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Knowledge as a strategic resource in supply chains

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Abstract

Despite the importance of supply chains to firms, we know little about the intangible aspects of why some supply chains excel while others struggle. Building on the resource-based view, strategic choice theory, and configurational research, we suggest that the relative fit among strategy and eight knowledge elements is a key to achieving superior supply chain performance. Using data from 913 entities in supply chains, we conducted a profile deviation analysis by using ideal ''knowledge profiles'' for five strategy types as the benchmarks. Separate analyses were conducted based on the ideal profiles derived from *qualitative*, *quantitative*, and *theoretical* inputs. Overall, the results indicate that the strategy-knowledge fit is associated with chain performance. Our findings lend support to the notion that capitalizing on knowledge can create superior performance in supply chains, but only if the relative emphasis on various knowledge elements matches strategy.

Keywords: Marketing/operations interface; Operation strategy; Supply management

1. Introduction

Why some firms outperform others has long been a central question within the organizational literature (e.g., Hitt et al., 2004; Vorhies and Morgan, 2005). Substantial inquiry has focused on knowledge (i.e., credible information and/or experience—Grant, 1996) as a means to achieve superior performance. Knowledge has been investigated under several monikers, including organizational learning, market orientation, and the knowledge creating company. Regardless of the terms used, the themes across this work are that knowledge can serve as an intangible strategic resource and, as such, is crucial to efforts to create value in a unique, inimitable, and non-transferable way (Wernerfelt, 1984, 2005).

Although much attention has focused on understanding performance differences between firms, little is known about the intangibles associated with why some supply chains outperform others. A supply chain is a ''network of facilities and activities that performs the functions of product development, procurement of material from suppliers, the movement of materials between facilities, the manufacturing of products, the distribution of finished goods to customers, and after-market support for sustainment'' (Mabert and Venkataramanan, 1998, p. 538). The lack of attention to the link between knowledge (as an intangible resource) and supply chain outcomes is unfortunate because firm and chain outcomes are increasingly intertwined. Today, competition pits supply chains against each other in the competitive arena (Ketchen and Guinipero, 2004).

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Firms such as Wal-Mart, Toyota, and Dell have exploited supply chain management skills into dramatic competitive advantages and excellent performance. This highlights the value of 'strategic supply chain management'—viewing supply chains not just as production and distribution mechanisms, but also as important competitive weapons (Hult et al., 2004). These firms' success also suggests that increased scholarly attention to supply chain outcomes is needed.

Building on extant theory and research, we focus on how supply chains' efforts to build and deploy knowledge influence important outcomes. We examine knowledge within two critical operations management functions within supply chains: logistics (the distribution of finished goods to customers) and supply management (procurement of material from suppliers) (cf. Mabert and Venkataramanan, 1998). Our investigation builds on three important theoretical traditions. The resource-based view (e.g., Barney, 1991; Wernerfelt, 1984) is the basis for isolating knowledge elements that may operate as value creating mechanisms for supply chains. Strategic choice theory draws our attention to how these knowledge elements may be differentially emphasized across five supply-chain strategies: prospectors, analyzers, low-cost defenders, differentiated defenders, and reactors (e.g., Miles and Snow, 1978). Configurational inquiry suggests that a profile deviation approach be used to examine how different types of supply chains leverage knowledge into superior performance (e.g., Doty et al., 1993).

Our research question is: how does the confluence of knowledge elements and strategy type relate to supply chain performance? In addressing this question, our study's overall theoretical contribution is developing an amalgam of the three perspectives (the resource-based view of the firm, strategic choice theory, and configurational theory) to explain the interdependencies among critical knowledge elements that result in superior supply chain performance within different strategy types. Empirically, we fill a gap in the operations management literature by providing quantitative support for theorized relations among knowledge elements, supply chain strategy, and performance. In doing this, we develop ideal knowledge profiles for the viable strategy types via qualitative, quantitative, and theoretical means. The next section addresses the theoretical background and hypotheses, followed by the method, analysis, results, and discussion.

2. Theoretical background and hypotheses

The common approach to examining how constructs, such as knowledge, strategy, and performance, are intertwined is to test hypothesized linear relationships that are expected to reflect each member of a sample. However, a significant drawback to this methodology is that critical relationships may be overlooked empirically (Miller, 1987). For example, if stressing organizational memory helps outcomes for some supply chains while decreasing the same outcomes among other chains, these effects, in essence, "wash out" in an analysis that spans the entire sample. As such, this aggregate analysis is problematic when examining the true effects of how strategic "knowledge" elements are organized as a collection to reap advantages in chains. Instead, a more appropriate analysis of knowledge within supply chains is via a focus on configurations—the simultaneous consideration of multiple interwoven factors (Miller, 1997). As applied in our study, a configuration refers to the constellation of knowledge elements and strategy (e.g., Meyer et al., 1993). Using configurational research as the foundation, the closer a supply chain matches an ideal constellation, the better its performance (cf. Vorhies and Morgan, 2003, 2005). Equally important, our focus on configurations avoids the aggregation problem described above (e.g., Miller, 1987).

Venkatraman (1990) suggests that our approach to fits (i.e., where fit among several knowledge elements and different strategy types is examined concurrently and linked to performance) requires configuration to be assessed using profile deviation analysis. Such an analysis portrays fit as the extent to which the knowledge elements of a supply chain vary from those of an "ideal" profile for its strategic type (Zajac et al., 2000). Next, we detail the theoretical basis for the elements of the profiles (knowledge elements and strategy) and the outcomes examined in this study. We then develop hypotheses relating the profiles and the outcomes.

2.1. Knowledge elements

We relied on the resource-based view (RBV), with complementary underpinnings in the knowledge-based view (e.g., Grant, 1996), as the foundation for isolating knowledge elements that are critical in the creation of strategic resources. The RBV asserts that a firm's resources shape important outcomes (e.g., Wernerfelt, 1984). Resources consist of physical and intangible assets as well as organizational capabilities (e.g., Wernerfelt, 1984, 2005). Drawing on the RBV, we suggest that in addition to its role in firms, knowledge can contribute substantially to an intangible "strategic resource" in supply chains as well (cf. Grant, 1996;

Hult et al., 2002, 2004). Chains that possess certain strategic resources have advantages over chains lacking such resources (e.g., Barney, 1991; Hult et al., 2004).

For knowledge to be a strategic resource, several criteria must be met (Barney, 1991). First, the resource must be *valuable*, meaning that knowledge should help to create outputs that are important to customers. Knowledge appears to overcome this barrier, particularly in supply chains (Hult et al., 2004). For example, Meyer (1993) argues that gaining speed efficiency in supply chains requires adopting a paradigm focused on knowledge initiatives. As such, knowledge is a valuable resource in supply chains in that it subtlety but determinedly steers members toward satisfying customers' needs.

A strategic resource also must be *rare*, meaning that the resource is found infrequently and that close substitutes are not obtainable. The phenomenon of knowledge encompasses both a process and a structure (e.g., Slater and Narver, 1994). The process is associated with the development of new knowledge that has the possibility to change behavior (Huber, 1991). The structural element of knowledge refers to the supply chain's ability to implement behaviors suggested by the new knowledge it develops (Garvin, 1993). Thus, chains that stress knowledge endeavors must learn and then behave accordingly to reap the advantages of knowledge initiatives. Relatively few supply chains are able to meet these dual challenges (cf. Slater and Narver, 1995). Further, other assets cannot easily substitute for knowledge, especially in supply chains (Hult et al., 2004).

Finally, a strategic resource must be *inimitable*, meaning that buying or copying the resource is difficult. Knowledge in supply chains is "history-dependent" (Levitt and March, 1988) in that supply chains adapt their operations based on interpretations of past experiences. The operations that result from this process may be evident to participants in other chains, but the idiosyncratic history that underlies knowledge cannot be duplicated. Thus, the transfer of experiences into innovative action is inimitable. More specifically, knowledge is an intangible phenomenon, one that cannot be easily transferred or bought because it is embedded in the chain's fabric (Barney, 1991; Grant, 1996).

Founded within the logic of the RBV and related literatures, eight knowledge elements appear critical in the formation of ideal performance-driving profiles in supply chains. These eight elements are: memory, tacitness, accessibility, quality, use, intensity, responsiveness, and learning capacity. We define *memory* as the achieved level of knowledge, experience, and familiarity with supply chain operations (Moorman and Miner, 1997). Knowledge *tacitness* is the degree of codifiability and teachability of the wisdom in the chain (Simonin, 1999; Zander and Kogut, 1995). Knowledge *accessibility* refers to the extent to which wisdom is easily available in the chain (O'Reilly, 1982). Knowledge *quality* is defined as the relevance, accuracy, reliability, and timeliness of chain wisdom (Low and Mohr, 2001). Knowledge *use* is defined as the application of chain wisdom to solve a particular problem or a make a particular decision (Deshpandé and Zaltman, 1982). Knowledge *intensity* refers to the extent to which a chain relies on the wisdom innate in its culture as a means to build a competitive edge (Autio et al., 2000). *Responsiveness* refers to the action taken as a function of knowledge that has been built in the chain (Kohli et al., 1993). Finally, *learning capacity* is defined as the extent to which a chain continuously builds its usable knowledge to develop a foundation for its competitive edge (cf. Grant, 1996; Hurley and Hult, 1998).

2.2. Strategy types

Building on Miles and Snow (1978), whose groundbreaking work was rooted in strategic choice theory (Child, 1972), Walker and Ruekert (1987) delineated five strategic types. Each strategy type was a direct reflection of its product-market strategy choices. First, *prospectors* "take on an aggressive new product-market position within broadly defined markets, and tend to be industry pioneers in the creation and development of new technologies" (Walker and Ruekert, 1987, p. 16). Prospectors are often the first to adopt new concepts and new tools when the opportunity arises, with the notion constantly to push performance boundaries. Their aim is always to have the most innovative chain operations. Next, *analyzers* "represent an intermediate form of strategy ... [they] maintain a secure market position within a core market ... but also seek new market positions" (Walker and Ruekert, 1987, p. 16). In this role, analyzers are rarely the pioneers of new chain operations. Instead, by monitoring others' chain activities, they tend to pursue a second to enter approach that is often more efficient and effective.

The defender category developed by Miles and Snow (1978) includes both strategy types that attempt to be successful through low-cost operations and those that seek success by providing high product quality and/or superior service. Walker and Ruekert's (1987) work suggests that these different defender strategies require very different foci (Olson et al., 2005). Specifically, *low-cost defenders* are seldom at the head of chain development practices. Their focus is instead on lowering costs of existing (niche) chain practices to maintain a stable market domain. *Differentiated defenders* focus on capitalizing on supply chain activities where they possess strong abilities. Their costs are usually above the industry average, while their focus is on maintaining a stable market domain by protecting their niches, which are often peculiar to specialized customer needs. *Reactors* are the most elusive of the strategy types. Conventional wisdom suggests that reactors do not have a consistent strategy (e.g., Zajac and Shortell, 1989). Instead, reactors primarily respond to short-term trends and events. Drawing on the RBV, our contention is that effective fit between the eight knowledge elements and a particular strategy type is valuable, rare, and inimitable, and as such serves as a strategic resource (cf. Grant, 1996; Wernerfelt, 1984).

2.3. Supply chain performance

The literature on ''competitive priorities'' forms the basis for the performance variable included in our study. This works suggests that four ''priorities'' are directly tied to supply chain performance. *Speed* refers to the time it takes from initiation to completion of an order fulfillment process in the supply chain (e.g., Mentzer et al., 2001). The focus of speed is the ability to deliver on time, according to a set schedule. In such cases, the organization may not have the least costly, greatest flexibility, or the highest quality process, but is able to compete on the basis of reliably delivering products when promised (Ward et al., 1998).

Quality, *cost*, and *flexibility*, in our study, are tied to the order fulfillment process itself, not directly to the product or service resulting from it. Supply chains that stress quality-based operations continually focus on improving their supply chain processes to increase product reliability and customer satisfaction (Youndt et al., 1996). Cost-driven supply chains strive to create customer value by either reducing costs or increasing benefits in the supply chain equation (i.e., value = benefits/costs) (Ward et al., 1998). Flexibility refers to a supply chain's agility, adaptability, and responsiveness to the needs of its users (Youndt et al., 1996).

2.4. Hypotheses

This study focuses on configurations—groups of supply chains displaying a common profile of conceptually independent characteristics. As noted by Meyer et al. (1993), a diverse set of theories including organizational ecology, institutional theory, and social construction suggest that key organizational characteristics coalesce to give rise to a limited number of configurations in any context. These theories share the belief that configurational inquiry is valuable to diagnosing relations among key variables, such as knowledge, strategy, and performance.

Our conceptualizing draws on Miller's (1987) concept of configurational imperatives. An imperative is a powerful force that drives important variables toward an ideal profile-defining alignment. For example, a cluster of attributes shared among configurations shaped by the ''structural imperative'' includes rigid bureaucratic structures, limitation of strategic actions to existing or predictable niches, minimal adaptation to environmental change, and using co-optation to attain scarce resources (Miller, 1987). The structural imperative leads organizations toward configurations, such as the tobacco monopoly described by Crozier (1964) or Mintzberg (1979) machine bureaucracy. In contrast, the ''strategic'' imperative drives firms that exhibit a strong planning orientation. By extension, the strategic imperative underlies configurations that possess a broad range of strategic possibilities, are capable of reconstructing structure around strategy, and take proactive stances toward environmental change. Many multi-business firms resemble this configuration.

Importantly, any given imperative is thought to act as an underlying configurational determinant for only a subset of entities. For example, Miller (1987) suggests that the structural imperative is relevant to large organizations that enjoy patents and other trade protections, whereas the strategic imperative dominates among firms with a strong commitment to strategy, such as those attempting turnaround. Thus, multiple imperatives, and multiple configurations, may be evident in any given setting. Further, an imperative may give rise to more than one configuration depending on goal orientation, as evidenced by multi-business firms arising from the strategic imperative.

Miller (1987) identified four imperatives: strategy, structure, leadership, and environment. Miller notes that the four imperatives are ''middle range'' (pp. 686, 699) theoretical concepts with deep roots in the literature. As such, the four imperatives can explain the origins of configurations in some, but not all, contexts (cf. Pinder and Moore, 1979). As traditional imperatives, they probably enjoy their strongest explanatory power in well-understood situations. One implication is that additional imperatives operate and perhaps dominate in other contexts, such as in supply chains. Our suggestion is that different arrays of knowledge elements serve as imperatives underlying different ideal supply chain profiles. Theory has not yet advanced to the point of providing likely candidates for each of the supply chain strategies. Thus, drawing on the conceptual material above, our prediction is limited to:

Hypothesis 1. The ideal profiles of knowledge elements will differ across supply chain strategies.

A central tenet of configurational theorizing is that strong fit among the elements that comprise a configuration enhances effectiveness. Drazin and Van de Ven (1985, p. 335) captured this principle effectively in noting, "deviation from ideal type designs should result in lower performance." Doty, Glick, and Huber's (1993) subsequent test using profile deviation to examine Miles and Snow's typology explained 24% of the variance in organizational effectiveness. Our second prediction extends this tenet into the supply chain context to consider ideal profiles of strategy and knowledge. Specifically, we predict:

Hypothesis 2. The closer a supply chain matches an ideal profile of knowledge elements and strategy, the better the supply chain's performance.

3. Method

3.1. Samples

To examine the hypotheses, we gathered data from separate samples of logistics and supply management (purchasing) professionals who did not originate from the same organization. Thus, our study of supply chains incorporated two critical marketing functions. Prior to data collection, we assessed the face validity of the scale items and the general quality of the research design via pretests involving seven academics and two logistics- and two supply management executives. To ensure the quality of informants, we omitted any potential respondents who were not in a management position in logistics or supply management. We also instructed respondents to answer the survey only if they had a high degree of knowledge of logistics or supply management, respectively, within the context of order fulfillment processes.

3.1.1. Logistics sample

The Council of Supply Chain Management Professionals (CSCMP) provided the sampling frame of logistics professionals. Founded in 1963, CSCMP is a professional organization consisting of about 14,000 individuals who have responsibilities in logistics and related functions. We restricted our logistics sample to manufacturing settings. Our sampling frame of 4000 logisticians had titles such as Director of Logistics, Manager of Corporate Logistics, Vice President of Global Logistics, and Senior Director of Logistics. The request for survey participation was relayed via email and the survey was posted online. Of the 4000 people targeted, 545 responded for an effective response rate of 16.9% (781 surveys were non-deliverable). The organizations represented averaged 52 years of operations and 11,695 employees.

3.1.2. Supply management sample

The Institute of Supply Management (ISM) provided the sampling frame of supply management (purchasing) professionals. Founded in 1915, ISM is a professional organization consisting of about 45,000 individuals who have responsibilities in purchasing and related functions. As with the logistics sample, we restricted the ISM sample to manufacturing settings. A total of 3000 requests for participation were sent either online (1700) or via regular mail (1300) depending on available contact information. In the ISM sample, individuals had such titles as Director of Purchasing, Vice President of Procurement, and Global Purchasing Manager. Regardless of the contact format, respondents were asked to complete the survey online. Of the 3000 people targeted, 368 responded for an effective response rate of 15.6% (642 were non-deliverable). The organizations averaged 55 years of operations and 3080 employees.

3.1.3. Non-response bias and comparison of samples and segments

The extrapolation procedure suggested by Armstrong and Overton (1977) was used to assess potential: (1) non-response bias; (2) differences across the two waves of data collection (1st and 2nd waves); (3) differences across the methods of data collection in the supply management sample (e-mail and regular mail); and (4) differences across the sample types (logistics and supply management). In total, we made 60 comparison tests and found only two differences. First, we found a difference in age (wave 1 age = 56 years, wave 2 age = 45 years) ($p = 0.04$) in the survey mailings to the logistics professionals. Second, we found that size in the logistics sample (11,695 employees) was larger than in the supply management sample (3080) ($p = 0.04$).

3.2. Measures

Appendix A includes all measurement scales. The applicable sources from which the scales were drawn are also included in the appendix, as is the set of instructions used for each category of items. The survey consisted of paragraph descriptor measures for strategy types and Likert-scale items for the eight knowledge elements and performance dimensions.

3.2.1. Strategy types

We used previous work by Doty et al. (1993), Slater and Olson (2000), and Zajac and Shortell (1989) to operationalize strategy types via self-identifying paragraphs. Appendix A includes these paragraphs for all five strategy types. Among our respondents, 162 (17.7%) characterized their supply chain strategy as prospector, 316 (34.6%) as analyzer, 288 (31.5%) as low-cost defender, 72 (7.9%) as differentiated defender, and 75 (8.2%) as reactor. Thus, while we did not expect a priori that reactors would be capable of adopting an ideal knowledge profile, our sample allows for a direct test of this possibility (cf. Snow and Hrebiniak, 1980).

3.2.2. Knowledge measures

Established scales were used to measure supply chain memory, tacitness of knowledge, accessibility of knowledge, quality of knowledge, knowledge use, knowledge intensity, and responsiveness. Learning capacity was measured by a newly constructed scale based on the works by Grant (1996) and Hurley and Hult (1998).

3.2.3. Performance

The competitive priorities literature served as the basis for our focus on outcomes specific to supply chains (e.g., McKone et al., 2001; Youndt et al., 1996). Following this literature base, four elements are tied to superior success in our application area of order fulfillment processes in supply chains: speed, quality, cost, and flexibility. Measures for each dimension was used to develop an overall performance index consisting of equally weighted (0.25) scores for the four dimensions.

4. Analysis

4.1. Analysis of measures

Table 1 reports the correlations among the variables in the study while Table 2 reports the means, standard deviations, and measurement results (i.e., average variances extracted, composite reliabilities, coefficient alphas, factor loadings, and fit indices). A five-step approach was used to assess the measures. First, the robustness of each item across the samples was tested. Two, the robustness of each item across the five strategy types was tested. Three, confirmatory factor analysis using the full sample ($n = 913$) was conducted. Four, the reliability and validity of the scales were assessed. Finally, the potential of the existence of common method bias was tested.

4.1.1. Equivalence of the item loadings across samples

To test the robustness of the survey items, we first conducted a multi-sample CFA. We used the input matrices from the logistics and supply management samples, relying on LISREL 8.72 (Jöreskog et al., 2000). Appropriate β estimates were constrained to be equal and then different across the two samples (Anderson, 1987). Then we evaluated whether the $\Delta\chi^2_{(\Delta \text{d.f.}=1)}$ was significant. The results indicated that of the 58 items, 14 were significantly different ($p < 0.05$) across the logistics and supply management samples (each is marked in Appendix A with a footnote no. "5"). Deleting these 14 items left 44 items for analysis.

4.1.2. Equivalence of the item loadings across strategy types

Next, we conducted a multi-sample CFA using the input matrices from the five strategy types to examine the robustness of each item across strategy types (Jöreskog et al., 2000). Each item loading was examined across the strategies by constraining pairs of β estimates, one pair at a time, to be equal and different across the five types. Then we evaluated whether the $\Delta\chi^2_{(\Delta \text{d.f.}=4)}$ was significant (Jöreskog et al., 2000). The results indicated that of the remaining 44 items, three were significantly different ($p < 0.05$) across the types (each is marked in Appendix A with a footnote no. "6"). Deleting these items left 41 items for subsequent analysis.

4.1.3. Confirmatory factor analysis (CFA)

The next step was conducting a CFA on the remaining 41 items using the full sample ($n = 913$). Based on suggestions by Gerbing and Anderson (1992) and Hu and Bentler (1999), model fits were evaluated using the DELTA2 index, the relative noncentrality index (RNI), the comparative fit index (CFI), the Tucker-Lewis index (TLI), and the root mean square error of approximation index (RMSEA). The CFA resulted in DELTA2, RNI, CFI, and TLI all being 0.96,

Table 1
Correlations ($n = 913$)

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Memory													
2. Tacitness of knowledge	0.44												
3. Accessibility of knowledge	0.62	0.52											
4. Quality of knowledge	0.62	0.48	0.75										
5. Knowledge use	0.48	0.41	0.53	0.63									
6. Knowledge intensity	0.66	0.53	0.63	0.73	0.58								
7. Responsiveness	0.31	0.36	0.38	0.41	0.38	0.35							
8. Learning capacity	0.42	0.43	0.43	0.48	0.42	0.50	0.35						
9. Speed	0.29	0.36	0.38	0.41	0.33	0.39	0.35	0.36					
10. Quality	0.35	0.36	0.37	0.44	0.38	0.44	0.42	0.40	0.67				
11. Cost	0.35	0.39	0.41	0.48	0.35	0.45	0.35	0.37	0.62	0.66			
12. Flexibility	0.33	0.39	0.40	0.44	0.42	0.44	0.38	0.42	0.63	0.66	0.63		
13. Size (employees)	0.01	0.03	−0.05	−0.05	0.01	0.00	−0.04	−0.04	−0.07	−0.02	−0.05	−0.04	
14. Age (years)	−0.09	−0.05	−0.04	−0.04	−0.00	−0.12	−0.03	−0.07	−0.10	0.01	−0.08	−0.09	0.23

All correlations ≥ 0.10 are significant at the $p < 0.05$ level.

and RMSEA = 0.09 ($\chi^2 = 6141.2$, d.f. = 713). Thus, the measurement structure of 12 factors and 41 items produced satisfactory fit statistics.

4.1.4. Reliability and validity assessments

Within the CFA setting, composite reliability was calculated using the procedures outlined by Fornell and Larcker (1981) (coefficient alphas are also included for comparison). Also, the parameter estimates and their associated t-values were examined along with the average variance extracted for each construct (Anderson and Gerbing, 1988). The composite reliabilities for the 12 scales ranged from 0.78 to 0.95 (coefficient alphas ranged from 0.78 to 0.94), the factor loadings ranged from 0.51 to 0.97 ($p < 0.01$), with average variances extracted ranging

Table 2
Basic statistics and confirmatory factor analysis results ($n = 913$)

	Mean	Standard deviation	Variance extracted (%)	Composite reliability	Coefficient alpha	Range of factor loadings
Memory	5.22	1.25	74.5	0.92	0.90	0.64–0.94
Tacitness of knowledge	3.65	1.28	59.3	0.85	0.83	0.65–0.89
Accessibility of knowledge	4.77	1.38	82.3	0.93	0.92	0.88–0.95
Quality of knowledge	4.93	1.20	78.0	0.95	0.94	0.81–0.93
Knowledge use	5.27	1.02	65.4	0.93	0.89	0.71–0.85
Knowledge intensity	4.58	1.52	82.7	0.93	0.94	0.85–0.94
Responsiveness	5.51	1.04	79.5	0.88	0.84	0.80–0.97
Learning capacity	4.64	1.35	80.3	0.92	0.91	0.83–0.94
Speed	4.78	1.11	55.3	0.78	0.78	0.51–0.84
Quality	4.80	1.13	66.0	0.85	0.86	0.65–0.90
Cost	4.40	1.14	62.0	0.83	0.83	0.58–0.90
Flexibility	4.52	1.16	69.0	0.87	0.88	0.65–0.92

Fit statistics

χ^2	6141.2
Degrees of freedom	713
DELTA2	0.96
RNI	0.96
CFI	0.96
TLI	0.96
RMSEA	0.09

from 55.3 to 82.7%. In addition, the 41 purified items were found to be reliable and valid when evaluated based on each item's error variance, modification index, and residual covariation. The skewness and kurtosis results of each item indicated that the data were normally distributed.

Discriminant validity was assessed in two ways. First, we calculated the shared variance between pairs of constructs and verified that it was lower than the average variances extracted for the individual constructs (Fornell and Larcker, 1981). In all cases, the average variances extracted were higher than 50%, the recommended cutoff by Fornell and Larcker (1981), and higher than the associated shared variance. Second, we analyzed all possible pairs of constructs in a series of two-factor CFA models using LISREL 8.72 (e.g., Bagozzi and Phillips, 1982). Each model was run twice—once constraining the ϕ coefficient to unity and once freeing this parameter. A χ^2-test was used to assess if the $\Delta\chi^2$ was significantly lower for the unconstrained models (Anderson and Gerbing, 1988). The critical value ($\Delta\chi^2_{(\Delta \mathrm{d.f.}=1)} > 3.84$) was exceeded in all cases. Overall, we found the 12 constructs and the 41 indicators to be reliable and valid.

4.1.5. Testing for potential common method bias

We used a confirmatory factor-analytic approach to Harmon's one-factor test. The rationale for this test is that if common method bias poses a serious threat to the analysis and interpretation of the data, a single latent factor would account for all manifest variables (Podsakoff and Organ, 1986). A worse fit for the one-factor model would suggest that common method variance does not pose a serious threat. The one-factor model yielded a $\chi^2 = 19164.4$ with 779 degrees of freedom (compared with the $\chi^2 = 6141.2$ and d.f. = 713 for the measurement model). The fit is considerably worse for the unidimensional model than for the measurement model, suggesting that common method bias is not a serious threat in the study.

4.2. Hypothesis testing

To address Hypothesis 1, we identified ideal supply chain profiles that could be used as the benchmark against which the fit of all members of a strategy type could be examined (e.g., Doty et al., 1993; Ketchen et al., 1993; Vorhies and Morgan, 2003, 2005). Hypothesis 1 would be supported if the ideal profiles associated with each strategy type have different emphases across the knowledge elements. To examine the hypotheses rigorously with sound theoretical and empirical rationale, we used three very different but complementary approaches to define the ideal profiles: qualitative, quantitative, and theoretical. First, the *qualitative* approach was based on work by Doty (1990) and Doty et al. (1993). Doty, Glick, and Huber (1993, p. 1212) argue that "the best approach for defining ideal profiles for theories that develop a priori ideal types is the method of theoretical specification, which relies on ratings by experts who are very familiar with the descriptions of the ideal types provided by the original theorist." Consistent with the work by Doty (1990) and Doty et al. (1993), the ideal profiles involving the eight knowledge elements for each strategy types were developed by the original experts—Raymond E. Miles and Charles C. Snow, who kindly gave their time to assist with our study. The means of the expert ratings were used to develop ideal profiles (Doty et al., 1993).

Second, the *quantitative* approach followed recent work in marketing (Vorhies and Morgan, 2003, 2005). Using this approach, we empirically identified high-performing supply chains implementing a given strategy in the sample studied and calibrated all other cases relative to this ideal profile (e.g., Doty et al., 1993). Specifically, to identify the ideal profiles we examined the frequencies of the performance variable (i.e., the combined effect of speed, quality, cost, and flexibility) and selected a cut-off within the top 10% of the performers (Venkatraman and Prescott, 1990) where a significant drop-off in performance was apparent. This resulted in a range of 4–17 cases being included in each ideal profile.

Third, the *theoretical* approach was based on the collective logic in the scholarly works related to the knowledge constructs included in this study (i.e., Autio et al., 2000; Deshpandé and Zaltman, 1982; Grant, 1996; Hurley and Hult, 1998; Kohli et al., 1993; Low and Mohr, 2001; Moorman and Miner, 1997; O'Reilly, 1982; Simonin, 1999; Zander and Kogut, 1995). Although it is likely that a diminishing return will eventually take place (and a negative effect may eventually occur), the original authors of the knowledge constructs we study unanimously suggest that the degree of memory, tacitness, accessibility, quality, use, intensity, responsiveness, and learning capacity ideally be as high as possible in any given organization to reap advantages vis-à-vis the competition. As such, the theoretical approach involved developing ideal profiles by assigning the maximum scores on the knowledge elements for each strategy type.

To address Hypothesis 2, we calculated the Euclidian distance (ED) from the ideal profile for its strategic type across the eight knowledge elements (e.g., Drazin and Van de Ven, 1985) using the following formula:

$$\mathrm{ED} = \sqrt{\sum_{j}^{N} (X_{sj} - \overline{X}_{ij})^2},$$

where X_{sj} is the score for a supply chain case on the jth element, $\overline{X}_{ij}$, the mean for the ideal supply chain profile along the jth element, and j, the number of knowledge elements (i.e., 1, 2, 3, ..., 8). These calculations establish profile deviation scores for each case in the dataset. Each score represents a particular supply chain's "distance" from the ideal profile for a particular strategy type. As a collective set, the profile deviation scores for all cases within a strategy type were then regressed, using the OLS method, on the summated performance variable. Hypothesis 2 would be supported if the results indicate that deviation from the ideal knowledge-based profile is negatively related to the performance variables for each of the strategy types.

5. Results

Table 3 summarizes the mean scores for the ideal knowledge profiles based on strategy types (Hypothesis 1) for the qualitative, quantitative, and theoretical approaches. Table 4 reports the OLS regression results for the profile fit with strategic type and its effect on performance (Hypothesis 2). For all models, the variance inflation factors (VIF) were lower than 2.05, indicating that multicollinearity does not inhibit the analysis.

As the results in Table 3 indicate, the ideal profiles associated with each strategy type have different emphases across the knowledge elements, providing support for Hypothesis 1. In describing the emphases here, we use the "average" scores in Table 3 as our primary metric because it incorporates all the approaches to establishing ideal profiles (i.e., qualitative, quantitative, and theoretical). A cut-off of $\geq$6.00 was used for inclusion to correspond to "agreement" on the seven-point Likert scale. Using these criteria, at least five elements appear important to prospector supply chains' performance: responsiveness (mean of 6.78 out of 7.00), quality of knowledge (6.56), accessibility of knowledge (6.50), knowledge intensity (6.38), and learning capacity (6.36). Similar to prospectors, learning capacity (6.43), responsiveness (6.42), knowledge intensity (6.29), quality of knowledge (6.19), and accessibility of knowledge (6.02) are important to analyzer supply chains. However, good-performing analyzer supply chains were also found to stress memory (6.18). For low-cost defenders, memory (6.58), knowledge intensity (6.44), knowledge use (6.30), and accessibility of knowledge (6.00) drive success. The smallest set of knowledge elements that drive superior performance was found for differentiated-defender supply chains; these chains were successful mainly due to accessibility of knowledge (6.33), quality of knowledge (6.22), and memory (6.06). Finally, interestingly, using the input from the quantitative and theoretical approaches only since the expert raters did not provide "ideal" scores for reactors due to their lack of a consistent strategy (e.g., Miles and Snow, 1978), we found that reactor supply chains owe their (potential short-term) success to learning capacity (6.13), memory (6.10), and quality of knowledge (6.02).

Prior to analyzing Hypothesis 2, it was important to validate three assumptions regarding our strategy type conceptualization. First, the conceptualization that the knowledge elements should be examined as a set instead of modeled independently and directly on performance assumes that valuable interdependencies exist among these knowledge elements. To verify this assumption, we followed the approach by Vorhies and Morgan (2005) and conducted a higher-order analysis, via Structural Equation Modelling (using LISREL 8.72—Jöreskog et al., 2000), wherein the eight knowledge constructs were modeled as first-order indicators with a second-order factor labeled "knowledge resource" capturing the covariance among the eight knowledge elements. In this analysis, we found that the higher-order factor is strongly and positively related to performance (parameter estimate = 0.62; $p < 0.01$). We also found that the indirect paths linking the knowledge elements with outcomes by way of the higher-order factor are stronger than the direct paths from the knowledge elements to the outcomes. The parameters estimates for the indirect paths range from 0.51 to 0.89 (all paths had $p < 0.01$) while the direct paths range from 0.02 to 0.22 with only four of the eight paths being significant at $p < 0.05$. These results indicate that in designing benchmarking activities for supply chains, the eight knowledge elements should be examined as an interdependent set.

Next, the equifinality assumption associated with configuration theory suggests that any of the viable strategic types can result in superior performance (Gresov and Drazin, 1997) and that overall performance is more dependent on how well the strategy is implemented than upon a specific strategy being selected (Olson et al., 2005). As such, we used analysis of variance (ANOVA) to examine that performance variations between cases in our dataset were not a

Table 3
Ideal mean scores of knowledge profiles

	Qualitative	Quantitative	Theoretical	Average
Prospectors				
Memory	4.00	6.50	7.00	5.83
Tacitness of knowledge	5.00	5.28	7.00	5.76
Accessibility of knowledge	6.50	6.00	7.00	6.50
Quality of knowledge	6.50	6.18	7.00	6.56
Knowledge use	5.00	5.94	7.00	5.98
Knowledge intensity	5.50	6.63	7.00	6.38
Responsiveness	7.00	6.33	7.00	6.78
Learning capacity	6.50	5.57	7.00	6.36
Analyzers				
Memory	6.00	5.53	7.00	6.18
Tacitness of knowledge	4.00	4.33	7.00	5.11
Accessibility of knowledge	6.00	5.06	7.00	6.02
Quality of knowledge	6.00	5.57	7.00	6.19
Knowledge use	4.00	5.75	7.00	5.58
Knowledge intensity	6.50	5.38	7.00	6.29
Responsiveness	6.00	6.27	7.00	6.42
Learning capacity	7.00	5.28	7.00	6.43
Low-cost defenders				
Memory	7.00	5.75	7.00	6.58
Tacitness of knowledge	4.00	4.08	7.00	5.03
Accessibility of knowledge	5.50	5.50	7.00	6.00
Quality of knowledge	5.00	5.70	7.00	5.90
Knowledge use	6.00	5.91	7.00	6.30
Knowledge intensity	7.00	5.33	7.00	6.44
Responsiveness	3.00	6.25	7.00	5.42
Learning capacity	3.00	5.38	7.00	5.13
Differentiated defenders				
Memory	5.50	5.69	7.00	6.06
Tacitness of knowledge	5.50	5.06	7.00	5.85
Accessibility of knowledge	6.50	5.50	7.00	6.33
Quality of knowledge	5.50	6.15	7.00	6.22
Knowledge use	5.00	5.67	7.00	5.89
Knowledge intensity	5.50	5.00	7.00	5.83
Responsiveness	4.50	6.00	7.00	5.83
Learning capacity	4.50	5.44	7.00	5.65
Reactors[a]				
Memory	N/A	5.20	7.00	6.10
Tacitness of knowledge	N/A	3.15	7.00	5.08
Accessibility of knowledge	N/A	4.20	7.00	5.60
Quality of knowledge	N/A	5.04	7.00	6.02
Knowledge use	N/A	4.90	7.00	5.95
Knowledge intensity	N/A	3.53	7.00	5.27
Responsiveness	N/A	4.93	7.00	5.97
Learning capacity	N/A	5.25	7.00	6.13

[a] Since reactors do not have a well-formed strategy (e.g., Miles and Snow, 1978), the expert raters who provided the ideal scores for the "qualitative" analysis did not assign scores to this group. Thus, the mean of the quantitative and theoretical approaches was used to calculate the "average" scores for reactors.

function of strategy type. The ANOVA results revealed no significant differences between strategy types on performance ($F = 1.38$). Finally, we compared performance outcomes of deviation from two different ideal knowledge-based supply chain profiles, one developed from cases of the same strategic type and one developed regardless of the type (e.g., Venkatraman, 1990; Vorhies and Morgan, 2003). The results indicate that calibrating ideal supply chain profiles within strategy type produces greater beta coefficients (Cohen et al., 2003) and larger

Table 4
Profile fit with strategic type and performances

Predictor variables	Qualitative	Quantitative	Theoretical
Prospectors ($n = 162$)			
KB-SC profile deviation[a]	-0.28^{**}	-0.40^{***}	-0.53^{***}
Size (log)	0.06	0.08	0.06
Age (log)	−0.01	−0.03	−0.08
R^2	0.09	0.14	0.29
F-value	2.13^{**}	4.74^{***}	9.12^{***}
Analyzers ($n = 316$)			
KB-SC profile deviation[a]	-0.38^{***}	-0.37^{***}	-0.47^{***}
Size (log)	-0.15^{*}	−0.13	-0.17^{**}
Age (log)	0.17^{*}	0.21^{**}	0.17^{**}
R^2	0.17	0.16	0.25
F-value	9.08^{***}	9.31^{***}	14.39^{***}
Low-cost defenders ($n = 288$)			
KB-SC profile deviation[a]	-0.27^{***}	-0.45^{***}	-0.49^{***}
Size (log)	−0.15	−0.02	−0.11
Age (log)	-0.22^{**}	-0.21^{**}	-0.21^{**}
R^2	0.16	0.22	0.33
F-value	6.84^{***}	10.51^{***}	17.53^{***}
Differentiated defenders ($n = 72$)			
KB-SC profile deviation[a]	-0.43^{**}	-0.53^{***}	-0.62^{***}
Size (log)	0.04	0.10	−0.01
Age (log)	−0.18	−0.17	−0.05
R^2	0.26	0.35	0.41
F-value	2.95^{***}	4.50^{**}	5.78^{***}
Reactors ($n = 75$)			
KB-SC profile deviation[a]	N/A	-0.42^{**}	-0.41^{***}
Size (log)	N/A	-0.29^{*}	−0.07
Age (log)	N/A	0.02	0.01
R^2	N/A	0.28	0.18
F-value	N/A	4.55^{***}	2.62^{**}

Standardized regression results.
[a] KB-SC profile deviation = knowledge-based supply chain profile deviation.
* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

explanatory power (Chow, 1960). Given that these three assumptions support the robustness of the hypotheses and the data used, we continued by examining Hypothesis 2.

As shown in Table 4, deviation from a supply chain's ideal profile was consistently associated with decreased performance, supporting Hypothesis 2. In each case we accounted for two control variables—size and age, indicated by the natural logarithm of the number of employees and years, respectively. For the *qualitatively* derived ideal profiles (using expert raters—Doty et al., 1993), the results were significant across all five groups: prospectors ($\beta = -0.28$), analyzers ($\beta = -0.38$), low-cost defenders ($\beta = -0.27$), and differentiated defenders ($\beta = -0.43$). Reactors were not included in this analysis since they do not have a well-formed strategy (Miles and Snow, 1978). For the *quantitatively* derived ideal profiles (using the top performers in the dataset studied—Vorhies and Morgan, 2003), the results were significant across all four viable strategies—prospectors ($\beta = -0.40$), analyzers ($\beta = -0.37$), low-cost defenders ($\beta = -0.45$), differentiated defenders ($\beta = -0.53$) as well as reactors ($\beta = -0.42$). Likewise, for the *theoretically* derived ideal profiles (whereas the literature suggests that maximum scores on each knowledge element is preferred), the results were significant across all five groups: prospectors ($\beta = -0.53$), analyzers ($\beta = -0.47$), low-cost defenders ($\beta = -0.49$), differentiated defenders ($\beta = -0.62$), and reactors ($\beta = -0.41$).

To assess the robustness of the results involving Hypothesis 2, we examined an alternative ''non-ideal'' model, where the ''average performers'' (those cases at the median on the performance scale) were selected from each strategy group to form the ''average benchmark'' model used to create profile deviation scores. We found that the results support the notion that calibrating ideal supply chain profiles within strategy type produces stronger profile deviation coefficients (Cohen et al., 2003) and larger explanatory power (Chow, 1960) than the average benchmark cases. Overall, the results indicate that the profile deviation predictor is supported in the 14 possible testing scenarios (see Table 4), which lends strong support for Hypothesis 2.

6. Discussion

Our study adds to the body of knowledge about why some supply chains outperform others—a central issue to researchers and managers alike. The research question guiding our study was: how does the confluence of knowledge elements and strategic types relate to supply chain performance? In elaborating on this question, Hypothesis 1 accurately predicted that ideal profiles of knowledge elements would differ across supply chain strategies. Likewise, Hypothesis 2's prediction that the closer a supply chain matches an ideal profile of knowledge elements and strategy, the better the supply chain's performance also held true in all analyses conducted. Table 5 summarizes the key knowledge elements within each strategy type (i.e., the imperatives that seem to drive each configuration of knowledge and strategy).

A number of practical and scholarly implications can be derived from this study by considering the patterns in Table 5. The knowledge profiles in Table 5 represent the

Table 5
Key knowledge elements within strategic types[a]

	Prospectors	Analyzers	Low-cost defenders	Differentiated defenders	Reactors
Memory		⊗	⊗	⊗	⊗
Tacitness of knowledge					
Accessibility of knowledge	⊗	⊗	⊗	⊗	
Quality of knowledge	⊗	⊗		⊗	⊗
Knowledge use			⊗		
Knowledge intensity	⊗	⊗	⊗		
Responsiveness	⊗	⊗			
Learning capacity	⊗	⊗			⊗

[a] Based on scores ≥6.00 on the "average scores" from Table 2.

preferred constellations of knowledge elements for each strategy type. These knowledge constellations suggest that managers should manipulate the implementation of certain knowledge elements over others, depending on the supply chain's strategic type and performance focus. Specifically, the vertical patterns in Table 5 indicate which knowledge elements are critical within each strategy. For low-cost defenders, differentiated defenders, and reactors, between three and four elements were vital. For prospectors and analysers; however, five and six of the eight elements were keys to success, respectively.

6.1. Prospectors

High performing prospectors effectively managed responsiveness, quality of knowledge, accessibility of knowledge, knowledge intensity, and learning capacity. Interestingly, knowledge use was one of the few knowledge elements that were not vital to prospectors (knowledge use is the application of wisdom to solve problems and make decisions—Deshpandé and Zaltman, 1982). One interpretation of these results is that prospector supply chains have to adopt a problem-solving orientation while also drawing extensively on knowledge embedded in the chain.

6.2. Analyzers

In Miles and Snow's (1978) typology, analyzers were depicted as the most difficult to manage because they confronted the challenges of maintaining a stable core of products while also seeking new market opportunities. Our results support this contention. Specifically, successful analyzers in our sample were those skilled at learning capacity, responsiveness, knowledge intensity, quality of knowledge, memory, and accessibility of knowledge. Managers of these supply chains must master more than twice as many knowledge elements as their counterparts in charge of differentiated defenders (and reactors), as well as more than low-cost defenders and prospectors. If our findings hold in future research for other intangible (and tangible) aspects of the supply chain beyond knowledge, this would represent an important step forward in understanding how the Miles and Snow typology applies to the supply chain context.

6.3. Low-cost defenders

Successful low-cost defenders relied on memory, knowledge intensity, knowledge use, and accessibility of knowledge. Viewed as a set, the four knowledge elements needed by low-cost defenders are consistent with the emphasis on "efficiency" that Miles and Snow attributed to their combined defender type. When facing strategic as well as operational issues, low-cost-defender supply chains must strive to find knowledge efficiently. Tapping existing knowledge (memory) that is relatively easy to access (accessibility) is often the most efficient use of resources. This knowledge must not simply be elicited, but also capitalized on in strategic analysis and decision-making (knowledge use) to gain an edge over the competition (knowledge intensity) for low-cost defenders.

6.4. Differentiated defenders

Differentiated defenders that prospered relied heavily on accessibility of knowledge, quality of knowledge, and memory—which also represent three of the six knowledge elements that analyzers preferred in their quest to achieve superior performance. Differentiated defenders have a difficult balancing act to follow—they strive to protect a niche through boldness and (often great) specialization that lead to (very) customized products or services rather than the more traditional cost containment exemplified by many supply chains. In some cases, differentiated defender-chains must make rapid changes to maintain their customer base. Given this unpredictable requirement of differentiators, the existing wisdom (memory) that provides the foundation for decisions must be easily available (accessibility) as well as be relevant, accurate, reliable, and timely (quality of knowledge).

6.5. Reactors

In contrast to research on the four so-called ''viable strategies'' discussed above (e.g., Walker and Ruekert, 1987; Slater and Olson, 2000), the potential role and viability of reactors is much less understood (or even supported). However, our research indicates that the reactor type may in fact be a viable strategy at least to achieve short-term performance in supply chains. This is an important finding because most studies that build on the Miles and Snow (1978) typology ignore reactors in their analysis, either because of lack of theoretical support for this category in the context of what is being studied and/or because an adequate sample size for reactors cannot be achieved. As a result, little is known about reactors' potential for success and what the makeup should be for successful reactors. Our findings contradict Miles and Snow's (1978) original conceptualization of reactors as a ''residual type'' without an ideal profile that can drive superior success. Specifically, reactors were found to be a distinct type with certain characteristics, supporting the thoughts presented by Snow and Hrebiniak (1980). They are likely to stress learning capacity, memory, and quality of knowledge in their quest to be successful (at least in the short term). However, if the maximum-score-based ''theoretical'' approach is omitted from the analysis, reactors appear to be less responsive than other supply chains (an average of around 5 or below out of 7 on the performance metric versus 6 or above for the other groups). Thus, more research is needed to understand what knowledge elements (and other critical strategy, structure, and behaviors elements) drive reactors' success. The next section elaborates on the study's limitations as a means to outline additional avenues for future research.

7. Limitations and future research

Our study has at least four major limitations that should be taken into account when interpreting the findings. Each limitation serves as an avenue for future research. First, although we researched the literature extensively to identify theoretically sound knowledge elements pertaining to supply chains, future research may lead to the uncovering of additional critical knowledge elements, possibly leading to added conceptual refinement and extension. Second, our focus was on the ''fit'' between knowledge elements and strategy types; as such, we deliberately did not attempt to study the interrelationships among the eight knowledge elements. Future research should examine the optimal co-alignment, interrelationships, and path flow of the knowledge elements to deliver superior performance. Third, we opted to study logistics and supply management (purchasing) functions in supply chains given those functional areas' prominence in the operations management literature. Future studies need to examine other functions important to supply chains (e.g., product development, innovation). Finally, we limited the scope of our study to manufacturing firms and order fulfillment processes. Broadening the study of knowledge elements to other firms and chain processes may lead to conceptual refinement and insights. Hopefully, our study can serve as the starting point for future research in this important area of inquiry.

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Appendix A. Measures[4]

Strategy types (based on work by Miles and Snow (1978) and Walker and Ruekert (1987); descriptions adapted from Doty et al. (1993) and Slater and Olson (2000)). The word ''logistics'' in the statements below was replaced with ''supply management'' in the supply management survey.

Instructions: This section of the survey deals with logistics strategies that an organization can adopt. Most organizations use a blend of strategies to be successful. Please read each of the short descriptions below. Then indicate which description seems to be the closest to your organization's logistics practices.

[4] All items used a 7-point Likert-type scale ranging from ''strongly disagree'' to ''strongly agree.'' The word ''logistics'' was changed to ''supply management'' for the supply management sample.

- *Prospector*: These organizations are frequently the first to adopt new logistics concepts. They do not hesitate to use new logistics tools where there appears to be an opportunity. These organizations concentrate on logistics tools that push performance boundaries. Their proposition is to always have the most innovative logistics practices, whether based on substantial performance improvement or cost reduction.
- *Analyzer*: These organizations are seldom first to implement new logistics practices or to adopt new logistics tools. However, by monitoring logistics activity, they can be early-followers with a better logistics strategy, increased user benefits, or lower total costs.
- *Low-cost defender*: These organizations attempt to maintain a relatively stable domain by aggressively protecting their logistics practices. They rarely are at the forefront of logistics development. Instead they focus on implementing their current logistics activities as efficiently as possible. These organizations generally focus on lowering the cost of their existing logistics practices.
- *Differentiated defender*: These organizations attempt to maintain a relatively stable domain by aggressively protecting their logistics practices. They rarely are at the forefront of logistics development. Instead they focus on implementing their current logistics activities by taking advantage of elements that they do particularly well. The cost of their logistics practices is typically higher than the industry average.
- *Reactor*: These organizations do not seem to have a consistent logistics strategy. They primarily act in response to competitive or other logistics pressures in the short-term.

Memory (adapted from Moorman and Miner, 1997)

Instructions: This section of the survey deals with your organizational memory with respect to logistics activities. Organizational memory refers to the achieved level of general knowledge, experience, and familiarity with logistics operations.

- We have a great deal of knowledge about logistics.
- We have a great deal of experience with logistics.
- We have a great deal of familiarity with logistics.
- We have invested a great deal of research and development related to logistics.

Tacitness of knowledge (items 1–4 are adapted from Zander and Kogut, 1995; item 5 is new based on Simonin, 1999)

Instructions: This section of the survey deals with the inimitability (tacitness) of your organization's logistics knowledge. Tacitness of knowledge refers to the degree of codifiability and teachability of the knowledge that exists in the logistics function. The questions deal with the ease or toughness with which you would have to describe what you do to new employees.

- A useful manual describing our logistics activities can be written for new employees. ⟨R⟩
- We have extensive documentation describing our logistics activities for new employees. ⟨R⟩
- New personnel can easily learn our logistics activities by talking to skilled workers. ⟨R⟩[5]
- Training new logistics personnel is a quick and easy job. ⟨R⟩
- New personnel can easily identify the knowledge needed to perform our logistics activities. ⟨R⟩

Accessibility of knowledge (based on O'Reilly, 1982)

Instructions: This section of the survey deals with the accessibility of logistics knowledge in your organization. Accessibility of knowledge refers to the degree to which knowledge that exists regarding logistics is easily available and obtainable. The questions deal with how the accessibility of knowledge affects your logistics activities.

- Knowledge that exists in our organization is readily available to assist in making our logistics decisions.
- Logistics knowledge contained in our organization is easily accessible when needed.
- On the average, it is easy to obtain logistics knowledge from key people in this organization.

Quality of knowledge (adapted from O'Reilly, 1982)

Instructions: This section of the survey deals with the quality of knowledge that your organization has with respect to logistics. Quality of knowledge refers to the relevance, accuracy, reliability, and timeliness of knowledge in pertaining to logistics.

- The logistics knowledge we have is very accurate.
- The logistics knowledge we have is very reliable.
- The logistics knowledge we have is very relevant to our needs.

[5] Item deleted after the item-level analysis across the logistics and supply management groups (i.e., an item was deleted if it were not robust across the logistics and supply management samples).

- The logistics knowledge we have is very specific to our needs.[5]
- The logistics knowledge we have is exactly what we need.
- The logistics knowledge we have is very useful.

Knowledge use (adapted from Deshpandé and Zaltman, 1982)

Instructions: This section of the survey deals with your use of logistics knowledge. Knowledge use refers to the direct application of knowledge to solve a particular logistics problem or a make a particular logistics decision. The questions deal with your existing knowledge about logistics and how it affected your latest logistics activity.

- Our existing knowledge enriched the basic understanding of our latest logistics activity.
- Our latest logistics activity would have been very different if the existing knowledge had not been available.[6]
- Our existing knowledge reduced the uncertainty of our latest logistics activity.
- Our existing knowledge identified aspects of our latest logistics activity that would otherwise have gone unnoticed.
- We used our existing knowledge to make specific decisions for our latest logistics activity.
- Without our existing knowledge, our latest logistics decision would have been very different.

Knowledge intensity (adapted from Autio et al., 2000)

Instructions: This section of the survey deals with the intensity of knowledge as it relates to logistics in your organization. Intensity of knowledge refers to the extent to which your logistics function depends on the knowledge inherent in its operations as a source of competitive advantage. The questions deal with the importance of up-to-date knowledge on logistics in your organization.

- We have a strong reputation for having cutting-edge knowledge about logistics.
- Knowledge intensity is a characteristic of our logistics practices.
- There is a strong knowledge component in our logistics practices.

[6] Item deleted after the item-level analysis across the five strategy types (i.e., an item was deleted if it were not robust across all five strategy types—prospectors, analyzers, low-cost defenders, differentiated defenders, and reactors).

Responsiveness (based on Kohli et al., 1993)

Instructions: This section of the survey deals with your responsiveness to your customers' needs. Responsiveness refers to the product-specific action you take as a function of the knowledge that you have generated and disseminated in logistics operations.

- We respond effectively to changes in a competitor's product offerings.[5]
- We respond rapidly to changes in our customers' product needs.[5]
- We periodically review our products to ensure that they are in line with our customers want.[6]
- We rapidly attend to product complaints from our customers.
- When we find out that our customers are unhappy with a product, we take corrective action immediately.
- When we find out that our customers would like us to modify a product, we make a concerted effort to do so.[5]

Learning capacity (new scale; item 1 is based on Hurley and Hult, 1998; items 2–5 are motivated by Grant, 1996)

Instructions: This section of the survey has to do with "knowledge outcomes." As opposed to normal performance questions, these questions deal with a select set of knowledge-based performance issues. Knowledge outcomes refer to the extent to which the logistics function continually increases its degree of usable knowledge to create a source of competitive advantage.

- The number of logistics suggestions implemented in our organization is greater than last year.[5]
- The percentage of skilled logistics workers is greater than last year.[6]
- The number of logistics individuals learning new skills is greater than last year.
- The resources spent on learning have resulted in increased logistics productivity.
- Our learning activities have resulted in better logistics performance than last year.

Process outcomes (Anderson et al., 1989; Boyer and Lewis, 2002; Boyer and Pagell, 2000; Hult et al., 2002; McKone et al., 2001; Ward et al., 1998; Youndt et al., 1996)

Instructions: This section of the survey has to do with logistics outcomes. Based on current logistics practice, performance related to the order fulfillment process is typically assessed as a function of speed, quality, cost, and flexibility. The following questions address those issues as they relate to the order fulfillment process.

Speed

- The length of the order fulfillment process is getting shorter every time.
- We have seen an improvement in the cycle time of the order fulfillment process recently.
- We are satisfied with the speediness of the order fulfillment process.[5]
- Based on our knowledge of the order fulfillment process, we think it is short and efficient.
- The length of the order fulfillment process could not be much shorter than today.[5]

Quality

- The quality of the order fulfillment process is getting better every time.
- We have seen an improvement in the quality of the order fulfillment process recently.
- We are satisfied with the quality of the order fulfillment process.[5]
- Based on our knowledge of the order fulfillment process, we think it is of high quality.
- The quality of the order fulfillment process could not be much better than today.[5]

Cost

- The cost associated with the order fulfillment process is getting better every time.
- We have seen an improvement in the cost associated with the order fulfillment process recently.
- We are satisfied with the cost associated with the order fulfillment process.[5]
- Based on our knowledge of the order fulfillment process, we think it is cost efficient.
- The cost associated with the order fulfillment process could not be much better than today.[5]

Flexibility

- The flexibility of the order fulfillment process is getting better every time.
- We have seen an improvement in the flexibility of the order fulfillment process recently.
- We are satisfied with the flexibility of the order fulfillment process.[5]
- Based on our knowledge of the order fulfillment process, we think it is flexible.
- The flexibility of the order fulfillment process could not be much better than today.[5]

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