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Linking supply chain processes' performance to a company's financial strategic objectives

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ABSTRACT

The main aim of this paper is to develop a performance measurement method which links supply chain (SC) processes' performance to a company's financial strategy through demonstrating and utilising the relationship between SC processes' performance and a company's financial performance.

The Dempster Shafer/Analytical Hierarchy Processes (DS/AHP) model is employed to link SC processes' performance to the company's financial performance through determining the relative importance weights of SC performance measures with respect to the priorities of financial performance.

The paper also introduces a Supply Chain Financial Link Index (SCFLI) to test the extent to which SC processes' performance is linked to the company's financial strategic objectives. This index offers an effective supply chain management (SCM) tool to provide continuous feedback on SC performance and identify the appropriate corrective actions. Analysing this index offers opportunities for detailed evaluation of SC processes' performance and enables companies to trace SC processes that need improvement, resulting in more control on daily SC operations.

The proposed method allows the evaluation, monitoring, and control of SC processes' performance to enhance SC strategy for better alignment with the company's financial strategy.

Linking SC processes' performance to the company's financial strategic objectives enables companies to gain competitive advantages and formulate strategies for improved SCM through linking such strategies to the focus area of enhancing the financial performance.

In this paper the rationale and the framework of this method are introduced and then illustrated with a numerical example.

1. Introduction

Due to the intense domestic and international competition that organisations currently face, firms will not be able to compete or survive unless they develop strategies to achieve cost reduction, quality improvement and increased productivity. The real challenge for organisations is how to manage the tradeoffs between such strategies as they usually work against one another. For example implementing a strategy to achieve cost reduction could negatively impact quality or result in reduced productivity. The management of material, products, information and time flows through the supply chain has a direct impact on the success of these strategies (Chan et al., 2002).

A supply chain is a set of a company's entire operations directly and indirectly interlinked and interacted to transform inputs into outputs that are delivered to the end customer. Harrison and New (2002) reported the results of a major international survey undertaken in 1999 into the relationships between corporate strategy, supply chain strategy and supply chain performance management in manufacturing companies across the major industrialised countries. The survey revealed that 90% of the respondents believed that supply chain performance was important or very important for achieving competitive advantage in the future (Forslund, 2007).

Managers at different levels should be aware of the connection between supply chain performance and the company's financial strategy and how the company's daily actions can impact the overall financial performance. Presutti and Mawhinney (2007) stated that 70% or more of manufacturing firms' expenditures are on supply chain-related activities, which highlights the potential impact of an effectively managed supply chain in contributing to overall improvement in financial performance.

To effectively measure the impact of supply chain activities on the company's overall financial performance, supply chain performance needs to be linked to the company's financial strategic goals (Kremers, 2010). The challenge for many companies is that the alignment of performance measurements between supply chain and financial functions is still rather poor. The main reason for this is that supply chain performance metrics and financial perfor-

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mance metrics are defined in different ways which creates difficulty to translate supply chain operational measures, with their focus on day to day operations, into financial targets (Camerinelli and Cantu, 2006).

The primary long-term financial goal of the company is to maximise profit. To accomplish this overall long-term goal, the company should translate it into meaningful short-term performance objectives that can be measured and monitored. These objectives can be achieved through identifying the source of poor performance in terms of specific activities and formulating short-term strategies for improving the performance of these activities (Grant, 2005). Understanding the link between supply chain performance metrics and the overall metrics used to measure the company's financial performance is essential to align SC processes' performance to the company's financial strategic goal.

The main aim of this paper is to develop a performance measurement method to link SC processes' performance to the company's short-term financial strategic objectives through demonstrating and utilising the relationship between SC processes' performance and the company's financial performance. According to the proposed method, SC performance metrics measure the performance of SC processes in terms of reliability, responsiveness, agility, cost, and asset management based on Supply Chain Operations Reference-model (SCOR) standard performance metrics, while financial performance metrics evaluate and analyse the performance of the outputs of these processes in terms of efficiency and profitability using Du Pont ratio analysis. To link SC processes' performance to the company's financial performance, the proposed method employs the Dempster Shafer/Analytical Hierarchy Processes (DS/AHP) model developed by Beynon et al. (2000). According to the DS/AHP model, the importance weight of the evaluation criteria is determined with respect to the priorities of related decision elements. Using this model, the importance weights of SC processes' performance measures can be determined with respect to the priorities of the company's financial strategy. Consequently, SC strategy is formulated based on these priorities through linking SC strategy to the focus area of enhancing the financial performance.

The developed method introduces a Supply Chain Financial Link Index (SCFLI) to test the extent to which SC processes' performance is linked to the company's short-term financial strategic objectives. Analysing this index provides more control over the daily SC operations as it enables companies to trace SC processes that need improvement and consequently identify their related performance indicators for better supply chain management.

The remainder of this paper is organised as follows. Firstly, a review of related literature is presented. In Section 3, the rationale for the proposed method is discussed. Then, the framework for the proposed method and a numerical example demonstrating the proposed method are illustrated in Sections 4 and 5, respectively. Finally, Section 6 suggests future work to be built on this research and presents conclusions.

2. Literature review

Interest in performance measurement and management has notably increased in the last 20 years. Companies have recognised that monitoring and understanding firms' performances have become essential to compete in continuously changing environments (Taticchi et al., 2010). Performance measurement is defined as the process of quantifying the effectiveness and efficiency of action (Chan and Qi, 2003; Neely et al., 2005). Effectiveness refers to the extent to which customer requirements are met, while efficiency measures how economically a firm's resources are utilised when providing a pre-specified level of customer satisfaction (Shepherd and Gunter, 2006).

From the fifteenth century until the nineteenth century, organisational performance measurement was based on the results of the accounting system. Identifying profit and controlling cash flow were the main aspects to dominate organisational performance measurement (Morgan, 2004). Although financial performance measures have been widely used to measure an organisation's performance, their ability to capture and reflect the different aspects relating to an organisation's performance is limited. Financial performance measures are used to measure inputs and outputs through their codification into financial terms (Neely, 2003). These measures evaluate how well the organisation converts inputs into desired outputs without tracing the way in which the various inputs interacted to produce the outputs. The inability to capture the organisation's processes that leads to such outputs makes these traditional financial measures unable to cope with the rapid changes in the business environment (Behn, 2003).

In the early 1900s a turning point was achieved in organisational performance measurement when William Durant, founder of General Motors, realised that profit was not the result of accounting practices, but the outcome of a cost stream that spread throughout the supply chain (Drucker, 1995).

SC performance measurement provides the tools to monitor SC operations' performance and to reveal the effectiveness of a company's strategies. In addition, it can provide feedback to enable managers to diagnose problems and identify success and potential opportunities (Ramaa et al., 2009). Many researchers have proposed various performance measurement systems to measure supply chain performance (Neely, 2005; Shepherd and Gunter, 2006; Gunasekaran and Kobu, 2007). However several criticisms were raised against these systems. Amongst the most widely highlighted criticisms of current performance measurement systems in supply chain management (SCM) are: the lack of a connection with strategy (Chan and Qi, 2003; Gunasekaran et al., 2004), the failure to make integration between financial and non-financial measures (Gunasekaran et al., 2001; Chan, 2003; Chan and Qi, 2003), and the lack of system thinking (Chan, 2003; Chan and Qi, 2003).

SCM requires standardisation of business processes to be able to link-up processes among the members of the supply chain and to conduct a meaningful comparison of organisational performance (Naslund and Williamson, 2010). Current evolution of organisations requires a shift from the traditional transaction focused measurement to process focused measurement systems (Morgan, 2007). Several authors have suggested implementing business processes in the context of supply chain management (Srivastava et al., 1999; Bowersox et al., 1999; Lambert and Cooper, 2000; Mentzer, 2001; Huan et al., 2004).

Lambert et al. (2005) identified five supply chain management frameworks that recognise the need to implement standardised business processes across corporate functions and across firms.

The first framework is the 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. This 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; Huang et al., 2005). In this sense, the SCOR provides standard descriptions of supply chain processes that make up the SC and a framework for defining relationships among these standard processes. In addition, the model includes standard performance metrics to measure the

performance of SC processes as well as a set of benchmarking tools for performance and process evaluation which allow companies to compare and benchmark their processes against those of other companies (Huan et al., 2004).

The second framework was developed in 1996 by the Global Supply Chain Forum (GSCF). It consists of three primary related elements: the supply chain network structure, the supply chain business processes, and the management (Lambert and Cooper, 2000).

The third framework developed by Srivastava et al. (1999) includes three business processes: customer relationship management, product development management, and supply chain management. The fourth framework was a SCM framework introduced by Bowersox et al. (1999) and focused on three "contexts": operational, planning and control, and behavioural. This framework was further developed by Melnyk et al. (2000) to include eight business processes: plan, acquire, make, deliver, product design/redesign, capacity management, process design/redesign, and measurement. Mentzer et al. (2001) developed the fifth framework which focused on the cross-functional interaction within a firm and on the relationships developed with other supply chain members.

Although these five frameworks suggest the implementation of standard cross-functional business processes, only the GSCF and SCOR frameworks include business processes that could be used by management to achieve cross-functional integration (Lambert et al., 2005). Although the impact of SCM on a company's performance has been discussed by many researchers, few studies have been conducted to find the links between SCM practices and financial performance improvements (Gardner, 2004).

Toyli et al. (2008) stated that supply chain performance and the organisation's financial performance have been widely studied but limited empirical affirmation of their relationship has been presented.

A study was conducted from 1997 to 2000 by a research team from Accenture, INSEAD and Stanford University to study the supply chain-financial performance link. The study aimed to test the statistical relationship between companies' financial success and the depth of their supply chains. The study statistically analysed publicly available data on 3000 companies, conducted in-depth interviews with more than 75 executives from 60 companies, and analysed 100 responses to a web-based survey designed to capture the supply chain insights and experiences of leading executives from companies across North America and Europe. The study's results were published in 2003 showing a statistical correlation between companies' financial success and the depth of their supply chains. According to the study's results, supply chain leaders accomplish significantly higher market-capitalisation growth rates than the industry average growth rate. Moreover, the analysis of the study's interviews and surveys revealed that all the winning business strategies of leading companies incorporate supply chain strategies that provide competitive advantage and devote significant attention to designing integrated supply chain operating models (D'Avanzo et al., 2003).

Deloitte conducted a study of 600 companies in 22 countries which concluded that effectively managing a complex global supply chain has a positive impact on a company's financial performance (as cited in Colman, 2003). The study revealed that companies which effectively managed their supply chain realised profit margins 73% higher than other companies with poor supply chain performance and less complex environments.

Another survey has been conducted to test the impact of implementing SCM practices on enhancing return on investment. The survey revealed that 76% of responses showed that practices of carefully managed supply chains resulted in financial benefits for participating firms (Gunasekaran et al., 2004).

Presutti and Mawhinney (2007) demonstrated how supply chain metrics can be linked to corporate financial metrics to achieve the critical link between supply chain performance and business performance. The supply chain performance metrics used were based on the Supply Chain Operations Reference model (SCOR), while the financial metrics used were based on the Economic Value Added (EVA) concept. The study concluded that there is a clear and direct link between how effectively supply chain activities are executed and how well the business performs. The success in making the link between corporate performance and supply chain performance results in satisfying two of the firm's most important stakeholders, its customers and shareholders.

Tejas and Srikanth (2007) linked supply chain metrics to financial key performance indicators through using scorecards to determine priorities for investments in improving processes and related technology. This linkage helps senior managers to quantify the performance of SC metrics and understand its impact on the organisation's top and bottom lines.

Toyli et al. (2008) analysed the relationship between logistics performance and financial performance in Finnish small and medium-sized enterprises (SMEs). The study comprised 424 SMEs that participated in a nationwide Finnish logistics survey in 2006. Logistics performance measures were derived from the survey data, and classified into three dimensions: service level characterising the service quality, operational metrics characterising the time-based logistics performance, and logistics costs characterising cost efficiency. The financial performance of these firms was then examined in terms of growth and profitability using financial reports-based data. The results implied that there was no positive linkage between logistics performance and financial performance among the surveyed companies, indicating that logistics is just starting to gain more attention among SMEs in Finland and that it might be relatively easy for SMEs to gain competitive advantage by focusing more on logistics performance.

Woei (2008) conducted research to explore the supply chain management–financial success (SCM–FS) relationship. To analyse the relationship between a company's financial success and its supply chain performance, an empirical study was undertaken based on financial information extracted from public quoted companies in Malaysia during the financial years from 1999 to 2006. Financial success was measured by market capitalisation while supply chain performance was measured by four variables namely revenue, cost of sales as percentage of revenue, cash to cash cycle and return on working capital. The data was statistically analysed to test the correlation between categories of SCM performance measures and financial success. The results showed that the correlation was weak for the financial years of 1999–2002, while the correlation became stronger for the subsequent financial years of 2003–2006. The results also revealed that companies which implement the full scope of supply chain measures can find opportunities to become financially successful companies in the new business environment.

Camerinelli (2009) illustrated the link between financial performance and operational decisions through mapping financial metrics to operational metrics. Since operational metrics assess the operational status of the company and are linked to operational decisions, a company's financial performance can reflect the quality of the operational decisions taken to accomplish it. The researcher identified the operational metrics that can be used to map financial metrics to operational metrics based on the SCOR model standard performance metrics through selecting the proper elements from the balance sheet and income statement to be linked to the SCOR level 1 and level 2 metrics.

Hutchison et al. (2009) suggested how cash-to-cash (C2C) strategies can be used in a supply chain environment as effective cash management and synergistic tools to realise opportunities for

improving efficiency, profitability, cash flow management, and communication channels among supply chain members. According to this approach, an information-sharing environment should be established among trading partners in the supply chain in order to identify possible opportunities that can ultimately improve cash flow and profitability. The C2C calculation includes three financial variables: inventory, accounts receivable, and accounts payable. Since each party in the supply chain may have an advantage in its weighted average cost of capital (WACC) or inventory carrying cost (ICC), the chain can manipulate inventory as well as receivable and payable terms to reduce costs that relate to purchases, inventory, and capital in order to benefit all trading partners throughout the supply chain.

Kremers (2010) proposed an approach that provides a comprehensive vision of the existing relationship between companies operational and financial performance. According to this approach, supply chain operational performance can be evaluated in terms of its impact on cash flow, market value, and key internal financial performance metrics. This approach tied SC operational performance to strategic business goals through linking SCOR model performance measures to the priorities of financial performance drivers (profitability, asset utilisation, and financial leverage efficiency).

Marquez (2010) developed and evaluated a comprehensive dynamic SCM model to determine operational and financial benefits from various levels of supply chain integration. The model highlighted the financial implications of different pricing strategies and cost structures when modelling financial aspects of the supply chain. It explored the operational and financial impacts of various potential problems in SCM, offering a compilation of practical solutions using system dynamics.

Wisner (2011) argued that SCM decisions and resource utilisation could impact the financial performance of the company. To demonstrate such impact, Wisner illustrated how SC functions influence the results shown in the company's financial statements (income statement, balance sheet, statement of cash flows, and statement of stockholders' equity). She introduced a linkage model linking SC performance metrics to the outcomes of the financial statements. The model identified the SC performance measures relevant to the components of each financial statement in order to ensure that supply chain actions and decisions are compatible with the company's financial goals.

The previous review of literature reveals that there is a connection between supply chain daily practices and financial performance. The challenge, however, is how to make that linkage. A well-designed performance measurement system is essential for improving business processes, but traditional performance measurement systems, which rely on financial measures only, do not fit today's business environment. The new business environment requires performance measurement systems to incorporate both financial and non-financial measures.

3. Rationale for the proposed method

Connecting SC activities to the company's financial strategic objectives represents an opportunity for companies to gain competitive advantages by focusing on linking SC processes' performance to the focus area of enhancing the financial performance.

The link identification problem is handled with respect to the aggregation of multi-criteria expressions in a SC context. Many approaches have been developed to aggregate the performance from multi-criteria expressions such as the weighted mean aggregation operator, to handle hierarchical links, the Choquet integral operator, for taking interactions into account, and the AHP technique and the FAHP approach, to quantify the weights and the performance elementary expression (Berrah and Clivillé, 2007).

The multi-criteria decision-making process (MCDM) is complex and challenging as the human capability to compare or decide on more than two factors has natural limitations (Abdul Moneim, 2008). In most cases in real life, there are interdependencies among criteria or alternatives while the available data and information are incomplete and the decision environment is uncertain and complex. In these cases, aggregation operators can play a central role to blend information in ways that allow performance aggregation. The Choquet integral, as a sophisticated aggregation operator, can be used in many industrial performance aggregation applications through ordering the arguments of the aggregation to determine the weights that are assigned to the different argument components (Tan and Chen, 2011).

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 the 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).

The fuzzy analytic hierarchy process approach (FAHP) is a multi-criteria decision making approach where the preference weights among -attributes and indicators are obtained by using a pair-wise questionnaire survey to rank the components of a given layer by giving interval judgments than fixed value judgments according to its comparative importance (Kunadhamraks and Hanaoka, 2008). Elgazzar et al. (2011a) proposed a method to link supply chain processes performance to the priorities of the company's financial strategy using the FAHP technique. According to this method, SC operations' performance is measured based on the SCOR model 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 relative importance weights of supply chain processes performance measures are determined with respect to the priorities of the company's financial strategy using the FAHP technique, and consequently, the appropriate supply chain strategy is formulated based on these priorities.

In this paper, SC performance is modelled according to the SCOR model standard performance matrix with its five main SC performance measures. The performance rates of all measurement attributes are aggregated – using the averaging aggregation method – throughout the hierarchy of the SC to determine the performance rate of the SC performance measurement attributes at the top level (reliability, responsiveness, agility, cost, and asset management). The weighted rates of the five main SC performance measures are then aggregated using the DS/AHP method to determine the company's SCFLI. These weights quantify the respective contributions of the SC performance measures to the overall financial performance.

A method derived from Presutti and Mawhinney (2007) and followed by Elgazzar et al. (2011a) has been developed. To explore the link between supply chain performance and the company's performance, Presutti and Mawhinney linked the SCOR model level 1 standard performance metrics (reliability, responsiveness, flexibility, cost, and assets) for measuring SC processes' performance to the Economic Value Added (EVA) components (revenue, cost, and assets) as a comprehensive measure of the company's profitability in relation to the amount of capital employed. According to this method, SCOR metrics performance attributes that have a direct impact on the customer (customer facing) were linked to the revenue component of EVA while SCOR metrics performance attributes that have a direct impact on the firm (internal facing) were linked to the cost and assets components of EVA.

Although this method demonstrates how supply chain metrics can be linked to a company's financial metrics, it does not specify how this link can be utilised to enhance the company's overall financial performance. The method proposed by Presutti and Mawhinney assumes that EVA components (revenue, cost, and assets) have the same influence weighting on the company's financial performance. It is considered relevant to set the priorities of these components according to the company's financial strategy in order to highlight the components that need improvement with respect to the focus areas for enhancing the financial performance. Moreover, setting priorities for these components enables the development of SC strategy linked to the company's financial strategic objectives through identifying SC processes and measures that have a significant impact on the focus areas of the company's financial strategy.

In addition, EVA metrics measure the value created by the company through evaluating its profitability in relation to the amount of capital employed. Linking SC processes' performance to the financial performance requires financial performance metrics which analyse the company's financial performance in terms of operating efficiency as well as profitability.

Presutti and Mawhinney method (2007) also addresses SCM as the only factor that can impact a company's financial performance. It does not address the impact of the ignorance factors, out of the firm's control, such as the political factors which may impact a company's financial performance and thus should be considered.

To overcome the above obstacles, this paper develops a method to link SC processes' performance to the priorities of the company's financial performance in the short-term and evaluates its impact on maximising profit as the company's primary long-term financial goal. SC processes' performance is evaluated based on SCOR model standard performance metrics while financial performance is evaluated in terms of efficiency and profitability based on Du Pont ratio analysis. The results of Du Pont analysis allow the priorities of financial performance factors (efficiency and profitability) to be determined through evaluating the contribution of each factor and highlighting factors that need improvement in the short-term.

Then, the DS/AHP model is used to link SC processes' performance to the priorities of financial performance factors through determining the relative importance weights of the main supply chain performance measures with respect to these priorities. The developed method illustrates how this link can be utilised to connect SC processes' performance to the company's short-term financial strategic objectives in order to contribute to improvement in the company's overall financial performance through impacting on its profitability and efficiency. Consequently, SC strategy is formulated based on the priorities of financial performance factors for better alignment with the company's short-term financial strategic objectives.

To test the extent to which SC processes' performance is linked to the company's short-term financial strategic objectives, a Supply Chain Financial Link Index (SCFLI) is developed. This index is different from the traditional SC performance index as it takes into consideration the relative importance weights of SC performance measures. It aggregates the weighted rates of the main supply chain performance measures to reflect SC processes' performance with respect to the priorities of the company's financial performance.

In addition, the method developed takes into consideration factors outside the firm's control that can impact on a company's financial performance as it allows use of the DS/AHP model to calculate the influence weight of the ignorance factor on the decisions made by the company.

4. Framework for the proposed methodology

In this section, the SCOR model, Du Pont ratio analysis, and the DS/AHP model are introduced in more detail. Then, the procedures for the proposed method are illustrated.

4.1. The SCOR model

The SCOR model is more applicable to a manufacturing context than the GSCF model (Ellram et al., 2004). It focuses on identifying areas of improvement in order to provide cost reductions and improve asset efficiency making the framework operational efficiency-oriented rather than relationship-oriented. Its processes are developed based on the operations strategy as it focuses on engaging partners from the logistics, production and purchasing functions in its five supply chain management processes (plan, source, make, deliver, and return) which makes the model somewhat limited in scope. The relatively narrow focus of SCOR makes it easier to implement, since the activities of logistics, production and purchasing are already naturally integrated within an organisational structure (Lambert et al., 2005).

Ten standard performance metrics are provided by the SCOR model such as: perfect order fulfilment, order fulfilment cycle time, upside supply chain flexibility, upside supply chain adaptability, downside supply chain adaptability, supply chain management cost, cost of goods sold, cash to cash cycle time, return on supply chain fixed assets and return on working capital. All these 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 the level 1 metrics (Supply-Chain Council, 2008).

4.2. Du Pont ratio analysis

Du Pont ratio analysis is a financial ratio commonly used to measure an organisation's financial performance. The Du Pont ratio analysis evaluates the areas of profitability (P) and operating efficiency (E) through assessing the performance of the components contributing to return-on-assets (ROA). These are revenue (sales), cost and total assets. ROA measures how much profit a company generates compared to the assets employed in the business. It consists of a profitability measure (Net Profit Margin) and an efficiency measure (Total Assets Turnover) which can be expressed in the following formula (Dehning and Stratopoulos, 2002):

$$\begin{aligned}\text{Return on Assets} &= \text{Net Profit Margin} \times \text{Total Assets Turnover} \\ &= (\text{Net Income}/\text{Sales}) \times (\text{Sales}/\text{Total Assets}) \quad (1)\end{aligned}$$

The Du Pont ratio can also be broken into more components depending upon the needs of the analysis (Nissim and Penman, 2001). DuPont analysis can also be applied based on the return on equity (ROE) ratio. It can be decomposed into the three multiplicative ratios of profit margin, asset turnover, and equity multiplier as follows:

$$\begin{aligned}\text{Return on Equity} &= \text{Net Profit Margin} \times \text{Total Assets Turnover} \\ &\quad \times \text{Equity multiplier} = (\text{Net Income}/\text{Sales}) \\ &\quad \times (\text{Sales}/\text{Total Assets}) \times (\text{Total Assets}/\text{Equity}) \\ &\quad (2)\end{aligned}$$

The ROE form is not applicable for this research as ROE is affected by changes in the company's financial structure (Soliman, 2007). Since this research focuses on how the company performs business operations not on how it decides to finance such operations, the ROA form is more relevant. As presented in Fig. 1, Presutti and Mawhinney (2007) considered the EVA components to link SC performance metrics to the company's financial performance. This is developed further in this paper by incorporating Du Pont analysis in the financial performance metrics to illustrate the impact of SC performance on financial performance through

assessing the contribution of each financial performance component (revenue, cost, and assets) to the improvement of the company's profitability and operating efficiency.

4.3. DS/AHP model

DS/AHP model is a multi-criteria decision-making model that incorporates Dempster–Shafer theory (DST) with the philosophy behind the Analytical Hierarchy Processes (AHP) technique to improve traditional approaches to multi-criteria decision modelling (Beynon, 2005b).

DST is a generalisation of the Bayesian theory of subjective probability (Smarandache, 2003). The Bayesian theory quantifies judgements about a question by assigning probabilities to the possible answers to that question while DST provides a non-Bayesian way of using mathematical probability to quantify subjective judgements. It allows the derivation of degrees of belief for a question from probabilities for a related question and then considers the implications of these probabilities for the question of interest (Shafer, 2008).

The basic difference between probability theory and DST is that DST framework is a broader framework for representing uncertainty than probability. Under the probability framework, the sum of probabilities of all possible values of a variable equals one while in the DST, uncertainty is not only assigned to the single elements of the frame but also to all other proper subsets of the frame and to the entire frame (Bovee et al., 2003).

DST gives the ability to assign probability measures (basic probability assignments) to groups of objects rather than in classical probability theory where measures must be given to individual objects. The utilisation of DST in DS/AHP allows decision makers to make preference judgments on groups of decision alternatives (D.A.'s) rather than considering all D.A.'s (as in the classical AHP technique) and consequently, the number of comparisons can be reduced (Beynon, 2002).

Incorporating DST allows the related measure of ignorance to be calculated on the judgements made by the decision makers. Within DS/AHP decision makers can ignore those D.A.'s that they do not have an opinion towards. They only need to give judgments to the D.A.'s that they have a level of opinion towards which enables the decision maker to have a greater level of control on their judgements compared to standard AHP methods (Beynon et al., 2001; Beynon, 2005a).

4.4. The procedures for the proposed method

The procedures for the proposed method are illustrated in the following steps, and then a numerical example will be conducted to demonstrate the proposed method:

Step one: 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 factors that need improvement. Based on the result of Du Pont ratio analysis, the priorities of financial performance factors (profitability and efficiency) are determined using a pair-wise comparison method.
Step two: To link SC processes' performance to the priorities of the financial performance, the relative importance weights of the five main SC performance measures can be determined with respect to the priorities of the financial performance factors using DS/AHP model. Since the company's financial performance components (revenue, cost, and assets) are classified into profitability factor and efficiency factor based on Du Pont analysis, the five main SC performance measures (reliability, responsiveness, agility, cost, and asset) can drive these financial performance components.

Fig. 2 illustrates the developed hierarchy framework to link SC processes' performance to the priorities of the financial performance. Using DS/AHP model, the company does not need to consider all decision alternatives (D.A.'s) (i.e., reliability (RL), responsiveness (RS), agility (AG), cost (CO), and asset management (AM)), instead it considers groups of D.A.'s for each financial performance criterion (i.e. profitability (*P*) and efficiency (*E*)). The selected group of D.A.'s that can drive each financial performance criterion is considered based on the Presutti and Mawhinney

	SC performance attributes					**Financial performance metrics**	
	Customer- Facing			**Internal - Facing**		**EVA components**	**Du Pont analysis**
SCOR level 1- stratgic SC metrics	Reliability	Responsiveness	Flexibility	Cost	Assets		
Perfect Order Fulfilment	■					**Revenue**	**Profitability & Efficiency factor**
Order Fulfilment Cycle Time		■					
Upside Supply Chain Flexibility			■			**Cost**	**Profitability factor**
Upside Supply Chain Adaptability			■				
Downside Supply Chain Adaptability			■				
Supply Chain Management Cost				■			
Cost of Goods Sold				■			
Cash-to-Cash Cycle Time					■	**Assets**	**Efficiency factor**
Return on Supply Chain Fixed Assets					■		
Return on Working Capital					■		

Fig. 1. Linking SCOR model performance metrics to the financial performance factors. (Developed from Presutti and Mawhinney (2007) and Elgazzar et al. (2011a)).

method (see Fig. 1). As demonstrated in Fig. 1, SC performance measures that can drive profitability components (revenue and cost) are: reliability, responsiveness, agility, and cost while SC performance measures that can drive efficiency components (revenue and asset) are: reliability, responsiveness, and asset management.

Step three: To evaluate the efficiency and the effectiveness of current SC strategy, the proposed SCFLI is calculated for the company in order to reflect the extent to which SC processes' performance is linked to the company's short-term financial strategic objectives.

To calculate SCFLI, the performance rate which is assigned for each of the five main SC performance measures based on the SCOR model's traditional SC performance index is adjusted by the relative importance weights of these measures. By multiplying the relative importance weight of each measure by its performance rate, the weighted rate of each performance measure is determined.

The weighted rates of all performance measures are then aggregated to determine the company's SCFLI.

Step four: Having evaluated and analysed its current financial performance and SC processes' performance, the company is now in a position to formulate its new SC strategy based on the priorities of financial performance with respect to the relative importance weights of the main SC performance measures. According to SCOR model standard performance metrics, each SC performance measurement attribute corresponds to specific processes in the SC. Based on the relative importance weights of SC performance measures, the company can identify the related processes that need improvement and their corresponding performance indicators to align with SC strategy, and consequently with the company's short-term financial strategic objectives.

Step five: At the end of the accounting period, SCFLI is calculated again to evaluate the efficiency and the effectiveness of the newly developed SC strategy in contributing to achieving the company's short-term financial strategic objectives.

Calculating this index at the end of the period reflects SC processes' performance for this period. This index also can be used as an effective SCM tool as it can be calculated at any time during the period hence allowing the company to get continuous feedback on SC strategy and take the necessary corrective actions for better results by the end of the period. By analysing this index, a company can trace SC processes that still need improvement enabling greater control of daily SC operations.

Step six: Du Pont ratio is calculated by the end of the accounting period to test the impact of SC processes' performance on enhancing the company's overall financial performance.

The complete procedures of linking SC processes' performance to the company's financial strategic objectives are summarised in Fig. 3.

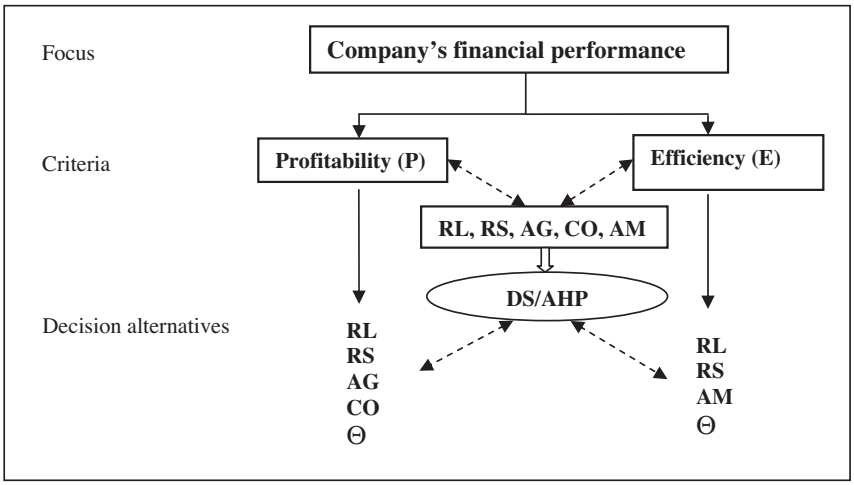
The framework of the proposed research method is presented in Fig. 4. As illustrated, SC processes' performance is measured in terms of agility, cost, reliability, responsiveness, and asset management based on SCOR model standard performance metrics. Financial performance is evaluated in terms of the company's profitability and operating efficiency through assessing the performance of the components contributing to ROA (cost, revenue, and assets). Using Du Pont ratio analysis, the priorities of financial performance factors (profitability and efficiency) can be determined according to the assessment of their corresponding components. Then, SC performance metrics are linked to financial performance metrics using the DS/AHP model. This model allows the determination of the importance weights of the five main SC performance measures with respect to financial performance priorities. Consequently, SC strategy is formulated based on these priorities, resulting in improvement in the overall financial performance.

5. Numerical example

In this section, a numerical example is developed and analysed by the authors to demonstrate the proposed research method. The example concerns XYZ Company performance relative to the industry average. The measurement algorithm is carried out using Microsoft Excel Spreadsheets. The procedures for applying the proposed method to this numerical example are described in the following steps:

5.1. Step one: Evaluating current financial performance and determining the priorities of financial performance factors

For XYZ Company, financial data relating to its total revenue, costs, net profit, and total assets are extracted from its financial statements at the end of an accounting period (period 1). The



Where: Θ is the frame of discernment which represents all decision alternatives (D.A.'s) (i.e., reliability (RL), responsiveness (RS), agility (AG), cost (CO), and asset management (AM))

Fig. 2. The developed hierarchy framework to link supply chain processes performance to the financial performance using DS/AHP model.

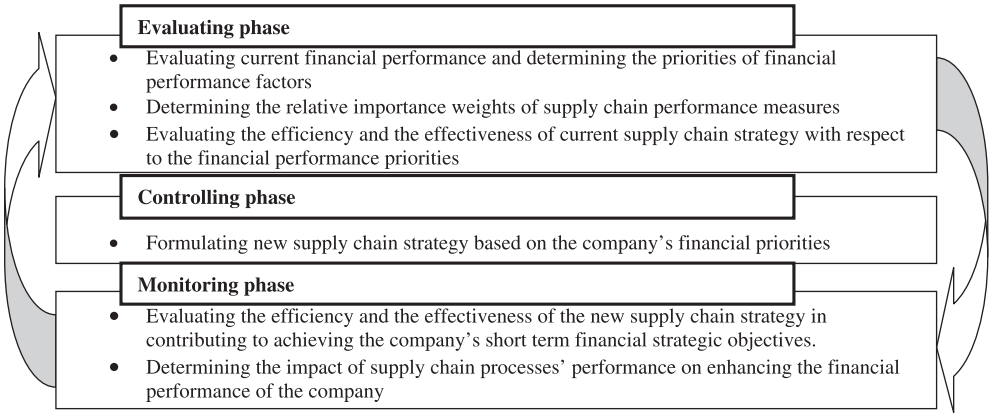


Fig. 3. Linking SC processes' performance to the company's financial strategic objectives.

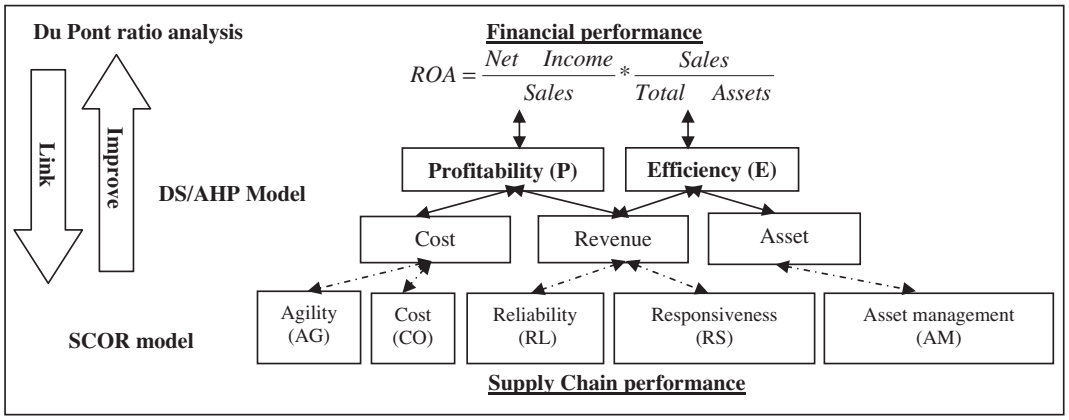


Fig. 4. Linking supply chain processes' performance to financial performance (Developed from Elgazzar et al. (2011a)).

benchmark in terms of industry average for this company is also provided (Table 1).

Du Pont ratio for XYZ Company is calculated and compared to the industrial average. As illustrated in Table 1, the company's return on asset ratio is below the industry average. To highlight the factors behind this low performance, the Du Pont ratio is broken into its components (Net Profit Margin and Total Assets Turnover) reflecting the company's financial performance in terms of profitability and operating efficiency.

The analysis reveals that the company has a high Total Asset Turnover resulting in higher than average efficiency in operations. 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 Du Pont ratio analysis, the focus area for enhancing the financial performance can be determined by repositioning the priorities of financial performance factors (profitability and efficiency). To reposition the priorities of these factors, a pair-wise comparison is conducted using a pair-wise questionnaire. As presented in Fig. 5, the questionnaire is designed based on 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.

Table 1
XYZ Company's financial performance compared to the industry average at the end of period (1).

	XYZ company	Industry average
Sales	$5000	$6000
Total cost	$4090	$4080
Net income	$910	$1920
Total assets	$6250	$8570
ROA	0.146	0.224
Net Profit Margin	18.20%	32%
Total Asset Turnover	0.8	0.7

A group of decision makers is assembled and asked to assign the priorities of the financial performance factors –with respect to Du Pont analysis results- using the pair-wise questionnaire's scale. The group of decision makers should comprise experts who have good understanding of the day to day operations of the company's supply chain as well as an overview of the company's strategic vision and goals. Also, the selected experts should be from several managerial levels and belong to different organisational functions in order to have a wide range of judgements from different organisational levels and job roles perspectives. It is recommended that the group of decision makers comprise 3–5 experts, as it is difficult to get more than 5 experts that match the above mentioned criteria. While if the group is smaller than three; it will not provide a meaningful judgement.

For this numerical example, we assume that four experts respond to the questionnaire and responses are as presented in Table 2. Since, the results of Du Pont analysis reveals that the company's Net Profit Margin is far below the industry average, the first expert (EXP. 1) believes that to enhance the financial performance, it is strongly more important for the company to focus on increasing profitability than improving operating efficiency. Both second and third experts (EXP. 2 and EXP. 3) consider that increasing the company's profitability is demonstrably more important; while the fourth one (EXP. 4) suggests that focusing on the profitability is absolutely more important.

With respect to (financial performance)	Importance or preference of one factor over another	
Attribute	Absolutely more important **(9)** / Demonstrably more important **(7)** / strongly more important **(5)** / Slightly more Important **(3)** / Equally important **(1)** / Slightly more Important **(3)** / strongly more important **(5)** / Demonstrably more important **(7)** / Absolutely more important **(9)**	**Attribute**
Profitability (P)		Efficiency (E)

Fig. 5. Questionnaire form to facilitate comparison of the importance of financial performance factors.

Table 2
The experts' consolidated responses on the questionnaire for assigning the priorities of the financial performance factors.

	EXP. 1	EXP. 2	EXP. 3	EXP. 4	G. MEAN
P vs. *E*	5	7	7	9	6.9

Then the geometric mean (G. MEAN) is used to aggregate the experts' responses in order to establish the pair-wise comparison matrix following the traditional AHP method. As shown in Eq. (3), based on the G. MEAN value, the pair-wise comparison matrix is established to express the consolidated opinions of the experts.

$$\begin{array}{c|cc} & P & E \\ P & 1 & 6.9 \\ E & 0.15 & 1 \end{array} \quad (3)$$

where 6.9 is the G. MEAN value while 0.15 is the reciprocal value of the G. MEAN.

For this pair-wise comparison matrix, the Eigenvector method is used for weight calculation and the priorities of the financial performance factors are determined as follows: profitability (*P*) 87.3% and efficiency (*E*) 12.7%.

For this company, the higher priority to enhance financial performance is given to the profitability factor with a priority weight of 87.3% compared to only 12.7% assigned to the efficiency factor.

The results reveal that for the new accounting period (period 2); enhancing the financial performance can be achieved through focusing on SC performance measures that drive profitability components.

5.2. Step two: Determining the relative importance weights of SC performance measures with respect to the financial performance priorities

Since the priorities of the financial performance factors are determined, the company now is in the position to link SC strategy to the focus area of enhancing the financial performance. To create this link, DS/AHP approach is conducted to determine the relative importance weights of the main SC performance measures (RL, RS, AG, CO, AM) with respect to the priorities of financial performance factors.

Based on the Presutti and Mawhinney method, groups of D.A.'s for each financial performance criterion (*P*, *E*) are selected and consequently the hierarchy of the problem is established (see Fig. 2).

DS/AHP model is based on a measure of favourability of knowledge that decision makers have about a group of D.A.'s compared with the frame of discernment (θ) within the context of each specific criterion. For each criterion there are certain groups of D.A.'s, including θ, about which the decision maker can express some degree of favourable knowledge.

The group of decision makers is asked to rank the SC performance measures priority – with regard to each financial performance criterion – using the following 4 unit scale as a basis for discriminating levels of preference: 3 for slightly more important, 5 for strongly more important, 7 for demonstrably more important, and 9 for absolutely more important.

Table 3 illustrates the initial knowledge matrices which represent the consolidated opinions of the decision makers for ranking the SC performance measures priority with regard to each financial performance criterion. In the knowledge matrix, the values in the final column are the measures of favourability of certain groups of D.A. in each row with respect to θ. For example in *P* knowledge matrix, CO is viewed as demonstrably more important compared to θ. The zeros which appear in the knowledge matrix indicate no attempt to assert preference between supply chain performance measures (e.g., RL to CO); this assertion can be made indirectly through knowledge of the favourability of RL to θ and CO to θ relatively. The indirect knowledge is that CO is considered more important to RL in relation to θ.

It is important to note that although DS/AHP method is adapted from the AHP method:

- This method does not use the equally preferred rating of 1 (as in the AHP method); this being a consequence of evaluating groups of D.A.'s vis a vis the frame of discernment.
- Since no pair-wise comparisons of D.A.'s are performed but relating groups of D.A.'s to θ, there are no consistency problems within a criterion, as long as no two proper subsets of θ considered in a criteria have a D.A.

Then, according to DS/AHP method the priority values of financial performance factors are incorporated into each of the initial decision knowledge matrices. As shown in Table 4, the initial knowledge matrices are influenced by the priority values of financial performance factors. This is done by multiplying the elements in the last column (except the last entry in that column) by the respective importance value for that criterion (noting that the importance values do not affect the elements in the matrix which are either zero or one).

Using the knowledge matrices for each of the criteria, we can produce normalised knowledge vectors as illustrated in Table 5, following the traditional AHP method.

Then, these normalised pieces of evidence can be combined using Dempster's rule of combination. The D–S combination rule determines the joint m_{1-2} from the aggregation of two basic probability assignments (BPA) m_1 and m_2 by following equation:

Table 3
Initial knowledge matrices for financial performance criteria.

Initial knowledge matrix for profitability (P)						Initial knowledge matrix for efficiency (E)				
	RL	RS	AG	CO	θ		RL	RS	AM	θ
RL	1	0	0	0	3	RL	1	0	0	4.4
RS	0	1	0	0	3	RS	0	1	0	4.4
AG	0	0	1	0	5.92	AM	0	0	1	8.45
CO	0	0	0	1	7.45	θ	0.23	0.23	0.12	1
θ	0.33	0.33	0.17	0.13	1					

Table 4
Knowledge matrices for financial performance criteria after influence of their priority rating.

Knowledge matrix for profitability (P) after influence of its priority rating						Knowledge matrix for efficiency (E) after influence of its priority rating				
	RL	RS	AG	CO	θ		RL	RS	AM	θ
RL	1	0	0	0	2.6	RL	1	0	0	0.56
RS	0	1	0	0	2.6	RS	0	1	0	0.56
AG	0	0	1	0	5.2	AM	0	0	1	1.08
CO	0	0	0	1	6.5	θ	1.78	1.78	0.93	1
θ	0.38	0.38	0.2	0.15	1					

$$m_{1\_2}(A) = \frac{\sum_{B\cap C=A} m_1(B)m_2(C)}{1-K} \quad \text{when } A \neq \Phi \text{ and } m_{1-2}(\Phi) = 0 \quad (4)$$

The denominator $(1-K)$ is a normalisation factor, which helps aggregation by completely ignoring the conflicting evidence where K is the degree of conflict in two sources of evidences.

$$K = \sum_{B\cap C=\Phi} m_1(B)m_2(C) \quad (5)$$

By applying D–S rule of combination on sources of information P and E, the following data is generated:

$m_2(E)$	$m_1(P)$					
	$m_2(E)_{RL} = 0.138$	$m_2(E)_{RS} = 0.138$	$m_2(E)_{AG} = 0.273$	$m_2(E)_{CO} = 0.344$	$m_2(E)_{AM} = 0$	$m_2(E)_{\theta} = 0.106$
$m_2(E)_{RL} = 0.143$	0.020 {RL}	0.020 {Φ}	0.039 {Φ}	0.049 {Φ}	0 {Φ}	0.015 {RL}
$m_2(E)_{RS} = 0.143$	0.020 {Φ}	0.020 {RS}	0.039 {Φ}	0.049 {Φ}	0 {Φ}	0.015 {RS}
$m_2(E)_{AG} = 0$	0 {Φ}	0 {Φ}	0 {AG}	0 {Φ}	0 {Φ}	0 {AG}
$m_2(E)_{CO} = 0$	0 {Φ}	0 {Φ}	0 {Φ}	0 {CO}	0 {Φ}	0 {CO}
$m_2(E)_{AM} = 0.274$	0.038 {Φ}	0.038 {Φ}	0.075 {Φ}	0.094 {Φ}	0 {AM}	0.029 {AM}
$m_2(E)_{\theta} = 0.441$	0.061 {RL}	0.061 {RS}	0.120 {AG}	0.152 {CO}	0 {AM}	0.047 {θ}

Degree of conflict (K) = 0.46.
Normalised factor ($1-K$) = 0.54.

$m_{1-2}(A)_{RL} = 0.096/0.54 = 0.178$	$m_{1-2}(A)_{CO} = 0.152/0.54 = 0.281$
$m_{1-2}(A)_{RS} = 0.096/0.54 = 0.178$	$m_{1-2}(A)_{AM} = 0.029/0.54 = 0.054$
$m_{1-2}(A)_{AG} = 0.120/0.54 = 0.223$	$m_{1-2}(A)_{\theta} = 0.047/0.54 = 0.086$

And then, the overall BPA for supply chain performance measures ($m_{\text{sc performance measures}}$) can be constructed and consequently the relative importance weights of SC performance measurement attributes are ranked as illustrated in Table 6 indicating that CO and AG are the most important SC performance criteria to focus on for the purpose of linking SC processes' performance to the company's short-term financial strategic priorities.

Table 5
The normalised knowledge vectors of the main supply chain performance measures for each of the financial performance factors.

Profitability (P)		Efficiency (E)	
RL	13.8%	RL	14.3%
RS	13.8%	RS	14.3%
AG	27.3%	AM	27.4%
CO	34.4%	θ	44%
θ	10.7%		

Also, from Table 6 it can be noticed that the sum of the relative importance weights of the five main SC performance measures is not equal to one (it equals 0.91). As mentioned before, under the probability framework, the sum of probabilities of all possible values of a variable equals one. Using DS/AHP model the related measure of ignorance can be calculated enabling companies to have greater control on their decisions as companies need only to give decisions according to the factors that they can control and have information and data about. This ignorance factor reflects the influence weight of the other unknown or uncontrollable factors that can impact the company's financial performance. In this example, the ignorance factor is 0.09; however this factor is subject to change according to the environmental uncertainty level and the degree of the experts' confidence in their preference based on information and data available.

5.3. Step three: Evaluating the efficiency and the effectiveness of current SC strategy

To evaluate the efficiency and the effectiveness of current SC strategy, the SCFLI is calculated for the company.

Based on the SCOR model, supply chain processes' performance is evaluated by assigning performance rate (0.2, 0.4, 0.6, 0.8, or 1) for each of the SC performance measurement attributes throughout the hierarchy of SC, from the process element levels till the configuration level, to assess the performance of the company's SC processes with respect to the SCOR model standard perfor-

Table 6
The relative importance weights of the main supply chain performance measures with respect to the financial performance's priorities.

Subsets	SUMm1(P)m2(E)	$m_{\text{sc performance measures}}$	Weight (W) (%)	Priority
RL	0.096	0.178	18	3
RS	0.096	0.178	18	3
AG	0.120	0.223	22	2
CO	0.152	0.281	28	1
AM	0.029	0.054	5	4
Θ	0.047	0.086		

Table 7
The aggregated weighted rates of the five main SC performance measures before applying the new SC strategy.

	Performance rate (R)	Weight (W) (%)	WR
RL	0.6	18	0.108
RS	0.8	18	0.144
AG	0.6	22	0.132
CO	0.6	28	0.168
AM	1	5	0.05
SUM	3.6	91	0.602

mance metrics. Then, the performance rates of all measurement attributes are aggregated- using averaging aggregation method throughout the hierarchy of the SC to determine the performance rate of the SC 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.

To calculate SCFLI, the performance rate which is assigned for each of the five main SC performance measures based on SCOR model 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 as shown in Table 7.

The weighted rates of all performance measures are then aggregated and the company's SCFLI is calculated as follows:

$$\text{Supply Chain Financial Link Index (SCFLI)} = \frac{\sum \text{WR}}{\sum W} = \frac{0.602}{0.91} = 0.66 \quad (6)$$

While the traditional SC performance index

$$= \frac{\sum R}{N} = \frac{3.6}{5} = 0.72 \quad (7)$$

where N represents the number of the main supply chain performance measures.

The traditional SC performance index is 0.72, by adjusting this index with the relative importance weights of the main supply chain performance measures, the company's SCFLI is calculated to be 0.66 to reflect the extent to which current SC processes' performance are linked to the company's financial priorities.

5.4. Step four: Formulating new SC strategy based on the company's priorities

Since the relative importance weight of each SC performance measure is determined, the company can now identify SC processes that need improvement and their corresponding performance indicators based on SCOR model standard performance metrics.

For XYZ Company, as the company's short-term financial strategic objective is to improve its profitability particularly through managing its costs, the most suitable supply chain strategy to align with this financial strategic objective is to focus on enhancing the processes to which cost and agility performance measures correspond. According to XYZ Company's strategic priorities, the main goals of its SC strategy should be managing SC costs and increasing SC agility.

For example: To accomplish the aim of managing SC costs, the company focuses SC strategy on managing SC costs that are relatively high (distribution costs and direct material costs). Then, the company determines the objectives and the action plans needed to implement this strategy.

Table 8 illustrates the objectives and plan of action at the top level in the SC to accomplish the aim of managing supply chain costs. Also key performance indicators to evaluate the effectiveness of accomplishing this aim are identified based on SCOR model level 1 metrics.

5.5. Step five: Evaluating the efficiency and the effectiveness of the new SC strategy in contributing to achieving the company's short-term financial strategic objectives

At the end of period 2, the performance rates (R) of the five main SC performance measures are determined and then adjusted by their relative importance weights (W). Table 9 illustrates the weighted rate (WR) of each SC performance measure after applying the new SC strategy.

The weighted rates of the five main SC performance measures are then aggregated and SCFLI is calculated again to measure and evaluate the significant contribution of the newly developed SC strategy in achieving the company's short-term financial strategic objectives.

At the end of period 2, the traditional SC performance index of XYZ Company is 0.8 while the company's SCFLI is 0.77. SCFLI increased by approximately 11% revealing improvement in the efficiency and the effectiveness of SC strategy in connecting to the company's short-term financial strategic objectives.

Although the traditional SC performance index measures the change in SC processes' performance; it is unable to trace the significant impact of such change on the company's overall financial performance. This index ignores the relative influence weight of each SC performance measure on enhancing the financial performance as it assumes that they are equally weighted.

Table 8
Supply chain top level strategy.

Strategic aim	Level 1 objectives	Level 1 plan of action	Responsibilities	Key performance indicators at level 1 metrics
Managing supply chain costs	Reducing distribution cost by 3%	Remapping the distribution channels	Marketing department	Supply chain management cost
	Reducing direct material cost by 5%	Searching for other suppliers at lower price with the same quality	Commercial department	Cost of goods sold

Table 9
The aggregated weighted rates of the five main SC performance measures after applying the new SC strategy.

	Performance rate (R)	Weight (W) (%)	WR
RL	0.6	18	0.108
RS	0.8	18	0.144
AG	0.8	22	0.176
CO	0.8	28	0.224
AM	1	5	0.05
SUM	4	91	0.702

Alternatively assuming that at the end of period 2, the performance rate (R) of supply chain asset management (AM) dropped to 0.6. In this case the traditional SC performance index would remain 0.72 revealing no change in the SC processes' performance; while SCFLI would be 0.75 showing improvement in the overall performance by approximately 9%. According to this assumption, although there are changes in SC processes' performance after applying the new SC strategy, the traditional SC performance index cannot capture these changes as it does not take into consideration the relative importance weights of SC performance measures with respect to the priorities of financial performance factors.

5.6. Step six: Determining the significant impact of SC processes' performance on enhancing the financial performance of the company

By the end of period 2, the Du Pont ratio for the company is calculated again and analysed to determine the impact of improving SC processes' performance on enhancing the company's overall performance.

The company's SC processes' performance and the overall financial performance before applying the new SC strategy (period 1) and after applying the new SC strategy (period 2) are summarised in Table 10.

Comparing Du Pont results at the end of period 2 to the results at the end of period 1 shows improvement in the profit margin which reflects the impact of the SC processes' performance on enhancing the company's overall financial performance.

6. Conclusion and further work

This research illustrated a method to link SC performance metrics to the priorities of company's financial performance. This method enables companies to connect SC processes' performance to the company's short-term financial strategic objectives through evaluating current SC strategy and then formulating the new SC strategy based on the priorities of the financial performance in the short-term for achieving improvement in the company's profitability as the primary long-term financial goal.

SCFLI was developed to test the extent to which SC processes' performance is linked to the company's short-term financial strategic objectives. This index provides an effective SCM tool to evaluate, monitor, and control supply chain processes' performance in order to enhance supply chain strategy for better alignment with the company's financial strategy.

The proposed SCFLI differs from the traditional SC performance index as it adjusts the performance rate of the five main SC performance categories at the top level by their relative importance weights to reflect SC processes' performance with respect to the priorities of the company's financial performance. However, it does not consider the relative importance weights of SC performance measures at lower levels (configuration level, process element level, and implementation levels) assuming that SC performance measures at lower levels are equally weighted.

In reality, determining the relative importance weights of SC performance measures at lower levels enables companies to identify the corresponding processes at each category that need improvement and to assess the performance of SC processes at lower levels in order to identify the core competence processes, identify processes which create value or create waste, and develop strategies to better manage the SC.

To determine the relative importance weights of SC performance measures at lower levels, a technique incorporating FAHP in the SCOR model can be adapted (Elgazzar et al., 2011b).

As a suggestion for future research, the SCOR FAHP technique can be combined with the method proposed in this paper to determine the relative importance weight of each SC performance measure at lower levels in order to identify SC processes that need improvement at each SC performance category with respect to the priorities of the financial strategy.

This paper demonstrated the developed method within the context of a simple SCM model. As illustrated in the previous numerical example, the aim of SCM was to enhance the processes to which cost and agility performance measures correspond assuming that all other variables would not change and remain constant. However, it should be noted that in real life, companies' objectives are not mutually exclusive. SCM may include a number of conflicting aims and achieving one of the aims may cause other variables to move into undesirable states. In a further refinement of the proposed method, system dynamics can be deployed to integrate more complex decision variables and evaluate multiple objectives in order to generate more realistic supply chain management dynamics models.

Since the proposed method was illustrated only by giving a numerical example, as further research, a real case study is cur-

Table 10
SC processes' performance and the financial performance before and after applying the new SC strategy.

Measure	Period 1			Period 2			Change direction
Supply chain processes' performance							
	R	W	WR	R	W	WR	
RL	0.6	18%	0.108	0.6	18%	0.108	No change
RS	0.8	18%	0.144	0.8	18%	0.144	No change
AG	0.6	22%	0.132	0.8	22%	0.176	Favourable
CO	0.6	28%	0.168	0.8	28%	0.224	Favourable
AM	1	5%	0.05	1	5%	0.05	No change
	Period 1			Period 2			
Traditional SC performance Index	0.72			0.8			Favourable (does not reflect the actual performance)
SCFLI	0.66			0.77			Favourable
Financial performance							
ROA	0.1456			0.2025			Favourable
Net Profit Margin (%)	18.20%			25%			Favourable
Total Asset Turnover (times)	0.8			0.81			Almost no change

rently being conducted to demonstrate the applicability of the proposed method in the real business environment.

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