Identification of Performance Measures for Textile Supply Chain: Case of Small & Medium Size Enterprise

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Abstract— **Identifying the performance measures for textile supply chain network is rapidly growing multi criteria decision making problem and so the task of performance measurement due to large number of parameter's involvement. Selection & analysis of appropriate performance measures is critical to achieve success for textile industry in today's global competitive market. With this paper, we tried to overcome it by recognizing three areas; cyclic processes of supply chain network (procurement-production-distribution), measures under three decisions making levels & considering balanced scorecard (BSC) perspectives. Developed a framework for supply chain performance measurement and analyzed using analytical hierarchy process.**

Keywords— Supply chain management, Performance measurement, supply chain network (procurement-production-distribution), Balanced scorecard, Analytical hierarchy process

1. Introduction

In recent times of world of globalization, many textile industries have developed strong supply chains to gain advantage in today's competitive market to deliver best product & provide best services to customers. In textile, decision at all levels reflects the performance of three different cyclic processes of supply chain. The objective of supply chain and performance measurement should be understood for developing the most effective supply chain. Performance measurements provide an approach identify the critical performance measures to keep the supply chain strategies up to mark.

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Supply chain management is defined as the integration of key business processes from raw material supplier to fabric producer and finally to customer. In globalization, main aim of textile supply chain is to provide quality product to customer by adding value at multiple cyclic processes. These cyclic processes are i) procurement where raw material such as yarn is received from suppliers, ii) production, where yarn is converted to fabric through various processes, iii) distribution, where final product is distribution/ delivered to end customer[3]. Measurement of supply chain performance is important to understand the effectiveness of implementing the supply chain management (SCM) [2]. Effectiveness of any supply chain management can be evaluated by analyzing the performance at three decisions making level viz. strategic, tactical and operational for different cyclic processes such as procurement, production and distribution.

Objective of this study is to present an easy and simple framework with the help of which textile managers can easily identify the critical performance measures. This study utilizes the consideration of four perspectives of BSC which are financial perspective, customer perspective, internal business perspective, innovation and learning perspective.

2. TEXTILE INDUSTRY & SCM

2.2 Textile Industry

Indian textile industry is prominently the oldest manufacturing sector, presently the largest. It has very important place in building the economy of the country by contributing to industrial output, employment generation and earning the foreign revenue. It has wide range of industrial units using variety of natural and synthetic fibers for producing

fabric. It ranges from small to large-scale production. The term textile should be understood in two ways; i) From raw material to fiber to fabric excluding clothing/apparel/ garments, ii) As a whole complex of textile including clothing/apparel/ garments [1]. The textile industry can broadly be classified into two categories; organized mill sector, unorganized mill sector.

2.3 Supply chain management

Number of definition has been coined for SCM. Academic and practitioner differ is defining the concept of SCM. Most relevant and simple definition of SCM is a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products and the distribution of these finished products to customers.

Companies with outstanding and efficiency supply chain (SC) are customer-centric, concentrate on process management, use of information technology as capability enabler and are well aware of performance measurement. Primary goal of SCM is to setup unique value added processes in order to satisfy customer needs efficiently. Maintaining functional process outstanding requires dramatic and often painful modification at all levels of management decision which are strategic, tactical and operational. [Gunasekaran] Companies to survive in global competitions, needs to effectively manage and monitor the performance of its value added processes of its supply chain and they are procurement process, production process and distribution process.

The textile supply chain is complex structure consist of cotton or other raw material supplier, manufacturer and wholesale distributor, retailer and consumer. It requires a complex processes to supply product to customer. But, irrespective of its complexity, the supply chain has separated links in which communication is carried out as needed with specific methods.

It was found that the textile companies supply chains are not utilizing the performance measurement, active information sharing and therefore the management at all levels of decision making. Characteristics of textile supply chain are time consuming labor intensive process which obstructs the efficient supply chain performance measurement [4].

3. SUPPLY CHAIN PERFORMANCE MEASUREMENT

Supply chain management philosophy got its identity from the recognition that process of converting raw materials into desired final goods/ services and finally distributing it to customer is becoming complicated. For effective and efficient management of customer needs, a collaborative effort in improving performance at different cyclic processes (procurement- production- distribution) in and out of organization on broader manner is required.

Supply chain performance measurement is most important aspect for today's competitive organizations. Companies need to analyze the current practices and need to adopt the world class practices, reason for which is enhancing the organizational performance has received much attention from academicians and practitioners. Because organizational performance is much relied on these measures as they affect the decision at strategic, tactical and operational planning, execution and control. There has been numerous effort put on to develop suitable performance measurement system in setting objectives, deciding metrics in evaluating performance and determining future course of action[5].

Various system have been developed to measure the performance of supply chain such as supply chin operation reference mode SCOR which covers both internal and external facing environment comprising both operational and financial[6]. Balanced scorecard (BSC) framework as also presents a comprehensive model for evaluating supply chain performance. Its use has been elaborated in study conducted for evaluating petroleum supply chain with some shortcomings [7]. BSC has been tested on some SMEs using case study [8] and in survey the impact of strategic, tactical and operational level decision on BSCs perspectives using AHP has been evaluated [9].

For the purpose of supply chain performance measurement, specific performance measures needs to be identified which should have following features; specific, measurable, achievable, realistic & time bounded [24]. Few such performance measures/ metrics such as quality, reliability, cost, assets etc have been used in a study conducted for an evaluating supply chain of an electronic industry [10], also in an open ended survey conducted in an Indian market seeking an impact of such metrics on five different links [11].

Measuring supply chain performance leads to intimated decision making to track the efficiency level. The aim of implementing performance measurement system is to improve organization performance [12]. Some performance measures found out in the subsequent literature review is listed below in table 1.

Table 1: Performance measures used earlier by researchers

Performance Measures/ Metrics	Researchers
Product Quality	Beamon (1999), Sahin et al (2000), Lambert & Terrance (2001), SCC (2000), Zheng & Li (2008), Chan & Qi (2003b), Lin et al (2005)
Process Quality	SCC (2000)
Customer Response Time	Vishwanadham (1999), Beamon (1999), Sahin et al (2000), Lambert & Terrance (2001), SCC (2000), Zheng & Li (2008), Chan & Qi (2003b), Lin et al (2005)
Vendor Managed Inventory	Lambert & Terrance (2001)
Lead Time	Vishwanadham (1999), Sahin et al (2000), SCC (2000), Zheng & Li (2008), Chan & Qi (2003b), Lin et al (2005)
Fill Rate	Vishwanadham (1999), SCC (2000), Zheng & Li (2008), Chan & Qi (2003b), Lin et al (2005)
Inventory Cost	Vishwanadham (1999), SCC (2000), Zheng & Li (2008), Chan & Qi (2003b)
Distribution Cost	Vishwanadham (1999), SCC (2000), Zheng & Li (2008), Chan & Qi (2003b)
Delivery Flexibility	Beamon (1999), SCC (2000), Zheng & Li (2008), Chan & Qi (2003b)
Volume Flexibility	Beamon (1999), SCC (2000), Zheng & Li (2008), Chan & Qi (2003b)
Rate of Return on Investment	Kaplan & Norton (1996), Beamon (1999), Zheng & Li (2008)
Innovations	Kaplan & Norton (1996), Zheng & Li (2008)
Used in Textile Industry: Accuracy of production planning/ queuing/ material planning/ Sourcing time/ Inventory turnover/ sample cycle time/ rework production/ on time delivery/ delivery cycle time/ cost of delivery ratio/ amount of dead stock return of defective products	Ekkprawatt Phong-arjarn et al (2010)

4. PROPOSED FRAMEWORK

4.1 Framework

With the fact that observed in literature that problems occurred in textile supply chain is synchronization of activities throughout the life cycle of its products. As there is very less literature available in textile supply chain performance measurement, integrating different cyclic processes of textile supply chain is difficult task [13]. The need to today's competitive globalization is the performance measures of textile supply chain [26].

Looking to this, we developed a framework for identifying critical performance measures having an impact on performance of three distinct cyclic processes s which are procurement division; production division and distribution division are selected [27].

For enveloping entire organization's measurable aspect in to consideration involving financial and non-financial as well, we selected the philosophy of BSC for measuring the performance of three cyclic processes s. BSC has four perspectives i.e. financial perspective, customer perspective, internal business perspective, innovation & learning perspective giving an insight of complete organization's measurement. Also the effectiveness of any process/ concept implementation or use of any productivity/ quality improvement can be evaluated at three decision level which are strategic, tactical and operational[9].

To arrange it in systematic framework as shown in figure 1, we preferred a hierarchical way with following levels;

Goals- Overall supply chain performance measurement

Criteria- Financial perspective, Customer perspective, Internal Business perspective, Innovation & learning perspective

Alternatives- Procurement Division, Production Division, Distribution Division

Sub-criteria: - Number of performance measures has been suggested in literature review under BSC perspectives [9].

4.2 Case Study

Case study has been conducting in a small & medium scale textile industry in the region of central India. The industry is medium scale enterprise producing yarn & fabric located in southern region of central India having 1200 employees. Enthusiastic to adopt new technologies & philosophies having number of employees approximately. Company has ISO certification.

Case study is conducted for understanding the utilization and implementation of BSC and finding the priorities of various performance measures under different perspectives as identified categorized in strategic, tactical and operational decision level by Bhagwat & Sharma [10].

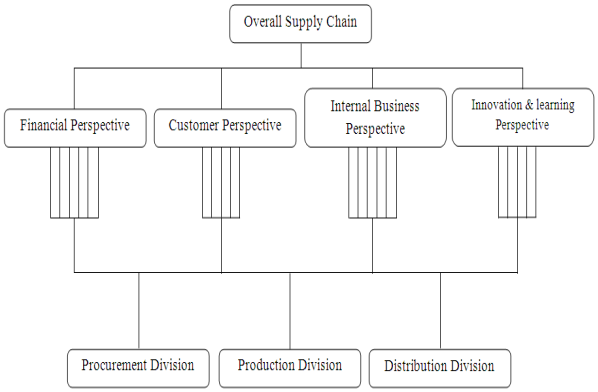

Figure 1: Pictorial representation of problem hierarchy

Experts from industry were interviewed with semi-structure questionnaire. Experts consists of person from every department of industry i.e. procurement, production (consist of different department of textile industry) and distribution and one from top management. At top management, representatives are general manager/ vice president. Experts from each department/ departmental division are preferably heads of the department. In all, total, 16 industry experts were interviewed in detail.

Responses were sought i) for the consensus on the selection of number of measures under each BSC perspective, ii) for establishing priorities among the selected criteria/ sub-criteria and their impact on the alternative i.e. procurement, production and distribution.

For analyzing such complex system involving various parameters which becomes problem of multi criteria decision making, analytical hierarchy process (AHP is the best technique to design the complex problem into hierarchical structure with specified goals, criteria, sub-criteria and alternatives. With the help of AHP, various parameters can be priorities to establish their pair wise comparison and find the impact of those criteria/ sub-criteria on alternatives [25].

Consensus of expert on identification of performance measures for selecting as sub-criteria for measuring the supply chain performance is shown in table 2. For seeking consensus, coefficient of variation (COV) & cronbach's alpha is calculated for checking expert's responses and reliability among the opinions.

Using pair wise comparison and mathematics of AHP, priority weights of various BSC perspectives & associated performance measures are calculated with respect to different cyclic processes as alternatives of supply chain. It is as shown from table 3 to table 8.

Table 2: Consensus of experts for performance measures under each perspective

BSC Perspective	Performance Measures	COV	Cronbach's Alpha
Financial Perspective	Net profit vs productivity ratio	0.36	0.8
	Rate of return on investment	0.093169	
	Supplier's cost saving initiatives	0	
	Supplier's rejection rate	0.408248	
	Information carrying cost	0.106479	
	Inventory carrying cost	0	
	Cost per hour of operation	0.11907	
	Manufacturing Cost	0	
	Variation against budget	0.333333	
Customer Perspective	Quality of goods delivered	0	0.8
	Effectiveness of delivery invoice methods	0.298807	
	Delivery performance & lead time	0.093169	
	Range of products/ services	0.372678	
	Customer satisfaction	0	
	Effectiveness of distribution planning schedules	0.11907	
	Level of customer perceived value of product	0.40745	
	Customer query time	0.152145	
	Quality of delivery documentation	0.298807	
Internal Business Perspective	Flexibility to meet particular customer needs	0	0.7
	Total supply chain cycle time	0.11907	
	Frequency of delivery	0.335346	
	Level of supplier's defect free deliveries	0.408248	
	Product development cycle time	0.124482	
	Capacity utilization	0	
	Planned process cycle time	0.11907	
	Total cash flow time	0.316715	
	Extent of cooperation to improve quality	0	
Innovation & Learning Perspective	Buyer-supplier partnership level	0.093169	0.8
	Accuracy of forecasting	0	
	Order Entry method	0.3803	
	Employing information technology and knowledge management concepts	0.124482	
	Use of quality engineering & quality management techniques	0.093169	
	Employee satisfaction and skill orientation	0	
	Supplier's booking procedures	0.475073	
	Range of products/ services	0.5	

Performance measures with COV value more than 0.15were not among the choices of experts under specific perspective. COV should be less than 0.15. Also, the acceptable range of cronbach's alpha is 0.7 to 0.8. Consensus is achieved with the elimination of some performance measures not having positive expert's opinion, also the judgments was found reliable.

Table 3: Weights of 4 BSC's perspective after pairwise comparison

Sr No	Criteria	Weights		
1	**Financial Perspective**	**0.489**	λmax. =	4.25
2	Customer Perspective	0.183	CI=	0.0843
3	Internal Business Perspective	0.356	CR=	0.0947
4	Innovation & Learning Perspective	0.105		

Table 4: Performance at Financial perspective

Sr No	Sub-criteria	Weights	
1	Rate of Return on Investment	0.188	λmax. = 6.4
2	Supplier's Cost Saving Initiative	0.113	CI=0.08
3	Information Carrying Cost	0.163	CR=0.064
4	Inventory Carrying Cost	0.126	
5	Manufacturing Cost	0.254	
6	**Cost per operation hour**	**0.321**	

Table 5: Performance at Customer Perspective

Sr No	Sub-criteria	Weights		
1	Quality of delivered goods	0.201	λmax. =	5.19
2	Delivery performance & lead time	0.191	CI=	0.05
3	**Customer Satisfaction**	**0.302**	CR=	0.05
4	Effectiveness of distribution planning schedule	0.165		
5	Customer Query Time	0.128		

Table 6: Performance at Internal Business perspectives

Sr No	Sub-criteria	Weights		
1	Flexibility to meet particular customer needs	0.169		
2	Total supply chain cycle time	0.104	λmax. =	6.053
3	Product development cycle time	0.14	CI=	0.108
4	**Capacity Utilization**	**0.289**	CR=	0.009
5	Planned process cycle time	0.154		
6	Extent of cooperation to improve quality	0.197		

Table 7: Performance at Innovation & Learning perspectives

Sr No	Sub-criteria	Weights
1	Buyer-supplier partnership level	0.28
2	**Accuracy of forecasting**	**0.308**
3	Employing IT & KM technologies	0.101
4	Use of QE & QM techniques	0.184
5	Employee satisfaction and skill orientation	0.128

λmax. = 5.22
CI= 0.05
CR= 0.05

We have also compared the functional processes of supply chain with respect to different perspectives of BSC. Their weights are shown in table 8.

Table 8: Priorities with respect to Performance at 4 BSC's perspectives

Sr. No.	Alternatives (Functional Processes)	Financial Perspective	Customer Perspective	Internal Business Perspective	Innovation & Learning Perspective
1	Procurement	0.209	0.119	0.165	0.214
2	Production	0.524	0.668	0.522	0.498
3	Distribution	0.265	0.213	0.313	0.287
Max. Eigen Value: - λmax.		3.064	3.004	3.014	3.0019
Consistency Index		0.00352	0.002	0.005	0.0009
Consistency Ratio		0.068	0.0384	0.096	0.0173

5. DISCUSSION

As per the observation from table no. 3 to 7, it is clear that, for small and medium sized textile industry, supply chain performance measurement is driven by financial achievement of an industry followed by internal business operational perspective. Among financial perspective, cost of each and every activity contributes mostly followed by entire cost of production leading to supply chain financial productivity. Customer perspective is driven by the fact that fulfilling the needs of customer achieving customer satisfaction is most important followed by quality of goods delivered also perceived to be important. Whereas, in case of internal business process perspective, capacity utilization is most important aspect so as to achieve the supply chain asset management efficiency. In this, extent of cooperation to improve quality is also got attention from small and medium sized enterprise. In case of innovation and learning perspective, accuracy of forecasting got maximum weightage form such enterprises, because being small, their ultimate objective is to sell out the entire manufactured item to avoid losses due to improper demand forecasting. In short, it can be summarized that, small sized textile enterprise are focusing on their day-to-day operation for maintaining the efficiency of supply chain. The issues may differ when investigation is executed for larger companies.

6. CONCLUSION

Application of BSC in textile industry is studied with the understanding of applicability of different perspective for measuring the supply chain performance. Performance measures at strategic, tactical & operational level, categorized under each perspective as suggested in [10] have been tested for the opinions of experts from the textile.

Accountability of cyclic processes of supply chain management i. e. procurement, production and distribution is considered to evaluate the performance of supply chain. As shown in table 1, performance measures having COV more than 0.15 are unacceptable for supply chain performance point of view. A hierarchical framework has been designed for measuring the overall supply chain performance. AHP is used for calculating the priority weights by establishing pairwise comparing of every criteria, sub-criteria and its impact on alternative in the form of cyclic processes of supply chain management are calculated.

Measures with high weightage are more critical as compared to others. Table 3 to table 8 shows the pairwise of different performance measures and sub-measures and impact on cyclic processes of supply chain management. The study gives an insight for

small & medium sized textile industry used to measure its supply chain performance, utilizing the comprehensive perspective of BSC. Application of AHP for solving such multi criteria decision making makes this approach more suitable for textile industry managers. This study is extended in our further work for elaborating the applicability of proposed framework by applying it to specific textile industry.

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