A Study of Supply Chain Performance Measurement Based on SCOR Model
基於供應鏈參考模式之供應鏈績效衡量之研究

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Abstract
Companies have been invested in supply chain management (SCM) to effectively plan and control the supply chain, so that the companies can use their resources to create the customer value. The supply chain operation reference (SCOR) model uses a process-based approach to the supply chain. This paper is based on the framework and proposes an approach of SCM performance measurement via the balanced score card (BSC) in manufacturing industry. The findings of this case study in this paper will benefit companies seeking to create a competitive advantage in the marketplace.

Keywords: Supply Chain Management, SCOR Model, Balance Scorecard, Performance Measurement.

1. Introduction

Intensive competition in the marketplace has forced companies to focus on process performance for the customer value of products and services recently. Companies have been invested in supply chain management (SCM) to effectively plan and control the supply chain, so that the companies can use their constrained resources to create the
customer value. SCM is “the alignment and downstream capabilities of supply chain partners to deliver superior value to the end customer at less cost to the supply chain as whole” [1]. Lambert, Stock, and Ellram define SCM as “the integration of business processes from end user through original suppliers that provides products, services, and information that add value for customers.” [2]

Although supply chain partnership promises mutual benefits for the partners, those benefits are rarely realized due to differences in interest. The supply chain members habitually work as an individual firm based on local perspective and opportunistic behavior that may maximize individual profit, but often occurs at the expense of other members and works against the overall supply chain profitability. The ultimate goal of SCM is to increase supply chain competitiveness [3]. Therefore, the overall performance of the system results from the combined performance of the individual players. In order to achieve high performance, supply chain functions must operate in an integrated and coordinated manner.

The objective of this research is to seek a way of supply chain performance measurement. This paper proposes a process-based approach for visualizing, tracking and monitoring supply chain performance. With the integrated planning framework, the supply chain strategies can be aligned across the supply chain, and it will help to visualize the supply chain.

2. Research Methods

In this paper, two methods have been utilized. First, literature review was conducted in the area of performance measurement of SCM. Second, an in-depth case study of a manufacturing company was conducted. The case study shows that the investment in information technology (IT) for managing supply chain has been an effective way of obtaining competitive advantage.

2.1 Approaches of SCM Performance Measurement

Common approaches to SCM can be organized into three categories: technological, relational and analytical [4]. Technological approaches are driven by computer technology, while relational programs start by changing relationships within and
between firms. Analytical programs are driven by tools and procedures to study customers, competitors, suppliers, and the firm itself. This paper proposes to deal with SCM performance measurement via the process-based and IT approach. An enterprise needs to manage both internal and external supply chain effectively [5]. SCM systems therefore have two important system functions, maintaining timely information sharing across the overall supply chain and facilitating the synchronization of the entire supply chain. Performance measurement provides an approach to identifying the success and potential of the SCM strategies, and facilitating understanding of progress. There are several different approaches to SCM performance measurement. Quick response manufacturing (QRM) focuses mainly on the reduction of lead times. The approach is in contrast to those applying a multitude of performance metrics such as the balanced score card (BSC) and the supply chain operation reference (SCOR) model [6]. The SCOR model is a cross-industry business and captures and links businesses processes, metrics, and technology. This paper is based on the SCOR model and develops performance measurement items via the BSC for manufacturing industry.

2.2 Supply Chain Modeling
Rapidly development in computing and communication technologies (ICT), multiple companies operating a virtual supply chain must have the business to business (B2B) linkages via Internet, so that they require extended or new enterprise resource planning (ERP) systems. An ERP system includes software and hardware that facilitate the flow of data in a company relating to manufacturing, logistics, sales, human resources, and finance. ERP systems are designed to integrate business functions and allow data to be shared across the boundaries of divisions and departments. This ability to share information gives businesses increased flexibility and allows them to operate more efficiently. Supply chain modeling has two important aspects, managing the supply chain effectively and integrating the supply chain processes. The flow of information concentrates on logistic data associated with parts, such as schedule, quantities, quality, and costs. The problem is that all of the activities in the supply chain represent the information in their own representations. The systematic integration of humans with the tools, resources, and information assets of a manufacturing system has become increasingly important because of the growing complexity of manufacturing information and the increasing need to exchange this information among various software applications in the different organizations. Many solution providers design
SCM systems by using modeling approach and adding electronic data exchange (EDI), enterprise application integration (EAI), extensible mark language (XML), and middleware, so that SCM systems could allow better B2B relationships and improve production and forecasting simultaneously. In order to achieve modeling optimization, business process re-engineering (BPR) should be implemented. IT is believed to serve as an enabler of BPR. In this paper, IT has been applied to BPR on SCM. The IDEF0 models are used to develop process models from the viewpoint of functional levels. IDEF0 is the most well-known and widely used method for functional modeling, and it is based on Structured Analysis and Design Technique (SADT) activity boxes. The basic element of an IDEF model is called a function block. A function block is linked with function blocks through four types of arrows: inputs, outputs, controls and mechanisms as shown in Figure 1 [7]. The graphical notation of function box represents an activity or a group of activities, which transforms input into output under the control and by using the mechanism provided, and uses the connected arrows to represent the flow dependency of functions. The functional decomposition principle of IDEF0 is a hierarchy model, in which each node in it is a sub-function to describe the foregoing in detail. The lowest level of node in IDEF0 is based on the complexity of system and the requirement of user experience. In this paper, IDEF Data model has been presented as a graphical representation using Entity-Relationship (ER) approach.

3. Literature Review

3.1 Performance Measurement System
Sink and Tuttle claim that you cannot manage what you cannot measure [8].
Performance measurement provides necessary information for decision-making. Logistics can be defined as strategically managing the procurement, movement and storage of materials, parts and finished product inventory and the related information flows. According to Johnson and Wood, “supply-chain management is somewhat larger than logistics.” “The focus of logistics is often intra-organizational, while SCM is inherently inter-organizational” [2]. In the other words, managing a supply chain therefore requires each firm in a supply chain to be supply chain oriented inside the firm and, at the same time, perform a specific set of collective managerial action across the firms within the supply chain.

3.2. Supply Chain Strategies
Logistics strategy is a set of guiding principles and driving forces that help to communicate goals, plans and policies to all employees and which are reinforced through conscious and subconscious behavior at all levels of the supply chain. The short-term objectives of SCM are primarily to increase quality and increase productivity while reducing inventory and cycle time. For the supply chain, strategy is about planning a long-term plan for aligning competitive criteria. The long-term strategic goals are to increase customer satisfaction, market share, and profits for all players of the supply chain. Therefore, logistics strategy is very important for improving the supply chain performance. Today, a number of organizations are linked together for the purpose of supply of goods or services that are required by the end customer. Therefore, the supply chain should be viewed as a supply network. This network is a system and the overall performance of the system results from the combined performance of the individual players. A performance management typically includes four components: (1). Mission, vision, and values; (2).Goals and objectives focused on outcomes; (3).Performance measures; and (4).Strategies to achieve targets. These key components should comprise the organization’s strategic plan.

3.3. The Process-Based Model
The SCOR model uses a process-based approach to the supply chain. The process thinking of SCOR model can be applied to the modeling of supply chain processes and supply chain performance measurements. This research focuses on process-based performance measures. In order to know how to find the opportunities for improvement and how to measure the supply chain performance, the cross-industry
framework developed by the Supply Chain Council has been reviewed. This provides guidelines for improving the source-make-deliver-return operations of an organization and the supply chain. It is founded on five distinct management processes (plan, source, make, deliver and return) within all of the organizations in the supply chain. The supply chain can be viewed as a network in terms of overlapping processes of source, make, deliver and return within an integrated planning framework, and all of the organizations in the supply chain are linked together with corresponding management processes. Plan activities balance resources and demand and provide integration between activities and organizations. Source activities are those that are associated with acquiring raw materials and sources activities connect organizations with their suppliers. Deliver activities connect an organization with its customers. Most organizations have make activities that transform raw materials into finished goods. Return activities include the return of raw materials to suppliers and the receipt of returns of finished goods from customers [9].

3.4. Performance Measurement in SCM

Through the supporting measurement functions of a performance measurement system, an organization can get better goal attainment. A well modeling supply chain can promise a structure that would provide insight into the linkage between business objectives and supply chain operations, and it will drive all of the players in the supply toward a systematic approach for identifying, evaluating, and monitoring supply chain performances [10]. As mentioned previously, the BSC and SCOR model are the approaches that apply multitude of performance indicators for both of short-term and long-term goals. The BSC is a tool for implementing a business strategy and distinguishes four different dimensions of performance metrics: customers, internal processes, innovations, and finance [11]. Every dimension may include five to six measurement items. To develop measurement items, the process recommended by several researchers was followed: (1) Item generation through literature review and experience / interviews with industry experts; (2) Academic expert review; (3) Debriefing with experts; and (4) Item purification with managers [12, 13]. Recently, item development and refinement becomes an iterative process. A large multinational company evaluates the logistical performance of its SCM systems through five key performance metrics: fill rate, confirmed fill rate, response delay, stock, and delay. Hewlett-Packard (HP) emphasizes the importance of shared performance metrics; that is,
metrics shared by all companies in the supply chain. The three metrics are fill rate, sales/inventory ratio, and sales [14]. The SCOR model describes supply chains in five dimensions: reliability, responsiveness, flexibility, cost, and efficiency in asset utilization. The five management processes are decomposed into three levels of detail. At level 1 supply chain performance can be directly tied to the business objectives of the organizations. Table 1 describes these performance metrics. In the case study, a BSC has been developed based on SCOR model.

Table 1: Supply chain performance is tied to measurements [15]

<table>
<thead>
<tr>
<th>SCOR level 1: SCM</th>
<th>Customer-facing</th>
<th>Internal-facing</th>
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<tbody>
<tr>
<td>Delivery performance</td>
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<td>Order fulfilment performance</td>
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<td>Fill rate</td>
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<td>Order fulfilment lead time</td>
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<td>Perfect order fulfilment</td>
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<td>Supply-chain response time</td>
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<td>Production flexibility</td>
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<td>Total logistics management cost</td>
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<tr>
<td>Value-added productivity</td>
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<td>Warranty cost or returns processing cost</td>
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<td>Cash-to-cash cycle time</td>
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<td>Inventory days of supply</td>
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<td>Asset turns</td>
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4. An In-depth Case Study

The CASE COMPANY (for confidentiality reasons, the name of the company is not revealed) is a state-run manufacturing company, and the supply policy is to integrate the capabilities of civilian, government and arsenal resources to reach the systems acquisition and integrated logistics support. It deals with the operations of customer order, quotation, production, delivery, profit and cost. The top priority concern of CASE COMPANY is that the profit will balance total cost basically, and the cost contains working force, material, and overhead. CASE COMPANY has also been faced with the dynamic changes and needs to carry out improvement efforts to rapidly produce products and services. CASE COMPANY was already ISO9001 and ISO14001 certified. In order to achieve the goals, CASE COMPANY has planned to conduct supply chain modeling and will develop an approach of SCM performance measurement via the BSC. At this stage, CASE COMPANY is conducting the re-engineering of inbound logistics, manufacturing logistics, and outbound logistics. Inbound logistics links between CASE COMPANY and tier-1 suppliers, while outbound logistics links between CASE COMPANY and tier-1 customers.

4.1. System Modeling

The flow diagram of logistics management system is shown in Figure 2. In this reengineering, the information flow, material flow, and all activities connected with the manufacturing in CASE COMPANY are determined and optimized to design the integrated business process model.

![Figure 2: Logistics Management System](image-url)
4.1.1. Requirements Definition
CASE COMPANY logistics management flow is based on meeting customer orders, and the operation goals need to satisfy customers’ requirements of quick delivery, in high quality, and for a reasonable price. According to these requirements, it is very important for CASE COMPANY to control the materials and parts provided by its contractors, and monitor all of the activities involved in the product cycle. These activities can be divided into five management process groups as Level 1 processes based on SCOR model. Each group can be decomposed into Level 2 and Level 3 processes elements that are used to describe more and more detailed activities. Every one of these enterprise activities has been examined by its primary or value-added secondary properties. In other words, any non-primary or non-value-added enterprise activity ought to be simplified, alternated or combined with other activities.

4.1.2 Process Model
The work during modeling phase connected function and data modeling with requirement definition for the system implementation. System analysis/design specialists select the modeling language as a communication tool to work with division manager and clerks. CASE COMPANY/BPR model provided a consistence frame for modeling business process in requirement definition, and conjoined business rule with event mechanism to support the requirement of non-determinism (such as exceptions or decision-making by situations) in the control view of IDEF0. The input/output arrow is a notation to represent the need/expectation of activities from user view in requirement analysis phase. The SA/SD scientists have to do their best to decompose process units for matching application programming tools.

4.2. The BSC in CASE COMPANY
The BSC developed in CASE COMPANY is used to translate the organization’s vision into a set of performance indicators distributed among four perspectives: Financial, Customer, Internal Business Processes, and Learning and Growth. Through the balanced scorecard, CASE COMPANY monitors both its current performance (finance, customer satisfaction, and business process results) and its efforts to improve processes, motivate and educate employees, and enhance information systems—its ability to learn and improve. The four perspectives of the balanced scorecard:
(1). Financial: The top priority concern of CASE COMPANY is that the profit will balance total cost basically. Success for CASE COMPANY should be measured by how effectively and efficiently CASE COMPANY to meet customers’ requirements of quick delivery, in high quality, and for a reasonable price.

(2). Customer: customer service and satisfaction. In the CASE COMPANY model, the principal driver of performance is different than in the strictly commercial environment. The most important thing is listening to the voice of the customer, staying close to the customer, and meeting or exceeding customer expectations.

(3). Internal Business Processes: In CASE COMPANY, key processes are monitored to ensure that outcomes will be satisfactory.

(4). Learning and Growth: In order to meet changing requirements and customer expectations, employees have been asked to take on dramatically new responsibilities, and required skills, capabilities, technologies, and organizational designs that were not available before.

This guideline helps CASE COMPANY set the critical indicators, and focus its efforts on the strategic vision.

5. Conclusion

A Computer Integrated Management information system has already been developed based on the integrated model of manufacturing by BPR approach. It can reflect how work has been done, and support overall business objectives. Now, CASE COMPANY has developed and implemented successfully this logistics management system using Information Technology. With this system, it is successful for CASE COMPANY to control the materials and parts provided by its contractors, and monitor all of the activities involved in the product life cycle.

From the above results, several conclusions have been reached as following:

(1). System implementation must have the full support of top management to succeed.

(2). BPR needs a dedicated steering board and a trained working team.

(3). Performance Measurement must be accompanied by BSC strategic planning, and during this process it is important to be able to link logistics management processes to business goals and objectives of the company.
In this paper, a framework of logistics management implementation in a manufacturing company has been developed. CASE COMPANY has realized it successfully. With this system, valuable data has been collected and analyzed, and the performance can be measured and evaluated the success of BSC performance indicators. In the future, the results of data analysis can be used for continuous development of SCM.

References


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