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# 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.

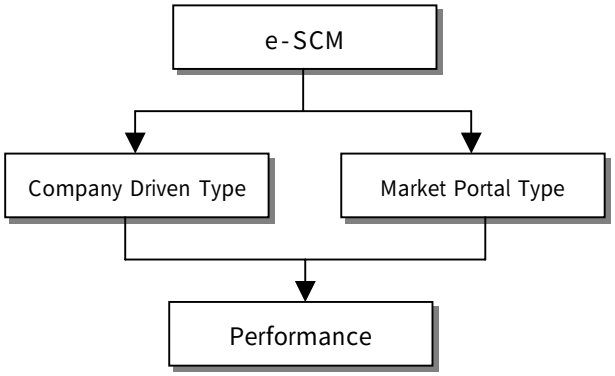
e-SCM is defined that to manage the flow of information, resources, and money on the supply chain, and to control all network between participants to achieve common goals using the Internet. This e-SCM is categorized into a company driven type and a market portal type. They have various differences.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

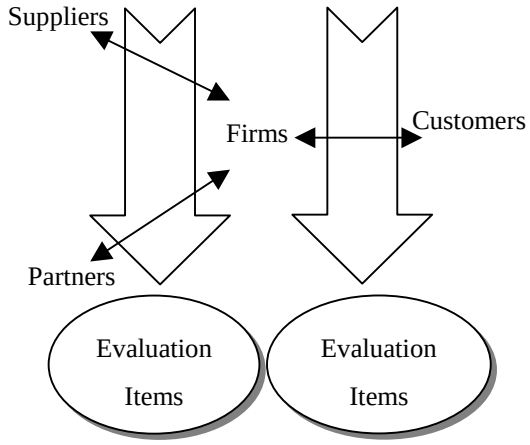
## 2. Research Model

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 ($a_1$, $a_2$, $a_3$,…, $a_n$) is $w_1$, $w_2$, $w_3$,…..$w_n$, and the pair-wise comparison of $a_{ij}$ or $a_{ji}$ can be replaced like equation (1).

$$a_{ij} = w_i/w_j \; a_{ij} = w_i/w_j \qquad (1)$$

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)].

$$A = \begin{pmatrix} w_1/w_1 & w_1/w_2 & \ldots w_1/w_n \\ w_2/w_1 & w_2/w_2 & \ldots w_2/w_n \\ \ldots. & \ldots.. & \ldots\ldots \\ w_n/w_1 & w_n/w_2 & \ldots\ w_n/w_n \end{pmatrix} \qquad (2)$$

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($w_1$, $w_2$, $w_3$, …, $w_n$) by matrix A[equation (2)], equation (3) is extracted.

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

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)

$$\sum Wi = 1 \qquad (4)$$

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:

$$C.I = (\lambda max - n)/(n-1) \qquad (5)$$

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 | | | | | | |
| | Providing Technical Services | 0.089 | | Communication on the OP | 0.023 | | Production Scheduling by Markets | 0.024 |
| | 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 | 0.006 | | | |
| | 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 |
|---|---|---|---|---|
| CUSTOMER | Customer Service | Dealing With Complaints | 0.181 | Complaints process ratio (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)<br>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) |
| | 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) |
| SUPPLIER | 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 Procure-ment | EDI Program | 0.031 | EDI Program (1: Don't have, 2: Have)<br>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)<br>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) |
| PARTNER | Produc-tion 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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