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A SCOR-Based Framework for Supply Chain Performance Management

Changrui Ren, Jin Dong, Hongwei Ding, and Wei Wang

Abstract—The importance of performance management in supply chains has long been recognized from a variety of functional disciplines. But much of the work has focused on designing performance measures with less concern for the other stages of the entire performance management process. The supply chain operations reference (SCOR) model, developed by the Supply-Chain Council (SCC), is widely accepted as the only cross-industry standard for supply chain management, which not only provides a standard description of supply chain processes, but standard metrics to measure supply chain performance. Based on the SCOR model, a comprehensive framework for supply chain performance management is presented in this paper, which includes all aspects of performance management from performance measurement to performance improvement. The methods for performance model design and performance analysis are mainly discussed.

Index Terms—Performance management, performance measures, supply chain, supply chain operations reference model (SCOR).

I. INTRODUCTION

The design, implementation and use of adequate performance management system can play an important role if supply chains are to succeed in an increasingly complex, interdependent and changing world, since “you cannot manage what you cannot measure” [1]. However, despite the widespread recognition of the importance of performance management in supply chains, there are still many issues which require further study if performance management is to be effective in supporting the decision making process and improving supply chain performance. In general, performance management embraces all the aspects from performance measures set, measurement procedure, comprehensive evaluation, to performance improvement processes. But taking a holistic view of the field of supply chain performance management, we can conclude that much of the work has focused on designing performance measures with less concern for the other stages of the entire performance management process. That is the reason why many efforts to improve supply chain performance have not

met with great success.

Designed to facilitate the blending of business objectives, strategy, process, and technology, the SCOR model has been widely accepted as the only cross-industry standard for supply chain management. In addition to the structured vocabulary of definitions of supply chain processes, SCOR also defines a set of measures that can be use to evaluate processes at each level of the process hierarchy. Thus SCOR has already laid a strong foundation for supply chain performance management.

The objective of this paper is to describe our research work conducted on a comprehensive supply chain performance management framework based on the SCOR model, and discuss related methods at each stage of the entire performance management process. The remainder of this paper is structured as follows. At first, a literature review of supply chain performance management is performed in Section II. In Section III, the SCOR-based framework for supply chain performance management is presented, and in Section IV, some key concepts in performance measurement are illustrated. The methods for performance analysis and improvement are introduced in Section V. Finally, in Section VI, we conclude with some closing remarks.

II. LITERATURE REVIEW

A. Performance Management in Supply Chains

The research of performance management has been popular for years. There were numerous publications emphasizing the need for relevant, integrated, balanced, strategic, improvement oriented and dynamic performance management systems [2]. This resulted in the development of numbers of frameworks, models, methodologies, tools and techniques, such as:

- The balanced scorecard by Kaplan and Norton [3].
- The strategic measurement analysis and reporting technique (SMART) system by Cross and Lynch [4].
- The performance criteria system by Globerson [2].
- The Cambridge performance measurement design process by Neely et al. [5]
- The integrated performance measurement systems reference model by Bititci and Carrie [6].

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With the popularity of supply chain management since 1990s, performance management in supply chains was often discussed in literature. Beamon [7] argues that supply chain measurement system must place emphasis on three separate types of performance measures: resource measures, output measures, and flexibility measures. Gunasekaran et al. [8] develop a framework for measuring the strategic, tactical, and operational level of performance in a supply chain, which deals mainly with supplier, delivery, customer service, and inventory and logistics costs. And in supply chain 2000 framework [9], the performance measures cover the aspects of time, quality, cost, service, and asset. Although people attempts to build new measures for supply chain performance management, most of the current performance management systems have too many defects to meet the supply chain management requirements. The main barriers to the effective adoption of performance management in improving supply chain performance can be summarized as follows:

- Lack of a balanced approach to integrate financial and non-financial measures.
- Lack of a clear distinction between measures at strategic, tactical, and operational levels.
- Lack of connections between strategic objectives and processes and activities.
- Too many isolated and incompatible measures.
- Lack of a structured framework which allows people to differentiate between improvement and control measures [2].
- Lack of a flexible platform to allow organizations to effectively and efficiently manage the dynamics of their performance management systems.
- Inability to quantify the relationships between performance measures within a system.
- Lack of system thinking, thus losing the supply chain context [10].

B. The Supply Chain Operations Reference Model

The SCOR model is a process reference model, which is intended to be an industrial standard that enables next-generation supply chain management. It provides a common supply chain framework and standard terminology for evaluating, positioning and implementing supply chain improvements. SCOR integrates the well-known concepts of business process reengineering, benchmarking, and process measurement into a cross-functional framework. More concretely, the structural framework of the SCOR model is composed of the following elements [11]:

- Standard descriptions of the individual elements that make up the supply chain processes.
- Standard definitions of key performance measures.
- Descriptions of best practices associated with each of the process elements.
- Identification of software functionality that enables best practices.

Since the model's first introduction in 1996, SCOR has been continually evolving based on practical needs by SCC, and the latest version is 7.0. SCOR has been successfully adopted worldwide by SCC members across various industry sectors, such as consumer foods, electronics, software and planning, aerospace and defense, etc.

The SCOR model consists of five basic processes: plan, source, make, deliver and return (see Figure 1), and the SCOR modeling approach starts with the assumption that any supply chain process can be represented as a combination of the five basic processes. In addition to these basic processes, there are three process types or categories, i.e., enable, planning and execution.

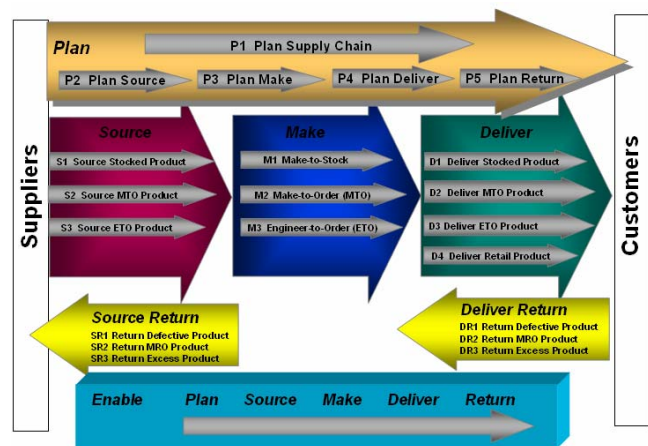


Figure 1. The SCOR infrastructure [12]

As a process reference model, SCOR provides a hierarchical framework for business process expression. Level 1 is the top level and deals with process types. It defines the scope and content for SCOR, i.e., the five basic processes. Level 2 is the configuration level and deals with process categories, and it defines 26 categories within the Level 1 processes. Level 3 allows businesses to define in detail the processes identified, as well as performance metrics and best practices for each activity. Inputs, outputs, and basic logic flows of process elements are also identified. Level 4 describes the detailed tasks within each of Level 3 activities. These tasks and their interactions are unique to each business, so implementation of supply chain processes takes place at this level. SCOR defines some general aspects of supply chain processes in Level 1-3, while leaving the concrete features of processes (Level 4 and below) to users. With the hierarchical SCOR model, a business can quickly and unambiguously describe its supply chain.

SCOR also defines a set of measures that one can use to evaluate processes at each level of the process hierarchy. The performance attributes and metrics are measured in five different categories namely supply chain reliability, supply chain responsiveness, supply chain flexibility, supply chain costs, and supply chain asset management. The first three attributes are customer-facing, while the last two are

internal-facing. In Level 1, SCOR defines 9 metrics, which provide a foundation for supply chain wide performance measurement.

However, SCOR implementers have indicated that the selection of metrics, the alignment of metrics with processes, and the sourcing of data to support operational measurement against those metrics can be a formidable task. Definitions must be easily understood by practitioners, consultants and technology providers to support benchmarking, managing and monitoring the supply chain. Clear and consistent definitions are required for implementation. The definitions must not only identify what should be measured but how the measurement should be calculated. The main issues on the current SCOR measurement system can be summarized as follows:

- Relationships between performance metrics and between metrics and processes are not clear.
- There are inconsistencies in Level 2 and Level 3 metrics.
- Metrics are not defined well enough to support a consistent application, e.g., it is difficult to collect data for metrics calculation.
- Metrics in the model, particularly as they relate to finance, tend to be US-centric.

To facilitate the selection and deployment of SCOR metrics and to provide practical approach for benchmarking of the supply chain processes, it has to be improved from the following aspects:

- Develop a hierarchical metrics structure, which maps the relationship between metrics (both vertically, i.e., general to more specific, and horizontally, i.e. dependencies) as well as the relationship to processes.
- Provide clear, concise, and benchmarkable definitions of the metrics, including their formulation, which can be understood by practitioners and lay-people alike, and to clarify differences in definition that may exist between industries and regions.
- Describe the relationship between business objectives and supply chain objectives, and identify the metrics that support each.
- Identify and define “diagnostic” metrics, which are used aperiodically to identify issues in supply chain performance.

III. THE SCOR-BASED FRAMEWORK FOR SUPPLY CHAIN PERFORMANCE MANAGEMENT

Despite the widely recognition of its importance, performance management for supply chain is still in its infancy. Thus in this paper, we present a comprehensive SCOR-based framework for supply chain performance management, see Figure 2.

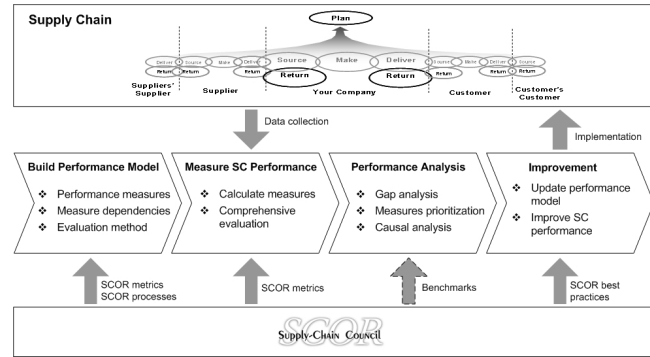


Figure 2. A SCOR-based framework for supply chain performance management

The above framework integrates two important concepts in performance management: performance measurement and performance improvement. From the performance measurement perspective, the framework includes all aspects from performance measures set, measure dependencies, to the evaluation method. While from the performance improvement perspective, it spans the whole cycle of supply chain performance improvement including steps of modeling, measurement, analysis, and improvement.

A. Build Performance Model

In addition to performance measures set, which is widely discussed in literature, our performance model also includes measure dependencies and evaluation method. The design of performance measures includes a balanced measure structure, measure definition, and the measure calculation and data collection method. The measure dependencies map the relationships between performance measures, which are the foundation for further analysis. The evaluation method is the mechanism to combine different performance measures or attributes into a single criteria.

B. Measure Supply Chain Performance

The performance measurement process includes measure calculation and performance evaluation. The measures can be calculated based on their definitions and the data from real supply chain. Performance evaluation is the process of attaching value weights to various measures of performance to represent the importance of achievement on each dimension.

C. Performance Analysis

This framework also provides several performance analysis methods for decision making and improvement, these are: gap analysis, measures prioritization, and causal analysis.

D. Improvement

Based on performance measurement and performance analysis, the improvement here could be split into two main subdivisions. Firstly, by analyzing the importance and causal

relationships of performance measures, we can rationalize the measure structure, i.e., adding/deleting measures or adjusting their relationships. Secondly, by gap analysis and process reengineering, we can improve real supply chain performance to a more ideal level.

SCOR model plays an important role in the framework. It not only provides a concrete structure and well defined reference metrics for performance measures design, but also benchmarks for gap analysis and best practices for improvement.

The whole performance management process is not a simple linear progression from performance measures design to the update of performance model and improvement, but a continuous improvement process that requires developing and reviewing at a number of different levels as the situation changes, as in Figure 3.

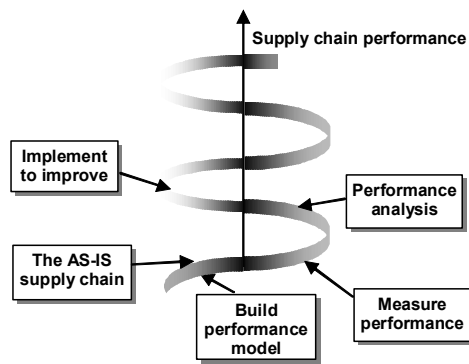


Figure 3. The continuous performance improvement process

IV. PERFORMANCE MEASUREMENT

A. Performance Measures

To design a set of “balanced” and “multi-dimensional” performance measures for supply chain is important but difficult, fortunately, SCOR model provides comprehensive performance metrics for each Level 2 and Level 3 processes, and 9 Level 1 metrics for supply chain wide measurement as well, which fall into the five performance attributes, see Table I [13].

The measures defined by SCOR can be used to evaluate processes at each level of the process hierarchy. The measures cater to various goals different companies might have. Thus the choice of measures depends on the company’s strategy and focus and it is upon the company to choose the measures they desire. The SCOR model calculates the measures based on precise formulae for each measure defined by a standard definition. Besides the measure definitions, in the appendix of SCOR model version 7.0, the detailed information for some Level 1 measures such as data collection, benchmarking, best practices, and economic impact are also provided.

TABLE I
SCOR PERFORMANCE ATTRIBUTES AND ASSOCIATED LEVEL 1 METRICS

	Performance Attribute	Performance Attribute Definition	Level 1 Metric
Customer-Facing	Supply Chain Reliability	The performance of the supply chain in delivering: the correct product, to the correct place, at the correct time, in the correct condition and packaging, in the correct quantity, with the correct documentation, to the correct customer.	Perfect Order Fulfillment
	Supply Chain Responsiveness	The speed at which a supply chain provides products to the customer.	Order Fulfillment Cycle Time
	Supply Chain Flexibility	The agility of a supply chain in responding to marketplace changes to gain or maintain competitive advantage.	Upside Supply Chain Flexibility Upside Supply Chain Adaptability Downside Supply Chain Adaptability
Internal-Facing	Supply Chain Costs	The costs associated with operating the supply chain.	Supply Chain Management Cost Cost of Goods Sold
	Supply Chain Asset Management	The effectiveness of an organization in managing assets to support demand satisfaction. This includes the management of all assets: fixed and working capital.	Cash-To-Cash Cycle Time Return on Supply Chain Fixed Assets

B. Measure Dependencies

There may be very complex relationships between the above measures may, such as various interactions, causal linkages, even loops. In order to structure all the measures in a logic manner, we design a mechanism to explore the qualitative and quantitative causal relationships among performance measures, see Figure 4.

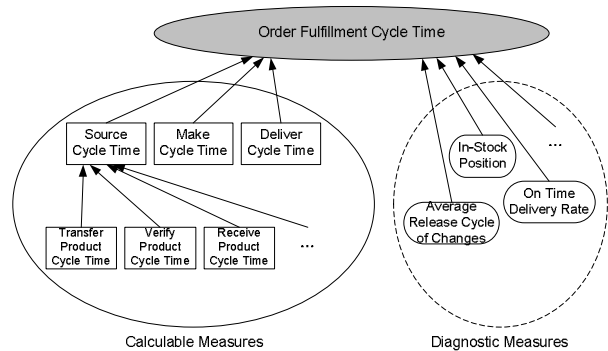


Figure 4. The measure dependencies

In this hierarchical structure, we divide performance measures into two groups: calculable measures and diagnostic measures. Given a specific performance measure, e.g., Order Fulfillment Cycle Time, the calculable measures can express the quantitative relationships from general to more specific, i.e., the relationships between measures from different levels can be expressed by mathematical equations, such as in Figure 4, Order Fulfillment Cycle Time = Source

Cycle Time + Make Cycle Time + Deliver Cycle Time. The diagnostic measures represent those measures which have relationships with the given measure, but the relationships are not easy to be quantified. In this case, one can only answer questions like which could affect which and to what extent the effect could be, so diagnostic measures are used to express qualitative relationships.

The usefulness of this hierarchical structure embodies on two levels: firstly, it links performance measures from different levels together, so that ease the calculation and enable the decomposition of strategic objectives; secondly, it lays a foundation for causal analysis.

C. Comprehensive Evaluation

To obtain the best and most optimum overall performance of different supply chains is very difficult, because the importance of each performance measure is different in various industries. Thus, when quantitative decomposition is not easy to obtain, weightings have to be assigned to each performance measure (or attribute) according to its contribution to the performance of a given supply chain, which equals to a multi-criteria decision-making problem.

The analytic hierarchy process (AHP) [14] is a commonly used tool for solving multi criteria decision-making problems. The AHP provides a framework to cope with multiple criteria situations involving tangible and intangible, quantitative and qualitative aspects. It consists of three main steps:

- (1) Decomposing the complex problem into a hierarchy of different levels of elements.
- (2) Using a measurement methodology to establish priorities among the elements.
- (3) Synthesizing the priorities of elements to establish the final decision.

The AHP helps to rank and make decision in a rational and systematic way. Weighting can be changed according to different companies or industries, thus it is a flexible kind of data analysis. The AHP provides versatility and power in structuring and analyzing a complex multi-attribute decision-making problem, by giving a means of quantifying judgmental consistency. The AHP allows flexibility to aid the management decision-making process and reduces assessment bias by pairwise comparison.

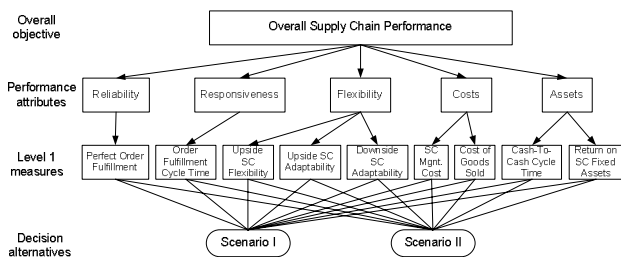


Figure 5. Performance evaluation using AHP and SCOR measures

Figure 5 gives an example. Given the default SCOR performance measures structure, we can get the values of SCOR Level 1 performance measures by calculation or decomposition, however, the objective and attributes are not quantifiable. By using the evaluation method based on AHP, we can evaluate scenarios to optimize the objective and make decisions.

V. PERFORMANCE ANALYSIS AND IMPROVEMENT

The ultimate objective of performance management is to achieve continuous performance improvement. Therefore, after performance measurement, performance analysis should be conducted to find opportunities and approaches to improve. Based on the performance model and the measurement results, we can analyze by the following methods to aid decision making and find appropriate direction to improve.

A. Gap Analysis

Gap analysis is an easy and effective method for diagnosis. By comparing the actual value of performance measures with benchmarks, the gaps against industry best practices will be obvious. SCORCard [15] and the spider chart are good tools for comprehensible expression. The benchmarks data can be obtained through organizations such as PMG (Performance Measurement Group) and APQC (American Productivity & Quality Center). Recently, SCC has just announced a joint program with APQC to provide benchmarks for SCOR measures in the near future.

B. Measures Prioritization

AHP can help to get the relative importance of each measure to a given objective. Pareto analysis and sensitivity analysis can be used for ABC classification by importance for performance measures. Furthermore, if we keep importance as one dimension, and add another dimension such as “rate of change”, then we can get a 2-dimension taxonomy of performance measures. The prioritization of performance measures can not only help to identify main performance drivers, but be used to reduce number of performance measures to a manageable set.

C. Causal Analysis

Based on the performance model with quantitative and qualitative relationships between performance measures, we can then do various analyses as follows:

- What-if analysis

Given the changes of one or more performance measures, what is the impact to other related measures? For example, if we increase “Price” by 10%, what’s the impact to “Sales” or “Total Profit”?

- Root cause analysis

This analysis is to find the reasons that cause the existing phenomena. For example, one has observed the “Total Profit” decreased by 10% in the last 5 months, what could be

the bottlenecks causing this decrease?

- Policy design

Given an objective (usually a function of one or several measures), to find an optimal policy (the measures that can be changed as decision variables) to achieve it. This is usually an optimization problem. For example, given the objective of achieve a 90% “Perfect Order Fulfillment”, then what’s the optimal policy? e.g., how to set the measure “Price”?

The value of these analyses can be summarized as follows:

- Link high-level business objectives with operational measures to understand root cause.
- Understand the dependencies among performance measures so that can decide how to change them to achieve business goals.
- Find possible conflicts among performance measures and establish collaboration dynamically.

Through above analyses, we can know the gaps and which measures should be improved, and the objectives as well. SCOR provides best practices for each Level 2 and Level 3 processes, which aim to identify management practices and software solutions used successfully by similar companies that are considered top performers. The identification of the best business practices needed to support the “to-be” state of the processes becomes the roadmap for implementation. In line with the focus of SCOR, this list of best practices includes tools primarily aimed at improving transactional efficiency in the supply chain, such as activity-based costing (ABC), advanced-shipping notification (ASN), Kanban, and supplier certification programs. Further information on how to implement these practices for improvement can be obtained through the SCC.

VI. CONCLUSIONS

This paper presents a comprehensive framework for supply chain performance management based on SCOR model, which includes all aspects of performance management from performance measurement to performance improvement. The performance model and performance analysis methods are discussed in detail.

This framework can be used for supply chain diagnosis, supply chain transformation, and the exploration for supply chain operational mechanisms. Especially, it can also be used as the guidance for business application design, e.g., the business performance management system (BPMS).

This paper is intended to describe the main framework of this SCOR-based performance management system, rather than elaborate technical details. Moreover, its contributions would be tested in later practices with necessary adjustments.

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