MEASUREMENT OF PERFORMANCE OF SUPPLY CHAINS AND THEIR IMPACT ON THE COMPETITIVENESS OF MANUFACTURING INDUSTRIES IN UNION TERRITORY OF PONDICHERRY (INDIA)

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ABSTRACT

The purpose of this research work is to empirically test the measurement of supply chain performance and its impact on competitiveness of manufacturing industries located in Union Territory of Pondicherry, INDIA. In order to find the impact of Supply Chain performance on the competitiveness of the organization, authors collected primary data from a randomly selected sample of 60 manufacturing companies in Union Territory of Pondicherry. Factor analysis is used to analyze data. Initially, attributes which are related to supply chain performance are studied and statistically analyzed. Subsequently, authors have done statistical analysis using Multiple regression to examine whether supply chain performance contributed to the competitiveness of companies with respect to the following factors; (1)market share, (2)sales growth, (3)return on assets and (4) overall competitive position. From the present research work, it is found out that the supply chain performance has significant impact on the overall performance and competitiveness of manufacturing companies situated in Union Territory of Pondicherry

INTRODUCTION

Fierce competition in today's global markets, the introduction of products with shorter life cycles, and heightened expectation of customers have forced business enterprises to invest in, and focus attention on their supply chains. This, together with continuing advances in communications and transportation technologies (e.g., mobile communication, Internet, and overnight delivery) have motivated the continuous evolution of the supply chain and of the techniques to manage it effectively.

In a typical supply chain, raw materials are procured and items are produced at one or more factories, shipped to warehouses for intermediate storage and then shipped to retailers or customers. Consequently, to reduce cost and improve service levels, effective supply chain strategies must take into account the interactions at the various levels in the supply chain. The supply chain, which is also referred to as the logistics network, consists of suppliers, manufacturing centers, warehouses, distribution centers and retail outlets.

Supply chain management is a key strategic function for increasing organizational effectiveness and for the better realization of organizational goals such as enhanced competitiveness, better customer care and increased profitability. In order to evolve an effective and efficient supply chain, supply chain management needs to be assessed for its performance to know the competitive position of a company in the market place. However, assessment of the supply chain performance with firm's performance is not easy task.

Research on supply chain may be defined as the systematic and objective search for, and analysis of, information relevant to the identification and solution of any problem in the field of supply chain management. Research in this field has been conducted around the premises that a relationship exists between a particular course of action and supply chain performance. The definition of performance is a challenge for researchers in any field of management because organizations have multiple and frequently conflicting goals. Some define goals in terms of profits. Others may choose goals such as customer service or sales maximization. Also difficult are the tasks of selecting and developing adequate measures for evaluating a supply chain.

RELEVANT LITERATURE REVIEW

Market globalization, growing competition and an escalating importance on customer orientation are frequently cited as catalyzing the rush in attention in supply chain management (e.g. Gunasekaran et al., 2001). Effective supply chain management is treated as solution to building a sustainable competitive edge through better inter and intra-firm relationships (Ellinger, 2000). Supply chains encompass all activities connected with the flow and transformation of goods from the raw material stage to the finished goods delivery to the end user. A variety of benefits have been achieved through efficient supply chain management, including reduced costs, improved market share and sales and solid customer associations (Ferguson, 2000).

A worldwide study of contemporary manufacturing practices reported fair uptake and perceived effectiveness of supply chain management (Clegg et al., 2002). While observing these modest levels of uptake and effectiveness, one would expect attention in developing measurement systems and metrics for evaluating supply chain performance to be growing. Likewise, it has been argued that measuring supply chain performance can result in understanding of the supply chain and improve overall companies' performance (Chen and Paulraj, 2004)

Performance measurement systems are described as the overall set of metrics used to quantify both the efficiency and effectiveness of action (Neely et al. 1995). The following are few of the many approaches to performance measurement: (1) the balanced scorecard (Kaplan and Norton, 1992),(2) the performance measurement matrix (Keegan et al., 1989),(3) performance measurement questionnaires (Dixon et al., 1990), (4) criteria for measurement system design(Globerson,1985) and (5) computer aided manufacturing approaches.

In addition, researchers highlight a range of limitations of existing measurement systems for manufacturing as mentioned below : (1) they encourage short term goal,(2) they lack strategic focus (the measurement system is not aligned correctly with strategic goals, organization culture or reward systems),(3) they encourage local optimization by forcing managers to minimize the variances from standard, rather than seek to improve continually and (4) they fail to provide adequate information on what competitors are doing through benchmarking. These and other studies have highlighted how the majority of the limitations cited by Neely et al (1995) remain salient in the case of performance measurement systems for supply chains.

In the past, researchers have done some work in the following domains: Factors influencing the successful implementation of performance measurement systems (Bourne et al.2002),(2) forces which shape the evolution of performance measurement systems (Kennerley et al, 2002 and Waggoner et al., 1999),and (3) how to maintain performance

measurement systems over time so that they remain aligned with dynamic environments and changing strategies (Kennerley et al., 2003). All of these issues are pertinent to performance measurement in supply chains. Yet, performance measurement has received limited attention in the literature. Companies that do have supply chain performance measurement metrics often do not monitor supply chain performance regularly. Or their metrics are not directly related to customer satisfaction. Hence, there is a need to investigate whether implementing measurement systems to evaluate supply chain performance in manufacturing companies are effective or not.

OBJECTIVE

Till date no researcher has done a scientific study in this subject in Union Territory of Pondicherry, Motivated by reasons explained above, the main objective of the present research work is to measure the performance of supply chains and their impact on the competitiveness of manufacturing industries in Union Territory of Pondicherry.

METHODOLOGY

The questionnaire contains 32 supply chain performance measures and 4 competitive performance dimensions. These 32 supply chain performance measures are shown in Table 1. One executive from 60 randomly selected manufacturing industries from Union Territory of Puducherry, INDIA were asked to fill in the questionnaire.

Table 1 Supply chain performance measures used

Serial number	Factors
1	Total cycle time
2	Order lead time
3	Total cash flow time
4	Vendor managed inventory
5	Process benchmarking
6	Supplier delivery performance
7	Early supplier involvement
8	Supplier lead-time against industry norms
9	Supplier capability auditing
10	Efficiency of purchase order cycle time
11	Customer query time
12	Cycle time reduction

13	Production quality
14	Increase of capacity utilization
15	Manufacturing flexibility
16	Delivery speed
17	Quality of delivered goods
18	Flexibility of services systems to meet customer needs
19	Delivery reliability performance
20	Team work
21	Third Party logistic
22	E-Commerce
23	Use of SCM application software
24	Advertisements
25	Development of core competencies
26	Brand image
27	Research and development
28	Outsourcing
29	Business Process outsourcing
30	Customer service
31	Level of customer perceived value of product
32	Employee training

Authors used factor analysis method and multiple regression method. Factor analysis helped to find out which set of factors were given more emphasis by executives from manufacturing companies to measure the supply chain performance in their organizations. Factor analysis also groups related factors. Each set of related factors is given a suitable name. Subsequently authors used multiple regression analysis to find out the relation between each set of independent variables and dependent variables namely (1) Market share (2) Sales growth (3) Return on assets and (4) Overall competitive position

RESULTS AND DISCUSSION

Results of factor analysis are shown in Table 2

Table 2 Results of factor analysis

Sl. no	Factors	Loadings	Communalities
1	**Operations related dimension**		
	Total cycle time	0.856	0.890
	Order lead time	0.697	0.859
	Total cash flow time	0.684	0.889
	Vendor managed inventory	0.618	0.822
	Process benchmarking	0.616	0.931
2	**Suppliers related dimensions**		
	Supplier delivery performance	0.850	0.890
	Early supplier involvement	0.795	0.860
	Supplier lead-time against industry norms	0.713	0.883
	Supplier capability auditing	0.625	0.826
	Efficiency of purchase order cycle time	0.557	0.865
3	**Order fulfillment related dimension**	0.787	0.763
	Customer query time	0.708	0.818
	Cycle time reduction		
4	**Flexible manufacturing system related**	0.873	0.843
	dimension	0.689	0.863
	Production quality	0.626	0.865
	Increase of capacity utilization		
	Manufacturing flexibility	0.872	0.898
5	**Delivery related dimension**	0.585	0.755
	Delivery speed	0.582	0.773
	Quality of delivered goods		
	Flexibility of services systems to meet customer	0.528	0.884

	needs		
	Delivery reliability performance	0.761	0.809
6	**Technology related dimension**	0.564	0.787
	E-Commerce		
	Use of SCM application software	0.886	0.907
7	**New product and marketing related dimension**	0.653	0.844
	Advertisements	0.547	0.807
	Development of core competencies	0.540	0.864
	Brand image		
	Research and development	0.813	0.849
8	**Outsourcing related dimension**	0.714	0.874
	Outsourcing		
	Business Process outsourcing	0.854	0.769
9	**Customer related dimension**	0.578	0.803
	Customer service		
	Level of customer perceived value of product	0.955	0.960
10	**Third Party Logistic related dimension**		
	Third Party Logistics		

Factors	F1	F2	F3	F4	F5	F6	F7	F8	F9	F1
Eingenvalues	3.833	3.604	3.263	2.938	2.827	2.651	2.607	2.203	1.895	1.21
Per cent of Total variance	11..98	11.26	10.20	9.18	8.84	8.28	8.15	6.89	5.92	3.8
Cummulative Per cent	1.98	23.24	33.43	42.62	51.45	59.74	67.88	74.77	80.70	84.4

SPSS version 16 was used to perform factor analysis. Factor analysis procedure grouped 32 factors mentioned in Table 1 into 10 families of factors. Each family of factors is given suitable name by authors. In subsequent discussions, each family of grouped factors (Dimension) will be referred as a factor. Each of ten factors (Dimensions) is explained below:

Factor one- the Operations related dimension

This first factor included a set of variables which are related to operations related dimension of the organization. This factor (dimension) underscored clearly the

importance of the Operations related dimension in the measurement of supply chain performance.

Factor two- the Supplier related dimension

This second factor included a set of variables which are related to supplier related dimension of the organization. This factor (dimension) underscored clearly the importance of the supplier related dimension in the measurement of supply chain performance.

Factor three – the Order fulfillment related dimension

This third factor included a set of variables which are related to order fulfillment related dimension of the organization. This factor (dimension) underscored clearly the importance of the order fulfillment related dimension in the measurement of supply chain performance.

Factor four – the Flexible manufacturing systems related dimension

This fourth factor included a set of variables which are related to flexible manufacturing system*s* related dimension of the organization. This factor (dimension) underscored clearly the importance of the flexible manufacturing systems related dimension in the measurement of supply chain performance.

Factor five- the Delivery related dimension

This fifth factor included a set of variables which are related to delivery related dimension of the organization. This factor (dimension) underscored clearly the importance of the delivery related dimension in the measurement of supply chain performance.

Factor six – the Technology related dimension

This sixth factor included a set of variables which are related to technology related dimension of the organization. This factor (dimension) underscored clearly the importance of the technology related dimension in the measurement of supply chain performance*.*

Factor seven – the new product and Marketing related dimension

This seventh factor included a set of variables which are related to new product and market related dimension of the organization. This factor (dimension) underscored clearly

the importance of the new product and market related dimension in the measurement of supply chain performance.

Factor eight – the Outsourcing related dimension

This eighth factor included a set of variables which are related to outsourcing related dimension of the organization. This factor (dimension) underscored clearly the importance of the outsourcing related dimension in the measurement of supply chain performance.

Factor nine – the Customer related dimension

This ninth factor included a set of variables which are related to customer related dimension of the organization. This factor (dimension) underscored clearly the importance of the customer related dimension in the measurement of supply chain performance.

Factor ten – the Third party logistics related dimension

This tenth factor included a set of variables which are related to third party logistics related dimension of the organization. This factor (dimension) underscored clearly the importance of the third party logistics related dimension in the measurement of supply chain performance.

Results of multiple regression analysis are show in Table 3.

Table 3 Results of multiple regression analysis

Independent variables	Dependent Variables			
	Market share	Sales growth	Return on assets	Overall competitive position
Operations related dimension	0.231 *	0.368*	0.400*	0.299*
Supplier related dimension	0.112	0.261*	0.249*	0.278*

Order fulfillment related dimension	0.007	0.050	0.175**	0.312*
Flexible manufacturing system related dimension	0.008	0.085	0.131***	0.088
Delivery related dimension	0.278*	0.364*	0.466*	0.241*
Technology related dimension	0.077	0.365*	0.238*	0.155**
New product and marketing related dimension	0.288*	0.049	0.012	0.119***
Outsourcing related dimension	0.015	0.166***	0.125***	0.233*
Customer related dimension	-0.116	-0.006	0.121***	-0.014
Third party logistics related dimension	0.041	-0.048	0.075	-0.007
Adjusted R^2	0.314	0.49	0.673	0.60

*Denotes significant at 1%; **Denotes significant at5 % ; ***Denotes significance at 10.

The relationship existing between independent variables (ten factors) and dependent variables (Market Share, Sales growth, Return on assets and overall competitive position) are explained below:

Multiple regression with Market share as dependent variable

From Table 3, one can infer that the dependant variable namely market share of companies in the Union Territory of Puducherry is significantly related to the following independent variables with 1% significance:

1. Operations related dimension
2. Delivery related dimension and
3. New product and market related dimension.

Improvement in Operations related dimension will significantly increase the market share of companies in Union Territory of Puducherry. Improvement in delivery related dimension will increase the market share of companies in Union Territory of Puducherry. Improvement in new product and market related dimension will increase the market share of companies in Union Territory of Puducherry.

From Table 3, one can infer that dependant variable namely market share of companies in the Union Territory of Puducherry is insignificantly related to the following independent variables:

1. Suppliers related dimension
2. Order fulfillment related dimension
3. Flexibility manufacturing system related dimensions
4. Technology related dimension
5. Outsourcing related dimension
6. Customer related dimension and
7. Third party logistics related dimension

The adjusted R square explains that there is 31.4 % variability between dependent variable and Independent variables.

Multiple regressions with Sales growth as dependent variable

From Table 3, one can infer that the dependant variable namely sales growth of companies in the Union Territory of Puducherry is significantly related to the following independent variables with 1% significance:

1. Operations related dimension
2. Suppliers related dimension
3. Delivery related dimension and
4. Technology related dimension.

Improvement in Operations related dimension will significantly increase sales growth of companies in Union Territory of Puducherry. Improvement in Suppliers related dimension will significantly increase sales growth of companies in Union Territory of

Puducherry Improvement in delivery related dimension will increase the sales growth of companies in Union Territory of Puducherry. Improvement in technology related dimension will increase the sales growth of companies in Union Territory of Puducherry.

From Table 3, one can infer that the dependant variable namely sales growth of companies in the Union Territory of Puducherry is significantly related to the independent variable namely outsourcing related dimension with 10% significance.

From Table 3, one can infer that dependant variable namely sales growth of companies in the Union Territory of Puducherry is insignificantly related to the following independent variables:

1. Order fulfillment related dimension
2. Flexible manufacturing system related dimension
3. New product and marketing related dimension
4. Customer related dimension and
5. Third party logistics related dimension

The adjusted R square explains that there is 49 % variability between dependent variable and Independent variables. Hence we can interpret that this multiple regression method is suitable.

Multiple regressions with Return on assets as dependent variable

From Table 3, one can infer that the dependant variable namely return on assets of companies in the Union Territory of Puducherry is significantly related to the following independent variables with 1% significance:

1. Operations related dimension
2. Suppliers related dimension
3. Delivery related dimension and
4. Technology related dimension.

Improvement in Operations related dimension will significantly increase the return on assets of companies in Union Territory of Puducherry. Improvement in supplier related dimension will significantly increase the return on assets of the companies in Union Territory of Puducherry Improvement in delivery related dimension will significantly increase the return on assets of companies in Union Territory of Puducherry. Improvement in technology related dimension will significantly increase the return on assets of companies in Union Territory of Puducherry.

From Table 3, one can infer that the dependant variable namely return on assets of companies in the Union Territory of Puducherry is significantly related to the independent variables namely order fulfillment related dimension with 5% significance.

From Table 3, one can infer that dependant variable namely return on assets of companies in the Union Territory of Puducherry is significantly related to the following independent variables with 10% significance:

1. Flexible manufacturing system related dimension
2. Outsourcing related dimension
3. Customer related dimension

Improvement in flexible manufacturing system related dimension will significantly increase the return on assets of companies in Union Territory of Puducherry. Improvement in Outsourcing related dimension will significantly increase the return on assets of the companies in Union Territory of Puducherry, Improvement in Customer related dimension will significantly increase the return on assets of companies in Union Territory of Puducherry.

The adjusted R square explains that there is 67 % variability between dependent variable and Independent variables. Hence we can interpret that this multiple regression method is suitable.

Multiple regressions with overall competitive position as dependent variable

From Table 3, one can infer that the dependant variable namely overall competitive position of companies in the Union Territory of Puducherry is significantly related to the following independent variables with 1% significance:

1. Operations related dimension
2. Suppliers related dimension
3. Order fulfillment related dimension
4. Delivery related dimension and
5. Outsourcing related dimension

Improvement in Operations related dimension will significantly increase the overall competitive position of companies in Union Territory of Puducherry. Improvement in Suppliers related dimension will significantly increase the overall competitive position of companies in Union Territory of Puducherry. Improvement in Order fulfillment related dimension will significantly increase the overall competitive position of companies in Union Territory of Puducherry. Improvement in delivery related dimension will significantly increase the overall competitive position of companies in Union Territory of Puducherry. Improvement in outsourcing related dimension will significantly increase the overall competitive position of companies in Union Territory of Puducherry.

From Table 3, one can infer that the dependant variable namely overall competitive position of companies in the Union Territory of Puducherry is significantly related to the independent variable namely technology related dimension with 5% significance.

From Table 3, one can infer that the dependant variable namely overall competitive position of companies in the Union Territory of Puducherry is significantly related to the independent variables namely new product and marketing related dimension with 10% significance.

The adjusted R square explains that there is 60 % variability between dependent Variable and Independent variables. Hence we can interpret that this multiple regression method is suitable.

CONCLUSIONS

In this work, authors have done an in-depth analysis on the performance of supply chain and its impact on the competitiveness of manufacturing industries in the union territory of Puducherry. Thirty two supply chain performance measures have been analyzed using factor analysis. Subsequently, authors have done statistical analysis using multiple regression to examine whether supply chain performance contributed to the competitiveness of companies with respect to the following factors: (1) market share, (2)sales growth, (3)return on assets and (4) overall competitive position. From the present research work, it is found out that the supply chain performance has significant impact on the overall performance and competitiveness of manufacturing companies situated in Union Territory of Puducherry.

Factor analysis procedure resulted in the extraction of nine dimensions with multiple variables and one dimension with only one variable (Third party logistics). The following are nine multivariate factors: (1) Operations related dimension (2) Supplier related dimension (3) Order fulfillment related dimension (4) Flexible manufacturing system related dimension (5) Delivery related dimension (6) Technology related dimension (7) New product and marketing related dimension (8) Outsourcing related dimension (9) Customer related dimension. Finally authors have explained the relationship existing between ten independent variables and four dependent variables using multiple regression analysis.

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