

# The Impact of Supply Chain Integration on Operation Performance: The Moderating Role of IT Competence

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## Abstract

This paper aims to provide empirical evidence of the effectiveness of various supply chain integration (SCI) under different IT competence in terms of IT human resource and IT strategy. Survey methodology was used to collect data from 191 manufacturers of ten countries. Hierarchical linear regression was used to analyze the moderating effects. The results showed that IT competence significantly influences the effectiveness of SCI practices, including internal integration, process integration and product integration. More specifically, internal integration significantly affected the operation performance of IT strategy, while product integration significantly affected the operation performance of IT strategy. The findings clarify the alignment of SCI with IT competence for practitioners, so that they can allocate their limited resources to improve the organization operation performance by the IT competence.

**Key words:** IT competence; Supply chain integration; Firm operation performance; Moderating effect

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## INTRODUCTION

Considering the severe competition of the global market, stress the firms faced has upgraded from the competition

among enterprises to the competition among the supply chains. Under this situation, the concept of supply chain integration (SCI) emerged, which drew much attention from both the academia and the practitioners. Supply chain integration helps firms to refigure their resources and capabilities internally and externally to consolidate their supply chain as a whole in an effort to improve long-term performance (Huo, 2012). It is generally acknowledged that SCI is the critical in improving the operation performance of a firm. However, the uncertainty of demands and innovation of information technology brings about the new challenge to the SCI. Furthermore, as the e-commerce and virtual finance flourish, the global manufacturing plants have to transformation and upgrading. And IT becomes the necessary selection for those manufacturers to deal with fierce competition. The current literature has verified that IT competence has significantly positive effect on the SCI (Bagchip, 2002; Cagliano, 2003; Mandal, 2003). Based on this, they also test that the mediating effect of SCI between IT competence and firm performance (Li, 2009; Raia, 2006). But the relationship between the SCI and operation performance does not be founded. What is more, does the IT competence of a firm strengthen the effectiveness of SCI to the enterprise operation performance?

According to the analysis above, this paper adds firm's IT competence into the basic model of supply chain integration and operation performance, which will further reveal the mechanism of SCI to operation performance to help firms to successfully upgrade.

## 1. CONCEPT DEFINITION

### 1.1 SCI

SCI, one of the hottest topics, is the latest achievement of the supply chain management field. The concept of SCI is so wide that different scholars differently define this

word. According to Bowersox et al. (1989), SCI refers to the integration of all supply chain partners' relationship, activities, department, process and location. Swink et al. (2007) study SCI from the value chain, and they put emphasis on the strategy sharing of information and knowledge. The domestic study of SCI also made a lot of progress. For example, Huo et al. (2002) think that SCI is a virtual organization in which all supply chain members work for a same destination. They coordinate and cooperate by sharing information, capital and physics to achieve the organization goal (overall performance). Based on the previous researches, this paper adopts the definition by Flynn et al. (2010): SCI is "the degree to which a manufacturer strategically collaborates with its supply chain partners and collaboratively manages intra- and inter- organization process"

SCI is a complicated construct, so it is a must to divide it into several dimensions. Many scholars tend to analyze SCI from internal integration and external integration (Stank, 2001; Frohlich, 2002; Droge C, 2004). Internal integration is "the degree to which a manufacturer structures its own organizational strategies, practices and processes into collaborative, synchronized processes, in order to fulfill its customers' requirements". And external integration is "the degree to which a manufacturer partners with its external partners to structure inter-organizational strategies, practices and process into collaborative, synchronized processes." This study further classifies external integration into product and process integration. Product integration refers to the involvement of suppliers and customers in the development (Huo et al., 2014a; Khazanchi et al., 2007) and aims to support such development through close interactions with supply chain partners (Koufteros et al., 2006). Process integration is the establishment of collaborative and synchronized processes with suppliers and customers (Huo et al., 2014; Kim et al., 2012) and aims to support product manufacture and delivery. Thus, we classify the SCI into internal, product and process integration in accordance with the above analysis.

## 1.2 IT Competence

The concept of IT competence was first put forward by foreign research scholars Ross et al. (1996). In their opinion, IT competence is the ability to influence the organization goal by controlling the cost relevant to IT and implement IT. Based on the resource-based view (RBV), IT competence was further classified into human, technology and relative resources. Some scholar defined IT competence as the ability to use and integrate IT resource (Bharadwaj, 2010). That is, enterprises mobilized and allocated the resources relevant to IT, and integrate them with other resources. He also classified the IT into IT infrastructure, IT human resources and IT intangible assets. The domestic scholars also define the construct. Cao (2007) proposed IT competence matches

the IT resources with the strategy and other superior resources in order to help enterprises to acquire the sustainable competitive advantage. And it consists of IT infrastructure, IT human resource, IT relevant resources and IT intangible resources. Although there is no unified definition of IT competence, all scholars tend to think that IT competence is the organizing ability integrating IT with other resources which are beyond IT itself. In this paper, we distinguish the concepts between IT resource and IT competence. IT competence refers to the ability use IT resources to achieve the firms' goal. Thus, IT competence consists of IT human resource and IT strategy.

## 1.3 Operation Performance

The effect of SCI directly reflects the operation performance of a firm. Those indexes including cost, customer service, flexibility, delivery, quality and innovation are usually used by scholars to evaluate and measure the enterprise's operation status. Wheelwright (1989) proposed to use cost, quality flexibility and delivery to evaluate the operation performance. Based on the theory of Wheelwright, Vickery (1991) tended to add the new product to evaluate the performance of the supplier. In the empirical research of Nyaga and Whipple's (2009), they use four indexes, which consist of 'reduced our order cycle times', 'improved our order processing accuracy', 'improved our on-time delivery', and 'increased our forecast accuracy' to describe the supply chain performance. Combining with the previous literature, this study use cost, service, quality and new product to measure the operation performance.

## 2. THEORETICAL BACKGROUND AND HYPOTHESES DEVELOPMENT

### 2.1 SCI and Operation Performance

The degree of SCI extremely influences the supply chain performance. According to the information processing theory (IPT), the integration of supply chain is beneficial to the manager to make decisions and communication among internal employee and external partners. Furthermore, SCI helps firms to timely attain the relevant information about demand, capability, technology and strategy to identify the activities of a firm and reduce the waste. In accordance with Knowledge—based View (KBV), the SCI integration will promote the broadcast and sharing of knowledge, which facilitates enterprises to acquire new knowledge and improve the performance. Internal integration ensures product quality and reduce the duplicated tasks by promoting the internal resources and capability (Flynn et al., 2010). Efficient external integration makes it possible that the manufacturers speed up the product delivery process. More accurate customer demand forecast information improves the production planning and decreases the inventory cost (Swink et al.,

2007). In addition, process integration with supplier helps the manufacturers reduce mistakes and improve product quality by information sharing and jointly planning to enhance the operation performance (Petersen et al., 2005). The product integration with suppliers and customers can enhance manufacturers' new product development capabilities, promoting product quality, flexibility and innovation in addition to product competitive advantage (Koufteros et al., 2007; Swink & Song, 2007). Therefore, we propose our first set of hypotheses:

H1a. Internal integration is positively related to operational performance.

H1b. Process integration is positively related to operational performance.

H1c. Product integration is positively related to operational performance.

## 2.2 The Moderating Effect of IT Competence

With the wide application of computer science and operation research, IT influences the operation of a firm in multi aspects, including product quality, types and customer service. Some scholar proposed that IT influences the operation and strategy of a firm, and the effect of operation reflects the enterprises operation performance (Mukhopadhyay, 2002). Also, IT competence promotes the integration of supply chain. First, IT competence timely coordinates and controls the activities of upstream and downstream partners through information sharing among enterprises. Furthermore, IT competence is the critical role to achieve SCI and optimize the cross-enterprises business process. However, the final goal of a firm is to make profit. Although managers invest much in IT, they still want to increase their performance by improving their IT competence. Thus, IT competence is the tools but purpose for enterprises to attain competitive advantages. In this study, IT competence is used as moderating role, so we propose the following set of hypotheses:

H2a. The positive relationship between internal integration and operation performance is strengthened by IT human resource.

H2b. The positive relationship between process integration and operation performance is strengthened by IT human resource.

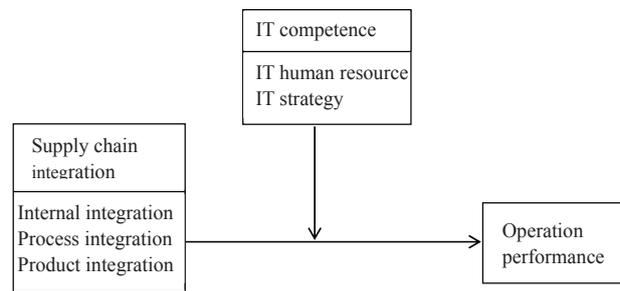
H2c. The positive relationship between product integration and operation performance is strengthened by IT human resource.

H2d. The positive relationship between internal integration and operation performance is strengthened by IT strategy.

H2e. The positive relationship between process integration and operation performance is strengthened by IT strategy.

H2f. The positive relationship between product integration and operation performance is strengthened by IT strategy.

Figure 1 is depicts the conceptual model.



**Figure 1**  
**Conceptual Model**

## 3. RESEARCH DESIGN

### 3.1 Questionnaire Design

The questionnaire for this study consists of three parts. The first part is about the construction of IT competence, which refers to 5 indexes from IT human resource and IT strategy two dimensions. The second part describes SCI construction, which refers to 13 indexes from internal, progress and product integration three dimensions. And the last part measures the operation performance through 5 indexes. A five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) was adapted in this study.

### 3.2 Data Collection

In this study, the survey method was used, and “manufacturing firm” was taken as the unit of analysis. We chose middle managers—who usually take the title of plant or functional managers—as target respondents. In total, 260 manufacturing companies were selected for questionnaire distribution. Of the number, 191 respondents completed the questionnaire. Those responding countries locate in 10 countries and three industries, including Finland, Germany, Taiwan, Sweden, China, Spain, Brazil, Italy, South Korea and Japan. Table 1 shows the profile of the responding companies.

**Table 1**  
**Demographics of the Sample**

Country	Industry			Total
	Electronics	Machinery	Transportation	
FIN	5	5	5	15
GER	5	9	8	22
TWN	18	8	2	28
SWE	3	4	1	8
CHN	10	9	9	28
ESP	4	3	9	16
BRA	2	5	2	9
ITA	6	13	5	24
KOR	8	5	10	23
JPN	6	5	7	18
Total	67	66	58	191

### 3.3 Psychometric Test

Reliability and validity are main two indexes of measurement model. And SPSS 19.0 was used to test. First, the internal consistency of the scale was assessed by Cronbach's alpha to verify the reliability. Table 2 indicates that all of the Cronbach's alpha value above 0.7 and thus acceptable in such a study.

**Table 2**  
**Reliability**

Construct	Number of question	Cronbach's alpha
IT human resource	3	0.870
IT strategy	2	0.650
Internal integration	4	0.811
Product integration	2	0.545
Process integration	8	0.862
Operation performance	5	0.744

Next, the construct validity was tested. We assess the convergent and discriminant validity by CFA. The fit indices were  $\chi^2/df=1.469$ , CFI=0.937, NNFI=0.926, RMSEA=0.050, which were better than the threshold values by Hu and Bentler (1999). In addition, all loadings were greater than 0.5, which indicates the validity of this scale is satisfactory. In this paper, the AVE is 0.6 greater than the squared correlation estimate. The indices above suggest that the convergence validity of scale is ensured. Furthermore, all of the differences were significant at the 0.001 level, indicating that discriminant validity was ensured.

## 4. DATA ANALYSIS AND RESULTS

In this study, the controllable variable is the industries types. The correlations among other variables are showed in Table 3. The result indicates that the pairwise correlation of these variables and the p-value is significant. Thus, each variable is suitable for the next regression analysis.

**Table 3**  
**Correlations, Means, and Standard Deviations**

Construct	II	PrdI	Prcl	ITHR	ITS	OP
Internal integration (II)	1					
Product integration (PrdI)	0.21*	1				
Process integration (Prcl)	0.22*	0.11	1			
IT human resource (ITHR)	0.28*	0.31*	0.19*	1		
IT strategy (ITS)	0.46*	0.07	0.25*	0.30*	1	
Operation performance (OP)	0.55*	0.19*	0.19*	0.26*	0.33*	1
Mean	3.71	3.94	3.19	3.63	3.92	3.51
SD	0.64	0.76	0.73	0.89	0.73	0.58

Note. \* correlation is significant level at 0.01.

The hypotheses were tested through a series of hierarchical linear regression analyses. The independent variables were mean-centered before calculating the interaction terms to minimize the effects of multicollinearity. In the Model 1, internal, process and product integration were entered as independent variables. In the Model 2, IT competence was entered as independent variables. In the Model3, the interactions between independent variables were entered. The dependent variable is operation performance.

Table 4 shows that the internal and product integration was positively and significantly associated with the operation performance, supporting H1a and H1c. However, the interactions between IT competence and SCI present different results. IT strategy significantly strengthens the relationship between product integration and operation performance, supporting H2f. The interesting thing is although IT strategy significantly moderates the relationship between product integration and operation performance, it weakens their relationship, indicating that H2d was not supported. Therefore, H2d should be revised as the relationship between internal integration and operation performance is negatively moderated by IT strategy. In addition, the effect between SCI and operation performance moderated by IT human resource are in significant. Therefore, H2a, H2b, and H2c were not supported.

**Table 4**  
**Regression Results on Operational Performance**

	Model 1	Model 2	Model 3
Constant	1.214***	1.057***	1.819***
Industry type	0.067*	0.067*	0.082*
Internal integration (II)	0.474***	0.429***	0.688***
Process integration (Prcl)	0.060	0.047	- 0.474
Product integration (PedI)	0.050	0.033	0.202*
IT human resource (ITHR)		0.051	0.0413
IT strategy (ITS)		0.061	- 0.139
II* ITHR			0.022
II* ITS			- 0.090*
Prcl* ITHR			0.055
Prcl* ITS			- 0.093
PrdI* ITHR			-0.062
PrdI* ITS			0.197**
F	28.263***	17.699***	9.249***
R <sup>2</sup>	0.319	0.331	0.373
Adjusted R <sup>2</sup>	0.305	0.309	0.331

Note. \*p<.05, \*\*p<.01, \*\*\*P<.001

## CONCLUSION

According to the relevant theory and literature on supply chain management, this study establishes the conceptual

model and research hypothesizes of the relationship between SCI and operation management moderating by IT competence. Multilinear regression and moderating effect were used to test hypothesizes through the sample of 191 manufacturing plants. The result indicates that internal integration is the most important influencing factors of SCI to operation performance. And product integration also promotes the firm's operation performance. The moderating effect of IT strategy and internal integration is significant, but the interesting thing is that it weakens the influence of internal integration of operation performance. It may be caused by the application status of IT in today's enterprises. IT is widely applied in organization's vertical layering, and the organization members in the sibling cannot communicate through IT. Under this situation, the integration IT and organizational goal lead to the increasing of the cost. In addition, IT strategy strengthens the relationship between product integration and operation performance, suggesting that most manufacturing plants should involve the suppliers and customers in product design based on IT platform. Only in this way can it improve firm's operation performance. The above findings provides guidelines for the managers in manufacturing plants to effectively use IT.

Although this study makes some contributions to academic research and practices, it has several limitations that open up avenues for further studies. First, the sample in this paper is limited for the limitation of research condition, and further study can enlarge the sample. Second, this study classifies the SCI into internal, process and product integration, and we did not take further discussion about the three dimensions. Then, IT resources and IT competence were divided in this study, further study can deeper explore the relationship of the two. Finally, this study only considers the moderating effect of IT competence and SCI to operation performance. Future research should take financial performance into account and comparing the operation and finance performance.

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