

An Exploratory Study of the Relationship between Supply Chain Management Practices and Technical Efficiency of Jordanian Manufacturing Companies

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Abstract

Recent arguments states that competition is no longer between organizations, but among supply chains to support different competitive priorities. Effective supply chain management (SCM) practices have become a recognized way of achieving competitive advantage and improving organizational financial performance. This paper presents an exploratory study of the relationship between (SCM) practices and organizational financial performance. Although research on the relationship was investigated by relating SCM practices and single organizational financial performance, but no research have surrogated many organizational financial performance in one measurement. Technical efficiency was used to surrogate organizational financial performance of Jordanian manufacturing companies. Data for the study was collected from 28 manufacturing companies registered in first market of Amman Stock Exchange. The results indicate a strong relationship between SCM practices and bottom-line profits of an organization.

Keywords: Supply chain management, Technical efficiency, DEA, Jordan

1. Introduction

Over the last decade the competitive landscape has shifted from lowest priced product, highest-quality or best-performing product to the ability to respond quickly to market needs and get the right product to the right customer at the right time (Suhong et al., 2005). This shift toward speed has pushed organizations to compete with their entire supply chain (Hult et al., 2007). Consequently understanding and practicing supply chain management (SCM) has become a mandate to compete and improve supply chain surplus in the global arena (Moberg et al., 2002).

The early attempts of empirical research in SCM have been limited at developing instruments capable of measuring SCM practices (Donlon, 1996; Tan et al., 1998; Alvarado and Kotzab, 2001; Chen and Paulraj, 2004; Suhong et al., 2005). Most recently, scholars like Suhong et al. (2006) have focused their research efforts into exploring the relationship between practices of SCM and organizational performance. They have used financial and market criteria to operationalize organizational performance (return on investment, market share, profit margin on sales, the growth of return on investment, the growth of sales and the growth of market share. Also, Lenny et al. (2007) investigated the relationship among SCM practices, operational performance and SCM-related organizational performance.

These studies and others have produced various results due to operationalizing the performance of the organization subjectively and objectively. Supply-chain driven organizational performance falls into three categories (Khan et al., 2009). First, resource performance reflects value addition in the form of achieving efficiency. Second, output performance reflects value addition as the firm's ability to provide high levels of customer service. Last, flexibility performance reflects value addition as the firm's ability to respond. This study will capture the performance of the organization through measuring technical efficiency by the use of data envelopment analysis (DEA) technique.

The primary goal of this paper is to explore the relationship among SCM practices and technical efficiency in manufacturing companies. In other words, this paper studies the extent to which SCM practices contribute to the efficiency of an organization. Since there are many measures of efficiency (Saha and Ravisanker, 2000), this

paper mainly deals with technical efficiency of manufacturing companies in Jordan.

The remainder of this paper is organized as follows. The literature review regarding SCM practices, its impact on organizational performance, and technical efficiency is discussed in the next section. Section three offers research framework. Section four discusses research methodology. Data and results are offered in section five. The final section draws implications and conclusions.

2. Literature Review

SCM is a set of practices utilized to efficiently and effectively integrate all different stages in the supply chain in order to produce and deliver goods at the right quantities, to the right locations, and at the required time with minimum costs while meeting customer needs (Simchi et al., 2003). SCM practices have been documented in measurement studies as well in research explored the relationship of SCM practices and organizational performance. Recent studies have begun to propose SCM practices as a multi-dimensional concept that covers upstream, internal and downstream side of a supply chain (Suhong et al., 2005). Their research has six empirically validated dimensions which include strategic supplier partnership, customer relationship, information sharing, information quality, internal lean practices and postponement. Also, Chen and Paulraj (2004) have developed a conceptual framework and an instrument that would help researchers better understand the scope of both the problems and the opportunities associated with SCM from a holistic view. Their research has fifteen empirically validated dimensions and some of them do address SCM practices. This paper will adopt dimensions related to SCM practices from both mentioned papers as will be discussed in the research framework section.

Since 1980s, SCM has been considered as one of the most driving forces for firms to improve their competitive advantage and performance (Kannan and Tan, 2005; Chin et al., 2010). Some studies have examined specific practices of SCM to analyze the impact on organizational performance, while others operationalize SCM practices as a multidimensional construct and investigated the impact on organizational performance (Suhong et al., 2006; Kim, 2006; Chin et al., 2010).

Organizational performance has been defined as how well an organization achieves its market-oriented goals as well as its financial goals (Yamin et al., 1999). Most studies operationalize organizational performance using both financial and market criteria (Suhong et al., 2006) to compare the performance among organizations. These criteria lack the characteristics of being able to address the whole in order to benchmark organizations (Wong and Wong, 2005). This paper suggests the use of technical efficiency to benchmark the performance of an organization using DEA modeling as discussed in the next paragraph.

Techniques used in measuring firm's efficiency can be grouped into three categories: ratio analysis, parametric methods and nonparametric methods. These techniques have both advantages and disadvantages (DÜzakin and DÜzakin, 2006). The major disadvantage of ratio analysis is inappropriateness of making decisions based on one single ratio when there are multiples of inputs and outputs. DEA is a nonparametric method in which multiple inputs and outputs are used to measure firm's performance. DEA enables the measurement of relative efficiency. For the sake of brevity of this paper, detailed discussions of this method are not described here. Important references are provided to help the interested readers. So, DEA was used by many scholars to measure the efficiency of a manufacturing firm (Chandra et al., 1998; Friedman and Stern, 1998; Shammari, 1999; Sena, 2001; DÜzakin and DÜzakin, 2006; Chen and Chen, 2009; and Halim, 2010).

In order to apply DEA, it is important that inputs and outputs considered for the study be specified and justified. Various studies on the measurement of efficiency in manufacturing firms with the utilization of DEA have used several inputs and outputs. Chandra et al. (1998) have specified their inputs as number of employees, average annual investment over last ten years, and their outputs were annual sales values. On the other hand, Friedman and Stern (1998) specified their inputs as assets, average wage man-hours worked by employees, labor cost, materials and expenses, but their outputs were revenue, export revenue, and income due to work and repairs and assts. Furthermore, Shammari (1999) considered number of employees, paid in capital and fixed assets as inputs, but market value, net sales and net income after taxes as outputs. Also, Zhu (2000) inputs were number of employees, assets and stakeholders equity, but the outputs were revenues and profits. In the same line, Chen and Chen (2009) considered their inputs as total assets, operation cost, and operation expenses and specified one variable output as net sales. This study will discuss its inputs and outputs with justification in the research framework section in line with previous studies.

3. Research Framework

Fig. 1 presents the proposed SCM practices framework. The framework explores the existence of a relationship between SCM practices and firm's technical efficiency.

Insert Figure 1 - Here

SCM practices are conceptualized as a five-dimensional construct. These dimensions are adopted from previous empirically validated studies (Chen and Paulraj, 2004; Sunhong et al., 2006). The five dimensions are strategic supplier partnership, customer relationship, information technology, logistic integration, delivery practices. Each dimension with representative items is provided in appendix A. For a detail description of the adopted dimensions, the interested reader can review studies conducted by Chen and Paulraj (2004), Suhong et al. (2005, 2006), and Zhou, (2007).

A considerable amount has been written documenting that organizational performance can be operationalize through measuring its efficiency using DEA method (Sena, 2001; DÜzakin and DÜzakin, 2006; Chen and Chen, 2009; and Halim, 2010). Previous studies measuring efficiency in manufacturing firms by the use of DEA method have identified several inputs and outputs (Chandra et al., 1998; Friedman and Stern, 1998; Shammari, 1999; Zhu, 2000; and Chen and Chen, 2009). In line with previous literature, this study will specify its inputs and outputs with justification in order to measure technical efficiency using DEA method.

The primary objectives of SCM in the short-term and long-term are to increase productivity, reduce inventory, increase market share and profits. SCM practices do influence the financial aspects of an organization (Krajewski et al., 2010) such as:

Total revenue: Percent of on-time deliveries to customers will increase total revenue because satisfied customers will buy more services and products from the firm.

Net income: Being able to buy materials or services at a better price and transform them more efficiently into services or products will improve a firm's cost of goods sold and ultimately its net income. Also, contribution margin will improve resulting in greater profit.

Operating expenses: Operating an organization with minimal expenses will increase profits.

Cash flow: Positive net cash flows can be achieved by reducing lead times and backlogs of orders.

Working capital: Decreasing weeks of supply or increasing inventory turns reduces the working capital needed to finance inventories. Reduction in working capital can be accomplished by improving the customer relationship, order fulfillment, or supplier relationship processes.

Return on assets: Reducing aggregate inventory investment and fixed investments, or increasing net income by better cost management will increase return on assets.

Based on the above justification and the interest of operational activities in an organization, this study will consider total current assets, working capital, and operating expenses as its inputs, while operating revenue, net income and cash flow from operating activities as its outputs.

4. Research Methodology

This study is based on an exploratory data analysis regarding SCM practices of Jordanian manufacturing companies. These manufacturing companies were selected for the analysis due to availability of financial data. This study administered a survey and collected quantitative data to explore the existence of a relationship between SCM practices and organizational performance.

A survey instrument was adopted from Chen and Paulraj (2004), Suhong et al. (2005, 2006), and Zhou, (2007). Five constructs of SCM practices were proposed which were felt important for SCM practices as shown in Appendix A. A sample of 28 manufacturing companies registered in the first market of Amman Stock Exchange was selected. A total of 140 questionnaires were personally administered to those companies. The number of returned questionnaire that were found to be usable in this study was 126, which represented about 90% response rates. Cronbach's alpha-values in this study were all greater than 0.71 (with a maximum value of 0.92). The statistical results confirm the significantly high consistency of the questionnaire.

The quantitative aspect of this study was collected in order to measure the technical efficiency of these manufacturing companies. This study will use DEA method to measure the technical efficiency of companies registered in the first market of Amman Stock exchange in the year 2007-2009. The data used to measure the technical efficiency is the financial information available at the Stock Exchange. As justified in the research framework section, the inputs considered are total current assets, working capital, and operating expenses, while operating revenue, net income and cash flow from operating activities are considered as outputs.

5. Data and Results

Using the non-parametric Kruskal-Wallis test on the instrument item (SCM practice) found no significant differences between the manufacturing companies in different industries as shown in the p-value in table (1). Thus, it is appropriate to treat the companies as a homogeneous sample for further analysis.

Insert Table 1 - Here

Descriptive statistics for the research dimensions are shown in table (2). The results show that the investigated companies are moderate in their adoptions of supply chain practices.

Insert Table 2- Here

In this study, performances of the organizations were analyzed by input oriented model under constant returns to scale (CRS) assumption. Objectives of input oriented model are to minimize inputs while producing at levels than given output levels (Cooper et al., 2000). This study believes recommendations about reducing input values are more appropriate than the output oriented model because SCM practices should reduce inventory and costs associated with transportation, warehousing, transaction costs and lead times. Also, constant returns to scale (CRS) assumption is appropriate than variable returns to scale (VRS) assumption (DÜzakin and DÜzakin, 2006). This study analyzed the correlation between inputs and the outputs variables from 2007 to 2009. The results in Table 3 showed that the Pearson correlation between the inputs and outputs variables are positive and the requirements of isotonicity condition is satisfied for the DEA analysis (Chen and Chen, 2009).

Insert Table 3 - Here

This study used DEA to evaluate the operational performance of the sample companies. As shown in Table 4, the average of CRS efficiency of the sample from 2007 to 2009 is 75.07 percent. Overall the performance of the sample was slightly better in 2009 as indicated by the average.

Insert Table 4 - Here

A simple correlation test was conducted among the overall construct (SCM practice) and technical efficiency. The correlation was 0.864 at a p-value of 0.003. Accordingly, the overall construct (SCM practice) was examined in relation to its impact on technical efficiency. A simple regression was conducted with the total score of SCM practices as the independent variable and technical efficiency as the dependent variable. The p-value for the regression test is shown in figure (2). Apparently, the overall SCM practices do have an effect on technical efficiency. Also, the five SCM practices were examined in relation to their impact on technical efficiency. A multiple regression test was conducted, with each practice as the independent variable, and technical efficiency as the dependent variable. The p-values for each practice are shown in figure (3). Apparently all practices have a significant effect on technical efficiency at $\alpha = 0.05$ except strategic customer relationship (SCR). Consequently that could be explained as the reliance of customer on those manufacturing companies as their sole providers of finished goods and these customers do not have a marginal effect on the operations of the manufacturing companies.

Insert Figure 2 - Here

Insert Figure 3 - Here

6. Conclusions

Current research of SCM practices are targeted toward finding the impact on individual measures of organizational financial performance. The individual constructs of SCM practices might have different impacts on these performances. This study suggested that organizational financial performance should be surrogated in one measurement that captures the complexity of operational activities of an organization. Technical efficiency was suggested as a means to capture the impact of SCM practices on different organizational financial performance. The main objective of this paper was to explore the impact of SCM practices on organizational performance in monetary value. The paper results show the significant correlation between SCM practices and technical efficiency as a measurement of organizational financial performance. The measures of SCM practices provided in this study can be useful to managers in benchmarking their current SCM practices and their impact on organizational financial performance against their competitors. This study offered insight about the role of SCM practices and its contribution to bottom-line profits.

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Table 1. Kruskal-Wallis Test (p-value results)

Industry Type	Kruskal-Wallis test ($\alpha = 0.01$)
Pharmaceutical and Medical Industries	0.736
Chemical Industries	0.265
Printing and Packaging	0.459
Food and Beverages	0.233
Tobacco and Cigarettes	0.165
Mining and Extraction Industries	0.584
Engineering and Construction	0.354
Electrical Industries	0.856
Textiles, Leathers and Clothing's	0.478

Table 2. Descriptive Statistics

Dimensions (SCM practices)	Average	STDEV.
Strategic supplier partnership	3.87	0.88
Strategic customer relationship	3.99	0.71
Information technology	3.23	0.86
Logistics integration	3.66	0.74
Delivery practices	3.80	0.79
Total	3.71	

Table 3. Correlation Coefficients between Variables (p-value)

		Operating revenue	Net income	Cash flow
Total current assets	Correlation	0.881	0.792	0.819
	p-value	0.000	0.000	0.000
Working capital	Correlation	0.846	0.807	0.823
	p-value	0.000	0.000	0.000
Operating expenses	Correlation	0.990	0.912	0.929
	p-value	0.000	0.000	0.000

Table 4. The CRS Efficiency Scores

Company	Year			Average %
	2007 %	2008 %	2009 %	
DMU1	80.71%	88.92%	100.00%	89.88%
DMU2	84.08%	100.00%	87.89%	90.66%
DMU3	77.17%	78.80%	81.20%	79.06%
DMU4	44.18%	50.22%	100.00%	64.80%
DMU5	66.89%	75.56%	67.26%	69.90%
DMU6	62.12%	66.57%	64.56%	64.42%
DMU7	63.81%	60.49%	60.03%	61.44%
DMU8	71.93%	75.16%	78.15%	75.08%
DMU9	74.65%	91.15%	76.82%	80.87%
DMU10	81.19%	85.00%	68.69%	78.29%
DMU11	69.15%	67.47%	60.65%	65.76%
DMU12	72.00%	71.20%	73.17%	72.12%
DMU13	63.94%	80.25%	70.56%	71.58%
DMU14	67.73%	78.08%	79.04%	74.95%
DMU15	73.57%	79.84%	86.87%	80.09%
DMU16	73.85%	96.92%	76.12%	82.30%
DMU17	61.00%	58.47%	62.50%	60.66%
DMU18	60.26%	62.60%	71.31%	64.72%
DMU19	87.96%	100.00%	86.07%	91.34%
DMU20	100.00%	100.00%	96.25%	98.75%
DMU21	100.00%	100.00%	100.00%	100.00%
DMU22	88.50%	77.53%	100.00%	88.68%
DMU23	59.50%	64.18%	67.07%	63.58%
DMU24	54.44%	53.18%	56.14%	54.59%
DMU25	64.66%	63.87%	63.67%	64.07%
DMU26	47.55%	82.12%	100.00%	76.56%
DMU27	67.34%	56.65%	63.17%	62.39%
DMU28	73.08%	72.29%	81.01%	75.46%
Average	71.12%	76.30%	77.79%	75.07%

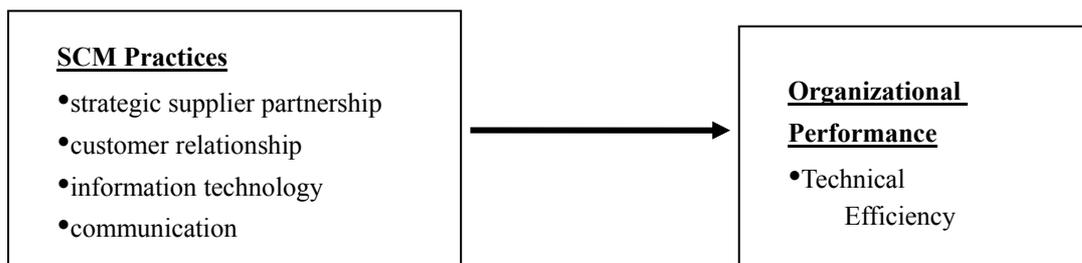


Figure 1. Research Framework

The regression equation is
 $EFF=0.267+0.129 \text{ TOTAVG}$

Predictor	Coef	SE Coef	T	P
Constant	0.2675	0.1049	2.55	0.038
TOTAVG	0.12945	0.02852	4.54	0.003

S=0.02825 R-Sq=74.6% R-Sq(adj)=71.0%

Analysis of Variance

Source	DV	SS	MS	F	P
Regression	1	0.016440	0.016440	20.59	0.003
Residual Error	7	0.005588	0.000798		
Total	8	0.022028			

Figure 2. Overall Construct with Technical Efficiency

The regression equation is
 $EFF=0.127+0.0319 \text{ SSP}+0.0157 \text{ SCR} + 0.0486 \text{ INT} + 0.0344 \text{ LGTT}+ 0.0408 \text{ DP}$

Predictor	Coef	SE Coef	T	P
Constant	0.12701	0.05010	2.54	0.019
SSP	0.03193	0.01337	2.39	0.026
SCR	0.01570	0.1917	0.32	0.422
INT	0.04862	0.01374	3.54	0.002
LGIT	0.03443	0.01492	2.31	0.031
DP	0.04077	0.01659	2.46	0.022

S=0.04249 R-Sq=89.9% R-Sq(adj)=87.6%

Analysis of Variance

Source	DV	SS	MS	F	P
Regression	5	0.352352	0.070470	39.04	0.000
Residual Error	22	0.039716	0.001805		
Total	27	0.392068			

Figure 3. SCM Practices with Technical Efficiency

Appendix A. Instruments for Supply chain management practices

With regard to the following items, please indicate the degree that your present firm practices (on 5 point Likert scale, 1--- least practice, 5--- most practice)

Strategic supplier partnership (SSP)

- A1. We select and rely on a small number of high qualified suppliers
- A2. We expect our relationship with key suppliers to last a long-time
- A3. We regularly solve our problems jointly with our suppliers
- A4. We consider our suppliers as an extension of our company
- A5. We share sensitive information with our suppliers
- A6. We include our key suppliers in our planning and goal-setting activities

Strategic customer relationship (SCR)

- B1. We anticipate and respond to customers' evolving needs and wants
- B2. We frequently measure and evaluate customer satisfaction
- B3. We emphasize the evaluation of formal and informal customer complaints
- B4. Customer focus is reflected in our business planning
- B5. We frequently interact with customers to set our competitive priorities
- B6. Our customers provide us with changes in purchase order information
- B7. Our customers provide us with their inventory level information
- B8. Our customers provide us with their future demand forecasting information
- B9. Our customers provide us with their production planning information
- B10. We provide our customer with our production capacity information
- B11. We provide our customers with order status and delivery schedule information

Information technology (IT)

- C1. There is direct computer-to-computer links with key suppliers
- C2. Intra-organizational coordination is achieved using electronic links
- C3. We have electronic mailing capabilities with our key suppliers
- C4. We use electronic transfer of purchase orders invoices and / or funds
- C5. Our coordination with suppliers and buyers is achieved using electronic links

Logistics integration (LIT)

- D1. Interorganizational logistic activities are closely coordinated
- D2. Our logistics integration is characterized by excellent distribution, transportation or warehousing facilities
- D3. The inbound and outbound distribution of goods with our suppliers is well integrated
- D4. Information and materials flow smoothly between our supplier firms and us

Delivery practices (DP)

- E1. We deliver products to our major customer on a just-in-time basis
- E2. We consolidate orders by customers, sources, carriers, etc.
- E3. We have a single point of contact for all order inquiries
- E4. We have real time visibilities of order tracking