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Abstract: The performance of supply chain is an important factor for the success of a company since it greatly affects the ability to provide customer value. Therefore, it is very important for a company to develop independent criteria to evaluate the performance, compare with competitors, and monitor the operation of a company. In the past, many companies tried to develop criteria for measuring their performance of supply chain. However, suitable criteria are hard to develop since the supply chain is generally very complex. The purpose of this study is to develop criteria to measure the performance of supply chain by using the Supply Chain Operations Reference Model (SCOR), which was shown by several previous studies to be an effective tool to develop criteria for measuring performance in diverse industries. To investigate the effectiveness of SCOR, we use the process reference model in SCOR to analyze the current state of a famous garment company's processes and its goals, and quantify the operational performance. Results from this study show that SCOR is a very effective tool to develop performance metrics of the supply chain. Through the use of SCOR, a company can clearly define key performance indices (KPI) to improve their performance.

Keywords: SCOR; Supply Chain Performance; Garment

I. Introduction

There are several obstacles when developing an evaluation system of the supply chain performance (CSC, 2004). First, the evaluation is very hard to execute. Second, functions and processes are usually very complex and lack consistency across a supply chain. Third, supply chain members who have been evaluated are usually not willing to provide true information. Fourth, definitions of evaluated items are different for different supply chain members. In addition, the communications between supply chain partners are usually time-consuming and with low efficiency. Hence, there is a requirement for well-defined metrics and a common language for evaluating the supply chain performance.

Hammer and Champy (2004) stated that we should employ a macroscopic perspective to view a supply chain. The optimization of each member of a supply chain is not the optimization of the whole supply chain. The main purpose of the supply chain management is integration of these activities through improved supply chain relationships to achieve a global optimization and sustain competitive advantages. Formerly, a company only has to consider their own performance within an organization and focus on processes in their department. However, in recent years, the industry has developed a number of strategies to allow supply chain partners to replace sequential planning, or sequential optimization, with global optimization (Simchi et al., 2003). In sequential planning, each member optimizes its own profit with almost no regards to how its decisions impact other supply chain partners. By contrast, the goal of global optimization is to find what the best for the entire supply chain is.

As we know, companies need a standard model to establish their own metrics of performance, analyze the values of indicators, and improve their supply chain efficiency. Moreover, a common language can improve the communications between the members of the entire supply chain. Recently, the SCOR model (SCC, 2005) is emerging as a powerful and potential tool to analyze a supply chain. It uses a process reference model that can analyze the current state of a company's process and its goals, evaluate operational performance, and compare it with benchmark data. To measure the performance of supply chain, SCOR has developed a set of metrics in five perspectives, including reliability, responsiveness, flexibility, cost, and, assets, which were successfully applied to many industries, such as car, electronics, and so on. In this study, we will also use the SCOR to develop the criteria for the performance of supply chain.

The remainder of this paper is organized as follows. Section 2 gives a brief overview of the structure for measuring the performance of supply chain based on SCOR. The case study is described in Section 3. Finally, conclusions are presented by summarizing the findings in Section 4.

II. Procedure for Measuring Supp-Ly Chain Performance

The procedure for measuring the performance of supply chain is shown in Fig. 1.

Fig. 1 The Steps of supply chain performance analysis

The first step is to choose performance metrics. There are five perspectives of metrics in SCOR: reliability, responsiveness, flexibility, cost, and assets. After choosing the metrics, the metrics are defined. Interviews on top managers are performed to ensure that the definitions of the metrics are the same for members within the supply chain. Comparison is made by benchmark data in the third step to find the gap rate. Finally, results are obtained by checking the gap rates and used to improve the performance. The details are mentioned as follows.

1) Choose Performance Metric

There are five perspectives in SCOR and in each perspective a SCOR card can be established. Table 1 illustrates the SCOR card. In the third column, the metric is categorized according to the type of the activity. For example, M1 stands for make-to-stock, M2 represents make-to-order, and so on. The actual and target values are shown in the fourth and the fifth columns, respectively. The gap, i.e., the difference between the actual value and the target value, is shown in the sixth column. Finally, the gap rate is calculated in the last column.

Table 1 SCOR card

SCOR card - (Type Name)						
Metric	Metric Definition	SCOR Categories	Actual	Target	Gap	Gap Rate
…	…	…	…	…	…	…
…	…	…	…	…	…	…

2) Define Performance Metric

A key point for a successful SCOR card is clear definitions of metrics. Therefore, each metric is clearly defined in the second column to avoid confusion between supply chain members. Only an appropriate definition is given is the information helpful. Interviews with managers in the supply chain must be performed to ensure a suitable definition is described.

3) Benchmarking

Most organizations tailor definitions of benchmarking to suit their own strategies and objectives (Shoshanah and Joseph, 2005). In practice, benchmarking usually includes regularly comparing perspectives of performance (functions or processes) with best practitioners, recognizing gaps in performance, seeking new approaches to bring about improvements in performance, following through with implementing improvements, and following up by monitoring progress and reviewing the benefits. Benchmarking is both internal and external that can give valuable data for improving supply chain performance and has two main benefits (http://www.benchmarking.gov.uk, 2005). First, external comparisons place your performance in an industry circumstance, which helps to identify supply chain improvement opportunities. And second, regions, or locations are the best performers. Then you can identify the underlying practices that make the difference and implement those practices across the company.

4) Evaluating and Improving

Benchmarking has been used by managers in different industries to evaluate and improve the quality of their products, work process and procedure, and work performance. By finding those gap rates which are less than a threshold value, managers can understand which metrics have poor performance and should be improved first.

III.   THE CASE STUDY

To evaluate the effectiveness of the SCOR model, a garment manufacturing company was selected to do the case study. Garment industry is characterized by high fashion, high creativity, high globalization, low repetition, and low standardization. It is generally difficult to analyze its supply chain and develop its measurements of performance since its processes are very complicated. In addition, it is necessary to use a common language to communicate with each partner across the supply chain as businesses become more and more worldwide. Therefore, an effective tool is much necessary while developing measures for evaluating the performance of the supply chain of garment industry.

The case company (hereafter referred to as J Company) is a holding company with worldwide markets in fabric and garment production. J Company has a capital of about 1 billion and a turnover of about 5.5 billion NT dollars in 2004. J Company is one of the top 500 manufacturing companies and one of the largest manufacturers of knitted fabrics in Taiwan. The headquarters is located in Taipei and it has factories in Mainland China, Vietnam, Thailand, Cambodian, Lesotho, and more. This company has been expanding the overseas undertaking actively all the time in recent years. To meet the change of environment, J Company has been deploying globally and changed its business model. Fig. 2 shows the global deployment of J Company.

Fig. 2 The global configuration of J Company

The as-is and to-be business models of J Company are illustrated in Fig. 3. J Company always tries to employ different e-strategies for improving its operational condition and performance. After employing the supply chain typology analysis, the business model was changed. A global logistics center was set up in charge of integrating two major product business, i.e., fabric division and garment division. Originally, the fabric division and the garment division do business nearly independent, lacking of integration. Its to-be business model integrates the fabric and the garment divisions vertically to take orders jointly to maximize the profit of the company. Once the business model of a company is changed, the processes are also changed. Therefore, it is very important to find appropriate performance metrics. It is important for an enterprise to find out the most appropriate evaluation performance index.
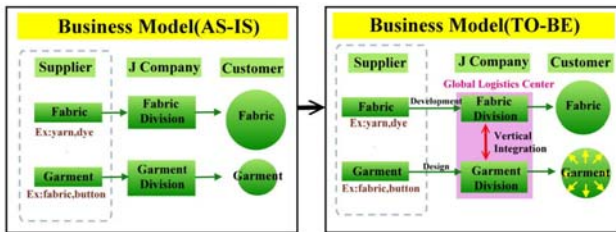

Fig. 3. The as-is and to-be business models of J Company

By using the SCOR model, 3 key performances indicators (KPI) were developed to evaluate the performance, compare with the target value, and to improve the gap between the actual and the target value.

1) Choose Performance Metric

After the interviews with staff in the case company, appropriate evaluation performance indicators from the five perspectives can be selected. The selected indicators are shown in Table 2. The metrics include the cycle time for responding customer's requirements, decision processing time, on-time delivery rate, the supply cycle time of main material, air transportation cost, and order processing cost.

Table 2 The performance perspectives and metrics
selected by J company

Perspectives	Metrics
Responsiveness	The cycle time for responding customer's requirements
	Decision processing time
Reliability	On-time delivery rate
	The supply cycle time of main material
Cost	Air transportation cost
	Order processing cost

2) Define Performance Metric

As for the definition of performance metrics, the SCOR model has provided with complete definitions for references. However, to suit the requirements of the practice, the case company had its own definitions for the metrics. After many deep interviews and discussion with some staff of the case company, the definitions of these metrics were finally confirmed. Table 3 shows the definitions of some performance metrics.

3) Benchmarking

Whether its market share, its annual turnover, or its development of own brand, the case company was top in the field of garment industry. As a result, this enterprise was inclined to learn from the precursors to intensify its competitiveness in this field.

The case company selected several similar industries as its models, with an eye to their industrial functioning and results, then evaluate its own characteristics and status quo to set up the most appropriate index for its target.

Table 3 Definitions of performance metrics

Metric	Definition
Cycle time for responding customer's requirements	The time period between on order and responding customer's requirements
Decision processing time	The time period between receiving and dispatching an order to a most suitable factory
On-time delivery rate	The ratio of the number of on-time-delivery orders to the number of orders
Supply cycle time of main material	The cycle time between placing on order to a supplier of fabrics and receiving the fabrics
Air transportation cost	The cost of transportation by air for delivering garment
Order processing cost	The total cost from receiving an order to shipping an order

4) Evaluation and Improving

Following the procedure mentioned above, the SCOR cards in several perspectives were set up. The description is illustrated in Table 4. Companies can fully or partially refer to SCOR in five perspectives. The advantage is that a company can exactly develop its best model on its own. In this case, J Company did not focus on the assets and the flexibility perspectives. Therefore, the metrics concerning the assets and the flexibility perspectives can be neglected.

Table 4 The SCOR card in the responsiveness perspective

Level 1-SCOR Card (Responsiveness)				
Metric	Actual	Target	Gap	Gap Rate
The cycle time for responding customer's requirements	14 Days	7 Days	7 Days	1
Decision processing time	2 Days	0.5 Days	1.5 Days	3

Table 5 The SCOR card in the reliability perspective

Level 1-SCOR Card (Reliability)				
Metric	Actual	Target	Gap	Gap Rate
On-time delivery rate	70%	90%	20%	0.22
The supply cycle time of main material	28 Days	24 Days	4 Days	0.17

Table 6 The SCOR card in the cost perspective

Level 1-SCOR Card (Cost)				
Metric	Actual	Target	Gap	Gap Rate
Air transportation cost	12 Million	6 Million	6 Million	1
Order processing cost	18 Million	6.8 Million	11.2 Million	1.65

Through SCOR card one can understand the gap between the actual value and the target value of specific metrics. It enables a company to manage performance based on criteria. The case company established several metrics in 3 perspectives by referring to the SCOR model and from the global viewpoint in order to check the effectiveness of 3 overall evaluation performance indicators.

After completing the SCOR card, the company must decide a threshold value of the gap rate according to its operation state. Indicators exceeding the threshold value of the gap rate are considered to have a poor performance. Because the threshold value of the gap rate is determined by high-level administrators' experiences and the culture of an enterprise, the optimistic administrators will generally set up higher values of threshold of the gap rate. For instance, the efficiency of decision-making has a larger gap rate than the required cycle time of customers at the perspective of responsiveness, providing that the threshold value of gap set up by the administrator is 1.5, indicating that the particular enterprise needs to focus on its improvement of efficient decision-making. Similarly, at the perspectives of reliability and cost, when the index has a higher gap rate than the threshold value of gap, the index indeed needs a great deal of adjustment and improvement.

Table 7 Key performance indicators of J Company

KPI	Actual	Target	Rate
Production cycle time	90 Days	45 Days	Reducing 100 %
Joint order-taking rate	8.55 %	17 %	Increasing 100 %
Order cycle time	120 Days	90 Days	Reducing 25%

Table 7 shows 3 key performance indicators that help the case company to observe the performance of the supply chain from a global viewpoint. The elevation of the overall performance indicators shows that the case company is on its right track of improvement or not.

IV. Conclusions

The supply chain performance is one of the most important factors for the success of a company since it considerably affects the ability to provide customer value. It is, thus, very important for a company to develop independent criteria to evaluate the performance, compare with competitors, and monitor the operation. However, suitable criteria are hard to develop since the supply chain is usually very complicated. The purpose of this study is to develop criteria to measure the performance of supply chain by using the Supply Chain Operations Reference Model (SCOR). To investigate the effectiveness of SCOR, we use the process reference model in SCOR to analyze the current state of a famous garment manufacturer's business processes and its goals, and quantify the operational performance. Results show that

SCOR is a very useful tool to develop performance metrics of the supply chain. Through the use of SCOR, a company can define key performance indicators (KPI) to improve their performance.

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