

Development of Indexes for the Performance Evaluation of e-SCM

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Abstract

Web-based sharing of information across the supply chain can bring a host of advantages to the trading partners. lower cost, leaner inventories, and more efficient shipping are just the beginning. e-SCM is technology-enabled ability to concurrently manage high levels of complexity and multiple external relationships.

This study presents that the development of indexes for the performance evaluation of e-SCM should be given more priority by companies giving weights to each index. Deductive research is used for the development of evaluation items and AHP method for the development of weights of the items.

According to priority of each category - relationship between supplier and company, relationship between partner and company and relationship between customer and company- is as follows;

- Company driven type: relationship between customer and company, relationship between supplier and company, relationship between partner and company.
- Market portal type: relationship between supplier and company, relationship between customer and company, relationship between partner and company.

keywords : e-SCM, Relationship, Measure of Performance, AHP method

1. Introduction

Recent business environments of global firms are summarized by the globalization of competition, the advent of economic blocks represented in the European economic cooperation, the North American Free Trade Agreement, and the Pacific economic cooperation, and changes of competition advantage elements by developing of Information technology. International leading firms are taking a supply chain management (SCM) strategy in order to respond to these environment changes [6]. Furthermore, the development of digital technologies causes for leading firms to establish the Internet-based supply chain management (e-SCM) by changing business concept [3]. Therefore, the framework to evaluate whether the supply chains are operated well or not is requested.

As for the performance evaluation of an e-SCM, it is related deeply to business goal on all process of the chain --- growth, profitability, market share, and customer satisfaction [9]. Therefore, to evaluate the performance of a supply chain and to correspond to it could be a basis to secure competitive advantage of firms.

e-SCM is defined that to manage the flow of information, resources, and money on the supply chain, and to control all network between participants to achieve common goals using the Internet. This e-SCM is categorized into a company driven type and a market portal type. They have various differences. For the company driven type, the management flexibility is high and control on suppliers is

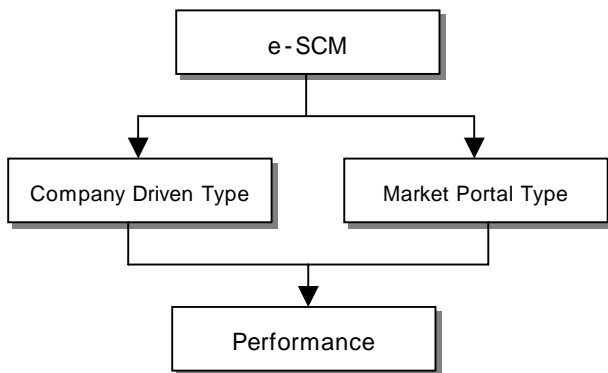
easy because the change of items is possible any time according to firms' own needs. Whereas, market portal type provides supplementary services such as purchasing guidance, payment guarantee, a risk management, a product delivery, payment, and storage. Besides, this type can provide more expanded services than the company driven type. However, it has a limit to provide the most suitable products that buyers want [5]. Therefore, this study finds weights of the performance evaluation items of the company driven type and the market portal type. And it suggests a guidance which items are more important, when the performance of firms is evaluated in both of the firms adopting company driven type and market portal type. Thus, the study provides the framework that can compare the performance before introduction of e-SCM with that after introduction of e-SCM

The research questions of this study are as follows:

- What is e-SCM and what kind of types are composed?
- What kinds of items are necessary to evaluate the performance of e-SCM? And what are weights of the performance of items in both of company driven type and market portal type?

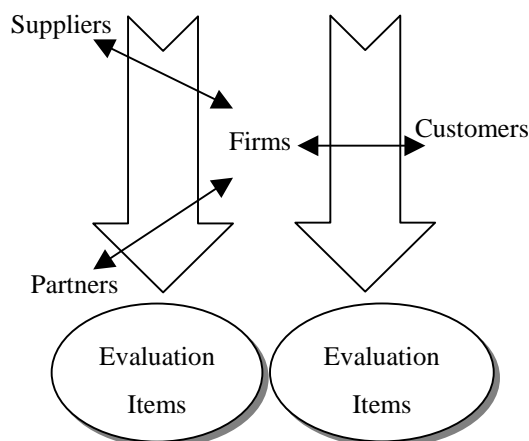
2. Research Model

The purpose of this study is to evaluate the performance of e-SCM, and to draw evaluation items and its weights depending on its types. The research model is shown in Figure 1.



<Figure 1> Research Model

The study tries to evaluate the process performance among the objects on the e-SCM based on the Internet as shown in Figure 2.



<Figure 2> Scope of Evaluation Items drawn for Performance

Performance will be evaluated by three categories. These categories are composed of (1)Performance on transaction process between suppliers and firms, (2)Performance between partners and firms excluding suppliers, (3)Performance on transaction process between customers and firms. From all of these categories, performance evaluation items will be extracted.

Although the operating method is different between Company Driven Type and Market Portal Type, the core concept -- process among suppliers, firms, partners, customers -- is the same, so the management items are regarded as the same. But, the quantity and quality of objects on the process is different, so these two types of performance evaluation items cannot have the same level of importance. So this study will pay different importance level by weighing differently according to types and items. The purpose of this process is to apply different evaluation weight according to respective types.

3. Research Methodology

This study uses the Analytic Hierarchy Process (AHP) as a research methodology. The analytic hierarchy was composed of the evaluation items that were extracted by previous studies and interviews with experts based on the framework for the development of evaluation items.

The AHP, which enables the user to determine the relative importance of criteria sets underlying their choice behaviors [1], is selected as the appropriate analysis tool. The AHP of Saaty [10]-is theory and reality-an often used to solve strategic decision problems [2] [4] [7] [10] [11]

According to Saaty's original proposal, a complex system is decomposed into subsystems and represented in the hierarchical form. The element at the highest level is called the goal. The elements at each level are the criteria (factors) of elements at the level below. The elements at the bottom level are called the

alternatives. In this way, AHP organizes the basic rationality of the priority setting process by breaking down a multi-element complex system into its smaller constituent parts called components (or levels). The process can be divided into three phases, which are structuring a system, comparing pair-wise and synthesizing priorities.

The principle of comparative judgment is setting up a matrix to carry out the pair-wise comparisons of the relative importance of the elements in a component with respect to the criteria, elements in a dominating component at a higher level in the hierarchy.

Let the relative importance of each evaluation items ($a_1, a_2, a_3, \dots, a_n$) is $w_1, w_2, w_3, \dots, w_n$, and the pair-wise comparison of a_{ij} or a_{ji} can be replaced like equation (1).

$$a_{ij} = w_i/w_j \quad a_{ji} = w_j/w_i \quad (1)$$

The entry a_{ij} measures the relative importance of the impact on the criterion from element i against that from element j . This matrix, denoted by A ($= [a_{ij}]$) in our notation, is called the pair-wise comparison matrix [See below equation (2)].

$$A = \begin{pmatrix} w_1/w_1 & w_1/w_2 & \dots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \dots & w_2/w_n \\ \dots & \dots & \dots & \dots \\ w_n/w_1 & w_n/w_2 & \dots & w_n/w_n \end{pmatrix} \quad (2)$$

It is straightforward to show that when A is consistent, the weight vector W , which gives the relative priorities of the elements, is identical to any one of the columns of A within a normalization factor. And when multiply

importance vector $W(w_1, w_2, w_3, \dots, w_n)$ by matrix A [equation (2)], equation (3) is extracted.

$$AW = nW \quad (3)$$

Since the relative importance of the elements depends only on the relative amplitudes of the components of the vector W , we may normalize W by requiring as shown on equation (4)

$$\sum W_i = 1 \quad (4)$$

In fact, the fuzzy nature of the comparison process dictates that inconsistency cannot be completely eliminated. It has been argued that even when A is not consistent, the weight vector W is still determined by the dominant eigenvector of A . The equality is reached only when the matrix is consistent. To measure the consistency of the matrix A , we define the Consistency Index (C.I.) as follows:

$$C.I. = (\lambda_{\max} - n) / (n-1) \quad (5)$$

When the consistency is perfect, $C.I.=0$, which means $\lambda_{\max}=n$. And when the consistency is low, $\lambda_{\max} > n$, so consistency index becomes high. In practice, we consider A is very consistent if the consistency index ratio is less than 0.1, which is the average consistency index of a random reciprocal matrix of the same dimension. And the consistency of A is acceptable if the ratio of C.I. is about 10% or less, we accept the estimate of W . Otherwise, we attempt to improve consistency [7] [10].

4. Conclusions

4.1 Results

This study divided the forms of e-SCM implemented in the Internet environment into

two types, such as the company driven type and the market portal type, and suggested evaluation items and their weights of each e-SCM type through previous studies and AHP technique.

The performance evaluation items of e-SCM were composed of the relationship between suppliers and firms, the relationship between partners and firms, the relationship between customers and firms. The detailed evaluation items of each were drawn. The analytic hierarchy was presented in Figure 3(see Appendices).

Program 'Expert Choice 9.5' was used for analysis. Results of the performance evaluation items satisfied non-consistency level 0.1 as Satty recommended. Firm driven type is 0.05, and Market portal type is 0.08, so Satty's standard was satisfied. To assign the importance of each evaluation item extracted by prior studies and interviews with experts, the related data were collected from the experts who had participated in the interview.

For the company driven type, the order of importance was calculated that the relationship between customers and firms is the first, the relationship between suppliers and firms, the second, and the relationship between partners and firms, the last. Among the sub-items of the relationship between customers and firms, the weight of customer service is the highest (Table 1 & Table 2 : See Appendices).

On the other hand, for the market portal type, the order of importance was calculated that the relationship between suppliers and firms is the first, the relationship between customers and firms, the second, and the relationship between partners and firms, the last. Among the sub-

items of the relationship between suppliers and firms, the weight of purchasing and procurement is the highest. In the company driven type, the importance of customers was highlighted because it is comparatively easy to manage relationship with suppliers by managing limited suppliers (Table 1 & Table 2 : See Appendices). For the market portal type, the relationship with supplier was emphasized since managing suppliers is relatively hard and on-line purchase was important.

4.2 Implications

It is natural to implement SCM on the Internet and make a performance using this tool. Many firms are using e-SCM in the developed countries, and Korea also recognizes the necessity of it and is using or implementing e-SCM. This study developed the evaluation items of the performance of e-SCM and established the evaluation framework to draw the weights of the items and performance evaluation method (Table 3 : See Appendices). Therefore, this effort contributes to evaluate each firm performance by providing evaluation criteria. Furthermore, this study provides a foundation of the study about e-SCM performance evaluation.

However, this study didn't provide the evaluation items subdivided according to industry and didn't verify the drawn evaluation items. The evaluation items of the performance presented in this study can be adopted as a general criterion. But the weight of each item could be different, and some items could be added or deleted according to firms. Therefore, it should be considered for the future study.

Appendices

Level 1	Level 2	Level 3	Level 4
The Evaluation Items of e-SCM Performance	The Relationship between Suppliers and Firms	Purchase and Procurement	EDI Program
			Investigation of estimate
			Negotiation of Transaction and Price
			On-line Purchase
		Inventory Management	On time Delivery Program
			Communication on Proper Inventory Level
		Order Process	Checking Credit of Suppliers
			Communication on the Order Procedure
		Production Scheduling	Coordinating Production Schedule of Suppliers
			Coordinating Production Schedule of Firms
		Relationship with Suppliers	Using On-line Catalogs
			Refunding and Dealing with Damaged Products
			Receiving and Managing Inquiries
			Providing the Order of Performance
	The Relationship between Partners and Firms	Delivery	Controlling Delivery
			Scheduling of Distributors
		Production Scheduling	Production Scheduling by Markets
			Production Scheduling by Other Firms
	The Relationship between Customers and Firms	Inventory Management	Notice of delayed delivery
			Communication related to Sold-Out
		Order Process	Providing Credit Information
			Providing Product Information
			Communication of Order Status
			Providing Performance of Total Order Cycle
			Communication Related to Sold-Out
			Communication Related to Refunding
		Customer Service	Dealing with Complaints
			Notifying Urgent Matters
			Providing Technical Services
			Selling on the Internet

<Figure 3> The analytic hierarchy of the evaluation items of e-SCM

<Table 1> Performance Evaluation Items' Weight (Firms Driven Types)

Customers (0.682)			Suppliers (0.235)			Partners (0.080)		
Customer Service 0.490	Dealing With Complaints	0.181	Order Process 0.089	Checking Credit of Supplier	0.066	Production Scheduling 0.058	Scheduling by Other Firms	0.034
	Notifying Urgent Matters	0.139		Communication on the OP	0.023		Production Scheduling by Markets	0.024
	Providing Technical Services	0.089						
	Selling on Internet	0.082						
Order Process 0.134	Communication Related to Sold-Out	0.049	Purchase and Procurement 0.058	EDI Program	0.031	Delivery 0.022	Scheduling of Distributors	0.018
	Providing Product Info.	0.031		On-line Purchase	0.010		Controlling Delivery	0.004
	Communication of Order Status	0.017		Negotiation of Transaction and Price	0.007			
	Communication Related to Refunding	0.017		Investigation of estimate	0.004			
	Providing Credit Information	0.013	Production Scheduling 0.051	Coordinating of Firms	0.032			
				Coordinating of Suppliers	0.019			
	Providing Performance of Total Order Cycle	0.006	Relationship with Vendor 0.023	Refunding and Dealing with Damaged Products	0.010			
	Inventory Mgmt 0.061	Notice of delayed delivery		0.030	Receiving & Managing requires			
					Communication related to Sold-Out	0.030	Using On-line Catalogs	0.004
				Inventory Mgmt 0.013	On time Delivery Program	0.010		
Communication on Proper Inventory Level					0.003			

<Table 2> Performance Evaluation Items' Weight (Market Driven Types)

Suppliers (0.682)			Customers (0.222)			Partners (0.095)		
Purchase & Procurement 0.256	On-line Purchase	0.127	Customer Service 0.150	Selling on the Internet	0.055	Production Scheduling 0.066	Scheduling by Other Firms	0.054
	Negotiation of Transaction & Price	0.070		Notifying Urgent Matter	0.042		Scheduling by Markets	0.012
	Investigation of estimate	0.032		Providing Technical Services	0.031	Delivery 0.029	Controlling Delivery	0.020
	EDI Program	0.027		Dealing with Complaints	0.022		Scheduling of Distributors	0.010
Relationship with vendors 0.141	Using On-line catalogs	0.066	Inventory Mgt. 0.047	Communication related to Sold-Out	0.030			
	Refunding and Dealing with Damaged Products	0.046		Notice of Delayed delivery	0.017			
	Receiving & Managing Inquires	0.020	Order Process 0.025	Communication Related to Sold-Out	0.008			
	Providing Order of Performance	0.008		Communication Related to Refunding	0.006			
Production Scheduling 0.129	Coordinating of Firms	0.100		Communication of Order Status	0.004			
	Coordinating of Suppliers	0.029		Providing credit Information	0.003			
Order Process 0.084	Communication on the order Procedure	0.059		Providing Performance of Total Order Cycle	0.003			
	Checking Credit of Suppliers	0.026		Providing Product Info.	0.002			
Inventory Management 0.071	On time Delivery Program	0.058						
	Communication on Proper Inventory Level	0.013						

<Table 3> Performance Evaluation Method (Firms Driven Types)

1	2	Level 3	W	Evaluation Method
C U S T O M E R	Customer Service	Dealing With Complaints	0.181	Complaints process ratio (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%) Process time (1: very slow, 2: slow, 3: average, 4: fast, 5: very fast)
		Notifying Urgent Matters	0.139	Urgent matters delivery (1: not delivered, 2: delivered)
		Providing Tech. Services	0.089	Technical service providing (1: not delivered, 2: delivered)
		Selling on Internet	0.082	Internet use ratio per sold(1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
	Order Process	Comm. Rela. to Sold-Out	0.049	Notifying ratio per sold-out(1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
		Providing Product Info.	0.031	Providing price and product info. (1: Don't, 2: Do)
		Comm. of Order Status	0.017	Response ratio (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
		Comm. Rela. to Refunding	0.017	Refunding comm.(1: never, 2: seldom, 3: average, 4: often, 5: very often)
		Providing Credit Info.	0.013	Credit Info. Providing (1: Don't, 2: Do)
		Providing Performance of Total Order Cycle	0.006	Providing performance of total order cycle (1: Don't, 2: Do)
S U P P L I E R	Inventory Mgmt.	Notice of delayed delivery	0.030	Notifying ratio per delay (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
		Comm. related to Sold-Out	0.030	Communication (1: never, 2: seldom, 3: average, 4: often, 5: very often)
	Order Process	Supplier Credit Checking	0.066	Credit checking ratio (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
		Communication on the OP	0.023	Order checking possibility (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
	Purchase and Procurement	EDI Program	0.031	EDI Program (1: Don't have, 2: Have) Program use ratio per event(1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
		On-line Purchase	0.010	On-line catalog (1: Don't have, 2: Have) On-line catalog use ratio (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
		Negotiation of Transaction and Price	0.007	Average consuming time for negotiation (1: very slow, 2: slow, 3: average, 4: fast, 5: very fast)
		Investigation of estimate	0.004	Estimate checking ratio (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
	Production Schedule	Coordinating of Firms	0.032	Firms schedule change ratio per suppliers schedule changes (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
		Coordinating of Suppliers	0.019	Supplier production schedule change ratio per firms request (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
	Relation-ship with Vendor	Refunding and Dealing with Damaged Products	0.010	Process ratio per refunding and damaged products (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
		Managing requires	0.006	Process ratio per requests (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
		Using On-line Catalogs	0.004	On-line catalogs use ratio (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
	Inventory Mgmt.	On time Delivery Program	0.010	On time delivery coordination using program (1: Not possible, 2: Average, 3: Possible)
		Communication on Proper Inventory Level	0.003	Inventory level communication degree (1: never, 2: seldom, 3: average, 4: often, 5: very often)
P A R T N E R	Production Schedule	Scheduling by Other Firms	0.034	Firms schedule change ratio per partners schedule change (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
		Scheduling by Markets	0.024	Production schedule change ratio by market (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
	Delivery	Scheduling of Distributors	0.018	Delivery scheduling coordination possibility (1: very difficult, 2: a little difficult, 3: average, 4: a little easy, 5: very easy)
		Controlling Delivery	0.004	Delivery controlling (1: never, 2: seldom, 3: average, 4: almost do, 5: strongly do)

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