PERFORMANCE METRICS IN SUPPLY CHAIN MANAGEMENT EVIDENCE FROM ROMANIAN ECONOMY

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Abstract
The proposed empirical research uses a national sample of 19 Romanian companies from various industries to estimate de utilities for financial and non-financial performance measures used in Romanian supply chains. Empirical findings show that national supply chain measurement systems are balanced, using both financial and non-financial performance measures. The high estimated utility corresponding to indicators measuring logistic costs provides evidence that inter-functional and inter-organization integration in supply chains at national level are realized through operational excellence. Achieving the full potential of supply chain integration requires that management fosters both integration of operations and integration of customers.

Keywords: supply chain management, performance metrics, conjoint analysis

JEL classification: C35, C51, M11

Introduction

Supply chain management (SCM) reflects the most recent approach to logistics integration, the final integrating perspective on the evolutionary processes of purchasing, production support and distribution (Marincas, 2008). Gunasekaran and McGaughey (2003) identify three hierarchical levels of SCM: strategic, operational and tactical level. At a strategic level, SCM provides strategic guidance, transforming the way in which improving the flows control within the supply chain better addresses customers' demands. At operational level, the above mentioned authors consider that SCM favors more efficient flows through cross-functional teams. At tactical level, the SCM deals with resource allocation given binding constraints.

Ho, Au and Newton (2002) identify three core elements of SCM: (i) value creation, (ii) collaboration and (iii) integration of key business processes. SCM aims at better serving the ultimate consumers (Cohen and Roussel, 2005; Vokurka and Lummus, 2000) while maximizing the benefits of supply chain members through inter-functional and inter-organizational integration of key supply chain business processes and collaboration among supply chain members (Chopra and Meindl, 2004).

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Logistics is a key business process, providing the link between production and marketing at organizational level and between supply and demand at supply chain level (Bowersox et al., 2000). Stank, Keller and Closs (2001) characterize 'five areas of competence that companies deploy to achieve supply chain logistics integration'. The required competencies include integration of: (i) customers, (ii) operations, (iii) suppliers, (iv) planning and (v) measurement system. Coordination between customers' needs and organization's strengths is paramount to customers' integration. An integrated approach of internal operations balances logistics costs and customer service (Constăngioară, 2004). Linking internal operations with those of external material and service providers contributes to reducing redundancies in the supply chains. Suppliers' integrations can be achieved through vertical integration. Nevertheless this option is inefficient because of the required capital investment (Stank, Keller and Closs, 2001). Alternatively, the above-mentioned authors show that collaboration is a solution to suppliers' integration, maximizing the benefits of all participants in the supply chain. Planning integration relies on information exchange technology to facilitate flow of materials, products, information, services and capital within the supply chain (Constangioara, 2004). Integrated supply chain measurement system (SCMS) is necessary to calibrate processes and coordinate multiple activities within the supply chain (Bowersox et al., 2000).

Intuitively we can infer that there is a link between SCM and firms performance. In most cases the literature on this link is anecdotal or based on case studies with only scarce formal supporting evidence (Wagner, Grosse-Ruyken and Erhun, 2012). Yet the transmission mechanism of supply chain performance to organizational performance is straightforward, requiring that (a) we improve resource allocation (b) reduce costs by ensuring a better coordination between supply chain design and product characteristics and (c) provide a better alignment between supply chain priorities and product / business strategies (Wagner and Neshat, 2012).

At national level, an important stream of research focuses on the characteristics of SCM in different industries. Prejmerean and Vasilache (2008) discuss the factors which influence the distribution of medicines on the Romanian pharmaceutical market whereas Muhcina and Popovici (2008) analyse the SCM in tourism. A second stream of research tackles the problematic of SCMS at national level. Balan analyses the negative effect on organizational performance of the 'bull-whip effect' and Seitan (2008) presents the performance benefits of harmonizing organizational strategy with strategy at supply chain level (SCS).

Building on existing SCM literature, this research focuses on the problematic of the measurements systems in supply chains at national level. After reviewing the literature on SCMS, the second part of the study uses a national dataset to analyse the specific of performance metrics in Romanian supply chains. The main hypothesis of interest is: in Romanian supply chains financial measures of performance are perceived as being more important that non-financial ones.

This paper proposes using the conjoint analysis to assess the relative importance of different supply chain performance metrics. The findings contribute to a better understanding of the impact on different stakeholders of the performance metrics used in Romanian supply chains.

1. Integrated supply chain measurement systems

The existing literature on SCM analyses the contribution of SCMS to organizational competitiveness (Gunasekaran, Patel and McGaughey, 2003). Stank, Keller and Closs (2001) bring empirical evidence of the relative influence of an integrated SCMS on individual elements of firm performance.

The condition necessary for a fully integrated SCMS are presented by Algren and Kotzab (2011):

- Linking supply chain performance with the overall competitive strategy (vertical integration);
- Including financial and non-financial metrics (inter-functional and inter-organizational integration);
- Measuring all relevant aspects of performance (horizontal integration)

According to Chopra and Meindl (2004) there are two strategies companies can apply at the level of supply chains: operational excellence and cooperation. The option for one of them shapes both the performance metrics and the performance areas covered by SCMS. Choosing the strategy of operational excellence, companies will strive to minimize costs while maintaining a desired level of customer service. SCM requires that organizations, rather than optimizing in isolation, need to consider the impact of their own actions on the other members of supply chain. The end result of cooperation in the supply chain is maximizing the output at the entire supply chain level (Bowersox et al., 2000). Failing to cooperate, results in sub-optimum output in the supply chain and negative consequences for the value offered to the end consumer. From the perspective of SCMS, the strategy of cooperation among supply chain members requires employing non-financial indicators suitable for measuring qualitative features of performance. In a study stressing the benefits of supply chain cooperation, Boudewijn and van Weele (2012) have labelled the qualitative aspects of performance facilitated by cooperation as 'cooperation effectiveness'.

Although Richard et al. (2009) have found that financial indicators continue to remain the most prevalent measures of organizational performance, SCM literature underlines the need for a balanced metrics employed for measuring performances is supply chains (Algren and Kotzab, 2011; Gunasekaran and McGaughey, 2003; Stank, Keller and Closs, 2001). It is generally accepted in SCM that there has been a shift from treating accounting and financial measures of performance as the 'foundation of performance to treating them as one among a broader set of measures' (Gunasekaran and McGaughey, 2003).

There are three approaches to defining the relevant areas of performances in the context of supply chains (Gunasekaran, Patel and McGaughey, 2003). First framework identifies the relevant performance metrics corresponding to the four performance areas defined by a balanced scorcard: financial, operational, marketing and innovation. This approach is balanced, using both financial and non-financial performance indicators to measure multiple areas of performance at supply chain level. The second possibility is to define performance metrics at the strategic, operational and tactical level of SCM. The third approach considers more closely the four major supply chain activities / processes: plan, source, make/assemble and deliver.

Table no. 1 presents an overview of supply chain performance indicators (adapted from Gunasekaran, Patel and McGaughey, 2003).

Table no. 1: Supply chain performance metrics

Level	Performance metrics	Financial indicators	Non-financial indicators
Strategic	Customers' satisfaction		X
	Range of products and services		X
	Delivery lead time		X
	Stockouts		X
	Buyer-supplier partnership level		X
	Net profits	X	
	Return on equity (ROE)	X	
	Return on sales (ROS)	X	
	Return on investments (ROI)	X	
Tactical	Accuracy of forecasting techniques		X
	Product development cycle time		X
	Planned process cycle time		X
	Effectiveness of distribution planning schedule		X
	Supplier assistance in solving technical problems		X
	Supplier ability to respond to quality problems		X
	Cost saving initiatives	X	
Operational	Cost per operation hour	X	
	Capacity utilization		X
	Total inventory costs		X
	Quality of delivered goods		X
	Achievement of defect free deliveries		X

Source: Adapted from Gunasekaran, Patel and McGaughey, 2003

2. Analysis of performance metrics in supply chains. Evidence using a Romanian dataset

2.1 Data

Budget considerations constrained our working sample to 150 companies, randomly selected from a national dataset of 1204 companies. Same sample size was also used by Gunasekaran, Patel and McGaughey (2003). Following Wisner (2003), our sample was limited to medium and large companies.

In the spring of 2008 we have collected data using a survey-based questionnaire targeting high-level management of the companies in the sample. The questionnaire used for data collection asked respondents to classify profiles of performance indicators on a scale from one to ten.

The 150 mailed questionnaires returned 19 usable responses. The 12.66% response rate is similar to response rates reported in supply chain empirical studies. For example the response rate in Gunasekaran, Patel and McGaughey (2003) was 14% whereas a recent study of Wagner and Neshat (2012) reports a response rate of 15.4%. The analysis of frequencies of companies in the working dataset is depicted in table no. 2.

Table no. 2: Frequencies by industry

Industry	Frequency	%
Manufacturing	10	52.63
Energy	1	5.26
Constructions	2	10.53
Transportation	2	10.53
Commerce	3	15.79
Other Services	1	5.26

The frequencies reported in table no. 2 reveals that subsequent analysis uses a sample of firms from various industries, covering all levels of a supply chain, from production to retail. We see that most firms in the working dataset are from manufacturing (10), followed by commerce (3). Random sampling has provided the national significance of the sample used in the analysis.

2.2 Methodology

Present research uses conjoint analysis to assess the metrics used in Romanian supply chains. Conjoint analysis is mostly used in marketing research, product management and operations research. According to Kuhfeld (2010), typical applications of conjoint analysis are designing new products, changing existing products and estimating the effect of price on purchase behaviour. Instead of directly asking the consumers' opinion about different features of a product, conjoint analysis asks respondents to evaluate different combinations of attributes. Conjoint analysis is a main-effects analysis meant to estimate the joint effect of a set of independent variables measuring the attributes of a product or service on a dependent variable measuring the preferences of consumers. There are two classes of conjoint analysis. The first class is called metric conjoint analysis. A second group of conjoint models is labelled 'non-metric'. The difference between them is that the non-metric conjoint analysis uses a transformation of the dependent variable.

Kuhfeld (2010) shows that when all of the attributes are nominal, the metric conjoint analysis is formally given by equation no. 1:

$$Y= \beta_1+\beta_2+\ldots+\beta_k +\varepsilon \quad (1)$$

In equation no. 1, the β coefficients correspond to utilities of the attributes under evaluation.

In most cases, empirical research in SCM uses ordinary least squares regressions (OLS) to model the performances in supply chains (Stank, Keller and Closs, 2010). More recent research in this field use graph theory (Wagner and Neshat, 2010).

Compared to a traditional OLS estimation, conjoint analysis increases the number of observations used in the analysis. This is the main advantage of the conjoint analysis over OLS in supply chains performance estimation. The number of observation in a conjoint analysis is given by: (i) the resulting set of profiles and (ii) their evaluation by the targeted respondents. This research uses four dichotomous performance variables, which results in 2^4 distinct profiles. Respondents evaluate each profile on a scale from one to ten. Consequently, the resulting number of inputs in this case increases to 39.

As a limit of conjoint analysis, Kuhfeld (2010) shows that, with too many options, respondents resort to simplification strategies. Using more performance measures in our case would have increased the number of profiles, making the job of completing the questionnaires by the respondents very difficult.

Additionally, conjoint analysis does not account for the interdependences among different performance dimensions in supply chains. A solution to this problem requires using the methodology proposed by Wagner and Neshat (2010).

Econometric analysis uses SAS statistical package. Conjoint analysis uses 39 observations. The sample size is sufficient for the proposed analysis.

2.3 Results

Variable used in the conjoint analysis are presented in table no. 3. For each variable the class YES has the significance of improvement and the class NO the significance of lack of improvement.

Table no. 3: Performance metrics used in the analysis

Variable	Classes	Label	Performance area
costs	YES NO	Logistics costs	operational
ROS	YES NO	Return on Sales	financial
Customers	YES NO	Customers' satisfaction	marketing
New_investments_ IT	YES NO	New investments in IT	innovation

Table no. 3 shows that the empirical research employs both financial and non-financial performance indicators, corresponding to the four areas of performance of a balanced scorcard: finance, marketing, operations and innovation. This approach has the advantage of accounting for the multidimensionality of performance in the context of a supply chain (Algren and Kotzab, 2011).

Table no. 4 shows the utilities table obtained in SAS 9.2.

Table no. 4 shows mixed evidence on the importance of financial indicators used in Romanian supply chains. Although the highest estimated value corresponds to the utility associated with improving customers' satisfaction (1.46) with a relative importance of 32.48%, results in table 4 also document the importance of financial indicators. We see that the utility coefficient for the importance of costs is only slightly lower (1.45) with a relative importance of 32.25%. Then the utility coefficient for the importance of ROS is 1.34 with a relative importance of 29.83%. Marketing, financial and operational performance accounts for almost 95% of the estimated aggregated utility.

Table no. 4: Utilities table based on TRANSREG Procedure

Variable, label	Utility	Standard Error	Importance (% Utility Range)
Intercept	5.32	0.02	
ROS, improvement	1.34	0.02	29.838
ROS, no improvement	-1.34	0.02	
Costs, improvement	1.45	0.02	32.252
costs, no improvement	-1.45	0.02	
customers, improvement	1.46	0.02	32.485
customers, no improvement	-1.46	0.02	
New investments in IT, yes	0.24	0.02	5.425
New investments in IT, no	-0.24	0.02	

2.4 Implications

The focus of conjoint analysis is modelling management perceptions of the relative importance of different performance indicators. Understanding management's perceptions on performance metrics employed in Romanian supply chains provides valuable insight on the actual indicators, managerial priorities and actions in the context of supply chains (Stank, Keller and Closs, 2001). Further on, understanding management's perceptions affords a better understanding of its stance relative to different stakeholders.

Consequently, our analysis documents that in Romanian supply chains management uses a broad range of performance indicators, measuring multiple dimensions of performances. The high estimated utility for indicators measuring consumers' satisfaction reveals that management allocate efforts and resources to provide products, services and information that add value for customers.

The high estimated utility corresponding to indicators measuring logistic costs can be interpreted as evidence that in Romania SCS in operationalized through operational excellence. Same operationalization strategy is preferred by Korean and Japanese firms (Kenneth, Whitten and Inman, 1998).

The importance of performance indicators measuring customers' satisfaction and logistic costs suggest a positive impact of operational and customers' integration on organizational performance. This leads to the conclusion that maximizing benefits for all supply chain members requires furthering pursuits for operational and customers' integration in Romanian supply chains.

Concluding remarks

Present empirical research shows that performance metrics used in Romanian supply chains enables the inter-functional and inter-organizational integration recommended by SCM. Measuring multiple dimensions of performance ensures the horizontal integration of SCMS at national level.

Results of the conjoint analysis reveal that, in the context of national supply chains, the primarily managerial target in to attain efficiency through lowering costs while maintaining a desired level of customers' satisfaction. Consequently, the present research shows that increasing organizational performance requires management to enhance efforts to foster both customer and operations integration.

Since using conjoint analysis limits the dimensionality of performances we can control for, future research should define the relevant measures of performance from a functional perspective, considering performance metrics for all the major supply chain processes. We also appreciate that it would be beneficial if future research would account for interdependences among multiple performance dimensions, using a research methodology similar to that proposed by Wagner and Neshat (2010).

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