The Impact of Logistic Capabilities on Supply Chain Agility and Performance

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Abstract

Most supply chain partners have realized the importance of using supply chain relationships and structures to facilitate fast response to customer needs and requirements. While traditional firm-level strategies such as low cost and high quality call for internal functional coordination, supply chain-level strategies require close relationships with external business partners. Thus, a firm should view inter-firm relationships as a critical part of supply chain strategy to achieve its business goals.

As logistics capabilities are utilized to develop customized solutions for either external or internal customers, the capabilities should be reviewed to ensure they are providing firms maximum benefit. We posit that logistics innovativeness and logistics service differentiation both positively impact logistics performance in today's business environment. Our study attempts to identify constructs of logistics capabilities and to analyze their impacts on supply chain agility and financial performance of firms.

Introduction

Today's dynamic, rapidly changing environments are forcing an organization to continuously reinvent itself through collaboration among its internal functions as well as with external business partners. In a highly networked supply chain, firms with non-integrated business processes and weak collaborative relationships are unlikely to be successful in the fiercely competitive global markets. As a result, an increasing number of firms are recognizing the importance of supply chain agility, which can be defined as a strategic ability that helps an organization quickly sense and respond to changes, opportunities, or threats in turbulent business environment via effective integration of supply chain relationships. With this shift of competition from the firm level to the supply chain level, supply chain agility is increasingly being viewed as a strategic lever that leads to an organization's success and prosperity. Fast fashion retailers such as H&M and Zara have incorporated agility into their supply chains to improve market responsiveness through postponed production processes, state-of-the-art sorting, and material handling technologies. Another example is Apple, which seeks to make its supply chain leaner and more agile with limited overstock of inventory. In order to meet a variety of customer needs, Apple maintains tight control over its supply chain from design to retail store, constantly balancing the products' characteristics with its respective supply chains.

Clearly, supply chain agility has emerged as one of the most important paradigms of contemporary supply chain management and the benefits of supply chain agility have been

acknowledged by both researchers and practitioners. It can be considered a main enabler of quick reaction, which is essential to achieve and sustain global competitiveness. Supply chain agility has been investigated in the literature mainly through a focus on a particular aspect such as manufacturing flexibility (Zhang and Sharifi, 2000), speed, and lean manufacturing. However, this level of understanding is somewhat superficial as it tells us little about the underlying mechanism that explains the antecedents and consequences of supply chain agility. The present study attempts to fill this gap by integrating the Strategy-Structure-Performance (SSP) paradigm, the resource- based view (RBV) and the relational view. Through the lens of multiple theoretical frameworks, this study develops an integrative model involving the factors that determine and influence supply chain agility. The proposed model is empirically tested with survey data gathered from 279 companies by using structural equation modeling. In this model, we explore the role of logistics capabilities as antecedents of supply chain agility. Considering logistics' boundary-spanning nature, logistics capabilities can play a crucial role in achieving supply chain agility. Also, we examine whether supply chain agility, developed as a result of a firm's specific logistics capabilities, contributes to the improvement of financial performance.

Literature

Review Strategy-structure-performance theory

Strategy-structure-performance (SSP) suggests that strategy dictates organizational structure, whereby influencing the performance of an organization. Chandler (1962) found through his studies that companies grew through a strategy of product diversification as they implemented a divisional organizational structure. This discovery was reinforced by numerous cases which exhibited that firms with certain combination of strategy and structure outperformed others without such combinations significantly. Also, through Rumelt (1974)'s study of Fortune 500 companies, another example was displayed that firms diversifying into a related business performed better in comparison with firms diversifying into unrelated businesses or firms vertically integrated which limited diversification options.

Similar framework was used in Defee and Stank (2005)'s research to study the value chain. While a firm's structure is dictated by the strategy it utilizes, the strategy is selected based on the environmental factors that affect it. Defee and Stank (2005) also used the SSP literature to presume an internal supply-chain environmental model and suggested that future research proves that model. As competition increased from a firm level to a supply chain basis, emphasis on both internally and externally oriented strategies grew and was identified as the core requirement for performance improvement of an organization. A similar trend is occurring to conceptually assimilate the E-S-P paradigm into supply chain operations in logistics literature.

The resource-based-view and the relational view

The resource-based-view (RBV) of the firm is considered to be the most significant framework in comprehending strategic management. The RBV defines strategic assets to contain resource which is rare, unique, and irreplaceable. A strategic asset can be both tangible and intangible. The RBV suggests that firms with the ability to accumulate such strategic assets will be able to sustain a competitive advantage (Barbet 2001). Firms with distinctive competencies formed by unique combinations of strategic assets can achieve advantage over competitors and earn above-normal rates of return (Acedo et al. 2006). In Wu et al (2006)'s discovery, it is said that information technology served as a catalyst in transforming a firm's resources into valuable assets throughout the supply chain. Barratt and Oke (2007) claimed that transparency would allow a firm to gain a sustainable competitive advantage in a supply chain.

The significance of green supply chain management was emphasized by Shi et al. (2016) as a strategic asset that contributes directly to better firm performance.

However, the RBV has been criticized as it only revolves around the internal perspective due to its focus on assets that are solely housed within a single firm (Priem and Butler 2001). Thus, such reasoning led to the development of new light of thought, called the relational view (Dyer and Signh 1998). Relational view introduces the idea that a firm's competitiveness is composed of not only internal resources but inter-firm relationships (Lee et al. 2001). There exist certain critical assets that are embedded within inter-firm processes, in which supply chain members are able to benefit from relational assets such as (1) investments in relation-specific assets; (2) substantial knowledge exchange; (3) complementary resources and capabilities; and (4) effective governance. Some recent studies have examined the impact of relational assets on supply chain performance. Direct and indirect effects of relational assets such as trust and knowledge exchange on buyer- seller integration and supply chain performance was examined by Chen et al. (2013). And investigation on the influences of communication, collaboration, and information integration on supply chain resilience was carried out by Wieland and Marcus (2013). In logistics literature, currently exists a large emphasis on the relationship between logistics service providers and client firms (Leauschner et al. 2014).

Most supply chain partners have realized the significance of flexibility and agile structure therefore paying much attention to the usage of supply chain relationships to facilitate fast response to customer needs and requirements (Defee and Stank 2003). While traditional firm-level strategies that consider low cost and high quality require internal functional coordination, supply chain-level strategies require close relationships with external business partners. Thus, inter-firm relationship should be viewed as a critical part of the supply chain strategy by firms. Such relationships are formed between supply chain members that share a common objective. Cooperation between firms with different resource constraints can overcome such limitations by utilizing complementary strengths from each other. This method suggests that it enables supply chain participants to rapidly respond to changing markets and quickly develop agile organizational structures. The term "resources" is broad in nature, as it can refer to not just tangible assets, such as equipment, plants, and location, but also to intangible assets, such as expertise, knowledge, and organizational assets. 3PL can be referred to as an external provider who manages, controls, and delivers logistics activities on behalf of a shipper (Hertz & Alfredsson, 2003). Firms conduct outsourcing arrangements with 3PL firms because of potential performance benefits (Knemeyer et al., 2003). By outsourcing firm can enhance performance in regards to cycle times, logistics cost reductions, increased customer support, improved logistics system information, enhanced cash-to-cash cycle time, improved demand forecast accuracy, and improved percentage of perfect orders (Hoffman, 2004; Newton et al., 1997).

In the past, 3PLs provided traditional logistics services, such as transportation and warehouse management. However, as the paradigm shifted to flexible and agile structures volume of services were increased to meet the requirement thereby changing the roles of 3PLs today. In order to enhance customer satisfaction and provide competitive advantage 3PLs now serve a critical role in achieving effective logistics integration of inter- and intra-firm activities (Murphy and Poist 200l Knemeyer et al. 2003). As a result, there has been a surge of academic and practitioner interest in the area of 3PLs and their impact on the supply chain (Leahy et al. 1995). 3PL nowadays require far greater number of scope of services in accordance to the changes in the logistics landscape. Companies are realizing that they can no longer compete against other competitors alone. And companies require substantial amount of resources in order to synchronize and coordinate complex supply chain activities across multiple facilities and countries. 3PLs have the expertise and resources to perform the aforementioned activities more

efficiently and effectively than an in-house team. The recent data shows to support this idea as about 80 percent of the Fortune 500 companies surveyed use 3PL services, which comprise a steadily increasing percentage of their logistics operating budgets (Lieb and Bentz, 2005).

Research Methodology

Data collection and sample

The data for this study was collected from Korean manufacturing firms. A mailing list of logistics or supply chain departments was compiled from the list of partner companies of Korea Trade-Investment Promotion Agency (KOTRA) and the survey was conducted in cooperation with a research consulting firm. Approximately 1,000 companies were randomly selected from the list. Senior or middle managers with direct responsibility for logistics or SCM were regarded as our target respondents. The survey team of the consulting firm first called the logistics or SCM department of the selected companies for their cooperation and then the questionnaire was sent to 350 companies that were willing to participate in the survey. A total of 279 responses were received. If any omitted questions were found, the survey team called the manager to complete the questionnaire.

Respondent profile

General industry characteristics of the respondents are shown in Table XX. The responding companies represent largely 5 industries including chemical (31), electrical and electronic (170), food and beverage (12), machinery (30), and apparel (20). The median firm size is 450 employees and the median firm revenue is $150 million.

Measurement scales

The scales used to measure the study's constructs are developed based on an in-depth literature review, and all constructs are measured using reflective, multi-item scales. The survey was first designed in English. To assure translation equivalence, the questionnaire was translated into Korean and then back-translated into English. The two English versions did not have any major difference.

Table 2: Distribution of responding firms by industry and size

	Frequency	Percentage
Industry		
Chemical	31	11.1
Electrical and electronic	170	60.9
Food and beverage	22	7.9
Machinery (except electrical and electronic)	30	10.8
Textile, footwear, wearing apparel	26	9.3
Total	279	100.0
Size (Employees)		
Less than 100	86	30.8
101 – 500	79	28.3
501 – 1,000	66	23.7
Greater than 1,000	48	17.2
Total	279	100.0

Results

Analysis of reliability and validity

The acceptability of the measurement model was examined by analyzing the convergent validity, the discriminant validity, and the reliabilities of all constructs. Convergent validity signifies that a set of measurement items represents one and the same underlying construct (Brown, 2006). It was examined in two ways. We first assessed composite reliability (CR) scores for all constructs, and then, second, calculated the average variance extracted (AVE). As reported in Table 5, all constructs exceed 0.7, the threshold of composite reliabilities, and all AVE estimates of the five constructs are greater than the cutoff point, 0.5 (Fornell and Larcker, 1981). In conclusion, CR and AVE values provide strong support for convergent validity.

Table 3: Correlation between theoretical constructs

Factors	DL	FL	CB	AG	FP
Differentiated Logistics (DL)	1.00				
Logistical Flexibility (FL)	.58	1.00			
Collaboration with 3PL (CB)	.52	.65	1.00		
Supply Chain Agility (AG)	.53	.47	.44	1.00	
Financial Performance (FP)	.62	.47	.42	.43	1.00

We also compared the squared correlation coefficients between two latent constructs to their AVE estimates (Fornell and Larcker, 1981). According to this test, discriminant validity exists if the items share more common variance with their respective construct than any variance the construct shares with other constructs. Thus, the squared correlation coefficient between each pair of constructs should be less than the AVE estimates for each individual construct. Comparing the correlation coefficients given in Table 3 with the AVE estimates reported in Table 5, all of the squared correlations were smaller than the AVE for each individual construct. Therefore, these results collectively provided evidence of discriminant validity among the theoretical constructs.

Reliability estimation was left for last because in the absence of a valid construct, reliability would not be meaningful (Koufteros, 1999). Item-to-total correlation analysis results provided in Table 4 suggest a reasonable fit of the latent factors to the data collected. Cronbach's α values for all factors were greater than 0.8, as shown in Table 5, which exhibit the internal consistency and validity of the constructs as they were well above the suggested lower limit of 0.7 (Nunnally and Vernstein, 1994). This result provides support for high degrees of construct reliability.

Table 4: Measurement items

Constructs	Items	Mean	S.D.	Item-to-total correlation
Differentiated Logistics				
DL1	Damage Free Deliveries	3.11	1.04	0.814
DL2	Line Item Fill Rate	3.08	0.99	0.864
DL3	Time Between Order Receipt and Delivery	3.27	1.06	0.900
DL4	Time on Backorder	3.33	1.05	0.825
DL5	Total Inventory Turns	3.02	1.00	0.864
DL6	On-Time Delivery	3.47	1.03	0.790
Logistical Flexibility through 3PL				
FL1	3PL's operational ability to accommodate special or non- routine requests	3.84	0.77	0.670
FL2	3PL's operational ability to handle unexpected events	3.60	0.84	0.673
FL3	3PL's operational ability to provide rapid response to customer requests	3.64	0.87	0.765
FL4	3PL's operational ability to accommodate changes in volume	3.75	0.91	0.816
FL5	3PL's operational ability to provide solutions to customer problems	3.69	0.92	0.785
Collaboration with 3PL				
CB1	Both our company and our 3PL company work together to exploit unique opportunities in the market	3.81	0.85	0.827
CB2	Both our company and our 3PL company look for synergistic ways to do business together	3.87	0.86	0.873
CB3	Our company work together with our 3PL company to develop new ideas	3.81	0.88	0.865
CB4	Both our company and our 3PL company continually share proprietary information with each other	3.89	0.86	0.873
Supply Chain Agility				
AG1	Deliver expedited shipments / speed of delivery	3.20	0.84	0.703
AG2	Offer short delivery lead-time	3.36	0.84	0.740
AG3	Offer greater proportion of on time and accurate delivery	3.35	0.86	0.777
AG4	Accommodate special or non-routine requests	3.21	0.86	0.808
AG5	Provide quicker response to customers	3.38	0.83	0.745
AG6	Aggressiveness in the reduction of order cycle time	3.34	0.83	0.764
Financial Performance				
FP1	Sales	3.32	0.87	0.712
FP2	Profit	3.27	0.89	0.758
FP3	Market share	3.27	0.95	0.823
FP4	Return on investment	3.24	0.93	0.774
FP5	Return on sales	3.21	0.91	0.808

Hypotheses testing

Direct effects. The results of the structural model are shown in Table 6. All fit indices were indicative of a decent fitting model. Figure 2 indicates support for all three Hypotheses 1, 3, and 5 with positive and significant effects: logistical flexibility through 3PL on supply chain agility (0.230; $p < 0.001$), collaboration with 3PL on supply chain agility (0.105; $p < 0.05$), and differentiated logistics on supply chain agility (0.442; $p < 0.001$). The test results further support Hypothesis 2 with positive and significant correlation of logistical flexibility through 3PL on collaboration with 3PL (0.285; $p < 0.001$). We also found a high correlation of supply chain agility on firm's financial performance (0.720; $p < 0.001$).

Table 5: Reliability and validity of measurement model.

Factors	Items no.	Standardized loading	t-value	Cronbach's α	AVE	CR
Differentiated Logistics	DL1	0.848	46.182	0.949	0.758	0.949
	DL2	0.892	63.009			
	DL3	0.924	85.269			
	DL4	0.851	47.128			
	DL5	0.890	63.440			
	DL6	0.815	38.103			
Logistical Flexibility through 3PL	FL1	0.716	21.371	0.895	0.607	0.885
	FL2	0.753	24.667			
	FL3	0.849	36.303			
	FL4	0.799	29.358			
	FL5	0.771	26.045			
Collaboration with 3PL	CB1	0.907	61.000	0.941	0.760	0.926
	CB2	0.807	35.925			
	CB3	0.957	78.068			
	CB4	0.806	35.556			
Supply Chain Agility	AG1	0.761	27.781	0.913	0.520	0.921
	AG2	0.780	30.118			
	AG3	0.861	45.838			
	AG4	0.882	51.734			
	AG5	0.701	21.504			
	AG6	0.708	22.161			
Financial Performance	FP1	0.797	31.401	0.911	0.655	0.904
	FP2	0.825	35.793			
	FP3	0.869	44.701			
	FP4	0.758	26.204			
	FP5	0.793	30.788			

Mediation analysis. To examine the mediating effect of collaboration with 3PL on the relationship between logistical flexibility through 3PL and supply chain agility, structural equation modeling (SEM) was used following the commonly used Baron and Kenny (1986) method. In the previous section, the direct link between logistical flexibility through 3PL and supply chain agility was found to be significant. Meanwhile, our results exhibit that the mediation effect of collaboration with 3PL on the relationship between logistical flexibility through 3PL and supply chain agility is also marginally significant (0.03; $P < 0.10$). The significant paths in our research model are shown in Figure 2 and the results of overall hypotheses tests are summarized in Table 6.

Figure 2: Hypothesized structural model results

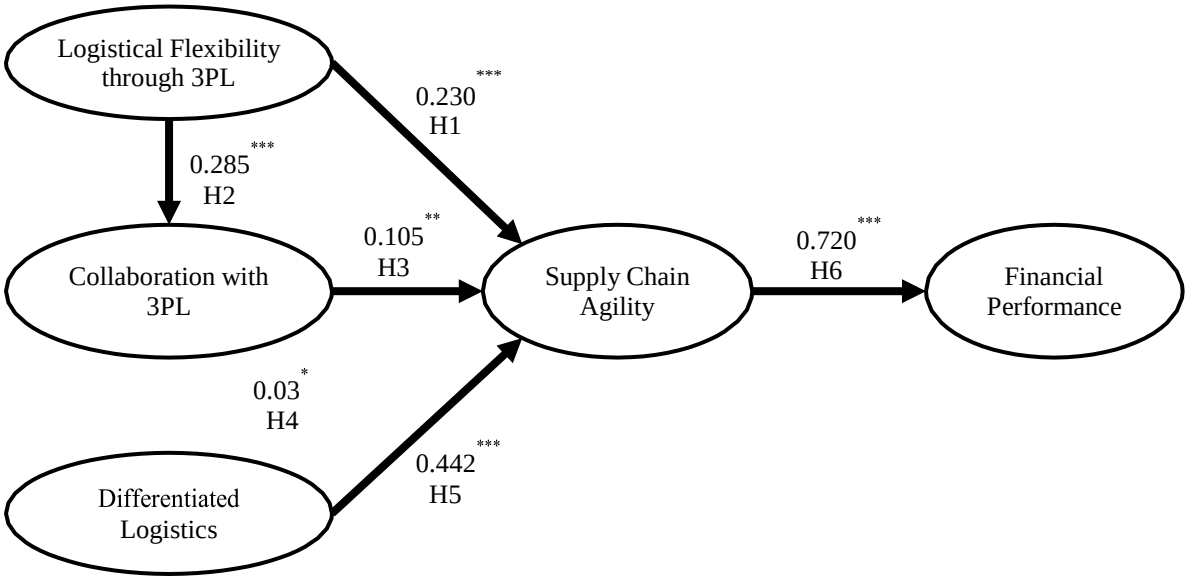

Table 6: Results of path analyses and hypotheses tests.

	Path (from-to)	Direct effects (t-value)	Indirect effect (t-value)	Hypotheses test results
H1	Logistical Flexibility → SC Agility	0.230 (3.667)***		**Supported**
H2	Logistical Flexibility → Collaboration	0.285 (4.808)***		**Supported**
H3	Collaboration → SC Agility	0.105 (1.960)**		**Supported**
H4	Logistical Flexibility → SC Agility		0.03 (3.667)*	**Supported**
H5	Differentiated Logistics → SC Agility	0.442 (7.997)***		**Supported**
H6	SC Agility → Financial Performance	0.720 (20.622)***		**Supported**

Fit indices: $\chi^2 = 620.616$ (d.f.= 289), χ^2/d.f. = 2.147, CFI = 0.952, RMSEA = 0.062, SRMR = 0.072

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

References

Acedo, F. J., Barroso, C., & Galan, J. L. (2006). The resource-based theory: main trends. Strategic Management Journal, 27(7), 621-636.

Barney, J. B. (2001). Resource-based theories of competitive advantage: A ten-year retrospective on the resource-based view. Journal of management, 27(6), 643-650.

Barratt, M., & Oke, A. (2007). Antecedents of supply chain visibility in retail supply chains: a resource-based theory perspective. Journal of operations management, 25(6), 1217-1233.

Chandler, A.D. Jr (1962), Strategy and Structure, The MIT Press, Cambridge, MA.

Defee, C., & Stank, T. P. (2005). Applying the strategy-structure-performance paradigm to the supply chain environment. The International Journal of Logistics Management, 16(1), 28-50.

Mentzer, J. T., Min, S., & Michelle Bobbitt, L. (2004). Toward a unified theory of logistics. International Journal of Physical Distribution & Logistics Management, 34(8), 606-627.

M. Gligor, D. (2014). The role of demand management in achieving supply chain agility. Supply Chain Management: An International Journal, 19(5/6), 577-591.

Miles, R.E. and Snow, C.C. (1978), Organizational Strategy, Structure and Process, McGraw-Hill,New York, NY.

Olavarrieta, S. and Ellinger, A.E. (1997), “Resource-based theory and strategic logistics research”,International Journal of Physical Distribution and Logistics Management, Vol. 27 Nos 9/10,pp. 559-587.

Priem, R. L., & Swink, M. (2012). A demand -side perspect
Journal of Supply Chain Management, 48(2), 7-13.

Qureshi, M. N., Kumar, D., & Kumar, P. (2008). An integrated model to identify and classify the key criteria and their role in the assessment of 3PL services providers. Asia Pacific Journal of Marketing and Logistics, 20(2), 227-249.

Ramsay, J. (2001), “The resource based perspective, rents, and purchasing’s contributionto sustainable competitive advantage”, Journal of Supply Chain Management, Vol. 37 No. 3,pp. 38-47.

Richey, R.G., Daugherty, P.J. and Roath, A.S. (2007), “Firm technological readiness andcomplementarity: capabilities impacting logistics service competency and performance”,Journal of Business Logistics, Vol. 28 No. 1, pp. 195-228.

Richey, R. G., Adams, F. G., & Dalela, V. (2012). Technology and Flexibility: Enablers of Collaboration and Time -Based Logistics Quality. Journal of Business Logistics, 33(1), 34-49.

Rodrigues, A.M., Stank, T.P. and Lynch, D. (2004), “Linking strategy, structure, process andperformance in integrated logistics”, Journal of Business Logistics, Vol. 25 No. 2, pp. 65-94.

Rumelt, R.P. (1974), Strategy, Structure, and Economic Performance, Harvard University Press,Cambridge, MA.

Sanders, W. M., & Boivie, S. (2004). Sorting things out: Valuation of new firms in uncertain markets. Strategic Management Journal, 25(2), 167-186.

Stank, T.P. and Traichal, P.A. (1998), “Logistics strategy, organizational design, andperformance in a cross-boarder environment”, Logistics and Transportation Review,Vol. 31 No. 1, pp. 75-86.