LINKING SUPPLY CHAIN OPERATIONS' PERFORMANCE TO THE COMPANY'S FINANCIAL STRATEGY: A CASE STUDY OF AN EGYPTIAN NATURAL BOTTLED WATER COMPANY

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1. INTRODUCTION

Over the last decade, supply chain management has become a recognized strategic tool to ensure customer satisfaction (Chopra and Meindl, 2004). Strategic supply chain management improves the way processes are done and hence improves long-term performance (Harrison and Van Hoek, 2005). Evaluating the performance of supply chain (SC) operations can contribute to redesigning business goals and strategies through assessing the current SC operations' performance in order to identify core competence operations and those operations which need improvement.

Current performance measurement systems in supply chain management have many drawbacks, such as the lack of a connection with strategy and the failure to provide integration between financial and non financial measures (Chan and Qi, 2003; and Chan et al., 2006). Presutti jr. and Mawhinney (2007) stated that about 70 percent of a manufacturing firm's expenditures are on supply chain-related activities. Linking supply chain operations' performance to the company's overall financial strategy represents an opportunity for companies to gain competitive advantages and develop strategies to better manage SC operations' through linking such strategies to the focus areas for enhancing financial performance.

This paper aims to propose a method to link supply chain operations' performance to the priorities of the company's financial strategy. According to this method, the priorities of the supply chain performance measurement attributes are determined with respect to the priorities of the financial performance drivers. Supply chain operations' performance is measured based on the Supply Chain Operations Reference-Model (SCOR) standard performance metrics, while the company's financial performance priorities are determined using Du Pont ratio analysis. To link supply chain operations' performance to the financial performance priorities, the Fuzzy Analytical Hierarchy Processes (FAHP) technique is used.

To demonstrate the applicability of the proposed approach, a case study of an Egyptian Natural Bottled Water Company was conducted.

The remainder of this paper is organized as follows. In the next section a review of related literature is performed. In section 3, the research approach is discussed. Then, the framework for the proposed research method is illustrated in section 4. In section 5, a case study is presented and analyzed to demonstrate the applicability of the proposed method. Finally, conclusions are presented in section 6.

2. LITERATURE REVIEW

2.1. SCOR model:

The SCOR model was developed in 1996 by the Supply-Chain Council (SCC). This model is based on five core processes (plan, source, make, deliver, and return) and divided into three levels of process detail (top level, configuration level, and process element level). The model attempts to integrate the concepts of business process reengineering, benchmarking, process measurement, and best practice analysis which allows the upper management of a firm to make connections between strategies and measurements and to concentrate on key processes and measures that have a significant impact on the overall performance of a SC (Lockamy and McCormack, 2004; and Huang et al., 2005).

SCOR provides standard descriptions of supply chain processes that make up the SC and a process framework for defining relationships among these standard processes. It includes a set of benchmarking tools for performance and process evaluation. Using this model allows companies to select the right performance measures as it includes ten performance metrics to measure the performance of SC processes (perfect order fulfillment, order fulfillment cycle time, upside supply chain flexibility, upside supply chain adaptability, downside supply chain adaptability, supply chain management cost, cost of good sold, cash to cash cycle time, return on supply chain fixed assets; and return on working capital) which fall into five standard performance categories: reliability, responsiveness, flexibility, cost, and asset metrics. These ten performance metrics are designed to provide a view of overall SC performance at level 1 (top level) while the SCOR model levels 2 and 3 (configuration level and process element level) supporting metrics are keys to these ten level 1 metrics (Huan et al., 2004, and Hwang et al, 2008).

2.2. FAHP technique:

One of the most critical challenges facing decision makers in different industries and businesses is to determine the relative importance of the evaluation criteria with respect to the overall objective. The natural limitations of human capability to compare or to decide on more than two factors or alternatives makes the multi criteria decision-making process(MCDM) complex and challenging (Deng, 1999; and Abdul Moneim, 2008). Numerous MCDM analysis methods have been developed (such as SAW analysis model, TOPSIS method, and VIKOR method) to deal with decision or selection problems (Kuo et al., 2006).

One of the most widely used approaches for MCDM is the analytic hierarchy process (AHP) method (Mikhailov, 2003). In the AHP, first, the decision problem is structured in a hierarchy of different levels of elements, and then a pair-wise comparison matrix is used to determine the relative priorities of the decision elements (weights of the criteria). The pair-wise comparisons are accepted as linguistic evaluations or assessments expressing relative importance of pairs. Finally, the weights of each element in each hierarchical level are aggregated to the next level applying the principle of hierarchic composition (Mikhailov, 2004).

In most cases in real life, the available data and information are incomplete and the decision environment is uncertain and complex. In these cases, the classical AHP technique is not valid and the decision makers could be uncertain about their level of preferences (Kahraman et al., 2003). In recent years, several studies have been developed to handle this kind of uncertainty in preferences using fuzzy set theory and the application of fuzzy set theory to multiple criteria evaluation methods (Kuo et al., 2006; and Leung and Cao, 2000). Fuzzy set theory is a tool which can deal with this type of inexact data by assigning to each object a grade of membership ranging between zero and one (Kahraman et al, 2003). According to Kunadhamraks and Hanaoka (2008), in the Fuzzy AHP procedure, the pair-wise comparisons in the judgment matrix are fuzzy numbers that are modified by the designer's emphasis. Preference weights among main-attributes, sub-attributes and indicators are obtained by using a questionnaire survey. The survey respondents are asked to rank the components of a given layer by giving interval judgments than fixed value judgments according to its comparative importance.

2.3. Combining the SCOR model and FAHP technique:

Despite all the advantages that SCOR model and FAHP technique have, there are some limitations regarding successful implementation of these approaches for measuring SC operations' performance. A combination of both approaches allows some of their limitations to be overcome offering a better alternative for measuring SC operations' performance.

Although FAHP appears to be an appropriate tool for analyzing complex multi-criteria decision-making problems, it doesn't specify relevant measures for measuring SC operations' performance. The inability to reach relevant performance measures and to define SC metrics can represent a barrier for successful implementation of the technique. The use of SCOR performance metrics allows the decision makers to deal with a limited number of critical measures to evaluate the supply chain performance (Theeranuphattana and Tang, 2008).

Huan et al., (2004) analyzed the weaknesses of the SCOR model. Their analysis illustrated that although SCOR provides ten performance metrics to measure overall supply chain performance, there is a debate about how these ten metrics can be used to derive a quantifiable supply chain performance measure. SC performance measures should be linked with strategies; which may need a quantitative tool to link SCOR metrics to SC strategies. Huan et al. illustrated how AHP can be applied with SCOR metrics to construct an overall objective function (overall supply chain efficiency) for network optimization. By using AHP measurement methodology managers can quantify – from their judgments – the weights of influence of SC strategy on individual performance measures.

Combining the SCOR model with the FAHP technique for measuring SC operations' performance can overcome some limitations of using each approach separately. Applying FAHP to the SCOR model, allows managers to determine the degree to which performance metrics contribute towards the success of a particular strategy.

2.4. Du Pont ratio analysis:

Literature on supply chain management assumes that high supply chain performance is associated with high-financial performance through managing costs, increasing revenues and improving asset utilization (Anderson et al., 1997).

One of the common financial measures to used measure an organization's financial performance is Du Pont analysis. Du Pont analysis is a financial ratio developed by F.Donaldson Brown to analyze the efficiency and profitability of the company. The analysis of the Du Pont ratio evaluates the areas of profitability and operating efficiency through assessing the performance of the components contributing to return-on-assets (ROA): revenue (sales), cost, and total assets. ROA measures how much profit a company generated compared to assets employed in the business. It consists of a profitability measure (net profit margin) and an efficiency measure (total assets turn over) (Dehning and Stratopoulos, 2002).

This can be expressed in the following formula:

Return on Assets = Net Profit Margin x Total Assets Turnover

$$= (\text{Net Income} / \text{Sales}) \times (\text{Sales} / \text{Total Assets}) \quad (1)$$

3. LINKING SUPPLY CHAIN OPERATIONS' PERFORMANCE TO THE COMPANY'S FINANCIAL STRATEGY

Although supply chain performance and the organization's financial performance have been widely studied; few empirical studies of their relationship have been presented (Toyli et al., 2008).

According to Lambert et al. (2005), a supply chain management framework can be evaluated by how it is linked to the corporate strategy (the strategic driver) and the extent to which it helps the achievement of strategic objectives. Therefore, it is important that the firm's supply chain management framework should be aligned to the firm's financial strategy to achieve the strategic objectives. The scope of the SCOR model framework is not linked directly to corporate strategy. SCOR processes are developed based on the operations strategy while the functional strategies and the corporate strategy are not explicitly considered in this model.

To overcome the above obstacle, according to the proposed methodology, supply chain performance metrics will be linked to the company's financial strategy through determining the priorities of the supply chain performance measurement attributes with respect to the priorities of the financial performance drivers.

Presutti Jr. and Mawhinney (2007) developed SCORcard performance metrics to measure the performance of both processes and the outputs of these processes of an organization. According to these SCORcard performance metrics, supply chain performance and company's financial performance are linked through measuring the performance of the processes in terms of reliability, responsiveness, flexibility, cost, and asset management based on SCOR model metrics and measuring the performance of the outputs of these processes in terms of revenue, cost, and assets based on the Economic Value Added (EVA) concept. Figure 1 illustrates the supply chain financial link as demonstrated in the SCORcard performance metrics:

Performance attributes					
Customer-Facing			Internal-Facing		
Reliability	Responsiveness	Flexibility	Cost	Assets	
■	■				Revenue
		■	■		Cost
				■	Assets

(Adapted from: Supply Chain Council, cited by Presutti Jr. and Mawhinney, 2007)
Figure 1: SCORcard Performance Metrics

The method proposed in this study focuses on the performance of both processes and the outputs of processes to link supply chain processes performance to the priorities of the company's financial strategy. According to the proposed method, supply chain performance metrics measure the performance of processes in terms of reliability, responsiveness, agility, cost, and asset management based on SCOR model standard performance metrics, while financial performance metrics measure the performance of the outputs of these processes in terms of efficiency and profitability based on Du Pont ratio analysis to identify the focus areas for improving a company's financial performance.

Using the FAHP technique, the relative importance weights of supply chain processes performance measures are determined with respect to the priorities of the company's financial strategy, and consequently, new supply chain strategy is set based on these priorities. Supply chain index (SCI) is calculated after applying the new supply chain strategy to evaluate to what extent supply chain operations' performance is linked to the company's overall financial strategy.

Finally, Du Pont ratio is measured again after applying the new supply chain operations' strategy to test the impact of supply chain operations' performance on enhancing the company's overall performance.

4. FRAMEWORK FOR THE PROPOSED METHODOLOGY

The procedures for the proposed method are illustrated in this section then in the next section a case study will be conducted to demonstrate the applicability of the proposed method:

Step one: the Du Pont ratio for the company is calculated and then compared to the industrial average to reveal the company's overall financial performance relative to the industrial average and highlight financial performance drivers (revenue, cost, and total assets) that need improvement.

Step two: the relative importance weights of the main supply chain performance measures are determined with respect to the priorities of financial performance drivers using the FAHP technique. The main factors to enhance financial performance are improving profitability and efficiency through increasing revenue, managing cost and increasing asset utilization, based on Presutti Jr. and Mawhinney SCORcard performance metrics ;SCOR model supply chain performance metrics -which includes five performance categories: reliability, responsiveness, agility, cost, and asset metrics-can drive financial performance.

Step three: the company now is in a position to set its new supply chain strategy based on the priorities of the financial performance and with respect to the relative importance weights of the main supply chain performance measures. Since the financial performance evaluation reflects the contribution of each of the financial performance drivers and highlights drivers that need improvement, setting the new supply chain strategy with respect to the priorities of these drivers can contribute to enhancing the overall financial performance. According to SCOR model standard performance metrics, each supply chain performance measurement attribute at each level corresponds to certain processes in the supply chain. Based on the relative importance weights of the main supply chain performance measures, the company can identify the related processes that need improvement and their corresponding performance indicators in order to align with supply chain strategy, and consequently, with the company's overall strategy.

Step four: to evaluate the efficiency and the effectiveness of the new supply chain strategy, a proposed SCI is calculated for the company to reflect to what extent supply chain operations' performance is linked to the company's overall financial strategy. To calculate SCI, the performance rate assigned for each of the five main supply chain performance measures based on SCOR model index is adjusted by the relative importance weights of these measures. By multiplying the relative importance weight of each measure (W) by its performance rate (R), the weighted rate (WR) of each performance measure is determined. The weighted rates of all performance measures are then aggregated to determine the company's SCI.

The traditional method for evaluating supply chain operations' performance is unable to track such improvement as it ignores the relative weight of each measure. The following numerical example illustrates that traditional SCI, which assumes that supply chain operations' performance measures are equally weighted, is unable to reflect the actual performance. To trace the actual change in supply chain operations' performance the relative importance weight of each measure should be taken into consideration.

Measure	Beginning of the accounting period			Ending of the accounting period			Change direction
Supply chain operations' performance							
	R	W	WR	R	W	WR	
Reliability	1	12%	0.12	0.6	12%	0.072	Unfavourable
Responsiveness	0.6	18%	0.108	0.8	18%	0.144	Favourable
Agility	0.6	30%	0.18	0.8	30%	0.24	Favourable
Cost	0.6	35%	0.21	0.8	35%	0.28	Favourable
Assets	0.8	5%	0.04	0.6	5%	0.03	Unfavourable
Aggregated performance	3.6/5 =**0.72**		**0.66**	3.6/5 =**0.72**		**0.76**	
Traditional SCI	0.72			0.72			No change (doesn't reflect the actual performance)
Weighted SCI	0.66			0.77			Favourable

Table 1: SC operations' performance before and after applying the new SC strategy

Step five: Du Pont ratio is calculated again at the end of the year to test the impact of the new developed supply chain strategy on enhancing the company's overall financial performance. Figure 2 illustrates the research method:

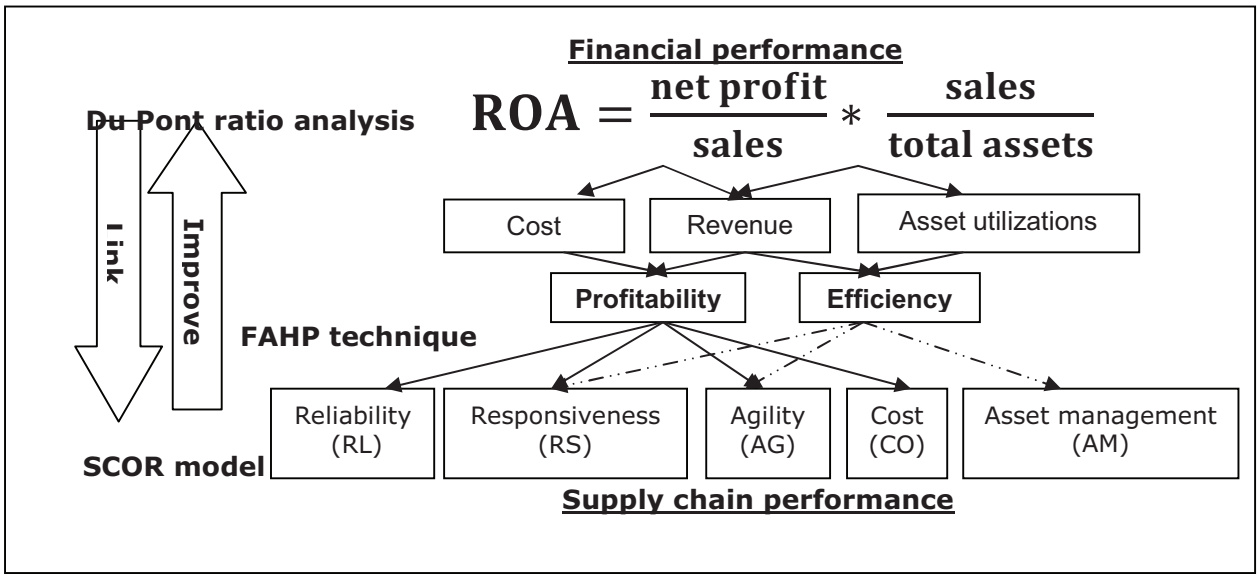

Figure 2: Linking supply chain operations' performance to financial performance

5. CASE STUDY

To demonstrate the applicability of the proposed method, a case study on an Egyptian natural bottled water company has been considered. The measurement algorithm was carried out by means of the Microsoft Excel Spreadsheet. The brief illustrative procedures for applying the proposed method are divided into the following five steps.

Step one: the Du Pont ratio of the Company was calculated and compared to the industrial average to evaluate the company's financial performance in terms of profitability and operating efficiency. The analysis revealed that the company has the ability to generate sales from assets employed in business compared to the industry average. However, the company's financial performance in terms of profitability is far below the industry average, which highlights that the company has a problem in generating profit from its sales. Based on the result of the Du Pont ratio analysis, the focus area for enhancing the financial performance should be to improve its profitability, especially through managing its costs.

Step two: Since the priorities of the financial performance drivers were determined, the supply chain operations' performance can be linked to the company's overall financial strategy. To create this link, FAHP approach was used to determine the relative importance weights of the main supply chain performance measures (RL, RS, AG, CO, AM) with respect to the priorities of financial performance drivers.

A group of four decision makers was assembled comprising the business planning manager, the commercial manager, the quality assurance manager, and Engineering division manager and asked to rank the importance weight of the main supply chain performance measures –with regard to each financial performance driver priority using pair-wise questionnaire. The relative importance of two elements was rated using a scale with the values 1, 3, 5, 7, and 9, where 1 denotes equally important, 3 for slightly more important, 5 for strongly more important, 7 for demonstrably more important, and 9 for absolutely more important.

To aggregate the experts' responses, a fuzzy prioritization method - derived from Chang et al. (2009) - was adopted. Based on this fuzzy prioritization method, the expert's

comparison judgments were represented as fuzzy triangular numbers where the uncertainty and imprecision of evaluations can be tackled. A fuzzy pair-wise comparison matrix based on triangular fuzzy numbers (L, M, U) was used in expressing the consolidated opinions of the experts. Where L denotes the minimum numerical value, U denotes the maximum numerical value and M is the geometric mean which represents the consensus of most experts.

As the preferences of experts were relatively subjective opinions, their responses could differ depending on the degree of environmental uncertainty and depending on whether the experts adopt a conservative or optimistic attitude when determining their preferences. Therefore, the degree of experts' confidence in their preference should be taken into consideration. To determine that, α was used to express the environmental uncertainty; in addition, λ was used to express the degree of experts' confidence in their preference. For the questionnaire responses, α = 0.5 was used to express that environmental uncertainty is steady; and λ = 0.5 was used to express that a future attitude is fair.

To establish the aggregate pair-wise comparison matrix, the defuzzication of the triangular fuzzy numbers derived from the fuzzy pair-wise comparison matrix was done. And consequently the aggregate pair-wise comparison matrix was established. Then, the Eigenvector method was used for weight calculation.

To verify the consistency of the comparison matrix, consistency ratio (C.R.) was calculated for the aggregate pair-wise comparison matrix. The consistency ratio (CR) is defined as a ratio between the consistency of a given evaluation matrix (consistency index CI) and the consistency of a random matrix (RI). The RI is the random index representing the consistency of a randomly generated pair-wise comparison matrix. The CR of a decision should not exceed 0.1. In the case CR exceeds 0.1; the comparison matrix is considered inconsistent and should be improved (Meixner, 2009).

Finally, the relative importance weights of the main supply chain performance measures were determined.

Step three: Once the relative importance weight of each main supply chain performance measure had been determined, the company could identify supply chain processes that need improvement and their corresponding performance indicators based on SCOR model standard performance metrics.

As the company needs to improve its profitability particularly through managing its costs, the most suitable supply chain strategy to align with this goal is to focus on enhancing the processes to which cost and agility performance measures correspond. According to the Company's strategic priorities, the main aims of its supply chain strategy should be managing supply chain costs and increasing supply chain agility.

Step four: at the end of the accounting period, SCI will be calculated before and after applying the new SC strategy to evaluate the efficiency and the effectiveness of the SC operations' performance in linking to the company's overall financial strategy.

Based on the SCOR model, supply chain operations' performance can be evaluated by assigning performance rate (0.2, 0.4, 0.6, 0.8, or 1) for each of the supply chain performance measurement attributes throughout the hierarchy of the supply chain, from the process element levels till the configuration level, to assess the performance of the company's supply chain operations with respect to the SCOR model standard performance metrics. Then, the performance rates of all measurement attributes will be aggregated- using averaging aggregation method- throughout the hierarchy of the supply chain to determine the performance rate of the main supply chain performance measurement attributes at the top level (RL, RS, AG, CO, AM). Where [0.2] denotes very

poor performance, [0.4] denotes poor performance, [0.6] denotes good performance, [0.8] denotes very good performance, and [1] denotes excellent performance with respect to the performance rating scale. The performance rates of the five main supply chain performance measures will then be adjusted by their relative importance weights. By multiplying the relative importance weight of each attribute (W) by its performance rate (R), the weighted rate (WR) of each performance measurement attribute will be determined. The weighted rates of the performance measurement attributes at the top level are then aggregated to determine the company's SCI. Comparing the index before and after applying the new SC strategy will reflect the improvement in supply chain operations' performance with respect to SC strategic priorities.

Step five: By the end of the accounting period, Du Pont ratio for the company will be calculated again and analyzed to determine the impact of improving supply chain operations' performance on enhancing the company's overall financial performance. Comparing Du Pont results at the end of the accounting period to the beginning of the accounting period will show the change in the profit margin% which reflects the impact of the supply chain operations' performance on enhancing the company's overall performance.

6. CONCLUSION

This research illustrated a method to link supply chain operations' performance to the company's overall financial strategy. According to this method, the priorities of the main supply chain performance measurement attributes were determined with respect to the priorities of the financial performance drivers.

Applying this method, enables companies to set the supply chain strategy based on the priorities of the financial performance drivers. Since the financial performance evaluation reflects the contribution of each of the financial performance drivers and highlights driver that need improvement, setting supply chain strategy with respect to the priorities of these drivers can contribute to enhancing the overall financial performance.

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