# A New Approach for Performance Evaluation of Supply Chain Management

Sadaei, Maryam[1]; Fazli, Safar

Address: No 51, Bakhtiari Alley, Bonyad junction, Qazvin, Iran
Postal Code: 15136 34199
University: International University of Qazvin
Email: m_sadaei@yahoo.com
Mobile: 0098 9375369652

**Abstract:** Supply chain management is the management of internal and external processes or functions to satisfy a customer's order from raw materials through conversion and manufacture through shipment. Recent studies indicate that supply chain performance affects more than 85 percent of a manufacturer's costs and a large percent of its revenues. Monitoring this performance through measurements is, therefore, practical and helps to identify optimization opportunities. Performance measures, or "metrics," are used to monitor the progress of supply chain initiatives. In other words, a performance measure is a value or characteristic to measure output or outcome. In this study, using improved Willis method and base on Gunasekaran Model, has been presented practical method that calculates degree of supply chain management performance. The measurement framework in this study offers guidelines for measuring the supply chain performance in manufacturing units. The case study of this research is relevant to performance measurement of supply chain management in MAHER ANDISH unit which is one of the largest motor vehicle parts manufacturers in Iran. Based on Gunasekaran Model, supply chain management levels were divided into 3 levels and 15 criteria. Findings indicate the degree of supply chain management Performance in this industry unit is equal to 0.783.
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**Key words:** performance measurement, supply chain management, strategy, tactics, operations

## Introduction

The new competition is in terms of improved quality, products with higher performance, reduced cost, a wider range of products and better service; all delivered simultaneously (Dangayach et al, 2003). Supply chain management is responsible for the entire lifetime of the product, from preparation of materials and supply management, to production and manufacturing, distribution and customer service, and ultimately recycling and disposal at the end of product life. Recent studies show that supply chain performance affects more than 85 percent of a manufacturer's costs. For any business activity, such as supply chain management, which has strategic implications for any company, identifying the required performance measures on most of the criteria is essential and it should be an integral part of any business strategy. The purpose of calculating the performance, on one hand, is to give more information about the degree of achievement of the objectives and on the other hand, is to find actions to improve the values of metrics and consequently total performance. Superior performers are reengineering their supply chains to decrease costs, improve customer satisfaction, and increase profits. Thus, the performance measurement systems are the necessary tools to support decision making (Berrah et al, 2007). Many performance measurement methods have been suggested over the years for SCM evaluation of any organization. Unfortunately, evaluation methods that rely on financial measures are not well suited for newer generation of SCM applications. It is an established fact that many companies have not succeeded in maximizing their supply chain's potential, because they have often failed to develop the performance measures and metrics needed to fully integrate their supply chain to maximize effectiveness and efficiency (Gunasekaran et al, 2004). A worldwide study of contemporary manufacturing practices reported fair uptake and perceived effectiveness of supply chain management (Clegg et al, 2002). While observing these modest levels of uptake and effectiveness, one would expect attention in developing measurement systems and metrics for evaluating SCM performance to be growing. Likewise, it has been argued that measuring supply chain performance can result in understanding of the supply chain and improve overall companies' performance (Chen et al, 2004).

In recent years, firms have realized the potential of SCM in the management of day to day operations. However, there are many firms without having enough insight for development of effective performance measures and metrics needed to achieve a fully integrated SCM. This is because they do not have the access to a clear distribution between the metrics at

strategic, tactical, and operational levels (Bhagwat et al, 2007). Measuring supply chain performance can facilitate a better understanding of the supply chain, positively influencing supply chain players' behavior and improving its overall performance (Chen et al, 2004). In order to achieve supply chain goal of fulfilling customer orders more quickly and efficiently than other competitors, a supply chain needs continuous improvements (Hausman, 2002). It is stated that supply chain performance measurement is extremely important in developing supply chain. Therefore, the main question of the research is "What is the degree of supply chain management performance in a certain system?" In this article, using improved Willis method and base on Gunasekaran Model, has been presented practical method that calculates degree of supply chain management performance. In other words, the aim of this study is to create a supply chain measurement framework for manufacturing units, the measurement framework in this study offers guidelines for measuring the supply chain performance in manufacturing units. As a case Study, to demonstrate the application of the proposed method, MAHER ANDISH unit which is one of the largest motor vehicle parts manufacturers in Iran is investigated.

**Main body**

The need of performance measurement systems at different levels of decision-making, either in the industry or service contexts, is undoubtedly not something new (Bititici et al, 2005). Performance measurement describes the feedback or information on activities with respect to meeting customer expectations and strategic objectives. It reflects the need for improvement in areas with unsatisfactory performance, Thus efficiency and quality can be improved (Chan, 2003). In this section, make an attempt to summarize some of the most appropriate methods of systems performance measurement and measurement of SCM (Bititici et al, 2002; Chan et al, 2003a; Chan et al, 2003b; Chan et al, 2006; Sharma et al, 2005). The balanced scorecard1 had proposed as a means to evaluate corporate performance from four different perspectives: the financial, the internal business process, the customer, and the learning and growth (Kaplan et al, 1992). Many companies are adopting the BSC as the foundation for their strategic management system. Some managers have used it as they align their businesses to new strategies, moving away from cost reduction and towards growth opportunities based on more customized, value-adding products and services (Martinsons et al, 1999). Strategic measurement analysis and reporting technique system consists of a four level pyramid of objectives and measures: corporate vision/strategy, business unit market and financial objectives, business unit operational objectives and priorities, departmental level operational criteria and measures (Cross et al, 1989). Performance measurement questionnaire involves a workshop to develop, revise, and refocus the set of performance measures. It has the advantage of providing a mechanism for identifying the improvement areas of the company and their associated performance measures. However, it cannot be considered a comprehensive integrated measurement system and does not consider continuous improvement (Dixion et al, 1990). Strategic performance measurement system presented as action-focused tool, which concentrates on the organization's strategies. The concepts and ideas were developed by hands-on experience (Vitale et al, 1994). Integrated dynamic performance measurement system developed to achieve an integrated system by combining three main areas of the company: management, process improvement team, and factory shop floor (Ghalayinin et al, 1997).

Holistic process performance measurement system presented especially for modern process-based businesses. It assesses the performance of the processes for five aspects: financial view, employee view, customer view, societal view, and innovation view (Kueng, 2000).

For any firm, the first activity to begin with is to procure orders. It is clear that the way the orders are generated and scheduled determines the performance of the downstream activities and inventory levels. Hence, the first step in assessing performance is to analyze the way the order-related activities are carried out. To do this, the most important issues, such as the order entry method, order lead-time and the path of order traverse, need to be considered (Christopher, 1992; Mason-Jones et al, 1997; Gunasekaran et al, 2001; Bower et al, 1988; Towill, 1997; Schonberger, 1990). Recently, buyer–supplier partnership has gained a tremendous amount of attention from industries and researchers, resulting in a steady stream of literature promoting it (Ellram, 1991; Fisher, 1997; Graham et al, 1994; Gunasekaran et al, 2001; Landeros et al, 1995; Maloni et al, 1997; McBeth et al, 1994; New, 1996; Thomas et al, 1996; Toni et al, 1994; Towill, 1997). Most of these studies stress the partnership for better supply chain operations. Accordingly, an efficient and effective performance evaluation of buyer and/or suppliers is not just enough; the extent of partnership that exists between them needs to be evaluated and improved, as well. This measurement is aimed to integrate the customer specification in design, set the dimensions of quality and the feedback for the control process. They contain

[1]- BSC

product/service flexibility, customer query time, and post-transaction service (Bower et al, 1988; Stewart, 1995; Gunasekaran et al, 2001).

As an important part of SCM, the performance of the production process also needs to be measured, managed, improved, and suitable metrics for it should be established. This category consists of range of product and services, capacity utilization, and effectiveness of scheduling techniques (Mapes et al, 1997; Fisher, 1997; Wild, 1995; Slack et al, 1995; Gunasekaran et al, 2001). These measures are designed to evaluate the performance of delivery and distribution cost in supply chain. The typical measures for delivery performance evaluation are lead-time reduction in the delivery process, on- time delivery (Note 1), distribution mode, the delivery channel, vehicle scheduling, and warehouse location, the percentage of goods in transit, quality of information exchanged during delivery, number of faultless notes invoiced, flexibility of delivery systems to meet particular customer needs (Gelders et al, 1994; Novich, 1990; Stewart, 1995; Gunasekaran et al, 2001; Stewart, 1995; Gelders et al, 1994; Gunasekaran et al, 2004; Novich, 1990). Determining the total logistics cost can assess the financial performance of a supply chain. It is necessary to decide on a broad level of strategies and techniques that would contribute to the smooth flow of information and materials in the supply chain environment. They are used to assess the financial performance of supply chain, such as assets cost, return on investment, and total inventory cost (Stewart, 1995; Christopher, 1992; Dobler et al, 1996; Lee et al, 1992; Levy, 1997; Slack et al, 1995; Fisher, 1997; Harrington, 1996).

The initial Willis method was used in 1990 for choosing some suppliers. In this method, different features and characteristics of various sizes and significance convert to a single unit. In Willis method, weighted value of experts is not considered for scoring according to their skill level, it implies that an expert and a novice have same weighted value and effectiveness of weighted value of experts is ignored by using a simple average, too. So this method improved and a new method has been introduced which weighted value of experts in scoring according to their skill level and experience has been included. In Willis improved method, scores given by experts would not be smoothed using a simple average and each score would be considered in calculations individually. Willis improved method has been presented in Eq. (1):

$$DA_j = \sum_{i=1}^{n} \frac{W_{ij}}{y} \left( \sum_{k=1}^{m} (d_k \times X_{ik}) \right) \qquad (1)$$

Where:
DAj is the degree of adaptability of jth criteria with standard characteristics.
n shows the number of criteria which are subsets of a level.
Wij is the weight of ith criteria from jth level.
Xik is the score given by kth expert to ith criteria.
m shows the number of experts.
dk is the kth weighted value of expert.
y is the standard score of criteria (y=9).
P shows the number of levels.

$$\forall_{j=j} \sum_{i=1}^{n} W_{ij} = 1 \quad \text{و} \quad 0 < W_{ij} \leq 1$$

$$1 \leq X_{ik} \leq 9$$

$$\sum_{K=1}^{m} d_k = 1 \quad \text{و} \quad 0 \leq d_k \leq 1$$

In Willis improved method, to achieve more accuracy, weighted value of experts is included in scoring. Also, weighted value of experts can change from one level to another. For example, weighted value of expert to judge "A" level criteria was .2, .3, .5 then to judge "B" level criteria, the weighted value of same expert can be .25, .35, .4, respectively. This shows the flexibility of this improved method, because experts may have a high skill level in a special field and a low skill level in another one. If experts have a high skill level in a special field, it is clear that in this case, weighted value of experts will be high and in the other field which they have a low skill level, their weighted value will be low. Also, it should be noted that the number of judging experts can be different from one level to another levels and still the calculation is accurate. For example, if the number of judging experts on “A” level criteria is 3, with a weighted value of .2, .3, .5, then the number of experts to judge on “B” level criteria can be 4 with a weighted value of .2, .3, .4, .1, respectively. This shows the high capability of this formula, too. It is clear that experts may have high skill in a certain field and participate in judging groups while they have not high skill in another field and could not participate in the judging group. For determining the total degree of performance, formula No. 2 is presented as follows:

$$DA_{Total} = (DA_1)^{W1} \times (DA2)^{W2} \times (DA_3)^{W3} \times (DA_4)^{W4} .... \quad (2)$$

Based on Gunasekaran model, the metrics or are classified into strategic, tactical and operational levels of management. Gunasekaran states that SCM could be measured in various management or operation levels. The main idea was to assign measures where they can be best dealt with by the appropriate management level, thus facilitating quick and appropriate decisions. Strategic level measures influence the top management decisions and also very often reflect the investigation of broad based policies and level of adherence to organizational goals. The tactical level deals with resource allocation and measuring performance against targets to be met in order to achieve results specified at the strategic level. Operation level measurements and metrics require accurate data and decision is made by low level managers. In operational level, metrics are relevant for day to day business and hence the main metrics are time related. Many of these metrics are time-related but also cost-related. These metrics are for top management for making strategic decisions as well as long-term plans and strategies. High performance metrics that target broader functional areas of supply chain were configured by Gunasekaran (Tables 1 to 3).

Table 1

| **Evaluation factors of " Strategic Level"** |
|---|
| Total cash flow time |
| Rate of return on investment |
| Flexibility to meet particular customer needs |
| Delivery lead time |
| Total cycle time |
| Buyer–supplier partnership level |
| Customer query time |

Table 2

| **Evaluation factors of " Tactical Level"** |
|---|
| Extent of co-operation to improve quality |
| Total transportation cost |
| Truthfulness of demand predictability/forecasting methods |
| Product development cycle time |

Table 3

| **Evaluation factors of " Operational Level"** |
|---|
| Manufacturing cost |
| Capacity utilization |
| Information carrying cost |
| Inventory carrying cost |

These measures are usually corporate level performance measures. It should be noted that tactical level measures performance against targets and also collects feedback from mid-management level. Operational level metrics require data that is relevant to low level management.

The case study of this research has been conducted in MAHER ANDISH unit which is one of the largest motor vehicle parts manufacturers in Iran. Based on Gunasekaran model, for Performance Measurement of Supply Chain Management 3 main levels and 15 criteria were set. The main levels include strategic, tactical and operational and 15 criteria of subsets were configured (Tables 1 to 3). Based on Willis improved method, the following is required for performance measurement:

- Weight of main levels and criteria
- Weighted value of experts
- Criteria scores

In this step, the paired comparisons & scoring are developed to determine weight and also the score of main levels and criteria by all MAHER ANDISH managers and experts. (Tables 4 to 6) indicate the weight and scores of main levels criteria. It should be noted that weight of criteria is determined based on paired comparisons done by MAHER ANDISH experts & managers. To determine the higher or lower priority of criteria, paired comparison has been performed with the scale of respectively 9 to 1/9.

Table 4

| Strategic Level criteria | Weight of criteria | Scores given by persons 1 to 5 | | | | |
|---|---|---|---|---|---|---|
| Total cash flow time | .211 | 7.25 | 7.00 | 8.00 | 7.75 | 6.75 |
| Rate of return on investment | .205 | 7.50 | 7.00 | 7.75 | 6.50 | 6.75 |
| Flexibility to meet particular customer needs | .116 | 5.50 | 6.50 | 6.50 | 6.75 | 7.00 |
| Delivery lead time | .166 | 7.50 | 8.25 | 7.75 | 7.25 | 7.50 |
| Total cycle time | .111 | 6.50 | 6.75 | 8.25 | 7.50 | 7.00 |
| Buyer–supplier partnership level | .092 | 6.50 | 6.50 | 7.00 | 7.25 | 7.00 |
| Customer query time | .099 | 7.50 | 8.00 | 7.00 | 6.25 | 6.75 |

Table 5

| Tactical Level criteria | Weight of criteria | Scores given by persons 1 to 5 | | | | |
|---|---|---|---|---|---|---|
| Extent of co-operation to improve quality | .310 | 8.00 | 7.75 | 7.00 | 6.25 | 8.00 |
| Total transportation cost | .386 | 7.75 | 6.75 | 7.00 | 7.50 | 7.75 |
| Truthfulness of demand predictability/ forecasting methods | .194 | 6.50 | 5.75 | 6.50 | 6.75 | 8.00 |
| Product development cycle time | .110 | 7.25 | 7.50 | 6.25 | 6.75 | 7.75 |

Table 6

| Operational Level criteria | Weight of criteria | Scores given by persons 1 to 5 | | | | |
|---|---|---|---|---|---|---|
| Manufacturing cost | .379 | 7.75 | 6.00 | 7.50 | 8.50 | 6.00 |
| Capacity utilization | .331 | 7.25 | 7.00 | 7.50 | 7.25 | 5.20 |
| Information carrying cost | .195 | 6.00 | 6.75 | 5.50 | 7.75 | 5.75 |
| Inventory carrying cost | .095 | 7.75 | 6.75 | 6.50 | 6.25 | 6.25 |

The only required parameter for Eq. (1) is weighted value of experts and managers in MAHER ANDISH unit for judging criteria which is described in (Table 7).

Table 7

| Expert/ Manager | weighted value for judging strategic level criteria | weighted value for judging tactical level criteria | weighted value for judging operational level criteria |
|---|---|---|---|
| **1** | .28 | .18 | .20 |
| **2** | .21 | .20 | .26 |
| **3** | .16 | .27 | .19 |
| **4** | .20 | .15 | .16 |
| **5** | .15 | .20 | .19 |

In this stage, degree of levels performance has been calculated based on Eq. (1) and using (Tables 4 to 7) as follows:

- DA (Strategic level) = .793
- DA (Tactical level) = .799
- DA (Operational level) = .756

Weight of strategic, tactical and operational levels is determined based on paired comparisons done by MAHER ANDISH unit experts & managers. Weights of these levels are respectively .375, .298, .327.

Also, the total degree of MAHER ANDISH unit supply chain performance has been calculated based on the Eq. (2) as follows:

- DA (Total) = .783

In last section, the most important results of this study are presented as conclusions.

**Discussion**

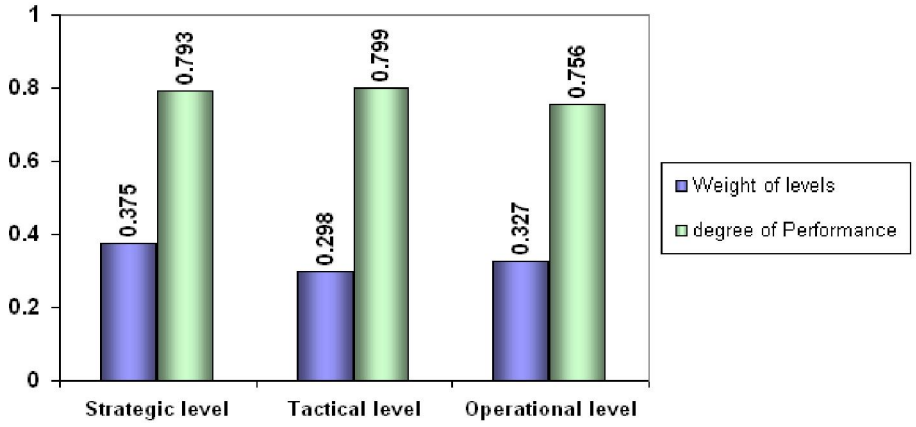
The need of performance measurement systems at different levels of decision-making, either in the industry or service contexts, is undoubtedly not something new. In recent years, firms have realized the potential of SCM in the management of day to day operations. However, there are many firms without having enough insight for development of effective performance measures and metrics needed to achieve a fully integrated SCM. Recent studies indicate that supply chain performance affects more than 85 percent of a manufacturer's costs and a large percent of its revenues. Monitoring this performance through measurements is, therefore, practical and helps to identify optimization opportunities. The measurement framework in this study offers guidelines for measuring the supply chain performance in manufacturing units. For any firm, the first activity to begin with is to procure orders. It

is clear that the way the orders are generated and scheduled determines the performance of the downstream activities and inventory levels. Hence, the first step in assessing performance is to analyze the way the order-related activities are carried out. To do this, the most important issues, such as the order entry method, order lead-time and the path of order traverse, need to be considered. The case study of this research is relevant to performance measurement of supply chain management in MAHER ANDISH unit which is one of the largest motor vehicle parts manufacturers in Iran. Based on Gunasekaran Model, supply chain management levels were divided into 3 levels and 15 criteria. Findings indicate the degree of supply chain management Performance in this industry unit is equal to 0.783.

**Conclusion**

The results of proposed method have been developed based on Gunasekaran model and improved Willis method in MAHER ANDISH unit Indicate the degree of supply chain management performance in this industry unit is equal to 0.783. Performance degree of tactical level is equal to 0.799 and this level has the maximum performance rate among other levels. Operational level has the minimum performance rate among other levels. It is observed that strategic level has highest importance among other SCM levels in MAHER ANDISH unit. So, promotion of mentioned level will lead to increased degree of SCM performance in mentioned industry unit. Result of this research proves efficiency and delicacy of proposed method in performance measurement of supply chain management. Future research works can use this SCM measurement framework and guideline for measuring the SCM performance in all motor vehicle parts industries. Intuitive understanding of SCM levels importance and rate of SCM levels performance in MAHER ANDISH industry unit, chart has been provided (Figure 1).

Figure 1




SCM levels Based on Gunasekaran Model

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