.

As noted earlier, around 20 indicators were deleted from the initial measurement instrument. Though these indicators exhibited acceptable convergent validity, some of them suffered from low levels of discriminant validity. This suggests a possibility of conceptual overlap between the theoretical domains represented by such constructs as supply base reduction, long-term relationships, communication, and cross-functional teams. Future research should refine and strengthen these constructs by adding indicators that will further bolster the discriminant validity between these essential constructs. We would also like to point out the potential drawback of the methodology used for the measurement instrument development. The approach of partial factor analysis (Atuahene-Gima and Evangelista, 2000; Moorman, 1995) was employed due to the extensive coverage of a large number of SCM constructs and a concern for the sample size requirements (Hair et al., 1995). Realizing this limitation, we encourage future studies to collect data from a larger population to further validate or extend the theoretical constructs identified in this study.

Having drawn from a list of ISM members, the results of this research can be generalized to the population of the firms represented by the ISM database. The initial goal of our study was to simultaneously consider a population from the Dun and Bradstreet Million Dollar Database, but it did not happen due to financial and time limitations. Though the final sample in this study spanned a wider range of firms based on demographics such as the number of employees and annual sales, we suggest that future research endeavors attempt to include a mixed population of respondents from multiple sources to extend the generalizability of the results, since the sample firms were limited to manufacturing firms only. Based on our strong inclination that some key constructs were more manufacturing oriented, this segregation of the population increased the validity of the measurement instrument. Nevertheless, it would be interesting to see future research that adds service-oriented constructs to study a sample of service firms. The manufacturing firms included in this study fall under the two-digit SIC codes between 34 and 39. Therefore, the extent to which the results of this study can be generalized is somewhat limited to the population of firms represented by these SIC codes. Future study could include firms under other SIC codes.

Another limitation of this study concerns the collection of supplier-related indicators. Since the unit of analysis in this study is the dyadic relationship between the buyer and supplier, purchasing, material management, supply management, and operations functions were considered to be the best candidates to answer both the customer-side and supplier-side questions posed in this study. Although the complexity of data collection increases when a researcher has to collect data from both the buyer and its supplier, this procedure allows the researcher to validate and cross-check the information from both parties. Future research can also consider gathering data from multiple respondents within each firm to increase the validity of the data.

6. Conclusion

Supply chain management represents one of the most significant paradigm shifts of modern business management by recognizing that individual businesses no longer compete as solely autonomous entities, but rather as supply chains (Lambert and Cooper, 2000). SCM, along with a number of other emerging areas in operations management, is, however, still in its embryonic stage (Handfield and Melnyk, 1998). The scientific development of a coherent supply chain management discipline requires that advances be made in the development of measurement instruments as well as in theoretical models to improve our understanding of supply chain phenomena (Croom et al., 2000), so the research agenda in supply chain management must not be driven by industrial interest alone (New, 1997). Research about supply chain management as a conceptual artifact of the modern world is also essential. Indeed, it is necessary to understand the broader context before robust prescription is possible.

Any scientific research discipline can be viewed in terms of two interrelated streams: substantive and construct validation. While the former reflects the relationships among theoretical constructs inferred through empirically observed relationships, the latter involves the relationships between the results obtained from empirical measures and the theoretical constructs that the measures purport to assess (Schwab, 1980). Since "all theories in science concern statements mainly about constructs rather than about specific, observable variables," (Nunnally, 1978) the process of construct conceptualization and measurement development is at least as important as the examination of substantive relationships (Venkatraman, 1989). While research on various supply chain relationships has been growing, there has not been a comprehensive approach to construct development and measurement. This could be largely attributed to the fact that astronomical efforts are required to undertake the development and validation of constructs and measures of SCM.

Recognizing the interdisciplinary nature of SCM, this study, through successive stages of analysis and refinement, has arrived at an initial set of constructs and operational measures with a strong support of their measurement properties (i.e., reliable, valid, and unidimensional). We hope that researchers will utilize the measurement either directly in their research contexts or as a basis for refinement and extension in the best tradition of cumulative theory building and testing, and to ultimately create a coherent theory of supply chain management.

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Appendix A

	Strategic purchasing	Supply network structure	Buyer–supplier relationships	Logistics integration
Environmental uncertainties	Ouchi, 1980; Pfeffer and Salancik, 1978; Zenger and Hesterly, 1997	Helfat and Teece, 1987; Huber et al., 1975; Huber and Daft, 1987	Manoocheri, 1984; Ouchi, 1980; Pfeffer and Salancik, 1978; St. John and Heriot, 1993; Zenger and Hesterly, 1997	
Competitive priorities	Gadde and Hakansson, 1993; Hakansson and Snehota, 1995; Santos, 2000; Stock et al., 1998			
Customer focus	Chernatony et al., 1992; Doyle, 1994; Hoekstra et al., 1999; Shepetuk, 1991; Takeuchi and Quelch, 1983; Tan et al., 1999			
Top management support	Blenkhorn and Leenders, 1988; Carr and Smeltzer, 1997; Hahn et al., 1990; Hines, 1994; Monczka et al., 1993			
Information technology	McIvor et al., 2000; Min and Galle, 1999; Palmer and Griffith, 1998; Radstaak and Ketelaar, 1998; Shaw, 2000	Christiaanse and Kumar, 2000; Greis and Kasarda, 1997; Holland et al., 1994; Holland, 1995; Palmer and Griffith, 1998; Teng et al., 1996	Grover and Malhotra, 1997; Karoway, 1997; Min and Galle, 1999; Palmer and Griffith, 1998; Radstaak and Ketelaar, 1998	Karoway, 1997; Min and Galle, 1999; Radstaak and Ketelaar, 1998; Webster, 1995
	Supply network structure	**Buyer–supplier relationships**	**Logistics integration**	**Supply chain performance**
Strategic purchasing	Ellram and Carr, 1994; Freeman and Cavinato, 1990; Gadde and Hakansson, 1993	Carr and Pearson, 1999; Carr and Smeltzer, 1999; Cox, 1996; Hahn et al., 1986; Handfield and Bechtel, 2002; Kekre et al., 1995; Keough, 1994; Kraljic, 1983; Manoocheri, 1984; Pilling and Zhang, 1992; Spekman, 1988; Spekman et al., 1995	Ellram and Carr, 1994; Freeman and Cavinato, 1990; Gadde and Hakansson, 1993	Carr and Pearson, 1999; Carr and Pearson, 2002; Narasimhan and Das, 2001; Reck and Long, 1988
Supply network structure		Alter and Hage, 1993; Bessant, 1990; Croom, 2001; Dyer and Nobeoka, 2000; Harland and Knight, 2001; Granovetter, 1992; Stock et al., 2000	Stock et al., 2000	Stock et al., 2000
Buyer–supplier relationships			Caputo, 1996; Choi and Hartley, 1996; Langley and Holcomb, 1992; Russell and Krajewski, 1992; Stock et al., 2000; Vollman et al., 1997	Billington and Amaral, 1999; Bonaccorsi and Lipparini, 1994; Burt, 1989; Burt and Doyle, 1993; Ellram and Pearson, 1993; Handfield and Nichols, 1999; Krause and Ellram, 1997; Krause, 1999; Noordewier et al., 1990; Ragatz et al., 1997
Logistics integration				Ballou et al., 2000; Stock et al., 2000; Vonderembse et al., 1995

Appendix B

Indicator (Cronbach's alpha; eigen value)	Principal component factor loading	Measurement model		
		Standard coefficient	R^2	t-value[c]
Environmental uncertainty measurement model (model fit: $\chi^2 = 34.13$; NC = 1.48; AGFI = 0.93; NNFI = 0.98; CFI = 0.99; RMSR = 0.04)				
Supply uncertainty ($\alpha = 0.88$; eigen value = 2.08)				
The suppliers consistently meet our requirements.	0.90	0.85	0.72	6.45
The suppliers produce materials with consistent quality.	0.88	0.99	0.99	6.70
We have extensive inspection of incoming critical materials from suppliers.[a]				
We have a high rejection rate of incoming critical materials from suppliers.[b]				
Demand uncertainty ($\alpha = 0.84$; eigen value = 2.48)				
Our master production schedule has a high percentage of variation in demand.	0.77	0.69	0.47	11.05
Our demand fluctuates drastically from week to week.	0.90	0.99	0.99	17.90
Our supply requirements vary drastically from week to week.	0.85	0.78	0.61	12.99
We keep weeks of inventory of the critical material to meet the changing demand.[a]				
The volume and/or composition of demand is difficult to predict.[b]				
Technology uncertainty ($\alpha = 0.83$; eigen value = 2.91)				
Our industry is characterized by rapidly changing technology.	0.84	0.76	0.57	12.07
If we don't keep up with changes in technology, it will be difficult for us to remain competitive.	0.73	0.59	0.35	8.75
The rate of process obsolescence is high in our industry.	0.81	0.84	0.70	13.63
The production technology changes frequently and sufficiently.	0.79	0.79	0.63	12.80
Driving forces measurement model (model fit: $\chi^2 = 444.01$; NC = 1.38; AGFI = 0.84; NNFI = 0.96; CFI = 0.96; RMSR = 0.06)				
Customer focus ($\alpha = 0.86$; eigen value = 4.06)				
We anticipate and respond to customers' evolving needs and wants.	0.57	0.61	0.32	8.45
We emphasize the evaluation of formal and informal customer complaints.	0.75	0.68	0.35	8.64

Appendix B (*Continued*)

Indicator (Cronbach's alpha; eigen value)	Principal component factor loading	Measurement model		
		Standard coefficient	R^2	*t*-value[c]
We follow up with customers for quality/service feedback.	0.76	0.80	0.45	10.31
We interact with customers to set reliability, responsiveness, and other standards.	0.78	0.85	0.53	11.38
Satisfying customer needs is the central purpose of our business.	0.67	0.75	0.49	10.92
Customer focus is reflected in our business planning.	0.74	0.90	0.64	13.50
We produce products that satisfy and/or exceed customer expectations.[b]				
Competitive priorities ($\alpha = 0.83$; eigen value = 3.38)				
Our strategy cannot be described as the one to offer products with the lowest price.	0.71	0.85	0.34	9.06
Our strategy is based on quality performance rather than price.	0.85	1.13	0.70	14.50
We place greater emphasis on innovation than price.	0.76	1.13	0.53	11.87
We place greater emphasis on customer service than price.	0.69	0.98	0.54	12.11
Our strategy places importance on delivering products with high performance.	0.65	0.78	0.48	11.07
We emphasize launching new products quickly.[a]				
Strategic purchasing ($\alpha = 0.82$; eigen value = 2.09)				
Purchasing is included in the firm's strategic planning process.	0.78	1.14	0.53	12.03
The purchasing function has a good knowledge of the firm's strategic goals.	0.69	0.99	0.58	12.15
Purchasing performance is measured in terms of its contributions to the firm's success.	0.63	1.12	0.50	11.57
Purchasing professionals' development focuses on elements of the competitive strategy.	0.64	1.16	0.58	12.62
Purchasing department plays an integrative role in the purchasing function.	0.47	0.58	0.32	8.88
Purchasing's focus is on longer term issues that involve risk and uncertainty.[a]				
The purchasing function has a formally written long-range plan.[b]				
Top management support ($\alpha = 0.92$; eigen value = 6.77)				
Top management is supportive of our efforts to improve the purchasing department.	0.69	0.89	0.49	11.74
Top management considers purchasing to be a vital part of our corporate strategy.	0.80	1.06	0.68	14.93

Appendix B (*Continued*)

Indicator (Cronbach's alpha; eigen value)	Principal component factor loading	Measurement model		
		Standard coefficient	R^2	t-value[c]
Purchasing's views are important to most top managers.	0.82	1.24	0.85	17.36
The chief purchasing officer has high visibility within top management.	0.81	1.23	0.67	14.72
Top management emphasizes the purchasing function's strategic role.	0.87	1.30	0.86	17.69
Requests for increased resources are mostly satisfied by top management.	0.53	0.90	0.37	9.34
Top management supports the need for interorganizational information systems.[a]				
Information technology ($\alpha = 0.84$; eigen value = 3.67)				
There are direct computer-to-computer links with key suppliers.	0.72	1.41	0.48	11.42
Interorganizational coordination is achieved using electronic links.	0.72	1.40	0.56	12.14
We use information technology-enabled transaction processing.	0.76	1.50	0.64	13.18
We have electronic mailing capabilities with our key suppliers.	0.56	1.01	0.30	8.43
We use electronic transfer of purchase orders, invoices and/or funds.	0.60	1.47	0.51	10.76
We use advanced information systems to track and/or expedite shipments.	0.74	1.35	0.48	11.33
Supply chain measurement model (model fit: $\chi^2 = 736.01$; NC = 1.94; AGFI = 0.82; NNFI = 0.90; CFI = 0.92; RMSR = 0.08)				
Supply network structure ($\alpha = 0.82$; eigen value = 2.83)				
We have a permeable organizational boundary that facilitates better communication and/or relationship with our key suppliers.	0.59	0.95	0.50	11.21
Our relation with the suppliers is based on interdependence rather than power.	0.72	1.00	0.62	12.97
Our organizational structure can be characterized as a flexible value-adding network.	0.61	0.91	0.50	11.23
Our organizational/supply network structure does not involve power-based relationships.	0.78	1.17	0.52	11.88
The decision making process in our organization is decentralized.[a]				
We have few management levels in our relationship with suppliers.[b]				

Appendix B (*Continued*)

Indicator (Cronbach's alpha; eigen value)	Principal component factor loading	Measurement model		
		Standard coefficient	R^2	t-value[c]
Supply base reduction ($\alpha = 0.65$; eigen value = 1.64)				
We rely on a small number of high quality suppliers.	0.57	0.99	0.50	9.17
We maintain close relationship with a limited pool of suppliers.	0.42	0.79	0.50	9.17
We get multiple price quotes from suppliers before ordering.[a]				
We drop suppliers for price reasons.[a]				
We use hedging contracts in selecting our suppliers.[a]				
Long-term relationship ($\alpha = 0.85$; eigen value = 2.77)				
We expect our relationship with key suppliers to last a long time.	0.77	0.65	0.52	11.83
We work with key suppliers to improve their quality in the long run.	0.55	0.75	0.52	11.79
The suppliers see our relationship as a long-term alliance.	0.71	0.91	0.71	14.79
We view our suppliers as an extension of our company.	0.60	1.17	0.70	14.58
We give a fair profit share to key suppliers.[a]				
The relationship we have with key suppliers is essentially evergreen.[b]				
Communication ($\alpha = 0.86$; eigen value = 3.98)				
We share sensitive information (financial, production, design, research, and/or competition).	0.52	1.03	0.38	9.67
Suppliers are provided with any information that might help them.	0.68	0.93	0.47	11.01
Exchange of information takes place frequently, informally and/or in a timely manner.	0.74	0.99	0.72	15.09
We keep each other informed about events or changes that may affect the other party.	0.67	0.99	0.74	15.48
We have frequent face-to-face planning/communication.	0.56	0.96	0.55	12.46
We exchange performance feedback.[a]				
Cross-functional teams ($\alpha = 0.90$; eigen value = 4.51)				
We collocate employees to facilitate cross-functional integration.	0.52	0.95	0.31	8.65
We coordinate joint planning committees with our suppliers.	0.75	1.35	0.68	14.73
We promote task force teams with our suppliers.	0.84	1.53	0.85	17.69
We share ideas and information with our supplier through cross-functional teams.	0.80	1.52	0.84	17.58

Appendix B (*Continued*)

Indicator (Cronbach's alpha; eigen value)	Principal component factor loading	Measurement model		
		Standard coefficient	R^2	t-value[c]
We use supplier involved ad hoc teams based on our strategic objectives.	0.74	1.25	0.60	13.37
We encourage teamwork between our suppliers and us.[a]				
Supplier involvement ($\alpha = 0.86$; eigen value = 2.23)				
We involve key suppliers in the product design and development stage.	0.63	1.12	0.61	13.17
We have key supplier membership/participation in our project teams.	0.50	1.37	0.62	13.33
Our key suppliers have major influence on the design of new products.	0.64	1.25	0.57	12.47
There is a strong consensus in our firm that supplier involvement is needed in product design/development.	0.64	1.33	0.63	13.41
We involve our key suppliers in business and strategy planning.[a]				
We have joint planning committees/task forces on key issues with key suppliers.[a]				
Logistics integration ($\alpha = 0.92$; eigen value = 4.62)				
Interorganizational logistic activities are closely coordinated.	0.77	1.10	0.58	13.31
Our logistics activities are well integrated with the logistics activities of our suppliers.	0.83	1.32	0.88	17.70
We have a seamless integration of logistics activities with our key suppliers.	0.83	1.27	0.74	15.82
Our logistics integration is characterized by excellent distribution, transportation and/or warehousing facilities.	0.80	1.26	0.71	15.03
The inbound and outbound distribution of goods with our suppliers is well integrated.	0.83	1.21	0.72	15.15
Information and materials flow smoothly between our supplier firms and us.	0.64	0.71	0.34	9.31
Supply chain performance measurement model (model fit: $\chi^2 = 190.44$; NC = 1.57; AGFI = 0.88; NNFI = 0.96; CFI = 0.97; RMSR = 0.06)				
Supplier operational performance ($\alpha = 0.76$; eigen value = 3.25)				
Volume flexibility	0.66	0.58	0.31	7.26
Scheduling flexibility	0.77	0.69	0.34	8.136
On-time delivery	0.79	0.81	0.55	10.86
Delivery reliability/consistency	0.78	0.80	0.58	11.26

Appendix B (*Continued*)

Indicator (Cronbach's alpha; eigen value)	Principal component factor loading	Measurement model		
		Standard coefficient	R^2	*t*-value[c]
Quality	0.49	0.68	0.42	9.52
Cost	0.78	0.26	0.39	2.75
Buyer operational performance ($\alpha = 0.95$; eigen value = 2.41)				
Volume flexibility	0.37	0.60	0.41	9.65
Delivery speed	0.49	0.61	0.33	8.31
Delivery reliability/dependability	0.56	0.65	0.38	7.61
Product conformance to specifications	0.80	0.20	0.39	2.31
Cost	0.38	0.55	0.30	7.90
Rapid confirmation of customer orders	0.78	0.67	0.41	9.61
Rapid handling of customer complaints	0.76	0.64	0.40	9.25
Customer satisfaction	0.61	0.74	0.50	10.95
Buyer financial performance ($\alpha = 0.81$; eigen value = 3.84)				
Return on investment	0.93	1.15	0.94	19.68
Profits as a percent of sales	0.94	1.24	0.96	20.04
Firm's net income before tax	0.93	1.20	0.85	18.03
Present value of the firm	0.83	1.02	0.56	13.02

[a] Items dropped after EFA.
[b] Items dropped after CFA.
[c] All *t*-values are significant at $P < 0.05$ level.

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