DEVELOPMENT AND ANALYSIS OF A SUPPLY CHAIN STRATEGY TAXONOMY

KATHLEEN MCKONE-SWEET AND YOO-TAEK LEE
Babson College

This research derives a numerical taxonomy that classifies manufacturers with similar combinations of supply chain (SC) capabilities into three SC Strategy Groups. This research also explores the relationship between the SC Strategy Groups and contextual factors, competitive priorities and firm performance. There are significant differences among the SC Strategy Groups for the location of the firm, the level of uncertainty, the competitiveness of the market and firm performance. Surprisingly, there is no relationship between the SC Strategy Groups and a firm's competitive priorities, indicating that firms are often not linking their SC strategy to their competitive strategy.

Keywords: *electronic commerce; strategy development; supply chain management; analysis of variance*

INTRODUCTION

A review of supply chain (SC) literature reveals that SC management is increasingly recognized as a critical component of a firm's strategic plan (e.g., Frohlich and Westbrook 2001; Vickery, Jayaram, Droge and Calantone 2003). Numerous studies present different SC strategies for firms in various circumstances (e.g., Fisher 1997; Lee 2002; Christopher, Peck and Towill 2006). Much research focuses on developing typologies that propose "ideal" types of SC strategies, each one presenting a unique combination of organizational attributes (Doty and Glick 1994; Narasimhan, Kim and Tan 2008). However, there has been limited effort in developing a taxonomy of SC strategies that delimits and classifies different strategy groups "a posteriori" through empirical work and in mutually representative groups (Martin-Pena and Diax-Garrido 2008).

There are two primary objectives of this research. The first objective is to derive a numerical taxonomy that classifies manufacturers with similar combinations of SC capabilities into SC Strategy Groups. This research will contribute to the SC management research by providing a taxonomy that complements the existing typologies of SC strategy. Our taxonomy offers a parsimonious description of SC Strategy Groups that provides insights into current SC strategic positions. The second objective of this study is to explore the relationship between the SC Strategy Groups and contextual factors, competitive priorities and performance of group members. The development of a taxonomy of SC Strategy Groups and the comparative analysis of the groups provides important information about the existing state of SC management.

LITERATURE REVIEW

The literature on the configuration approach and the resource-based view (RBV) establishes the theoretical foundation for our research. This review discusses these two theoretical approaches and relates them to our research on SC strategy taxonomy.

Configuration Approach

A configuration approach is widely accepted in the field of strategy and is applied accordingly to a number of operations management studies (Miller and Roth 1994; Boyer, Bozarth and Mcdermott 2000). The conventional econometric research approach statistically isolates the independent effects of each strategic attribute on a firm's performance. However, the configuration approach considers strategic combinations or gestalts as an interrelated bundle (Hambrick 1984; Bozarth and McDermott 1998). The configuration approach is typically divided into the development of typologies and taxonomies. A typology describes ideal types, each of which reflects a particular combination of organizational attributes (Doty and Glick 1994), although no existing firms may fit exactly the suggested ideal type (Venkatraman and Prescott 1990; Bozarth and McDermott 1998). Taxonomies, without defining ideal types, attempt to classify existing organizational phenomena into mutually exclusive and exhaustive groups (Doty and Glick 1994; Miller and Roth 1994; Bozarth and McDermott 1998).

Numerous works focus on developing typologies that specify types of SC strategies that are contingent upon product characteristics (Fisher 1997; Lamming, Johnsen, Zheng and Harland 2000) and supply and demand uncertainty (Lee 2002). Based on conceptual frameworks developed "a priori," these researchers provide a normative suggestion in which performance is a consequence of the congruency between factors: SC strategy, demand characteristics and level of supply uncertainty. More recently, Narasimhan et al. (2008) developed SC strategy typologies based on the degree of supply network dynamics and the degree of focal firm supply network influence and then tested the typologies using a large sample of U.S. firms. Since typologies are often not confirmed empirically (Meyer, Tsui and Hining 1993; Miller 1996), this study made a contribution by validating its proposed typologies through data analysis.

There has been some effort to develop taxonomies in the field of SC study. One such effort is made by Harland, Lamming, Zheng and Johnsen (2001) who develop a taxonomy of supply networks. The taxonomy was initially developed based on a combination of interviews and case studies and was later modified based on a phone survey of 50 firms. Another effort is made by Frohlich and Westbrook (2002) classifying firms based on the degree of integration. Our study differs from Harland et al. (2001) and Narasimhan et al. (2008) in its unit of analysis (manufacturing firms versus supply networks) and from Frohlich and Westbrook (2002) in the number of dimensions used for classification (multidimensional SC capabilities versus a single dimension of integration).

This study makes a contribution to the literature by developing a taxonomy that delimits and classifies different types of firms' SC strategies "a posteriori" by using multiple classification variables supported by a large-scale data analysis of manufacturing firms. Our analysis also provides insight into the characteristics of each SC Strategy Group by examining the context, the priorities and the performance levels of each group within the taxonomy. In addition, since the role of SC management in strategic formulation is dynamic in accordance with ever-changing competitive environments (Frohlich and Dixon 2001), the development of our taxonomy based on more recent data is important to understanding the current state of SC strategy.

The RBV in SC Literature

One of the criticisms of taxonomic study is that classification variables are disconnected from existing theory. As a result, the taxa (strategy groups) are viewed as a result of "data dredging" rather than reflecting actual organizational conditions (Doty and Glick 1994; Ketchen and Shook 1996; Bozarth and McDermott 1998). In this study, the approach of defining SC strategy taxonomy is based on the RBV of the firm, which contends that the resources and nonimitable capabilities of firms are the key sources of sustained competitive advantage (Prahalad and Hamel 1990; Oliver 1997).

The literature on the RBV (Wernerfelt 1984; Barney 1991) identifies conditions and firm-specific factors that underlie the competitive advantage enjoyed by a firm. This perspective views a firm as a bundle of resources and capabilities, with firms differing in their endowments of each. While resources are defined as productive factors that a firm uses to achieve its business objectives, capabilities refer to a firm's ability to "deploy these resources to affect a desired end" (Amit and Shoemaker 1993). Since the "competitive advantage" (Porter 1991) tends to vanish when competitors can readily acquire resources from a factor market, one of the main focuses of the RBV is to determine the firm's capabilities that increase the barriers to imitation by bundling various resources (Dierickx and Cool 1989; Peteraf 1993).

The RBV is widely accepted in the strategic management literature but has only more recently been applied to the study of operations management (e.g., Coates and McDermott 2002; Schroeder, Bates and Junttila 2002). However, it has frequently been suggested that operations strategy content embodies the choice of the set of manufacturing capabilities that becomes the source of competitive advantage (Prahalad and Hamel 1990; Miller and Roth 1994). Hunt and Davis (2008) use the "the resource-advantage research tradition," that combines heterogeneous demand theory with an RBV of the organization, to support the conclusion that purchasing strategy, in particular, and SC management, in general, can lead to a long-term competitive advantage. SC strategy, therefore, can be defined as the choice of a set of capabilities that are developed through a pattern of investments over time and cannot be easily imitated or acquired by trade, nor can good substitutes be found (Dierickx and Cool 1989).

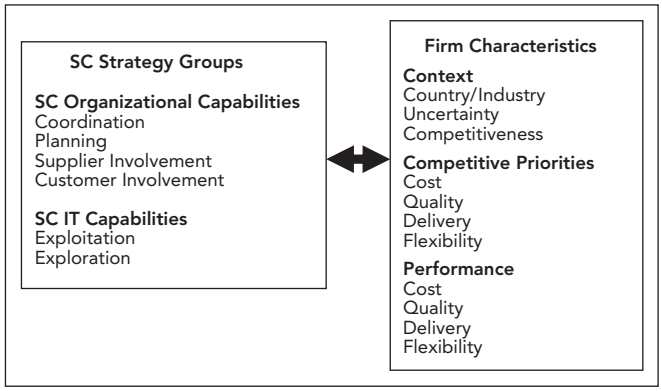
Drawing on the RBV, this study develops an SC strategy taxonomy by using six SC capabilities. These capabilities will be examined in more detail in the next section. The development of an SC strategy taxonomy provides a better understanding of the key SC capabilities that firms bundle together.

CONCEPTUAL FRAMEWORK

In this section, we present our conceptual framework, the variables examined in our research, and our hypotheses. The conceptual framework for our research is shown in Figure 1. Details of the measurement of each variable in the framework will be discussed in our "Research Methodologies" section.

We analyze the SC capabilities and identify a taxonomy of SC Strategy Groups that deploy similar sets or bundles of SC capabilities. Then, we examine the contextual factors and the competitive priorities that are common to a

FIGURE 1
Conceptual Framework



particular SC Strategy Group. This helps to identify conditions under which firms develop specific SC capabilities. We also examine the performance of particular SC Strategy Groups, identifying differences in the perceptual and actual performance of the SC Strategy Groups.

SC Capabilities and SC Strategy Groups

In this study, we consider six SC capabilities, assessing both SC organizational and SC information technology (IT) dimensions. Our choice of capabilities is based on past research on SC management.

The SC research considers the organizational capabilities of integration with internal and external SC partners as a critical component of managing SCs. Narasimhan and Kim (2002) examine outward-focused capabilities (supplier-based integration and customer-based integration) as well as inward-focused capabilities (that enable systemwide integration) when they evaluate the impact of SC integration on diversification and performance. Similarly, Wisner (2003) considers supplier management strategy, customer relationship strategy and SC management strategy when evaluating the impact of SC management on performance. Germain and Karthik (2006) suggest that external integration alone, without internal integration, will limit the level of performance improvement.

We consider two aspects of organizational capabilities for internal integration — coordination and planning. Coordination is an indicator of a firm's ability to integrate across business processes across the organization and planning is an indicator of a firm's ability to integrate their internal planning process with information from other members of the SC. Our conceptualization of intraorganizational coordination relates to Pagell's (2004) definition of internal integration across operations, purchasing and logistics and Swink, Narasinham and Wang's (2007) concept of horizontal integration. Our planning capability captures the need for integrated planning that incorporates information from customers and suppliers. Aviv (2001) and Fisher, Hammond, Obermeyer and Raman (1994) consider methods for improving planning capabilities. We also consider two aspects of organizational capabilities for external integration — customer involvement and supplier involvement. Vickery et al. (2003) consider two categories of integration — supplier partnering and customer relationships. Similarly, Rungtusanatham, Salvador, Forza and Choi (2003) present an SC management framework that includes integration with suppliers and customers. Drawing on this literature, this study conceptualizes the organizational capabilities of SC integration with four SC organizational capabilities, using measures for Coordination, Planning, Supplier Involvement and Customer Involvement.

The importance of developing IT to manage the SC has also been emphasized in the literature. Forrester (1961) and Sterman (1989) emphasize the need to share information to better coordinate efforts in the SC. Research also suggests that the use of IT in managing the SC needs to align with interorganizational and intraorganizational resources such as the structure of an SC (e.g., Lynagh, Murphy, Poist and Grazer 2001), supplier relationships (Barratt and Rosdahl 2002; Skjott-Larsen, Kotzab and Grieger 2003) and SC strategy (Lee 2002). Other research emphasizes that IT is a necessary but not a sufficient capability for creating sustainable competitiveness (Roberts and Mackay 1998; Strader, Lin and Shaw 1999; Barratt and Rosdahl 2002). The RBV claims that IT can bring competitive advantage when it is bundled with other resources or capabilities (Hammer and Champy 1993; Keen 1993; Powell and Dent-Micallef 1997). Therefore, we consider IT capabilities along with organizational capabilities to identify SC Strategy Groups.

We consider two aspects of IT capabilities — the use of IT for Exploitation and Exploration — as suggested by March (1991). Subramani (2004) also utilizes this classification to categorize IT use for SC management. According to Subramani (2004), Exploitation is the use of IT to improve operational efficiencies (e.g., order processing, exchange of information, controlling

inventories). These activities or technologies aim to reduce variance or streamline processes. Exploration, on the other hand, is the use of IT to learn about the environment and discover new ways of creating value (e.g., scanning the market, collaborations with suppliers and customers). These activities or technologies aim to understand the variance and develop new methods of dealing with the variance. Exploration typically involves innovations and risk taking while Exploitation brings greater standardization and control. Based on the literature, this study examines two aspects of SC IT capabilities based on the use of the Internet for Exploitation and Exploration.

In summary, this study considers six SC capabilities that address issues of SC organizational capabilities and SC IT capabilities. Descriptions of these capabilities are shown in Table I. SC organizational capabilities refer to the capabilities within the company for coordination (Coordination) and planning (Planning) of the SC and for involvement with suppliers (Supplier Involvement) and customers (Customer Involvement) throughout the SC. SC IT capabilities refer to the use of IT to improve operational efficiencies (Exploitation) and to learn about the environment and discover new ways of creating value (Exploration) in the SC. We examine these six SC capabilities to identify a taxonomy of SC Strategy Groups.

SC Strategy Groups and Context

The literature emphasizes the need for developing SC capabilities that are compatible with the context or environment in which the firm operates. We consider several aspects of context: location (country where firm is located), industry (firm's industry type), uncertainty and competitiveness.

The industry and country in which a firm operates has been shown to relate to manufacturing management practices (McKone, Schroeder and Cua 1999; McKone and Schroeder 2002). Lawrence and Lorsch (1967) emphasized that it is important to place the organization in the context of its environment and recognized that an organization must interact with its environment, obtain resources from it and transform them into products in order to survive. For example, Lawrence (1981) indicates that a particular industry (at a specified point in time) can be characterized by its resource constraints and its strategic uncertainty. An organization must adapt to its industry characteristics in order to be competitive in its environment. Similarly, the country in which an organization operates can constrain or enable an organization by the availability of natural resources, the level of government involvement in businesses, the culture and education of employees and other unique characteristics of a country.

In this study, we test the following null hypotheses:

H1: There is no difference in the industries of the firms across the SC Strategy Groups.

H2: There is no difference in the countries of firms across the SC Strategy Groups.

Uncertainty has been recognized as one of the root causes of the difficulty in efficiently coordinating SCs (e.g., Lee, Padmanabhan and Whang 1997b; Ganeshan 1999). Although there has been great effort to improve forecasting performance, the ever-changing competitive environment, such as the proliferation of products, shortened product life cycle and global expansion of the supplier/market, continues to make forecasting a challenge.

Fisher (1997) notes that while innovative products can allow firms to achieve higher profit margins, the very newness of innovative products makes demand unpredictable. As product life cycles shorten, streams of new product innovations continue to lead to demand volatility. Firms that operate in a highly innovative market, therefore, need to have different SC capabilities to minimize the risk of obsolescence and the cost of excess supplies and to meet time-to-market objectives. Our research examines product innovation with measures of the length of the product life cycle and the percentage of

TABLE I

Supply Chain Capabilities

Supply Chain Capability	Defined as Capability to:
Organizational capabilities	
Coordination	Integrate supply chain activities across the organization
Planning	Integrate forecasting and planning of supply chain activities
Supplier involvement	Integrate and collaborate with suppliers
Customer involvement	Integrate and collaborate with customers
IT capabilities	
IT for exploitation	Use IT to automate and improve existing supply chain process
IT for exploration	Use IT to learn about the environment and discover new ways of creating value in the supply chain

sales generated through new products. We test the following null hypotheses:

H3: There is no difference in the length of the product life cycle across the SC Strategy Groups.

H4: There is no difference in the mean percentage of sales generated through new products across the SC Strategy Groups.

In addition to product innovation, there are other factors that contribute to the uncertainty of demand and supply for a product. According to bullwhip effect theory, firms that are located in the upper stream of an SC are exposed to a higher level of demand uncertainty because of the amplified demand information aggregated from downstream SC partners (Lee et al. 1997a, b). Our third measure of uncertainty is based on the firm's position within the SC. Therefore, we test the following null hypothesis:

H5: There is no difference in the position of the firm within the supply chain across the SC Strategy Groups.

Competitiveness is the second type of contextual factor that we consider. While most studies focus on recognizing strategic SC practices as a source of competitive advantage (e.g., D'Avanzo, Lewinski and Sassenhove 2003; Cecere, O'Marah and Preslan 2004; Mckone-Sweet, Hamilton and Willis 2005), some identify the relationship between the competitive market and SC strategy. Fein (2006), from his recent data analysis of productivity in the SC, reports that there exists a positive relationship between SC practices and competitive intensity. Randall, Morgan and Morton (2003) report that market growth rate can be an important factor in the choice of SC type (efficient or responsive). They suggest that low growth rate can signal that a market may never develop into a larger market or that a product is at the end of its viable life, both characterized by different forms of competition. Porter (1980), in his early work of developing a competitive strategy framework, identifies five forces that together determine the intensity of industry competition. In his competitive strategy framework, he describes the relationship between forces that drive the competitiveness within an industry and various strategic options for firms. Drawing on these previous studies, our research considers competitiveness as a contextual factor and measures two aspects of this factor with market growth and competitive intensity measures. We test the following null hypotheses:

H6: There is no difference in the market growth across the SC Strategy Groups.

H7: There is no difference in the competitive intensity across the SC Strategy Groups.

SC Strategy Groups and Competitive Priorities

While the research on the fit between operations capabilities and a firm's competitive priorities has been a focal discussion in operations management (e.g., Hayes and Wheelwright 1984; Roth and Velde 1991; Hill 1994), there have been limited efforts to investigate the fit between SC capabilities and competitive priorities. The general consensus within the field of operations management is that the degree of fit between a firm's capabilities and its competitive priorities is related to a firm's performance (Boyer and McDermott 1999).

Frohlich and Westbrook (2001) point out that it is a critical factor for successful firms to carefully link the firm's internal processes to external suppliers and customers in unique SCs. It is a crucial capability for firms to integrate upstream and downstream partners in a way to support the firm's competitive priorities. However, Tamas (2000) reports that an independent survey reveals that only 13% of the 80 respondents believe that their company's SC practices are fully aligned with their priorities.

Our research begins to bridge the gap between theory and practice by examining the relationship between SC capabilities and competitive priorities. We test the following null hypotheses:

H8: There is no difference in the competitive priorities across the SC Strategy Groups in terms of:

H8a: low price,

H8b: performance quality,

H8c: fast delivery,

H8d: on-time delivery and

H8e: fast response to nonstandard orders.

SC Strategy Groups and Performance

Research provides evidence of the positive relationship between SC capabilities and firm performance. Numerous studies report that there exists a relationship between SC integration and performance (e.g., Frohlich and Westbrook 2001; Narasimhan and Kim 2002; Vickery et al. 2003). Ittner and Larcker (1997) and Wisner (2003) report that strong partnerships/relationships with suppliers and customers improve performance. The literature also suggests that the higher the degree of integration, the better a firm performs (Tan, Kannan and Handfield 1998; Lee, So and Tang 2000; Frohlich and Westbrook 2001). Frohlich and Westbrook (2001) provide evidence that the wider the arc of integration (encompassing suppliers and customers), the stronger the association with performance.

IT is considered to be a core component for increasing the effectiveness of SC transactions (e.g., Croom 2000; Essig and Arnold 2001; Ellinger, Lynch and Hensen 2002; Frohlich and Westbrook 2002). The use of IT for Exploitation and Exploration is expected to lead to different performance outcomes for firms. For instance, benefits associated with Exploitation are definable and concrete — cost reduction, process efficiency, or fast turnaround time (Subramani 2004). Benefits associated with Exploration are harder to evaluate in advance, but may take the form of greater understanding of the operating environment and shared understanding of market demand (Subramani

2004). DeSantis and Poole (1994) use the term appropriation to refer to how firms use IT and use differing patterns of appropriations to explain diverse performance outcomes in the context of group decision support systems. The research suggests that specific patterns of IT use can explain different performance outcomes.

We examine differences in actual performance and perceived performance relative to the competition. We test the following null hypotheses:

H9: There is no difference in the perceived performance relative to the competition across the SC Strategy Groups in terms of:
H9a: manufacturing cost,
H9b: inventory turns,
H9c: conformance to product specification,
H9d: on-time delivery,
H9e: delivery speed,
H9f: product mix flexibility and
H9g: volume flexibility.

H10: There is no difference in the actual performance across the SC Strategy Groups in terms of:
H10a: manufacturing cost as percentage of sales,
H10b: inventory turns,
H10c: percentage of orders shipped on time and
H10d: length of leadtime.

RESEARCH METHODOLOGIES

Data

This research used data collected by a team of international researchers in 2004 as part of the High Performance Manufacturing Research Project. The data collection constitutes Round 3 of an ongoing research project that began in 1989. The objective of Round 1 of the study was to examine the emergence of Japanese manufacturing practices in the United States. This was done by collecting data from 25 manufacturing plants each, operating in electronic, transportation and machinery industries in the United States. Conducted in 1996, Round 2 of the study extended the original objective to comparing and contrasting the state of manufacturing in five countries. This involved collecting data from 164 plants located in the United States, United Kingdom, Germany, Italy and Japan in electronic, transportation and machinery industries.

In Round 3, referred to as the high-performance manufacturing or HPM project, the study was expanded to include additional countries and to explore more advanced and up-to-date manufacturing practices, including the use of IT and SC practices. This round collected data from 238 manufacturing plants located in Finland, Sweden, Germany, Austria, Italy, Japan, Korea and the United States. This multicountry sample allowed us to examine firms from North America, Europe and Asia. This round also selected 10 firms from three different industries (automotive suppliers, electronics and machinery industries) in each country, for a total of about 30 plants in each country. These three industries provide a sample of firms with a variety of characteristics (different product characteristics, manufacturing practices, levels of competition and SC structures). Table II provides a summary of our data.

The survey instrument was developed by teams of operations management experts, formed for each topic area (i.e., SC management, IT systems, performance measurement). Each team designed survey questions for the specific topic, based on an extensive literature review and expertise in the area. Then the instrument was translated into the native language of the participants by teams from the associated countries. The translations were then translated back into English by a different group of people to check the accuracy of translation. The instrument was also pretested at several manufacturing plants. Necessary modifications to the instrument were made for clarity and consistency across all translations. Care in the development and pretest of the questions provides

TABLE II

Description of the Data

Country	AUT	FIN	GER	Italy	Japan	South Korea	Sweden	USA	Electronics	Machinery	Transportation
Total	21	30	41	27	35	31	24	29	79	79	80
Electronics	10	14	9	10	10	10	7	9	79	0	0
Machinery	7	6	13	10	12	10	10	11	0	79	0
Transportation	4	10	19	7	13	11	7	9	0	0	80
# Employees[a]	272	350	652	337	1342	4964	344	460	534	1148	834
% Exports[a]	78	67	52	59	36	38	55	25	55	54	44
Market share %[a]	19	22	31	24	26	33	23	24	21	30	26

[a]Average of sample firms.

assurance that the constructs were measured to an acceptable degree of content validity.

Members of the research team contacted the plant manager of the manufacturing plants to request their participation. Sixty-five percent of the plants completed written surveys for inclusion in our research data. This relatively high response rate was assured by communicating with the plants personally and by promising that they would receive a plant profile for comparison with other plants.

Once the plant agreed to participate, the plant manager appointed a coordinator to randomly select the internal participants, distribute the questionnaires, collect the responses and mail the completed surveys back to the research team. The instrument was distributed in 10 questionnaires (each with a different assortment of questions) that were administered to 24 informants ranging from shop floor employees to various functional managers, including the plant manager within a manufacturing plant. Specific questions were assigned to informants on the basis of their job title and expertise in order to increase the probability of getting accurate information. Responses for most questions were collected from multiple informants to provide greater reliability. Different respondents were used for specific measures to avoid common-rater bias. For this study, we used the average response of the informants for each survey item.

Twenty-six firms were eliminated from our data due to one or more missing values for the SC capability measures, resulting in a total of 212 firms being used for the analysis.

Measurement

We used survey questions to measure SC capabilities, contextual factors, competitive priorities and operational performance for each plant. Details of the measures are provided in the Appendices.

SC capabilities. For SC capabilities, we assessed organizational capabilities that involve practices and procedures to collaborate and integrate within the SC and IT capabilities that involve the use of the Internet to leverage information and technology to improve the efficiency of SC processes and to better understand market needs. See Appendix A (SC Organizational capabilities) and Appendix B (SC IT capabilities).

The SC organizational capabilities included coordination and planning and customer and supplier involvement. The items used to measure **Coordination** consider the extent of corporatewide cooperation and involvement with SC activities. The items for **Planning** refer to the importance of using an SC perspective in planning activities. These two capabilities relate to the collaboration within an organization and refer to intraorganizational capabilities. The items for **Customer Involvement** measure the frequency and type of customer involvement. The items for **Supplier Involvement** refer to the openness of communication and the level of cooperation between the supplier and the plant. These two capabilities relate to the collaboration with organizations external to the firm and refer to interorganizational capabilities.

The respondents for the survey questions that assessed the SC organizational capabilities were the quality manager, the inventory manager, the supervisor and the plant superintendent. We computed an average rating of the respondents for each of the items. We conducted factor analysis of these four SC capability constructs to verify that the items for each construct were associated with only one single factor. Then, we evaluated item level reliability and convergent validity to assess how each item behaved within the block of items intended to measure the specific SC capability. We assessed item reliability by calculating the Corrected Item to Total Correlation score. One item was dropped from the SC Planning and Coordination constructs since it loaded on a second factor. Anderson and Gerbing (1988) suggest that evidence of convergent validity exists if the manifest variable loads significantly (t-value > 2.58, $p < 0.01$) on its respective latent variable. All specified parameter estimates were within an acceptable range (see Appendix A) and highly significant, which indicates good convergent validity among the measures of each construct. We assessed construct validity with Cronbach's α. All Cronbach's α values exceeded 0.73 (Appendix A).

The SC IT capabilities included IT for Exploitation and IT for Exploration. For this study, we consider Internet use and do not consider all types of IT. We have chosen to examine Internet use since it is becoming a common means for collecting, sharing and analyzing information within the SC (e.g., Gunasekaran, Marri, McGaughey and Nebhwani 2002). Kouvelis, Chambers and Wang (2006) summarize recent research and discuss the importance of the Internet to manufacturers and retailers and how most if not all established firms are expanding their business practices and relationships with some Internet-enabled components. Our measure for **Exploitation** considers the use of the Internet to improve operational efficiencies and our measure for **Exploration** considers the use of the Internet to learn about the environment and discover new ways of creating value. The items for Exploitation assess the extent of Internet use for order processing, invoicing, settling accounts, managing inventories and exchanging shipment and delivery information. In contrast, the items for Exploration assess the level of Internet use to support nonroutine, unstructured tasks to understand market trends and customer preferences. Our operationalization for Exploitation and Exploration is similar to Subramani's (2004) categorization of SC management systems along Exploitation and Exploration dimensions and the measures used in Boynton, Zmud and Jocobs (1994).

Six items were used to measure Exploitation and seven items to measure Exploration. The survey respondent for all items was the information systems manager. Responses to all 13 items were binary in nature. We used

an additive approach to create the IT capability scales, adding 1 for each use of the Internet. More uses or applications of the Internet, therefore, indicate a higher level of IT capabilities.

Contextual factors. Next we considered seven contextual or environmental factors that might be related to the choice of a firm's SC capabilities. Our research included different countries and industries by design. This research also examined indicators of the uncertainty in the SC (the percent of current products that were introduced within the last 5 years, the average product life cycle, and the firm's position within the SC), and the competitiveness (market growth and competitive intensity) of the industry. Factor analysis and tests for reliability, convergent validity and construct validity were confirmed for the competitive intensity measure (Cronbach's α was 0.641). Appendix C shows the respondents and measures for each contextual factor.

Competitive priorities. We also considered the competitive priorities of each firm. We assessed the firm's priorities relative to cost, quality, delivery and flexibility. As shown in Appendix D, we asked the plant manager, plant superintendent and the process engineer to identify the importance of each goal or priority. We computed an average rating of the respondents for each of the items.

Performance. Finally, we considered operational performance measures and assessed multiple dimensions of cost, quality, delivery and flexibility. As shown in Appendix E, we asked the plant managers their opinion about how their plant compares to its competitors in the industry, on a global basis. We also asked the accounting manager for actual performance on cost and delivery. Therefore, we assessed both perceptual and actual performance.

Both actual and perceptual performance measures are important to our study. The actual performance is based on reported accounting data and is therefore an accurate measure of performance. However, the actual performance metrics do not capture differences in "good" performance that may differ by industry as well as by the firm's position within the SC. The perceptual measures try to capture a firm's performance relative to its direct competitors.

Analysis Approach

We conducted our data analysis using SPSS statistical software. There were three stages to our analysis: identification of SC Strategy Groups, interpretation of the underlying differences of the strategy groups, and comparison of the context, competitive priorities and performance for the groups. We employed *Cluster Analysis* to classify the plants based on their SC capability profiles and identify the SC Strategy Groups. We used ANOVA and Scheffe post hoc pair comparison (when necessary assumptions of homogeneity and normality were met) and Kruskal–Wallis comparison (when assumptions for ANOVA were not met) to identify significant differences in SC capabilities for SC Strategy Groups. These analyses helped to interpret the SC strategy for each group.

Next we conducted crosstabs analysis to consider differences in the country and industry of each strategy group or cluster. We also used ANOVA and Scheffe post hoc pair comparison and Kruskal–Wallis comparison to examine the significant differences across the clusters in terms of **contextual factors**, **competitive priorities** and **performance**. The contextual analysis defined the environment of each SC strategy group. The competitive priority analysis highlighted the goals of the SC strategy groups. Finally, the performance analysis identified the competitive positions of the SC strategy groups. These differences enabled us to better understand characteristics of specific SC strategy groups within the taxonomy.

When using the ANOVA and Scheffe post hoc comparisons for identifying significant group mean differences, we designated a statistical significance of 0.05 or less. In our post hoc analysis of the mean differences (to determine which means are different from each other), we used the conservative Scheffe post hoc analysis approach that adjusts the *F*-critical value for multiple comparisons to minimize type I error.

We also tested the assumptions of homogeneity of variance (Levine statistic) and normality (Kolmogorov–Smirnov test). For some variables, the Levine statistic indicated nonhomogeneity and the Kolmogorov–Smirnov test indicated nonnormality of the data. Therefore, we also compared group differences using the Kruskal–Wallis test, a nonparametric test of whether the independent samples that are defined by clusters are from the same population. For this test, we designated a statistical significance of 0.05 or less.

It is important to note that the Kolmogorov–Smirnov test is very sensitive to nonnormality. For our analysis, the sample size of 24 or more for each cluster exceeded the 20 degrees of freedom for error suggested to assure multivariate normality of the sampling distribution of means, even with unequal sample sizes (Tabachnick and Fidell 1989, p. 411). Therefore, for our analysis, the Kolmogorov Smirnov test results were consistent with those from the ANOVA and Scheffe post hoc analysis.

ANALYSIS AND DISCUSSION

For this study, 26 firms were eliminated from our data due to one or more missing values for the SC capability measures, resulting in a total of 212 firms being used for the analysis. In this section, we present our results for each stage of the analysis.

Identification of SC Strategy Groups

Using the six SC capabilities — Coordination, Planning, Supplier Involvement, Customer Involvement, Exploitation and Exploration — we employed Cluster Analysis to identify groups within the SC Strategy taxonomy.

One problem with cluster analysis is the determination of the number of clusters. Three criteria were used. First, we utilized the elbow criteria, a common rule of thumb to determine what number of clusters should be chosen based on the marginal gain in the percentage of variance explained by adding another cluster. Second, we looked for cluster groupings that agreed with existing or expected structures (i.e., that have managerial interpretability). The ANOVA and the Scheffe post hoc tests of mean differences helped guide the interpretability of the results. Third, we were guided by Lehmann's (1979) suggestions that the number of clusters should be limited to between $n/30$ and $n/60$ where n is the sample size. Therefore, only models with between three and seven clusters were considered. The three-cluster model best satisfied these three criteria. Table III describes the three resultant SC Strategy Groups in terms of their respective group centroids.

Interpretation of the Strategy Groups

Next we analyzed the mean difference in SC capabilities for each SC Strategy Group. Table III provides the results of the ANOVA and Scheffe post hoc pair comparison as well as the Kruskal–Wallis comparison. The SC Strategy Groups all significantly differed on three of the organizational capabilities (coordination, planning and customer involvement) with Group 1 having low levels, Group 3 having moderate levels and Group 2 having high levels. Group 1 also had significantly lower levels of supplier involvement than Groups 2 and 3. Finally, Group 3 had lower levels of IT capabilities (Exploitation and Exploration) than Groups 1 and 2.

The results of the cluster analysis suggested that SC Strategy Group 1 has low levels of SC organizational capabilities and high levels of SC IT capabilities. In practice, these firms look for an IT solution to SC problems and do little to change the existing organizational processes within the firm or the SC.

Strategy Group 2 has high levels of both SC organizational capabilities and SC IT capabilities. In practice, these firms take an integrative approach to SC management, believing that IT and organizational capabilities are both needed for superior SC performance.

SC Strategy Group 3 has low levels of SC IT capabilities and moderate levels of SC organizational capabilities. In practice, these firms emphasize their SC organizational capabilities but do not develop strong IT capabilities to complement their SC organizational capabilities.

Comparison of the Clusters

After developing and interpreting the clusters, we extended our analysis by systematically examining the factors associated with SC Strategy Group membership. We explored significant differences across clusters for contextual variables, competitive priorities and performance. Tables IV–VIII show our results, including both the ANOVA and Kruskal–Wallis test statistics and significance. Since the conclusions were the same for both tests, we simplified the tables and report the mean and standard error for each group but did not report the rankings generated from the Kruskal–Wallis analysis.

Context: In our data, firms were sampled from three different industries and eight different countries. Table II describes our data sample and identifies differences in the number of employees, the percentage of exports and the market share across industries and countries. Table IV shows the results from a crosstabs analysis for industry. While the results indicated that firms within the transportation industry tended to be in SC Strategy Groups 2 and 3 (develop more SC organizational capabilities) more than those in the machinery industry, these results were not significant at the 0.05 level using the Chi-Square Statistics. Therefore we failed to reject the null hypothesis H1.

Table V shows the crosstabs analysis for country. There were significant differences in the location of firms of SC Strategy Groups; therefore, we rejected the null hypothesis H2. Group 1 had more firms from Japan and fewer firms from Finland and the United States than expected. Group 2 had more firms from Finland and fewer from Japan than expected. The Finnish firms in this study appear to develop organizational and IT capabilities together. Group 3 had more firms from the United States than expected and no firms from four countries. It is important for managers to understand that SC strategies differ from one country to another. It provides insight into the SC capabilities of domestic and international competitors. Further research should examine the differences in countries and the nature of the firms within each country (i.e., in our sample, firms in Japan and South Korea were larger on average than firms in other countries and firms in Finland had a higher percentage of exports than many other countries).

Next we examined the differences in the uncertainty of demand and the competitiveness of the market for each SC Strategy Group. Table VI shows the results of the group mean differences.

Our results showed that there are significant group mean differences in the uncertainty (for the SC position measure) and the competitiveness (for the Competitive Intensity measure) faced by the SC Strategy Groups. In particular, Group 3 (with low IT capabilities) included firms that are further away from the customer and have higher levels of competition. In this context, firms have low levels of IT capability and moderate levels of organizational capabilities. In practice, the relationship between the SC position and the development of SC IT capabilities makes sense. Firms that are upstream in the SC may not have the resources to develop SC IT capabilities or the access to valuable information from their consumers. These firms also may not have direct pressures from large retailers or distributors to develop specific IT systems. However, the relationship between the high levels of competition and the SC strategy group is

TABLE III

Results of the Cluster Analysis for SC Capabilities

SC Capabilities	Test of Assumptions		Suggested Test	ANOVA and Scheffe Post Hoc Analysis				Kruskal–Wallis (rank)			
	Homogen. of Var.[a]	Normality[b]	ANOVA	SCS Group 1[c,d]	SCS Group 2	SCS Group 3	*F*=value *p*=prob *N*=212	SCS Group 1	SCS Group 2	SCS Group 3	χ^2 value *p*=prob.
Coordination	LS=0.363 *p*=0.686	KS=0.864 *p*=0.444	ANOVA	**4.4611** (0.0744)	**5.197** (0.0537)	**4.699** (0.145)	*F*=32.469 *p*=0.000	**65.93**	**130.65**	**89.65**	χ^2=48.97 *p*=0.000
Planning	LS=2.822 *p*=0.062	KS=0.835 *p*=0.488	ANOVA	**4.644** (0.559)	**5.450** (0.044)	**4.986** (0.148)	*F*=53.972 *p*=0.000	**53.63**	**135.46**	**97.85**	χ^2= 75.66 *p*=0.000
Supplier relationships	LS=1.81 *p*=0.166	KS=0.516 *p*=0.953	ANOVA	**4.774** (0.0469)	5.330 (0.0359)	5.126 (0.0108)	*F*=3.029 *p*=0.000	**57.20**	**131.20**	**110.35**	χ^2=61.532 *p*=0.000
Customer involvement	LS=2.018 *p*=0.135	KS=0.556 *p*=0.917	ANOVA	**4.972** (0.052)	**5.662** (0.036)	**5.273** (0.107)	*F*=58.722 *p*=0.000	**54.13**	**136.88**	**89.21**	χ^2=78.956 *p*=0.000
IT exploitation	LS=5.533 *p*=0.000	KS=3.590 *p*=0.000	Kruskal–Wallis	15.203 (0.193)	14.798 (0.158)	**6.167** (0.541)	*F*=247.622 *p*=0.000	127.7	113.8	**13.5**	χ^2=66.379 *p*=0.000
IT exploration	LS=27.580 *p*=0.000	KS=3.284 *p*=0.000	Kruskal–Wallis	10.281 (0.138)	10.218 (0.134)	**5.958** (0.594)	*F*=74.548 *p*=0.000	115.4	113.5	**25.9**	χ^2=40.099 *p*=0.000
Sample size				64	124	24		64	124	24	
Summary of results	Both tests arrive at same conclusions for all capabilities. All clusters differ on SC planning, coordination, and customer involvement (1=low level, 3=mod level and 2=highest level). Cluster 1 has lowest group mean for supplier involvement. Cluster 3 has lower group mean for all SC IT capabilities (Exploitation and Exploration).										

[a]Levine statistic used for testing Homogeneity of Variances.
[b]KS is Kolmogorov-Smirnov test of normality.
[c]Top values are mean values for each cluster and bottom values are standard errors. Numbers in bold are significantly different than the other means using the Scheffe post hoc analysis (0.05 level).
[d]SCS=supply chain strategy.

TABLE IV

Crosstabs Analysis for Industry

	Industry				Summary
	Electronics	Machinery	Transportation	Total	
SC Strategy Group					
1					
Count	22	29	13	64	Cluster 1 has fewer firms from transportation industry and more from machinery industry than expected.
Expected count	22.3	21.1	20.5	64.0	
Standard residual	0.0	1.7	−1.7		
2					
Count	45	32	47	124	Cluster 2 has lower number of firms from machinery industry and more from transportation than expected.
Expected count	43.3	40.9	39.8	124.0	
Standard residual	0.3	−1.4	1.1		
3					
Count	7	9	8	24	Cluster 3 has approximately the expected number of firms from each industry.
Expected count	8.4	7.9	7.7	24.0	
Standard residual	−0.5	0.4	0.1		
Total					
Count	74	70	68	212	
Expected count	74.0	70.0	68.0	212.0	

χ^2 Tests	Value	DF	Asymptotic Significance (2-sided)
Pearson χ^2	9.414[a]	4	0.052
No. of valid cases	212		

unexpected. Fein (2006), for example, reported a positive relationship between SC practices and competitive intensity. Furthermore, in practice it is assumed that firms with high levels of competition need to develop SC capabilities to maintain or grow their position in the market.

Although we rejected the null hypotheses H5 and H7, we failed to reject H3 (Length of product life cycle), H4 (% of product sales from new products) and H6 (market growth). These results do not support the research on typologies that recommends different SC strategies based on the innovativeness of the product (Fisher 1997; Lee 2002). This may mean the firms are not adhering to the advice from these typologies and do not differentiate their strategy based on the innovativeness of their products. Of course, this result may also occur because our measures do not fully capture all aspects of product innovativeness from the past studies.

Competitive priorities: Next we examined the group mean differences in the competitive priorities. We expected the groups to exhibit differences which would suggest that there was a link between a firm's priorities and their SC Strategy Group membership. Our results, in Table VII, showed that there were no significant differences in group means for competitive priorities and we failed to reject the null hypothesis H8.

This somewhat unexpected result suggests that firms develop their SC strategies independently from their competitive strategies. We expected firms to align their SC strategies with their competitive priorities in order to use their SC capabilities to achieve performance improvements relative to the priorities. However, our results correspond with Tamas' survey report (2000) that revealed the lack of alignment between strategic priorities and SC strategies.

Manufacturing performance: Finally, we examined the group mean differences in perceived and actual competitive manufacturing performance. Table VIII shows the results from our analysis. Based on the literature review, we expected the group that bundled complementary SC organizational and SC IT capabilities to achieve higher levels of performance.

Based on the perceived competitive advantage, there were no group mean differences for SC Strategy Groups on the dimension of cost. However, there were differences on the dimensions of quality, delivery and flexibility. SC Strategy Group 2 had higher performance relative to quality, on-time delivery, and flexibility to volume changes than SC Strategy Group 1. Firms in SC Strategy Group 2, by developing higher levels of SC organizational capabilities than SC Strategy Group 1, perceived their performance to be more competitive on these three

TABLE V

Crosstab Analysis by Country

	Country									Summary
	AUT	Finland	Germany	Italy	Japan	South Korea	Sweden	United States	Total	
SC Strategy Group										
1										
Count	6	3	15	7	13	9	9	2	64	Cluster 1: More firms from Japan and fewer from Finland and United States than expected.
Expected count	6.0	9.1	12.1	7.8	8.2	6.9	5.7	8.2	64.0	
Standard residual	0.0	−2.0	0.8	−0.3	1.7	0.8	1.4	−2.2		
2										
Count	14	27	25	16	9	13	8	12	124	Cluster 2: More firms from Finland and fewer from Japan than expected.
Expected count	11.7	17.5	23.4	15.2	15.8	13.5	11.1	15.8	124.0	
Standard residual	0.7	2.3	0.3	0.2	−1.7	−0.1	−0.9	−1.0		
3										
Count	0	0	0	3	5	1	2	13	24	Cluster 3: Most firms from United States (48% of Cluster 3 firms) and Japan (20% of cluster 3 firms) and no firms from AUT, Finland, or Germany.
Expected count	2.3	3.4	4.5	2.9	3.1	2.6	2.2	3.1	24.0	
Standard residual	−1.5	−1.8	−2.1	0.0	1.1	−1.0	−0.1	5.7		
Total										
Count	20	30	40	26	27	23	19	27	212	
Expected count	20.0	30.0	40.0	26.0	27.0	23.0	19.0	27.0	212.0	

χ^2 Tests	Value	df	Sig. (2-sided)
Pearson χ^2	70.030[a]	14	0.000
No. of valid cases	212		

TABLE VI

SC Strategy Groups and Contextual Factors

Contextual Factors	SC Strategy Groups[a]			Tests of Assumption		ANOVA Results	Kruskal–Wallis Results[e]	Summary
	1	2	3	Homogeneity[b]	Normality[c]	*F*=Value *p*=probability *N*=sample[d]	CS=value *p*=probability	
Uncertainty								
Percent of innovation	53.565 (4.702)	64.173 (2.811)	58.842 (7.610)	LS=1.510 *p*=0.224	KS=1.909 *p*=0.001	*F*=2.129 *p*=0.151 *N*=171	CS=3.486 *p*=0.175	No significant difference
Length of product life cycle	9.883 (0.999)	8.525 (0.639	9.291 (01.97)	LS=0.172 *p*=0.842	KS=3.142 *p*=0.000	*F*=0.726 *p*=0.485 *N*=165	CS=2.115 *p*=0.347	No significant difference
SC position	347.266 (24.477)	336.385 (18.411)	**461.869** (28.294)	LS=3.730 *p*=0.026	KS=1.865 *p*=0.002	*F*=4.932 *p*=0.008 *N*=170	CS=9.473 *p*=0.009	Cluster 3 firms are farther away from customers than clusters 1 and 2
Competitiveness								
Competitive intensity	**5.325** (.082)	5.460 (0.062)	**5.783** (0.107)	LS=0.771 *p*=0.464	KS=1.104 *p*=0.175	*F*=4.373 *p*=0.014 *N*=210	CS=8.189 *p*=0.017	Cluster 3 has higher competitive intensity than cluster 1
Market growth	149.593 (24.22)	109.075 (10.012)	109.895 (14.998)	LS=3.123 *p*=0.047	KS=2.918 *p*=0.000	*F*=1.914 *p*=0.151 *N*=171	CS=3.180 *p*=0.204	No significant difference

[a]Top values are mean values for each cluster and bottom values are standard errors. Numbers in bold are significantly different than the other means using the Scheffe post hoc analysis (0.05 level).
[b]Levine statistic used for testing homogeneity of variances.
[c]KS is Kolmogorov–Smirnov test of normality.
[d]There were missing values for some contextual factors. Therefore, the sample size varied for each analysis.
[e]Kruskal–Wallis Results: CS=Chi-Square statistic, *p*=significance. Ranks are not reported since same conclusions are made from ANOVA.

TABLE VII

SC Strategy Groups and Competitive Priorities

Competitive Priorities	SC Strategy Groups[a]			Test of Assumptions		ANOVA Results[d]	Kruskal–Wallis Results[e]	Summary
	1	2	3	Levine[b]	KS[c]			
Cost								
Low price	3.804 (0.095)	3.763 (0.071)	3.882 (0.138)	LS=959 p=0.386	KS=1.941 p=0.001	F0.256 p=0.774 N=210	CS=0.434 p=0.806	No difference
Quality								
Performance quality	4.249 (0.070)	4.368 (0.045)	4.347 (0.122)	LS=2.309 p=0.102	KS=2.131 p=0.000	F=1.167 p=0.313 N=210	CS=1.828 p=0.401	No difference
Delivery								
Fast delivery	3.878 (0.083)	3.844 (0.059)	3.785 (0.125)	LS=0.093 p=0.912	KS=2.135 p=000	F=0.181 p=0.834 N=210	CS=0.711 p=0.701	No difference
On-time delivery	4.278 (0.067)	4.186 (0.048)	4.118 (0.119)	LS=0.399 p=0.672	KS=2.337 p=0.000	F=0.956 p=0.386 N=210	CS=1.971 p=0.373	No difference
Flexibility								
Fast response to nonstandard orders	3.661 (0.088)	3.493 (0.069)	3.417 (0.158)	LS=0.160 p=0.852	KS=1.818 p=0.003	F=1.381 p=0.254 N=210	CS=2.401 p=0.122	No difference

[a]Top values are mean values for each cluster and bottom values are standard errors. Numbers in bold are significantly different than the other means using the Scheffe post hoc analysis (0.05 level).
[b]Levine Statistic used for testing Homogeneity of Variances.
[c]KS is Kolmogorov–Smirnov test of normality.
[d]There were missing values for some competitive priorities. Therefore, the sample size varied for each analysis.
[e]Kruskal–Wallis Results: CS=Chi-Square statistic, p=significance. Ranks are not reported since same conclusions are made from ANOVA.

dimensions. This result supports past research that found that the joint development of IT and organizational capabilities can lead to a competitive advantage.

Based on actual performance measures, the SC Strategy Groups only differed on the dimension of inventory turns, with SC Strategy Groups 2 and 3 (both having higher levels of SC organizational capabilities) having higher inventory turns than Group 1. This result suggests that the development of SC organizational capabilities is associated with improved inventory performance.

These results, showing higher performance for SC Strategy Group 2, indicate that the combination of high SC organizational capabilities and high SC IT capabilities enables firms to perform well on quality, delivery and flexibility. The SC IT and organizational capabilities appear to be complementary and help to achieve competitive advantage in SC responsiveness. This result supports the findings from previous research grounded in the RBV (Clemons and Row 1991; Powell and Dent-Micallef 1997).

Our results suggest that there are some perceived and actual performance benefits from specific SC strategies. However, there are differences in the results for the perceived and actual performance. This may mean that plant managers believe that their capabilities are differentiating their performance but, in reality, they are not. However, the differences could also be due to the difficulty of comparing actual measures across multiple industries, countries and throughout the SC. Good performance in one industry may not be good performance in another. Similarly, a good performance level for a second or third tier supplier may differ from that of a firm delivering final product to the consumer. Future research should examine these differences in more detail.

RESEARCH SUMMARY AND LIMITATIONS

This research identified a taxonomy with three SC Strategy Groups of manufacturers with similar combinations

TABLE VIII

SC Strategy Groups and Performance Relative to the Competition

Performance Dimensions	SC Strategy Groups[a]			Test of Assumptions		Test of Group Differences	
	1	2	3	Levine[b]	KS[c]	ANOVA Results[d]	Kruskal–Wallis Results[e]
Perceived performance relative to the competition							
Cost							
Manufacturing cost	3.123 (0.117)	3.336 (0.088)	3.044 (0.172)	LS=3.259 p=0.041	KS=2.985 p=0.000	F=1.695 p=0.186 N=192	CS=4.204 p=0.122
Inventory turnover	3.158 (0.117)	3.460 (0.087)	3.435 (0.152)	LS=1.169 p=0.313	KS=3.242 p=0.000	F=2.271 p=0.106 N=190	CS=5.679 p=0.058
Quality							
Conformance to product specs	**3.710** (0.092)	**4.009** (0.065)	3.750 (0.150)	LS=2528 p=0.082	KS=4.348 p=0.000	F=4.064 p=0.019 N=195	CS=7.507 p=0.023
Delivery							
On-time delivery	**3.579** (0.125)	**4.035** (0.075)	3.833 (0.173)	LS=2.958 p=0.054	KS=3.538 p=0.000	F=5.339 p=0.006 N=194	CS=9.284 p=0.010
Fast delivery	3.404 (0.103)	3.541 (0.073)	3.174 (0.015)	LS=0.680 p=0.508	KS=3.506 p=0.000	F=2.363 p=0.097 N=190	CS=3.708 p=0.157
Flexibility							
Flexibility to change product mix	3.875 (0.085)	3.956 (0.069)	3.913 (0.177)	LS=0.301 p=0.741	KS=4.888 p=0.000	F=0.450 p=0.638 N=193	CS=1.375 p=0.503
Flexibility to change volume	**3.638** (0.085)	**4.009** (0.076)	4.000 (0.173)	LS=0.536 p=0.586	KS=4.215 p=0.000	F=4.960 p=0.008 M=195	CS=12.566 p=0.002
Summary	Cluster 2 has a perceived competitive advantage in quality, on-time delivery and flexibility to Clusters 1						
Reported performance[f, g]							
Cost							
Mfg. costs as percentage of sales	0.764 (0.027)	0.762 (0.023)	0.737 (0.061)	LS=0.506 p=0.604	KS=1.790 p=0.003	F=0.105 p=0.900 N=179	CS=0.197 p=0.906
LN (inventory turns)	**1.771** (1.399)	**2.257** (1.111)	2.276 (0.720)	LS=0.325 p=0.723	KS=1.929 p=0.000	F=3.337 p=0.038 N=166	CS=9.034 p=0.011
Delivery							
Percentage shipped on-time)	90.006 (1.459)	91.084 (1.115)	88.486 (4.881)	LS=4.370 p=0.014	KS=3.326 p=0.000	F=3.95 p=0.674 N=174	CS=2.687 p=0.261
LN (lead-time)	3.222 (1.277)	2.7942 (1.370)	2.5619 (1.380)	LS=0.178 p=0.878	KS=0.590 p=0.878	F=2.254 p=0.108 N=168	CS=3.985 p=0.136
Summary	Cluster 2 has higher performance on inventory turns than Cluster 1						

TABLE VIII Continued

Performance Dimensions	SC Strategy Groups[a]			Test of Assumptions		Test of Group Differences	
	1	2	3	Levine[b]	KS[c]	ANOVA Results[d]	Kruskal–Wallis Results[e]

[a]Top values are mean values for each cluster and bottom values are standard errors. Numbers in bold are significantly different from each other using the Scheffe post hoc analysis (0.05 level).
[b]Levine Statistic used for testing Homogeneity of Variances.
[c]KS is Kolmogorov–Smirnov test of normality.
[d]There were missing values for some performance factors. Therefore, the sample size varied for each analysis.
[e]Kruskal–Wallis results: CS=Chi-Square statistic, *p*=significance. Ranks are not reported since same conclusions are made from ANOVA.
[f]Ranks for inventory turns are SCS Group 1 (67.9), Group 2 (92.2), and Group 3 (89.7).
[g]The logarithm of inventory turns and lead time were used for this analysis.

of SC capabilities using a data-based analytical approach. We found that there were significant differences on the dimensions of SC organizational capabilities and SC IT capabilities among the three SC Strategy Groups. One group has high levels of both organizational and IT capabilities. A second group has significantly lower levels of SC organizational capabilities than the other groups. A third group has significantly lower levels of SC Internet capabilities than the other groups.

We also found that firms with high levels of both SC organizational and SC IT capabilities outperformed other firms on at least some of the measures of cost, quality, delivery and flexibility. This result suggests that SC organizational capabilities and SC IT capabilities are complementary and that when bundled together enable firms to improve SC performance. When developing SC capabilities, it is important for managers to recognize the interdependency of organizational and IT capabilities.

This analysis also provides evidence of a significant relationship between groups within the SC strategy taxonomy and uncertainty (measured by SC position) and competitiveness. Firms that are further away from the customer and have higher levels of competition have lower levels of SC IT capabilities. These firms may not have access to consumer demand information or may not have the resources to develop SC IT capabilities. Future research should examine these firms in more detail.

Surprisingly, our analysis did not provide support for a relationship between groups within the SC capability taxonomy and competitive priorities. While previous studies suggested that the fit between capabilities and strategy can lead firms to have better performance, our results showed that there still is a missing link between SC capabilities and competitive strategy. The implication of our results is that firms do not yet appear to align their SC capabilities with their competitive priorities. In practice, this mismatch between overall business strategy and SC strategy can occur when the SC management organization is a separate entity within the company and/or operates with different organizational metrics of performance. Given our result that SC strategies are related to overall performance, it is important for managers to match their SC and competitive strategies to best meet their strategic objectives.

This research, involving a large-sample database with a diverse set of companies, makes an important contribution to the SC research by identifying and analyzing an SC capability taxonomy. However, it is important to address the limitations of this research and to expand upon our analysis in the future. First, given the number of measures (context, competitive priorities and performance) examined in this study, the type I error may be inflated. Future research should be done to confirm the findings. Second, this study examined a set of firms at one point in time. It will be interesting to take a more longitudinal approach to the analysis and examine how SC strategies evolve over time. This is particularly important given the rapid changes that occur in IT. Additional analysis will be needed to understand whether the taxonomy developed in this research will stand the test of time. Third, this study considered a limited number of contextual factors. It will be important to examine relationships between the SC taxonomy and other contextual factors, such as the complexity of the product and the supplier network and the characteristics of the product and customers. It will be helpful to also consider the interactions between contextual factors, such as between country and uncertainty, country and firm size and the percentage of exports. Finally, our research found no relationship between SC Strategy Groups and competitive priorities and some performance measures. Future research should examine the relationship in more detail. It will be useful to examine the performance benefits of alignment among SC capabilities, competitive priorities and the contextual environment.

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Kathleen McKone-Sweet (Ph.D., University of Virginia) is an associate professor in the Technology Operations and Information Management Division at Babson College in Babson Park, MA. Dr. McKone-Sweet received her B.S. and M.Eng. in Operations Research and Industrial Engineering at Cornell University. She received her MBA and Ph.D. in Operations Management at the University of Virginia. Her current research is in supply chain management. Her work appears in numerous academic and practitioner journals, including *Journal of Operations Management*, *Production Operations Management*, *Journal of Supply Chain Management*, and *Supply Chain Management Review*.

Yoo-Taek Lee (DBA, Boston University) is an assistant professor of technology and operations management at Babson College in Babson Park, MA. Professor Lee's research interests include global SC strategies, web-based SC management applications and supplier development strategies from the view of socioeconomics. His current work investigates development strategies of small and medium-sized suppliers in global SCs and complementary resources to the implementation of web-based applications in managing SCs. His work experience includes HR at Samsung, a research associate appointment at Boston University Asian Management Center, and the development of executive education programs for Asian organizations such as Sanyo, Samsung, LG, Daewoo, SK, the Federation of Korean Industries and the Ministry of Commerce in China. He has produced more than 65 best practice reports of Motorola, IBM, Texas Instruments, GE, Federal Express, Intel, Sun Microsystems, Toyota and others.

APPENDIX A

Measurement of SC Organizational Capabilities

Please indicate your opinion about the following statements on a 7 point Likert scale.
1=strongly disagree, 2=disagree, 3=slightly disagree, 4=neutral, 5=slightly agree, 6=agree, 7=strongly agree
(Respondents were the quality manager, the inventory manager, the supervisor and the plant superintendent.)

Measurement Items	Loading	Reliability
Coordination		
Purchasing of common materials is coordinated at the corporate level.	0.53	α =0.780
Our corporation implements ordering and stock management policies, on a global scale, in order to coordinate distribution.	0.82	
Our corporation performs aggregate planning for plants, according to our global distribution needs.	0.76	
Managerial innovations are transferred among plants within our corporation.	0.78	
Our corporation transfers technological innovations and know-how between plants.	0.76	
Planning		
We actively plan supply chain activities.	0.79	α =0.816
We consider our customers' forecasts in our supply chain planning.	0.66	
We strive to manage each of our supply chains as a whole.	0.75	
We monitor the performance of members of our supply chains, in order to adjust supply chain plans.	0.77	
We gather indicators of supply chain performance.	0.82	
Supplier Involvement		
We are comfortable sharing problems with our suppliers.	0.85	α =0.770
In dealing with our suppliers, we are willing to change assumptions, in order to find more effective solutions.	0.61	
We believe that cooperating with our suppliers is beneficial.	0.83	
We emphasize openness of communications in collaborating with our suppliers.	0.82	
Customer Involvement		
We frequently are in close contact with our customers.	0.81	α =0.775
Our customers give us feedback on our quality and delivery performance.	0.85	
Our customers are actively involved in our product design process.	0.64	
We strive to be highly responsive to our customers' needs.	0.75	
We regularly survey our customers' needs.	0.60	

APPENDIX B

Measurement of SC Internet Capabilities

For which of these activities does your plant use the Internet? Please circle either Yes (1) or No (0).
(Respondent is information systems manager.)

Exploitation

Transmitting orders to suppliers
Tracking/tracing supply orders
Real-time integrated scheduling, shipping and warehouse management across supplier network
Providing fixed pricing offers to potential buyers
Online order entry
Customers can check delivery status of their orders

Exploration

Scanning the marketplace for identification of potential sources
Receiving and comparing suppliers' offers
Providing dynamic pricing (negotiations and sellers' bids) for purchased items
Supporting collaborative product design/improvement with suppliers
Supporting collaborative process and technology design/improvement with suppliers
Providing on-line customized customer service, where customers can configure the product within the constraints stated by the plant
Providing dynamic pricing to potential buyers

APPENDIX C

Measurement of Contextual Variables

Uncertainty

Product Life Cycle	**What is the average life cycle of your products (years)?** (Respondent is plant superintendent.)
Percent New Products	**What percent of plant sales is from products introduced in the last five years?** (Respondent is process engineer.)
Supply Chain Position	**What percent of your sales is to each of the following types of customers?** (Respondent is inventory manager.) **End Consumers (1), Retailers (2), Wholesalers (3), Distributors (4), Assemblers (5), Manufacturers (6)** Calculated by using a weighted average (percent times assigned #). A lower value indicates that the plant is located closer to the end consumers

Competitiveness

Market Growth	**What is the annual growth rate in the market which this plant serves? This is not the growth rate in the plant's sales, but rather, the growth rate of the market served.** (Respondent is plant manager.)
Competitive Intensity (α=0.641)	**Please indicate your opinion about the following statements on a 7 point Likert scale.** **1=strongly disagree, 2=disagree, 3=slightly disagree, 4=neutral, 5=slightly agree, 6=agree, 7=strongly agree** (Respondents include process engineer, plant manager, and plant superintendent.) We are in a highly competitive industry. (loading=0.809) Our competitive pressures are extremely high. (loading=0.737) There are few significant competitors for our products. (loading=0.532) Competitive moves in our market are slow and deliberate, with long time gaps between different companies' reactions. (Reverse scored.) (loading= $-$ 0.700)

APPENDIX D

Measurement of Competitive Priorities

Competitive Priorities	Please identify the importance of each goal below. Identify the goal as absolutely crucial only if it helps "win the order" from the customer in the marketplace relative to the competition. Rate the other goals according to their relative importance. On a scale of 1 to 5 with 1=least important and 5=absolutely crucial (Respondents include the plant manager, plant superintendent and the process engineer.)
Cost	Low price
Quality	High performance quality
Delivery	Fast delivery
	On-time delivery
Flexibility	Fast response to nonstandard orders

APPENDIX E

Measurement of Performance

	Relative Competitive Performance Measures
Dimension of Performance	**Please circle the number that indicates your opinion about how your plant compares to its competition in your industry, on a global basis.** **5: superior, 4 better than average, 3 average, 2 equivalent to competitors, 1 poor, low end of industry** (Respondent is plant manager)
Cost	Unit cost of manufacturing
	Inventory turnover
Quality	Conformance to product specifications
	Product capability and performance
Delivery	Cycle time (from raw materials to delivery)
	On-time delivery performance
	Fast delivery
Flexibility	Flexibility to change product mix
	Flexibility to change volume
	Actual Reported Performance Measures
Dimension of Performance	**Calculated based on reported performance** (Respondent is Accounting Manager)
Cost	Manufacturing cost/sales value of production
	Total inventory/manufacturing costs[a]
Delivery	Percent of orders shipped on time
	Average lead time, from the receipt of an order until it is shipped (days)[a]

[a]These measures were transformed (logarithmically) for our analysis.