Effect of IT-enabled Supply Chain Process Integration on Firm's Operational Performance

Completed Research Paper

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Abstract

In the context of supply chain integration (SCI), information technology (IT) is regarded as a backbone of process integration within a firm and between partnering organizations. The literature reports mixed results on relationship between IT and firm's performance. We propose a model that constitutes the relationship between IT capability and flexibility and delivery performance, mediated by supply chain integration, internal and external with suppliers and customers. The empirical study with 117 Japanese manufacturing firms reveals that flexibility performance is improved when both supplier integration and customer integration are supported by supply chain application capability. Delivery performance is enhanced when internal integration is backed with strong cross-functional application capability, along with customer integration supported by supply chain application capability. This study makes significant contributions to the IT and SCI literature by investigating the effect of IT capability on flexibility and delivery performance through internal and external integration, providing managerial implications.

Keywords

Supply chain integration, IT capability, delivery, flexibility.

Introduction

Many researchers in areas of information systems and supply chain management have discussed extensively on a critical role that information technology (IT) plays in managing supply chain activities and partnerships to enhance firm's performance. However, due to uncertain direct affect of IT on supply chain performance (Devaraj et al. 2007; Heim et al. 2010), previous literature tried to explain how and why IT can improve firm's operational performance in terms of quality, cost, delivery, and flexibility in a supply chain context focusing on external integration with suppliers and customers (Devaraj et al. 2007; Rai et al. 2006). The results of the past empirical studies prove that among the four dimensions of operational performance, delivery and flexibility were found to be positively related with IT initiatives (Iyer et al. 2009; Jayaram et al. 2000; Swafford et al. 2008). Flynn et al. (2010) defined supply chain integration (SCI) as "the degree to which a manufacturer strategically collaborates with its supply chain partners and collaboratively manages intra- and inter-organization processes", which emphasizes the dimensions of *external integration* with both suppliers and customers and *internal integration* that should be considered upon supply chain integration. Thus, *objective* of this study is to find out if IT capability impacts firm's operational performance in terms of delivery and flexibility through both internal integration and external integration.

The goal of supply chain integration (SCI) is to achieve effective and efficient flow of materials, information and money, in order to provide maximum value to customers (Ben Naylor et al. 1999; Bowersox et al. 1999; Flynn et al. 2010; Frohlich et al. 2001) quickly. Supply chain integration can be hindered because of fragmented IT applications that constrain information flows and activity coordination (Barua et al. 2004; Sambamurthy et al. 2003). In this study, IT capabilities based on cross-functional application (CFA) and supply chain application (SCA) are considered as enablers of internal integration and external integration, respectively.

Based on this foundation, we address the following questions in our research:

1. Do IT capabilities from CFA and SCA impact supply chain integration?

2. Do internal integration and external integration with partners impact operational performance of a firm in terms of flexibility and delivery?

Theoretical Background and Hypotheses Development

Supply Chain Integration

Broad range of study has been conducted on supply chain integration (SCI), as one of the key practices for performance improvement, in the area of supply chain management (Leuschner et al. 2013; Van der Vaart et al. 2008). SCI is defined as "the degree to which an organization strategically collaborates with its main supply chain partners and manages intra- and inter-organization processes to achieve effective and efficient flows of products, services, information, money and decisions, with the objective of providing maximum value to its customers" (Zhao et al. 2008, p. 7). According to Flynn et al. (2010) there are different types of SCI distinguished in the current literature, with the majority of authors considering SCI as a uni-dimensional construct (Armistead et al. 1993; Crespo Marquez et al. 2004; Rosenzweig et al. 2003), other researchers classified SCI into external and internal integration (Campbell et al. 2005; Hill et al. 2002; Morash et al. 1998; O'Leary-Kelly et al. 2002; Stank et al. 2001a; Stanley et al. 2001; Zailani et al. 2005), while some authors considered multiple dimensions of SCI (Droge et al. 2004; Gimenez et al. 2005; Narasimhan et al. 2002; Stank et al. 2001a; Vickery et al. 2003).

In this study, we consider three distinct types of SCI, namely, customer integration, supplier integration and internal integration. Customer integration and supplier integration are regarded by researchers as an external integration, which is defined as the degree to which a focal organization can partner with its key supply chain members (suppliers and customers) to structure their inter-organizational strategies, practices and processes into collaborative, synchronized processes (Flynn et al. 2010; Stank et al. 2001b). However these two integration types are called as an external integration, each of them pertains to various activities depending on whether it's supplier integration or customer integration, because the context of the relationship between suppliers and customers is different.

Supplier integration involves communication and coordination activities, information sharing, and participation by suppliers in a focal organization's procurement and production processes. On the contrary, customer integration includes such activities as communication and contact with customers, sharing of market and inventory information, and follow-up with customers for feedback of its services and products.

Internal integration is defined as the degree to which a firm structures its own organizational strategies, practices and processes into collaborative, synchronized processes, with the aim to fulfill its customers' requirements (Cespedes 1996; Flynn et al. 2010; Kahn et al. 1996; Kingman-Brundage et al. 1995). Internal integration mostly includes information sharing between internal functions, strategic cross-functional cooperation and collaboration.

Impact of Internal Integration on Customer Integration and Supplier Integration

In spite of inconsistent findings on the relationship between internal integration and external integration in the existing literature, we argue that internal integration has a positive impact on customer integration and supplier integration. From the perspective of organizational capability, it is argued that when a firm has a high level of internal communication and coordination capabilities, it will be more competent to achieve a high level of customer and supplier integration (Zhao et al. 2011). Stank et al. (2001b) found that internal information sharing between functional departments of a firm is positively related to external cooperation with partners. Strategic cooperation literature also suggests that internal integration based on communication, information sharing and cross-functional teamwork is especially important for establishing and maintaining the firm's alliance with its customers and suppliers.

Bowersox (1989)suggests that the process of supply chain integration should progress from the integration on internal logistics processes to external integration with suppliers and customers, implying that the higher internal integration can lead to higher customer and supplier integration, respectively

(Kanter 1994). Therefore, we argue that firms with higher level of internal integration are more likely integrate with their customers and suppliers.

H1a. Internal integration has a direct and positive impact on customer integration.

H1b. Internal integration has a direct and positive impact on supplier integration.

IT Capability

IT capability is defined as technological capability used to acquire, process, and transmit information for more effective decision making (Grover et al. 1999), and to facilitate communication, coordination and collaboration between multiple parties. The literature states that IT construct in the context of supply chain management is broadly measured by one general concept (Sanders et al. 2005; Subramani 2004). On the contrary, other papers (Sanders 2007) measure IT narrowly by one specific type of technology. Zhang et al. (2011) in their literature review of survey-based research on information and communication technology (ICT) and supply chain management found that majority of observed literature focused on the inter-organizational ICT, while fewer on the intra-organizational ICT. We argue that IT capability can be divided into two types, cross-functional application capability and supply chain application capability, corresponding to the typology of SCI, internal integration and external integration. Cross-functional application (CFA) capability facilitates integration of data and information system within a firm through use of enterprise resource planning (ERP), real-time data searching of inventory and operating data, and enables information sharing, communication, and collaboration of functional departments of the firm. On the other hand, supply chain application (SCA) capability facilitates interactions between multiple parties in the supply chain, closer coordination between supply chain members and coupling their business activities for the purpose of improving efficiency and effectiveness of business activities, by means of supplier relationship management and customer relationship management applications. Hence, we argue that the higher level of CFA and SCA capabilities results in a higher level of integration not only among the internal functions in an organization but also with outside customers and suppliers.

H2a. Cross-functional application capability has a direct and positive impact on internal integration.

H2b. Supply chain application capability has a direct and positive impact on internal integration.

H3a. Cross-functional application capability has a direct and positive impact on customer integration.

H3b. Supply chain application capability has a direct and positive impact on customer integration.

H4a. Cross-functional application capability has a direct and positive impact on supplier integration.

H4b. Supply chain application capability has a direct and positive impact on supplier integration.

Firm's Operational Performance

The literature identifies a growing number of empirical evidence that suggests the higher level of integration along the supply chain positively associated with greater prospective benefits for the performance of supply chain. Provided broad range of literature, which discuss an impact of SCI on such performance measures, such as operational costs and customer service (Chen et al. 2004; Droge et al. 2004; Vickery et al. 2003), level of service to customer and quality (Stanley et al. 2001), financial performance measures of ROI, profits, and net income (Chen et al. 2004; Dixon et al. 1990), operational-oriented performance (Neely et al. 1995), product development performance (Petersen et al. 2005); we measure operational performance by two measures of operational performance, flexibility and delivery, which are deemed to be important elements for responsiveness capability of a firm (Danese 2013; Hallgren et al. 2009). Flexibility is measured in terms of product modification and new product introduction to meet with changing customer needs. Delivery is measured with regard to reliability and lead time to fulfill customer orders.

Impact of Internal Integration on Operational Performance

With regard to relationship between internal integration and operational performance, not all the findings in the literature seem to be consistent. Some authors found no direct relationship between these constructs (Koufteros et al. 2005), others found a positive relationship between internal integration and operational performance, including process efficiency (Saeed et al. 2005). Thus we argue that internal integration is positively related to flexibility and delivery.

H5a. Internal integration has a direct and positive impact on flexibility.

H5b. Internal integration has a direct and positive impact on delivery.

Impact of Customer and Supplier Integration on Flexibility and Delivery

The literature suggests mixed results on the relationship between SCI and business performance (Droge et al. 2004; Flynn et al. 2010; Frohlich et al. 2001; Rosenzweig et al. 2003; Zailani et al. 2005), and it is not easy to draw generalized conclusions. Stank et al. (2001b) regard customer integration as one of the most instrumental factors of overall firm performance besides internal integration. Devaraj et al. (2007) found a positive relationship between supplier production integration and firm's operational performance. We propose that both customer integration and supplier integration positively influence flexibility and delivery.

H6a. Customer integration has a direct and positive impact on flexibility.

H6b. Customer integration has a direct and positive impact on delivery.

H7a. Supplier integration has a direct and positive impact on flexibility.

H7b. Supplier integration has a direct and positive impact on delivery.

Following the existing literature on SCI, IT and operational performance, our analytical framework was developed as shown in Figure 1, with the research hypotheses described above.

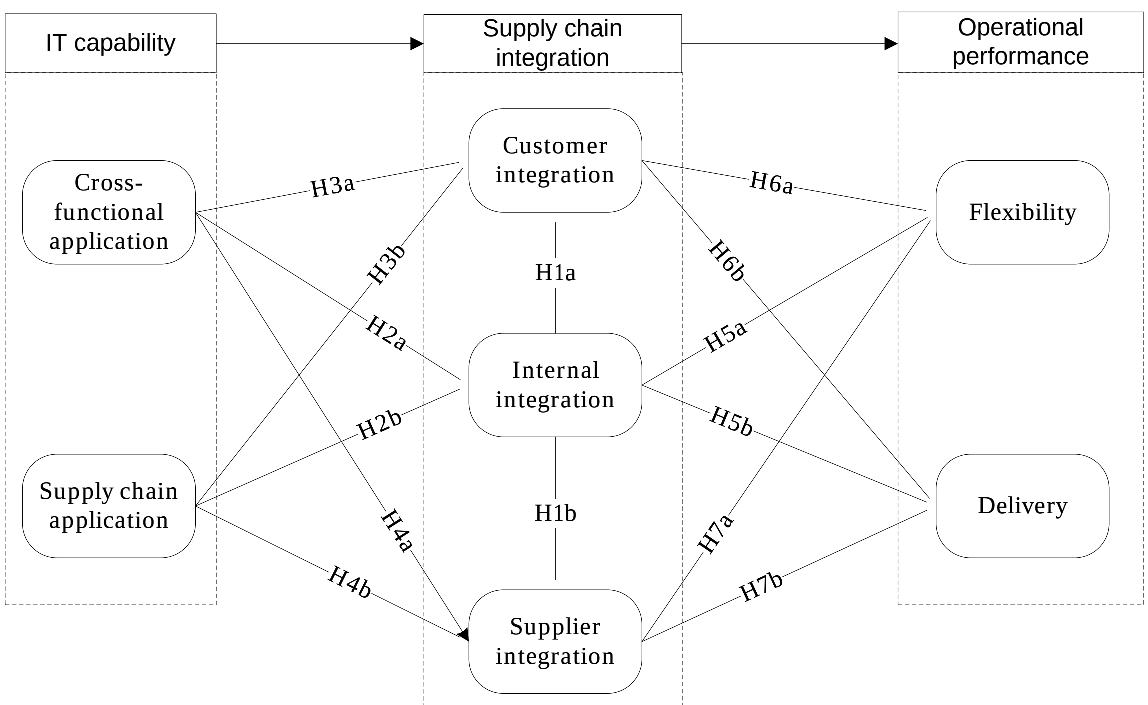


Figure 1. Analytical Framework
(IT Capability, Supply Chain Integration, and Operational Performance)

Research Methodology

Questionnaire Development

We designed a survey instrument based on previous studies and some have been adapted to measure supply chain application capability (Rai et al. 2006), cross-functional application capability and internal integration (Flynn et al. 2010; Narasimhan et al. 2002; Zhao et al. 2011), customer and supplier integration (Flynn et al. 2010; Morash et al. 1998; Narasimhan et al. 2002; Zhao et al. 2011), and two operational performance constructs of flexibility and delivery (Beamon 1999; Flynn et al. 2010; Frohlich et al. 2001; Vickery et al. 2003). All items are measured using seven-point Likert scale, ranging from 1 (strongly agree) to 7 (strongly disagree) for flexibility, delivery, and supply chain application capability constructs; from 1 (not at all) to 7 (extensively) for internal integration, customer integration, supplier integration, and cross-functional application capability constructs. The complete list of scales is listed in Table 2.

Additionally, the survey instrument included the demographic information of the company such as physical assets, size in terms of assets and number of employees in the firm. In this study, we used two major dyadic relationship (manufacturer – major supplier, and manufacturer – major customer) to represent the supply chain integration, since a manufacturer might have many suppliers and customers, the level of integration might be different for different customers and suppliers. Therefore, we limited our items on external integration to be applied to the company's major customer and major supplier following (Zhao et al. 2011). The major supplier is defined as the supplier who supplies the respondent the highest monetary value of supplies among all suppliers, and the major customer is defined as the customer who buys from the respondent's company the highest monetary value of products among all customers.

Since the measurement items were adopted from the literature in English, the initial survey instrument was developed in English and translated into Japanese by both authors independently. Later we discussed for wording and finalized the questionnaire in order to ensure that the items were understandable and relevant to Japanese practices.

Sampling and Data Collection

Data for this study were collected through a survey of manufacturing firms in Japan during September through October in 2013. The survey instrument was mailed to 815 large manufacturing companies which are listed in the First Section of the Tokyo Stock Exchange. This study focused on large firms generally considered as "leaders in innovative practices, such as IT and SCM" (Sanders et al. 2005: 6).

As the information targeted in this research is strategic in nature, and concerns relationship management and process integration with internal functions, customers and suppliers within the supply chain; the survey instrument was sent to the highest ranking manager, a key informant, who is knowledgeable in supply chain management, and is familiar with internal processes, processes for purchasing and distribution, and customer and suppliers relationship management. This is supported by a study by Phillips (1981) that shows high ranking informants tend to be more reliable sources of information than low ranking. The target key informants included supply chain managers, CEO, presidents, senior executives, vice presidents, senior directors and senior managers. The name and contact information of the most suitable informant was identified from the latest annual financial statement of each company.

The mailing included the survey instrument, a return envelope with postage pre-paid, and a cover letter, which contained objectives of the research and a web-link for the web survey.

Follow-up telephone calls were made after approximately 30 days to increase the response rate. This resulted in total of 117 responses yielding a response rate of 14.36%, of which 95 responses were received by mail and 22 responses through the web-survey interface.

Of 117 responses, 7 incomplete responses were discarded. Accordingly, the analysis that follows and all reported statistics were based on a sample of 110 manufacturing firms. However the response rate is low, the rate is similar to other surveys that targeted senior managers (Sanders et al. 2005; Wisner 2003).

Industry sub-sector	Frequency	Percentage
Metal, mechanical and engineering	25	21.4%
Electronics and electrical	24	20.5%
Chemical and petrochemicals	23	19.7%
Transportation	11	9.4%
Textiles and apparel	8	6.8%
Food, beverage and alcohol	6	5.1%
Pharmaceutical and medical	5	4.3%
Rubber and plastics	4	3.4%
Wood and furniture	3	2.6%
Ceramic	3	2.6%
Building materials	2	1.7%
Pulp and paper	2	1.7%
Jewelry	1	0.8%
	117	100%

Table 1. Company Profiles

Table 1 shows the demographic profiles of the sample. A wide variety of industries are represented, with around 21% companies representing the metal, mechanical and engineering industry, and another around 21% standing for the electronics and electrical industry sectors, followed by around 20% coming from the chemical and petrochemicals sector.

Non-response Bias and Common Method Bias

Non-response bias is a concern for every survey methodology. We compared the responses between the early and late respondents using an independent t-test (Armstrong et al. 1977) for fixed assets, annual sales, and number of employees (Handfield et al. 2002; Stank et al. 2001a; Zhao et al. 2011). Early respondents were those who had completed and returned the questionnaires within the given deadline for survey response; late respondents refer to those who returned the questionnaires after the deadline. The t-tests show no significant differences ($p<0.05$), suggesting that non-response bias does not appear to present in the data.

As we use one respondent to answer the self-reported questionnaire for this study, potential common method bias is checked. We tested for possible common method variance with Harman's single-factor test (Podsakoff et al. 1986). According to this approach, common method bias is present if a single factor accounts for the majority of the variance extracted from the exploratory factor analysis. An exploratory factor analysis (EFA) using the Principal Axis Factoring Analysis and Oblimin rotation for all of our measurement items revealed seven distinct factors with eigenvalues above or equal to 1.0, explaining 66.3% of total variance. The first factor explained 32.9% of the variance, which is not the majority of the total variance, implying that common method bias was not a serious threat. For further analysis, confirmatory factor analysis applied to Harman's single factor model (Sanchez et al. 1996) was conducted. The results show that the fit for the common method factor model is unsatisfactory, suggesting that the common method bias is not a serious concern.

Reliability and Validity

Content validity of measurement instrument was confirmed through a thorough search of the literature and critical evaluation of existing constructs by domain experts. In order to test the reliability of our measurement model, we followed two-step approach: (1) using exploratory factory analysis (EFA) to ensure unidimensionality of the scales, (2) followed by Cronbach's alpha for assessing construct reliability.

EFA with principal component analysis was used for data reduction and for determining the main constructs measured by the items from different sources. Varimax rotation with Kaiser normalization was employed to clarify the factors (Loehlin 1998). Emerged three types of SCI, internal integration, supplier integration and customer integration, two types of IT capability, cross-functional application capability and supply chain application capability, and two types of operational performance, delivery and flexibility. All the question items for those seven constructs had strong loadings on the construct they were supposed to measure, and lower loadings on the constructs they were not supposed to measure. Further, we applied the maximum likelihood method with promax rotation, loaded with all the question items, in order to make sure that seven factors could clearly emerge. The internal integration, supplier integration, customer integration, supply chain application capability, delivery, flexibility, and cross-functional application capability constructs explained 11.77%, 27.15%, 7.42%, 6.08%, 7.25%, 4.22%, 2.42% of total variances cumulatively.

Items	**Description**	**Mean**	**S.D.**	**α**
Internal integration				**0.911**
INTER1	The use of periodic interdepartmental meetings among internal functions	5.04	1.07	
INTER2	The use of cross functional teams in new product development	4.50	1.27	
INTER3	The extent of strategic partnership among different internal functions	4.40	1.17	
INTER4	Different internal functions jointly develop strategic plans in collaboration with each other	4.43	1.18	
INTER5	Different internal functions monitor business processes together	3.88	1.23	
Supplier integration				**0.902**
SUP_INT1	Our level of information exchange with our major supplier through information network	3.70	1.39	
SUP_INT2	The establishment of a quick ordering system with our major supplier	4.16	1.41	
SUP_INT3	The extent of our strategic partnership with our major supplier	4.00	1.27	
SUP_INT4	Stable procurement through networking with our major supplier	4.02	1.41	
SUP_INT5	The participation level of our major supplier in our procurement and production processes	3.55	1.47	
SUP_INT8	We share our demand forecast with our major supplier	3.95	1.25	
Customer integration				**0.869**
CUS_INT1	The extent of our linkage with our major customer through information network	3.77	1.35	
CUS_INT2	The extent of sharing of market information by our major customer	3.83	1.26	
CUS_INT3	Our level of communication with our major customer	4.68	1.01	
CUS_INT4	The establishment of a quick ordering system with our major customer	4.38	1.44	
CUS_INT5	Our follow-up with our major customer for feedback	4.32	1.12	
CUS_INT6	The frequency of our contacts with our major customer	4.99	0.92	
CUS_INT7	Our major customer shares demand forecast with us	4.19	1.32	

Table 2. Descriptive Statistics of Measurement Items

Items	Description	Mean	S.D.	α
Supply chain application capability				**0.887**
SCA1	Supply chain planning applications (e.g., demand planning, transportation planning, manufacturing planning) communicate in real time.	3.90	1.46	
SCA2	Supply chain transaction applications (e.g., order management, procurement, manufacturing and distribution) communicate in real time.	3.92	1.47	
SCA3	Supply chain applications communicate in real time with internal applications of our organization (e.g., ERP).	3.99	1.58	
SCA4	Customer relationship management applications communicate in real time with internal applications of our organization.	3.62	1.47	
Cross-functional application capability				**0.896**
CFA1	Data integration among internal functions	4.06	1.18	
CFA2	Enterprise application integration among internal functions	4.39	1.10	
CFA3	Integrative inventory management	4.39	1.29	
CFA4	Real-time searching of logistics-related operating data	4.03	1.49	
CFA5	Real-time integration and connection among internal functions from raw material management through production, shipping, and sales	4.13	1.36	
Flexibility				**0.881**
FLEX1	Our company can quickly modify products to meet our customers' requirements	5.24	1.38	
FLEX2	Our company can quickly introduce new products into the market	4.86	1.34	
FLEX3	Our company can quickly respond to changes in market demand	4.99	1.25	
Delivery				**0.858**
DELIV4	Our company has an outstanding record of on-time delivery to our customers	5.65	1.12	
DELIV5	Our company has an outstanding record of reliable delivery to our customers	5.81	1.04	
DELIV6	The lead time for fulfilling customer orders (the time which elapses between the receipt of a customer's order and the delivery of the goods) is short	5.06	1.33	
DELIV7	Our company provides a high level of customer service to our customers	5.75	1.06	

Table 2. Descriptive Statistics of Measurement Items (cont.)

Table 2 shows the mean and standard deviations of all items, as well as Cronbach's alpha for each construct. The scales are all reliable with alpha values ranging from 0.858 to 0.911, thereby exceeding the generally agreed lower limit for Cronbach's alpha of 0.60 (Flynn et al. 1990; Nunnally et al. 1991).

Further, unidimensionality and reliability were evaluated using confirmatory factor analysis (CFA). As shown in Table 3, composite reliability (CR) and average variance extracted (AVE) values are greater than threshold values of 0.60 and 0.50 respectively (Bagozzi et al. 1988; Fornell et al. 1981; Hair et al. 1998; Nunnally et al. 1991).

The measurement model fit indices were $\chi^2(496) = 760.96$, GFI = 0.74, AGFI = 0.69, CFI = 0.90, NFI = 0.76, RMSEA = 0.07. Thus the model was marginally acceptable (Hu et al. 1999) indicating convergent validity.

Next, Using Fornell et al. (1981) approach, we examined the measurement model for discriminant validity. As illustrated in Table 3, all the scales illustrate considerably higher AVE values compared to the correlations with other constructs, suggesting the support for discriminant validity. Moreover, in Table 4 we ensured convergent validity by evaluating the individual item's standardized regression weights in the measurement model and the statistical significance (Anderson et al. 1988). The results indicate that all measurement items tested have standardized regression weights twice their standardized error, and were significant ($p<0.001$), indicating good convergent validity.

	CR	AVE	FLEX	INTER	SUP_INT	CUS_INT	SCA	DELIV	CFA
FLEX	0.886	0.723	0.850						
INTER	0.913	0.680	0.245	0.824					
SUP_INT	0.905	0.616	0.274	0.472	0.785				
CUS_INT	0.881	0.517	0.347	0.444	0.288	0.719			
SCA	0.889	0.670	0.340	0.342	0.560	0.365	0.819		
DELIV	0.872	0.636	0.541	0.364	0.332	0.431	0.265	0.797	
CFA	0.905	0.656	0.239	0.759	0.578	0.363	0.494	0.413	0.810

Table 3. Discriminant and Convergent Validity Test

Data Analysis and Results

The structural equation modeling (SEM) is applied to estimate the relationship between constructs and to test hypotheses developed earlier in the research, using AMOS 21.0. The SEM methodology ascertains the fit between the variance-covariance matrix observed in the sample data and that implied by the research model. For illustrating this fit, we report goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI) (Bagozzi et al. 1988), comparative fit index (CFI) and normed fit index (NFI), and the root mean square error of approximation (RMSEA) (Steiger 1990). Values greater than 0.90 for GFI, CFI, and NFI (Gefen et al. 2000), AGFI values greater than 0.80, and RMSEA value less than 0.1, are considered a good fit of the hypothesized model (Gefen et al. 2000; Steiger 1990). The research model was found to fit the data well: $\chi^2(4) = 6.31$, GFI = 0.98, AGFI = 0.89, CFI = 0.99, NFI = 0.98, RMSEA = 0.07, thus suggesting a good fit of the hypothesized model (Gefen et al. 2000). The results of estimating the structural model are presented in Figure 2.

The squared multiple correlations (SMC), that are considered to be similar to r-squared values in regression analysis, demonstrate that the structural model accounts for 64% of the variance in internal integration, 29% for the variance in customer integration, 49% of the variance in supplier integration, 18% for the variance in flexibility performance, 26% for the variance in delivery performance.

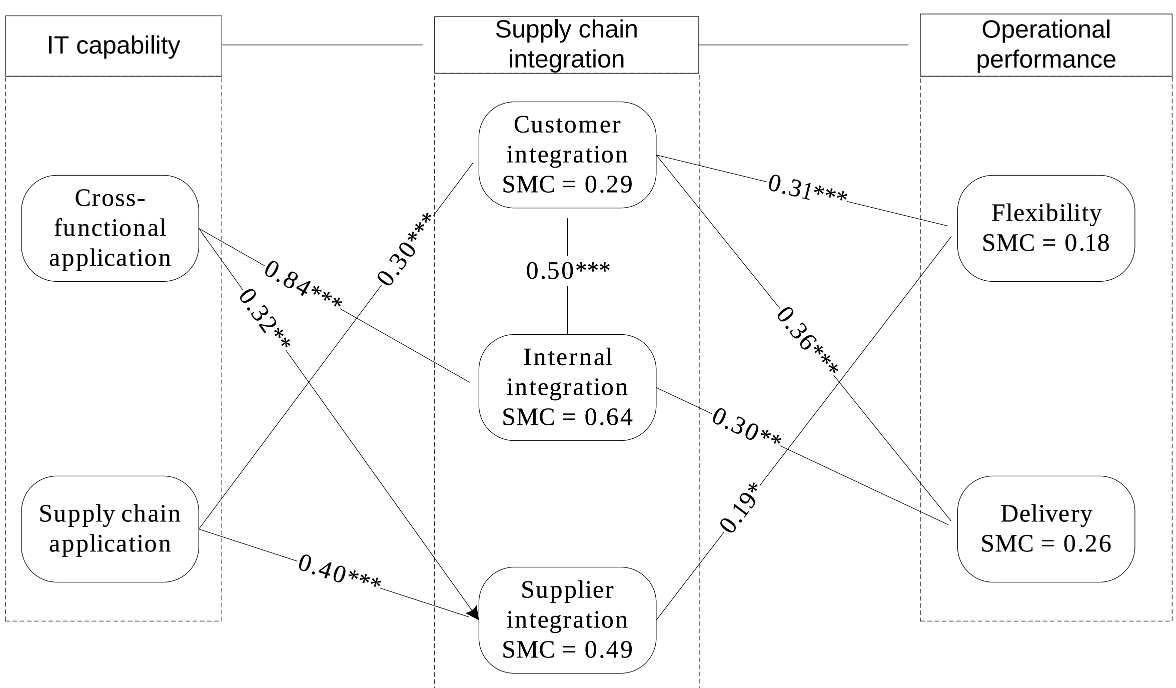
Nine out of fourteen paths show significantly positive relationships, supporting their corresponding hypotheses. Customer integration and supplier integration have significantly positive impact on flexibility. Thus H6a and H7a are supported. Next, customer integration and internal integration have significantly positive influence on delivery, which suggests, H6b and H5b are supported. Supply chain application capability and internal integration have significantly positive impact on customer integration, therefore supporting H3b and H1a. The results also show that cross-functional application capability and supply chain application capability have significantly positive effect on supplier integration, which supports H4a and H4b. Finally, cross-functional application capability has significantly positive impact on internal integration, hence supporting H2a.

On the other hand, we found that the impacts of internal integration on flexibility, supplier integration on delivery, cross-functional application capability on customer integration, supply chain application capability on internal integration, internal integration on supplier integration were not statistically significant. Hence, H5a, H7b, H3a, H2b, and H1b are not supported.

A summary of the hypotheses test is given in Table 5. The findings from the analysis are discussed in the next section.

Constructs (items)	Standard loading	Standard error	t-value	Constructs (items)	Standard loading	Standard error	t-value
Internal integration				**Supply chain integration**			
INTER1	0.662	0.085	8.023	SCA1	0.871	0.094	10.543
INTER2	0.810	0.089	11.101	SCA2	0.898	0.094	10.93
INTER3	0.874	0.077	12.824	SCA3	0.812		
INTER4	0.887			SCA4	0.675	0.103	7.534
INTER5	0.868	0.081	12.657	**Cross-functional integration**			
Supplier integration				CFA1	0.764	0.088	8.521
SUP_INT1	0.810	0.100	9.552	CFA2	0.791	0.096	7.54
SUP_INT2	0.814	0.101	9.611	CFA3	0.809	0.078	11.211
SUP_INT3	0.758	0.093	8.748	CFA4	0.799		
SUP_INT4	0.866	0.100	10.357	CFA5	0.881	0.100	10.034
SUP_INT5	0.803			**Delivery**			
SUP_INT8	0.639	0.098	6.916	DELIV1	0.908	0.084	12.921
Customer integration				DELIV2	0.896		
CUS_INT1	0.558	0.166	5.781	DELIV3	0.697	0.116	8.557
CUS_INT2	0.694	0.149	7.441	DELIV4	0.655	0.095	7.816
CUS_INT3	0.780			**Flexibility**			
CUS_INT4	0.597	0.171	6.35	FLEX1	0.754	0.088	9.586
CUS_INT5	0.791	0.130	8.613	FLEX2	0.918		
CUS_INT6	0.801	0.106	8.883	FLEX3	0.871	0.075	11.827
CUS_INT7	0.772	0.154	8.35				

Table 4. Loadings of the Measures



***p < 0.001, **p < 0.01, *p < 0.05

Figure 2. Structural Model Results

Discussion

In an attempt to understand relationship between IT capability, SCI, and operational performance, we developed a research model and used an empirical data from manufacturing organizations in Japan. We found that most of our hypotheses were supported or partially supported, indicating that IT capabilities do impact operational performance through internal and external (customer and supplier) integration. Specifically, we found that flexibility is positively influenced by both customer and supplier integration, while delivery is positively impacted by customer and internal integration. Moreover, both CFA and SCA had positive impact on supplier integration, while customer integration was impacted by internal integration and SCA. Internal integration was influenced positively by cross-functional application capability.

			Standardized coefficient	t-value	Sig. (one-tailed)	Hypotheses	Outcome
CUS	←-	INTER	0.50	3.718	0.001	H1a	Supported***
SUP	←-	INTER	0.11	0.932	0.176	H1b	Not supported
INTER	←-	CFA	0.84	12.467	0.001	H2a	Supported***
INTER	←-	SCA	-0.09	-1.349	0.089	H2b	Not supported
CUS	←-	CFA	-0.17	-1.128	0.130	H3a	Not supported
CUS	←-	SCA	0.30	3.116	0.001	H3b	Supported***
SUP	←-	CFA	0.32	2.538	0.006	H4a	Supported**
SUP	←-	SCA	0.40	4.9	0.001	H4b	Supported***
FLEX	←-	INTER	0.02	0.202	0.420	H5a	Not supported
DELIV	←-	INTER	0.30	2.422	0.008	H5b	Supported**
FLEX	←-	CUS	0.31	3.091	0.001	H6a	Supported***
DELIV	←-	CUS	0.36	3.898	0.001	H6b	Supported***
FLEX	←-	SUP	0.19	1.889	0.030	H7a	Supported*
DELIV	←-	SUP	0.11	1.142	0.127	H7b	Not supported

Model fit: $\chi^2(4)=6.31$, GFI = 0.98, AGFI = 0.89, CFI = 0.99, NFI = 0.98, RMSEA = 0.07
Notes: *** p < 0.001, **p < 0.01, *p < 0.05; INTER = Internal integration; CUS = Customer integration; SUP = Supplier integration; CFA = Cross-functional application capability; SCA = Supply chain application capability; FLEX = Flexibility performance; DELIV = Delivery performance.

Table 5. Results of SEM Test

The positive impact of customer integration on both performance measures proves the findings from previous research on SCI (Flynn et al. 2010; Germain et al. 2006; Koufteros et al. 2005). This can be explained by the objective of SCI, which is to provide maximum value to customer, hence the measurements of operational performance are basically customer-oriented (Flynn et al. 2010). On the other hand supplier integration had impact only on flexibility, which partially supports the findings of Devaraj et al. (2007) who found a positive relationship between supplier production integration and operational performance, latter being as a formative construct consisting of cost, quality, flexibility and delivery. When a firm is highly integrated with its suppliers through frequent contact, communication and coordination of procurement and production processes, this could improve the flexibility of the firm in terms of product modification, new product introduction and response to market changes. However, delivery was not found to be influenced by supplier integration, which, again, can be explained by the fact that delivery performance is directly related to one of goals of SCI, customer satisfaction.

The third integration construct of internal integration had a positive effect on delivery, providing a partial support for findings of Flynn et al. (2010). When internal functions such as procurement, production and marketing functions communicate and share information frequently, and collaborate strategically, it could bring higher efficiency and effectiveness of processes in the organization and result in better delivery performance.

With regard to relationship between internal integration and external integration, only customer integration was positively related with internal integration, which partially supports findings from the study of Zhao et al. (2011), while supplier integration did not have any relationship with internal integration, which contradicts to their results. This can be explained by intention of an organization to get in frequent communication and higher level collaboration with customers than with suppliers and to receive important market information from the customers in order to improve its performance.

A positive and highly significant impact of CFA capability on internal integration provides strong support for our hypothesis, describing the fact that the high level of CFA capability will improve internal integration. We found a positive impact of CFA capability on supplier integration also. Previous literature suggests that in practice the level of supplier integration is higher than that of customer integration. Supplier relationship management system might be well integrated with the internal cross-functional applications such as ERP systems, explaining the positive relationship between CFA capability and supplier integration.

The positive relationships between SCA capability and customer integration, SCA capability and supplier integration provide partial support for findings of several papers (Devaraj et al. 2007; Heim et al. 2010), suggesting that SCA capability contributes to building the external integration with partners of the organization.

Conclusions, Managerial Implications and Limitations

This research and its findings contribute to the existing literature on SCI, IT capability and operational performance in several major ways. First, it extends the literature by empirically testing the impact of IT capability, on delivery and flexibility performance separately, through internal, customer and supplier integration. Second, this research proposes two types of IT capability in SCI settings: cross-functional application capability and supply chain application capability. Both of these capabilities were found to have impact on delivery and flexibility performance through internal and external integration. Third, our study extends the literature by indicating the importance of the three types of SCI, internal, supplier and customer integration, across various manufacturing industries in Japan.

Findings from this study also provide some guidelines for managers to lead their organizations for achieving better operational performance in terms of flexibility and delivery. Firstly, for a better flexibility performance to be reached, managers should consider enhancing external integration with the firm's suppliers and customers, with more emphasis on supplier integration. On the contrary, a better delivery performance can be attained, when internal integration and customer integration are brought to higher levels, with more concentration on the internal integration.

For improved flexibility performance, organizations will need to build not only strong internal IT capability in terms of well integrated data and internal departmental functions, which cooperate and coordinate their activities, but also robust external IT capability with regards to close integration and real-time communication of such information systems as procurement, manufacturing, demand and transportation planning with those of supply chain partners through supplier relationship management application as well as customers relationship management application. These integrated systems can facilitate the coordination and collaboration, information sharing with suppliers and customers, improving flexibility performance of the organization.

Firms trying to improve their flexibility performance in terms of meeting customer requirements, speeding up their new product introduction into the market are suggested to improve their external integration with suppliers and customers, while ensuring their supply chain applications, namely, supply chain planning and transaction applications, as well as supplier relationship management and customer relationship management applications, are well integrated and communicating in real-time with intra-organizational applications that are also well developed and supporting internal data integration and cooperation and collaboration of internal functional processes. In this case, close attention should be paid to improve the supplier integration side of external integration.

On the other, delivery performance is highly influenced by both internal and external IT capabilities through internal and customer integration. Supply chain application capability improves delivery through customer integration, while cross-functional application capability impacts delivery through internal integration. When firms are seeking to advance their delivery performance and carry out it with reliable and on-time service, therefore shortening their lead time for fulfilling customer orders, it is critical, firstly, to concentrate on achieving integrative internal applications among different departments and inventory management systems that improve intra-organizational communication and collaboration among different internal functions. Secondly, it is important to focus on inter-organizational planning and transactions applications and their real-time communication to ensure that the extensive customer integration in terms of communication and coordination of activities should be achieved. The internal integration coupled with strong intra-organizational application capability can be of greater importance for delivery performance.

In conclusion, there are some limitations of this study and more opportunities for future research. First, the results from this study might not be generalizable to the whole population in terms of other industries than manufacturing and/or small and medium organizations, even though we could generalize our results to large-sized manufacturing firms. Second, the study was conducted from manufacturer perspective only. Further research should be done to investigate the research constructs and the relationship among them from supplier, manufacturer, and customer perspectives. Finally, the study used cross-sectional data. In the future longitudinal research can be conducted to examine the dynamics in the development of internal and external integration, advancement of technology capability, and performance improvement.

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