A Coordination-theoretic Investigation of the Impact of Electronic Integration on Logistics Performance

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Abstract

Using the Coordination Theory, we explored the impact of electronic integration of intra-organizational and inter-organizational business processes on organizational performance in terms of logistics cost and service improvements. Our work extends knowledge on adoption of IT in logistics operations, with a focus on examining the performance implications of electronic integration within and between firms in a supply chain. Data was collected from 227 trading firms in Hong Kong and analyzed to investigate the research issues. Our empirical findings revealed that electronic integration is positively

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associated with logistics performance in cost but not in service, suggesting that electronic integration is not sufficient for delivering superior logistics services. Theoretical and practical implications of our results are discussed.

Keywords: Electronic integration, Coordination Theory, Logistics service performance, Logistics cost performance

Introduction

What can be done to improve the logistics performance of firms? This is a question facing managers in business and industry. Logistics has become an integral part of corporate strategy; it contributes to the primary activities of the value chain of firms. The logistics activities are inter-dependent, requiring careful allocation of resources to achieve service goals and to reduce wastes in the supply chain such as idle time, and duplication of efforts. Logistics deals with the processes of planning, implementing, and controlling the efficient flow and storage of raw materials, in-process inventory, finished goods, services, and related information from points of origin to consumption while conforming to customer requirements. These processes require the use of IT for effective coordination. However, the logistics business processes of many firms are still confined to manual processes and to isolated functional automation [19], which lack coordination to manage the tasks effectively.

Electronic integration (E-integration) can be traced to Porter's Value Chain Model [33]. Electronic linkage is the enabling mechanism to coordinate logistics activities and integrate the business processes [20]. According to Stevens [38], there are different types of integration, ranging from functional to internal and external integration. Romano [36] suggested that there are two levels of e-integration in support of the coordination of business processes in a supply chain; intra-company, spanning internal functional boundaries, and inter-company improving communication between companies. A systematic investigation of the performance implications of e-integration is highly desirable as many reputable companies such as Dell Computer, Seven-Eleven Japan, Lucent Technologies, Wal-Mart, and Procter & Gamble have reported being their benefits from integrating activities with their supply chain partners. To provide empirical evidence of the contribution of e-integration, we therefore examined through the use of empirical data, the extent of e-integration and its logistics performance implications.

Although some case studies have documented intra- and inter-organizational e-integration for logistics operations, they only investigated the use of IT in logistics processes for better performance [37]; they provided limited understanding of the link between e-integration and logistics performance. But as Rogers' Innovation Diffusion Theory [35] says, there are multiple stages in the diffusion of IT from being exposed to an innovation to making a decision to adopt or reject it.

However, several research gaps still exist. First, past studies were limited to examining the prerequisite of e-integration and its related measures in the decision stage, focusing on analysis of the supplier selection process for logistics process integration, raising awareness of e-integration benefits, and designing business networks for logistics management, etc. Second, work has tended to focus on the effects of antecedents, such as organizational characteristics, organizational support, organizational readiness, institutional pressures, and inter-organizational relationships, on the performance of e-integration. Such studies have only provided limited insights into the business value of e-integration. Third, there have been few empirical investigations into the performance implications, due mainly to a lack of appropriate measurements to cope with the complexity of electronic linkages between business processes.

There is a need for theoretical explanations for the observation that some firms perform better than others when using e-integration. In Figure 1, we have summarized the research issues in the different stages of e-integration (decision, adoption, and implementation), and identified the position of this study in the literature.

<Insert Figure 1 about here>

The objective of our study was to examine the link between e-integration and logistics performance, providing reasons why such a link may exist from the Coordination Theory aspect. The questions were:

(1) Is the implementation of intra- and inter-organizational e-integration associated with cost- and service-related logistics performance?

(2) What are the different aspects (dimensions) of e-integration? and

(3) Why some firms perform better than others despite though they all have implemented e-integration?

Theoretical Background

The Coordination Theory and Logistics Performance

The Coordination Theory investigates how activities can be integrated amongst multiple organizations working together towards common goals [26, 27]. Four major components are considered in the coordination of activities; a set (i.e., at least two) of *actors*, who create or use *resources* to perform *tasks*, to achieve *goals* [8, 28].

Communication and information sharing between partners is essential for coordination of business activities. Establishing communication standards and electronic linkages is necessary to ease information flows. The coordination mechanism contributes to: (1) a reduction in coordination costs, (2) allocation of organizational resources to handle complex tasks, and (3) an efficient coordination structure.

The Coordination Theory provides an appropriate theoretical way to examine if and how e-integration contributes to logistics performance. With it, parties (the actors) perform the tasks that require information sharing (resources) to achieve a set of goals. The implementation of e-integration requires reengineering of the logistics processes. E-integration serves as the coordination mechanism to manage the task dependency between the logistics processes, extend their activities across intra- and inter-organizational boundaries. Thus, the logistics process shift from being locally optimized; e-integration is useful for managing the logistics process.

Research Model and Hypotheses

Inter-organizational E-integration

Without e-integration of inter-organizational processes, a piece of data, e.g., a trade document, must be entered manually into different systems. In doing this, errors, inconsistencies, information loss, and costs may result. Hart and Saunders [14] observed that inter-organizational e-integration can speed up data interchange. In their investigation of the effects of various supplier and customer integration strategies on performance, Frochlich and Westbrook [10] found that firms attaining a high level of e-integration with suppliers and customers tend to perform better.

E-integration enables the suppliers to replenish stocks to an agreed level of inventory, which allows fast replenishment for firms and improves the accuracy of the production forecasts for the suppliers. The inter-organizational e-integration of a firm is useful to reduce inventory and order processing costs for its supply chain. We therefore posited that

> *Hypothesis 1: The inter-organizational e-integration of a firm is positively associated with its logistics cost performance.*

As e-integration provides an information processing mechanism to coordinate logistics activities, it enables a firm to improve the flows of goods along its supply chain, achieving without manual intervention in inter-organizational information interchange, errors in coordinating logistics processes can be reduced and reliability of the services provided can be improved. Therefore, we conjectured that

> *Hypothesis 2: The inter-organizational e-integration of a firm is positively associated with its logistics service performance.*

Intra-organizational E-integration

Intra-organizational e-integration enables flows of information between internal business processes with electronic linkages. It allows firms to eliminate paperwork and to increase the timeliness, accuracy, and accessibility of the information in their internal business processes [16]. Thus, we posit that

> *Hypothesis 3: The intra-organizational e-integration of a firm is positively associated with its logistics cost performance.*

Intra-organizational e-integration enhances the ability of firms to fulfill customer requirements and to cope with unpredicted events in their supply chains by increasing the effectiveness of information processing of the firms [6]. It also allows sharing of accurate market information, which enables firms to make timely changes to their internal operations, such as changing production and shipping schedules, and even product features. Thus, it is useful for firms to create customer value and excel in service performance through effective coordination of activities. We therefore hypothesized that

Hypothesis 4: The intra-organizational e-integration of a firm is positively associated with its logistics service performance.

Methodology

Sample Characteristics

We tested the hypotheses with survey data collected from trading companies in Hong Kong. We chose trading companies because they are heavily involved with logistics activities because of their business nature. Our focus on a single industry allows us to customize items in our survey questionnaire to cater for the characteristics of the firms and obtain more accurate responses. Using the *Hong Kong Business Directory – Trading and Transportation*, we drew a sample of 1,000 firms from the 3,445 trading firms in the directory, using a random sampling procedure comparable to studies conducted in similar contexts. Top executives, i.e., Chairman, CEO, and Managing Director, of these trading firms were our target respondents. As the majority of our sample firms were small in size, i.e., with fewer than 100 employees, it was reasonable to assume that such high-level executives would have comprehensive and adequate knowledge of e-integration and logistics activities with their partner firms in their organizations.

We first sent a survey questionnaire to each of the 1,000 sampled firms, together with a cover letter that explained the purpose of our study and enclosing a self-addressed postage-paid response envelop. After two weeks, a follow-up letter and a second copy of the questionnaire were mailed to all non-respondents. We finally sent a reminder to the non-respondents two weeks after the second mailing.

We received a total of 257 responses after the two waves of mailings and follow-up reminder. We removed 30 responses due to either incomplete information or late receipt. Thus, we had 227 usable responses (155 in the first mailing and 72 in the second mailing) resulting in a 22.7% response rate, which was comparable to other studies of a similar nature. Table 1 shows the characteristics of the respondent firms. Over half of the firms reported annual sales revenues of less than US$12.8 million and had fewer than 25 employees.

<Insert Table 1 about here>

Non-response Bias

We tested the likelihood of non-response bias by the extrapolation technique, whereby the responses from the first mailing were compared to those from the second one [2]. We computed the differences in the mean values of a random selection of the measurement items in the survey questionnaire and found no significant differences between the early and late respondents. We also checked the non-response bias based on the information obtained from the responding firms and archival data obtained from the *Hong Kong Business Directory – Trading and Transportation.* From these sources, we were able to compare the firm size (i.e., number of employees) between the responding and the nonresponding firms; these were known from the company identification code number we stamped on each questionnaire. The difference in the mean values of number of employees between the respondents and non-respondents was tested using an unpaired t-test. The resulting t statistic was insignificant, suggesting that non-response bias was not a problem.

Common Method Variance

Of course, the problems of perceptual measures may have led to common method bias. However, the response rate of our survey would have suffered if we had requested sensitive and objective data from our respondents. Also, the cost performance data could be biased by differences in the accounting practices of the firms. Moreover, prior studies have cautioned that business research should devote more attention to understanding the perceived value of the participants. We therefore employed self-reported perceptual measures in our study. To detect the threat of common method bias, we conducted the Harman's one-factor test suggested by Podsakoff and Organ [32]. Four factors with eigenvalues greater than one were extracted from all the measurement items for intra- and inter-organizational e-integration, and cost and service performance, as detailed below, and they explained 75.6% of the variance, with the first factor accounting for 26.6% of it. Since no single factor emerged that accounted for most of the variance, common method variance did not appear to be a problem in our study.

Measurement Development

We operationalized e-integration as the degree of electronic linkages and data interchange between business processes by measuring the extent of electronic data interchange that had been developed for intra- and inter-organizational information interchange. Thus, e-integration was assessed using a multi-dimensional measurement, covering the different dimensions of the electronic connectivity in business processes and used the dimensions of electronic connections developed by Massetti and Zmud [30] . This comprised four dimensions: volume, diversity, breadth, and depth. These dimensions of electronic linkages serve different strategic and operational purposes. They are complementary and co-vary with one another – thereby helping firms to attain performance improvements. To measure intra- and inter-organizational e-integration, we modeled them as reflective second-order constructs, consisting of four first-order dimensions as depicted in Table 2. The two e-integration constructs were measured using 30 items on a five-point Likert scale, where our study targets were asked to indicate the level of electronic data interchange between business processes within and between their organizations on individual items (1: very low, 0 -20%; 2: low, >20 -40%; 3: neither low nor high, >40 -60%; 4: high, >60 -80%; 5: very high, <80-100%).

<Insert Table 2 about here>

Logistics cost refers to the costs incurred in coordinating and managing logistics activities, such as transportation, warehousing, order processing, customer service, and inventory management [23]. It represents a large portion of the operating costs of firms.

Cost-related performance has been a traditional criterion in measuring logistics performance. However, studies have criticized the limitation of cost-related performance and advocated broadening it to embrace the operational aspects of logistics activities [3, 12], including such indicators as delivery reliability, customer responsiveness, and customer satisfaction, to measure logistics service performance [21]. Logistics service refers to the customer value created in the logistics processes in such areas as availability, timeliness, and order condition [31]. The supply chain operations reference model (SCOR) also embraces the cost and service aspects of logistics performance in terms of costs, assets, reliability, and responsiveness/flexibility [39]. Following SCOR and previous studies, e.g., [18], we measured logistics cost and service improvements using nine- and seven-item sets, respectively. Our survey targets were asked to assess their logistics cost and service performance relative to their major competitors on a five-point Likert scale (1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree).

Validity and Reliability

To ensure content validity of the measurement items, we first developed a draft survey questionnaire (instrument) and circulated it to five academics in the fields of supply chain management, logistics management, operations management, and IS management for content validation and instrument refinement. The instrument was refined based on the feedback. Subsequently, we conducted a test with a group of practitioners who were pursuing a part-time postgraduate degree in logistics management. The pre-test was conducted to ensure the clarity and appropriateness of the instrument. Based on the feedback, some items were rephrased to avoid confusion. Finally, we conducted a pilot test with a sample of 30 randomly selected trading firms in Hong Kong. This test provided sample data that allowed us to perform statistical tests to establish face validity of the constructs and further refine the questionnaire. Since no major problems were found during the pilot test, we mailed the survey questionnaire to the sample of firms in our study.

Validity and reliability of the constructs were initially assessed using Cronbach's alpha and item-total correlation analysis. Confirmatory factor analysis (CFA) using maximum likelihood estimation was conducted to evaluate the constructs. The results showed that all the measurement items had high loadings on their respective latent factors, ranging from 0.65 to 0.95. The alpha values of all the first-order factors exceeded the 0.70 cutoff level, ranging from 0.89 to 0.97, thus indicating that the factors of e-integration were reliable.

Since the number of factors could be specified in advance, we applied CFA instead of exploratory factor analysis (EFA) to test the measurement model of e-integration in our study. The details of the measurement model validation are discussed in Appendix A.

Hypotheses Testing

The hypotheses and the research models were tested with path analysis using structural equation modeling (SEM) with maximum likelihood estimation using Amos 5.0. Both intra- and inter-organizational e-integration were taken as exogenous constructs, while logistics service and cost performance were taken as endogenous constructs. The results offered support for some of the hypothesized relationships. The results indicated that the model provides a reasonable fit to the data. Table 3 shows the parameter estimates and model statistics for the structural model.

For H1 [Inter-organizational e-integration → Logistics cost performance], the structural link was positive and significant (0.18, $p < 0.05$). This provided support for H1.

For H2 [Inter-organizational e-integration → Logistics service performance], the structural link was insignificant (0.17, $p > 0.05$). Thus, H2 was not supported.

For H3 [Intra-organizational e-integration → Logistics cost performance], the structural link was positive and significant (0.23, $p < 0.05$). This lent support to H3.

For H4 [Intra-organizational e-integration → Logistics service performance], the structural link was insignificant (0.12, $p > 0.05$). Thus, H4 was not supported.

<Insert Table 3 about here>

Thus, intra- and inter-organizational e-integration was positively associated with logistics cost performance, but not with logistics service performance.

Discussion and Implications

Our study results are consistent with the Coordination Theory: both intra- and inter-organizational e-integration can reduce operations costs by providing an alternative coordination mechanism between business processes. Based on the typology of task dependency and the associated mechanisms, e-integration can be considered as a mechanism to support resource flows. Crowston [8] suggested that there are four types of task dependency: task assignment to actors, dependency between tasks, task-resource dependency, and resource-resource dependency. E-integration as a coordination mechanism contributes to managing these task dependencies. The tasks can be the logistics activities that support flows in the supply chain, e.g., coordination of replenishment or distribution of goods. The resources can be the information and finance needed to perform the logistics activities.

We hypothesized that intra- and inter-organizational e-integration were positively associated with logistics service improvement. However, these relationships failed to receive empirical support. These results imply that firms need to understand and respond to market needs by developing suitable organizational conditions, e.g., a market-oriented culture, to create customer value.

We also proposed that e-integration was a multidimensional construct comprising a system of electronic linkages to attain logistics cost reduction. Our findings were consistent with this development of e-integration with a uni-dimensional electronic linkage which provides a limited coordination mechanism within and between firms for logistics performance, neglecting the complexity of coordination between business processes. The multi-dimensional nature of intra- and inter-organizational e-integration suggests that firms should recognize the potential of developing different aspects of electronic linkages.

Theoretical Implications

Our study extended the examination of e-integration from the decision and adoption to the implementation stage and assessed its performance impact on logistics performance. Consistent with the Coordination Theory, our findings indicated that implementation of e-integration was beneficial as it had a direct effect on logistics cost performance. Nevertheless, the insignificant relationship between e-integration and logistics service improvement suggested that intra- and inter-organizational e-integration are insufficient alone improving performance.

We also extended the Coordination Theory to investigate the implementation of intra- and inter-organizational e-integration for logistics performance; we examined the coordination mechanisms of e-integration that are implemented within and between firms and developed a measurement to capture the different dimensions of electronic linkages.

Managerial Implications

Our study addressed the concern of managers about ways of improving their information management to improve the logistics performance of firms. The findings revealed that implementation of e-integration was useful for reducing logistics costs. Firms may find it valuable to utilize intra- and inter-organizational e-integration, as a coordination mechanism, to facilitate information flows and manage task dependency amongst business processes. The questionnaire items (in Appendix B) can be used to identify the dimensions of electronic linkages that may have been neglected in the firms.

Our findings could be useful for those implementing (or intending to implement) e-integration to understand that their efforts may not deliver their expected performance. Managers should not just emphasize developing electronic linkages. In the implementation process, they need to listen to the voice of customers and create customer value. In addition to improving information flows between processes for operations efficiency, it is crucial for firms to be market-oriented to achieve both logistics cost and service performance.

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Stage	Pre-e-integration	e-integration	Post-e-integration
	Decision Stage	*Adoption Stage*	*Implementation Stage*
Issues/ Concerns	• Logistics coordination problems and needs • IT selection • Evaluation of cost and benefit of e-integration • Partner selection	• Logistics processes reengineering • IT adoption • Analyze and assign tasks to partners • Barriers and conditions that affect e-integration adoption	• Logistics processes reengineered • IT implementation • Coordinated logistics processes • Logistics performance impacts • Developed electronic linkages
Studies	[17, 25, 36]	[4, 11, 22, 24, 34, 36]	this study

Figure 1. Stages of e-integration.

Company characteristics	**Number of Observations**	**Percentage**
Number of employees		
1-4	14	6.2
5-9	58	25.6
10-19	39	17.2
20-49	57	25.1
50-99	7	3.1
100-199	11	4.8
200-499	10	4.4
>499	3	1.3
Unknown	28	12.3
Level of turnover (HK$)		
Below 100 million	116	51.1
100-199 million	13	5.7
200-299 million	8	3.5
300-399 million	9	4.0
400 million or above	28	12.3
Unknown	53	23.3

Table 1. Profile of the respondents (n = 227).
Note: US$1 is approximately equal to HK$7.8

Dimensions of Electronic Linkages	**Inter-organizational e-integration**	**Intra-organizational e-integration**
Breadth	the number of electronic linkages with different supply chain partners	the number of electronic linkages between different internal processes
Diversity	the variety of electronic linkages for different types of data	the variety of electronic linkages for different types of data
Volume	the number of data being interchanged electronically	the number of data being interchanged amongst internal processes
Depth	the number of business processes within a firm that has been migrated to electronic integration to facilitate bidirectional flows of information with partner firms	the number of internal process that are electronically integrated to facilitate bidirectional flows of information between one another

Table 2. Descriptions of intra- and inter-organizational e-integration.

	Supply Chain Performance	
Paths	**Service**	**Cost**
Structural Model		
Hypothesized relationships		
Inter-organizational e-integration --> logistics cost performance (H1)		0.18*
Inter-organizational e-integration --> logistics service performance (H2)	0.17	
Intra-organizational e-Integration --> logistics cost performance (H3)		0.23*
Intra-organizational e-Integration --> logistics service performance (H4)	0.12	
Goodness of fit statistics		
d.f.	25	25
Comparative fit index (CFI)	0.94	0.94
Goodness-of-fit index (GFI)	0.83	0.83
Normed fit index (NFI)	0.93	0.93
Root mean squared residual (RMR)	0.04	0.04

*** $p < 0.001$; ** $p < 0.01$; * $p < .05$

Table 3. Standardized Parameter Estimates and Model Statistics

Appendix A: Measurement Model Estimation

The Cronbach's alphas, composite reliabilities, and the values of average variance extracted of the constructs are summarized in the following table[1] [9, 13].

Measurement model: first-order constructs

Constructs	Items	Standardized Loadings	Cronbach's Alpha	Composite Reliability	AVE
Intra-Vol	InVol1^	0.936***	0.889	0.901	0.756
	InVol2	0.973***			
	InVol3	0.668***			
Intra-Div	InDiv1^	0.946***	0.952	0.954	0.873
	InDiv2	0.993***			
	InDiv3	0.859***			
Intra-Bre	InBre1^	0.980***	0.953	0.951	0.747
	InBre2	0.985***			
	InBre3	0.733***			
	InBre4	0.913***			
	InBre5	0.903***			
	InBre6	0.698***			
Intra-Dep	InDep1^	0.961***	0.951	0.955	0.876

[1] Following Fornell and Larcker [9], we calculated composite reliabilities and AVE values using the following formulae:

Composite reliability (ρ_{η}) $= \dfrac{(\sum_{i=1}^{n}\lambda_{yi})^2}{(\sum_{i=1}^{n}\lambda_{yi})^2 + \sum_{i=1}^{n}\varepsilon_i}$,

Average variance extracted (AVE $_{\eta}$) $= \dfrac{\sum_{i=1}^{n}(\lambda_{yi}{}^2)}{\sum_{i=1}^{n}(\lambda_{yi}{}^2) + \sum_{i=1}^{n}\varepsilon_i}$,

where η is the construct, λ_y is the standardized factor loading for measurement item y_i , and ε_i is the measurement error for scale item y_i . The measurement error is 1.0 minus the reliability of the scale item, which is the square of the scale item's standardized loading [9, 13].

	InDep2	0.989***			
	InDep3	0.853***			
Inter-Vol	ExVol1^	0.842***	0.955	0.950	0.828
	ExVol2	0.846***			
	ExVol3	0.973***			
	ExVol4	0.969***			
Inter-Div	ExDiv1^	0.829***	0.947	0.941	0.801
	ExDiv2	0.808***			
	ExDiv3	0.976***			
	ExDiv4	0.955***			
Inter-Bre	ExBre1^	0.933***	0.958	0.958	0.885
	ExBre2	0.965***			
	ExBre3	0.923***			
Inter-Dep	ExDep1^	0.962***	0.972	0.971	0.894
	ExDep2	0.973***			
	ExDep3	0.922***			
	ExDep4	0.923***			
Logistics service Performance	SQ1^	0.650***	0.901	0.905	0.555
	SQ2	0.873***			
	SQ3	0.857***			
	SQ4	0.817***			
	SQ5	0.609***			
	SQ6	0.722***			
	SQ7	0.768***			
Logistics cost Performance	CR1^	0.747***	0.939	0.945	0.610
	CR2	0.862***			
	CR3	0.865***			
	CR4	0.810***			
	CR5	0.860***			
	CR6	0.737***			
	CR7	0.791***			
	CR8	0.711***			
	CR9	0.761***			

*** $p < 0.001$; ** $p < 0.01$; * $p < .05$
^ Item was fixed to 1 in the original solution

In CFA, we allowed all the factors to correlate freely in their respective measurement models [15]. All the items loaded significantly (i.e., $p < 0.001$ and $t > 2.0$) onto their underlying factors with loadings ranging between 0.650 and 0.993. Also, the AVE estimates of the constructs were greater than 0.50. These results suggest that convergent validity of the measurement items for e-integration was supported [1]. We assessed discriminant validity by examining the average variance extracted estimates. The AVE of each construct was greater than the squared correlation between constructs, which suggests that the items share common variance with their hypothesized constructs more than with other constructs [9]. We also tested discriminant validity with the phi estimate, i.e., inter-correlation amongst the factors in the two constructs. All the phi values shown in the following table were significant at $p < 0.01$ level. Furthermore, we conducted a series of pairwise chi-square tests of the difference between two models involving two constructs. The first model fixed the covariance between the two constructs (e.g., cost and service performance) to 1.0 (i.e., a constrained model) while the second model allowed the covariance to be freely computed (i.e., an unconstrained model). A statistical difference between the models indicates that the models are different. Thus, discriminant validity was established.

Descriptive statistics and intercorrelations of first-order factors

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10
1 Intra-organizational Volume	2.40	1.29	1									
2 Intra-organizational Diversity	2.34	1.28	0.920	1								
3 Intra-organizational Breadth	2.30	1.27	0.837	0.896	1							
4 Intra-organizational Depth	2.27	1.28	0.854	0.907	0.909	1						
5 Inter-organizational Volume	2.12	1.09	0.656	0.578	0.536	0.561	1					
6 Inter-organizational Diversity	2.03	1.07	0.685	0.668	0.602	0.620	0.873	1				
7 Inter-organizational Breadth	1.98	1.06	0.575	0.565	0.557	0.590	0.810	0.798	1			
8 Inter-organizational Depth	2.04	1.08	0.625	0.621	0.612	0.683	0.803	0.836	0.852	1		
9 Service Performance	3.58	0.64	0.230	0.220	0.227	0.233	0.220	0.216	0.194	0.282	1	
10 Cost Performance	3.18	0.69	0.357	0.341	0.331	0.347	0.320	0.348	0.283	0.336	0.672	1

All correlation coefficients are significant at the 0.01 level

Using the composite scores of the factors by taking the arithmetic mean of the items, we estimated the measurement models of intra- and inter-organizational e-integration, respectively. The CFA results with Cronbach's alpha coefficients, standardized loadings, t-values, composite reliabilities, and AVE values of intra- and inter-organizational e-integration at the second-order level, where each of the constructs is composed of four first-order factors, are summarized in the following table on the measurement model for e-integration. The descriptive statistics and correlations amongst the constructs under this study are presented in the following table on descriptive statistics and correlations. All the Cronbach's alpha values for the second-order factors exceeded the 0.70 cutoff level [7], yielding satisfactory evidence of internal consistency. We also estimated the second-order factors, i.e., intra- and inter-organizational integration, by examining the target coefficient (*T*) [2] [29]. The T indicates the extent to which the second-order factor accounts for the variance amongst the first-order factors, i.e., volume, diversity, breadth, and depth. Both the intra- and inter-organizational e-integration constructs had high T ratios of 0.93 and 0.92, respectively, implying that the relationships amongst the first-order factor are sufficiently captured by the second-order factor. Moreover, the paths from the second-order factors to the eight respective first-order factors were significant and of a high magnitude greater than 0.70 [5], ranging from the lowest of 0.892 to the highest of 0.973. Thus, on both theoretical and empirical grounds, the conceptualization of intra- and inter-organizational e-integration as higher-order, multidimensional constructs was tenable. Having determined that the latent constructs and their observed indicators possess acceptable measurement properties, we proceeded to estimate the hypothesized structural paths of the constructs.

Measurement model for e-integration

Constructs	**Items**	**Standardized Loadings**	**Cronbach's Alpha**	**Composite Reliability**	**AVE**
IntraOrg	IntraVol^	0.928***	0.970	0.969	0.888
	IntraDiv	0.973***			
	IntraBre	0.928***			
	IntraDep	0.939***			

[2] The *T* is computed using the following formula:

$$T = \chi^2 \text{ (first-order model)} / \chi^2 \text{ (second-order model)}$$

InterOrg	InterVol^	0.915***	0.953	0.951	0.828
	InterDiv	0.925***			
	InterBre	0.892***			
	InterDep	0.908***			

*** p < 0.001; ** p < 0.01; * p < .05

^ Item was fixed to 1 to set the scale

Descriptive statistics and intercorrelations

	Intra-organizational e-integration	**Inter-organizational e-integration**	**Service performance**	**Cost performance**
Intra-organizational e-integration	1	0.690**	0.236**	0.347**
Inter-organizational e-integration		1	0.244**	0.322**
Logistics service performance			1	0.659**
Logistics cost performance				1
N	227	227	227	227
Mean	2.32	2.05	3.58	3.15
Standard Deviation	1.22	1.00	0.64	0.69

*** p < 0.001; ** p < 0.01; * p < .05

Appendix B: Questionnaire Items

General instructions to respondents:
Internal documents in this study are defined as electronic copy of internal documents, e.g. purchasing approval, memos, and sales records. *Trade documents* refer to electronic copy of trade related documents, e.g. invoices, purchase orders, quotations, shipping notice, packing list. *External parties* are defined as the entities that are trading with your company, e.g. customers, suppliers, distributors. *Business processes* refer to any activity or collection of activities that provide a result that has value to an internal and external customer, e.g. purchasing, sales, logistics. *Transactions* are defined as any activity or collection of activities that involve buying and selling something to external parties. *Electronic data interchange (EDI)* is used as the replacement of paper-based system for electronic transmission of orders, invoices, and remittance information between businesses.

A.1 Intra-organizational e-integration: Volume
(5-point Likert scale anchored by 1: very low 0 -20%; 2: low >20 -40%; 3: neither low nor high >40 -60%; 4: high >60 -80% 5: very high <80-100%)

Within our company, the ***number*** of
… internal documents that are shared between the business processes via EDI is
… internal documents that are processed between the business processes via EDI is
… trade documents that are processed between the business processes via EDI is

A.2 Intra-organizational e-integration: Diversity
(5-point Likert scale anchored by 1: very low 0 -20%; 2: low >20 -40%; 3: neither low nor high >40 -60%; 4: high >60 -80% 5: very high <80-100%)

Within our company, the ***varieties*** of
... internal documents that are shared between the business processes via EDI is
... internal documents that are processed between the business processes via EDI is
… trade documents that are processed internally via EDI is

A.3 Intra-organizational e-integration: Breadth
(5-point Likert scale anchored by 1: very low 0 -20%; 2: low >20 -40%; 3: neither low nor high >40 -60%; 4: high >60 -80% 5: very high <80-100%)

Within our company, the ***number*** of
… internal documents that are shared cross-functionally via EDI is
… internal documents that are processed cross-functionally via EDI is
… trade documents that are processed cross-functionally via EDI is
… internal documents that are shared vertically via EDI is
… internal documents that are processed vertically via EDI is
… trade documents that are processed vertically via EDI is

A.4 Intra-organizational e-integration: Depth
(5-point Likert scale anchored by 1: very low 0 -20%; 2: low >20 -40%; 3: neither low nor high >40 -60%; 4: high >60 -80% 5: very high <80-100%)

Within our company, the ***number of business processes*** of our company that
… share internal documents via EDI is
… process internal documents via EDI is
... process trade documents via EDI is

B.1 Inter-organizational e-integration: Volume
(5-point Likert scale anchored by 1: very low 0 -20%; 2: low >20 -40%; 3: neither low nor high >40 -60%; 4: high >60 -80% 5: very high <80-100%)

Within our company, the ***number*** of
… trade documents that are sent to external parties via EDI is
… trade documents that are received from external parties via EDI is
… transactions that are sent to external parties via EDI is
… transactions that are received from external parties via EDI is

B.2 Inter-organizational e-integration: Diversity
(5-point Likert scale anchored by 1: very low 0 -20%; 2: low >20 -40%; 3: neither low nor high >40 -60%; 4: high >60 -80% 5: very high <80-100%)

Within our company, the ***varieties*** of
… trade documents that are sent to external parties via EDI is
… trade documents that are received from external parties via EDI is
… transactions that are sent to external parties via EDI is
… transactions that are received from external parties via EDI is

B.3 Inter-organizational e-integration: Breadth
(5-point Likert scale anchored by 1: very low 0 -20%; 2: low >20 -40%; 3: neither low nor high >40 -60%; 4: high >60 -80% 5: very high <80-100%)

Within our company, the ***number*** of
… external parties that send trade documents to us via EDI is
… external parties that request trade documents from us via EDI is
… external parties that transact with us via EDI is

B.4 Inter-organizational e-integration: Depth
(5-point Likert scale anchored by 1: very low 0 -20%; 2: low >20 -40%; 3: neither low nor high >40 -60%; 4: high >60 -80% 5: very high <80-100%)

Within our company, the ***number of business processes*** of our company that
… receive trade documents from external parties via EDI is
… send trade documents to external parties via EDI is
… receive transactions from external parties via EDI is
… send transactions to external parties via EDI is

C.1 Logistics service Performance
(5-point Likert scale anchored by 1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree)

Comparing with our major competitors
… our company receives fewer complaints from trading partners (i.e., suppliers/customers)
… our main trading partners are satisfied with our services
… our main trading partners find our services more reliable (e.g. on-time delivery, error free invoice, on-time payment)
… our service performance is more effective (e.g. close to customer requirements)
… the number of required contact points in our company for trading partners to receive our products/services is fewer
… our response time to trading partners is faster
… our trading partners have more trust with us

C.2 Logistics cost Performance
(5-point Likert scale anchored by 1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree)

Comparing with our major competitors
… our order management cost is lower
… our inventory cost is lower
… our warehouse cost is lower
… our transportation cost is lower
… our logistics administration cost is lower
… our cash-to-cash cycle is shorter
… our net asset turns (i.e., working capital) is better
… our business processes are more efficient
… our utilization of corporate resources (e.g. inventory) is better

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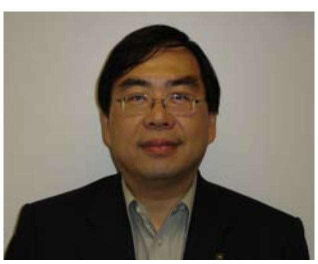

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