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Impact on Manufacturing Process Through Effective Supply Chain Performance Measurement Approaches

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Abstract: *To meet the future competitive challenges in the field of Small and Medium Scale Enterprises(SMES), decision makers of their companies are ready to take any risks through strategic, tactical and operational level decisions with respect new advanced technologies and practices. Identifying any wastes in the manufacturing process is tedious for which better standards and practices are essential in this regard. so we can identify the route cause for the any cause of the problem in process through the application of new performance measurement techniques. The important and effective advanced technology to check the performance of the process line for the same is supply chain performance indicators or metrics. This shows greater impact on effective operation and efficiency of the product and their processes. Measuring performance characteristics of small and medium scale enterprises in simple and economical way is most essential in current trends in the market for sustainability and continuous improvement. The SCM performance techniques is a management technology, application of this to SMES process line is the new idea for the improvement of the products in effective manner with ideal cycle time is the main logic behind this work, by adopting this management performance technique to manufacturing process line effectively can definitely gives the great value to the product in customer view.*

Index terms: *Small & Medium scale enterprises, Performance measurement techniques, SCM performance Measures (SCPM).*

1. INTRODUCTION

Supply chain management (SCM) is an important multi-disciplinary topic in modern business management and research environment for the organizational productivity and profitability through a revolutionary philosophy to managing the business with sustained competitiveness [1]. SCM has become increasingly important to businesses activities of an any organizations to supplying goods and services to the end customers, manufacturing firms worldwide have embraced, in SCM the new innovative technology and new management thinking is required to cope up with local and global competitors[2]. A typical supply chain (SC) commonly involves a network of tiered suppliers producing raw materials, parts, components, subassemblies, assemblies and final products together with business process and customers, SC(supply chain) performance for a firm as the performance of the various processes included within the firm's functions [3]. The several metrics of supply chain performance enable firms to have a benchmark to assess their SCM performance including internal and external firms. The application of internal linkage performance metrics results in elimination of non-value added activities, reduction in order variation, faster product flows, more efficient use of time, material and human resources, and reduction of the bullwhip effect, Benefits of usage of external linkage performance metrics include the creation of end-customer value through closer integration activities and communication with other member firms along the supply chain [4]. Increasing competitiveness through SCM related to key performance indicators (KPI's). So the present study attempts to review the empirical contributions of various authors' views in SCM & its performance indicators values, finally its limitations and future research opportunities are discussed clearly.

1.1 Definitions and developments

SCM concept is originated in the manufacturing industries in the early 1980s. It was developed from innovations such as just in time (JIT) and total quality management (TQM) [5]. According to Council of Supply Chain Management SCM encompasses the planning and management of all activities involved in sourcing and procurement, conversion and all logistics management activities, which also includes coordination and collaboration with channel partners, suppliers, intermediaries, The evolution of supply chain categorized in to 3 steps as

- Direct supply chain: is a set of three or more companies directly linked by one or more upstream and downstream flows of products, services, finances and information from a source to a customer.

- Extended supply chain: which includes supply of the immediate supplier and customer of the immediate customer
- Ultimate supply chain: from the initial supplier to the ultimate customer. upstream and downstream flows of products, services, finances and information fl

1.2 supply chain management performance measurement (SCPM)

The SCPM is the process of quantification and actions leads to performance by satisfying customers with greater efficiency and effectiveness than their competitors [6]. Considering the supply chain processes with respect to decision making levels also that needs collaboration from all stakeholders of supply chain system to evaluate the framework, present different performance measurement frameworks specifically designed for the inter-organizational environment. They further develop a performance measurement system looking into the requirements of extended enterprise, via two performance measurement frameworks: the structural extended enterprise balanced scorecard and the procedural framework for the selection and implementation measures. [7] Describes Balanced score card perspectives for supply chain management and apply in SMEs in India to determine the proposed perspectives. [8], Supply chain processes propose a framework using a systematic approach to improving the

2. LITERATURE REVIEW

In various dimensions and perspectives of SCM and its performance measurement, The literature review is focuses on key concepts, developments, revolution approaches of performance Measurement techniques, practices and its improvements are discussed in related to SMES in India and globally. The review begins with a overview of supply chain and its performance management, including definitions and development and its applications in various manufacturing industries

2.1 Performance measurement developments

In consistency measures how economically a firms resources are utilized to achieve a predetermined level of customer satisfaction which Specifies on Combine decision making levels with financial and non-financial criteria and measures with too many number of metrics and measures The Balanced score card perspectives for supply chain management in SMEs applications in India can determine the proposed perspectives & the SCPM developmental criteria is given per Table: 1

Table 1: Evolution of SCPM

Before 1980	1980-1990	1990-2000	2000-2010
Financial aspects	Operational and value added perspectives	Financial & Non financial orientation	Balanced score card Interposes activities

2.2 SCPM frame works and its classifications

Performance measurement is defined as the process of quantifying effectiveness and efficiency of action. Performance measurement systems are described as the overall set of factors used to quantify both the efficiency and effectiveness of action. [9] Specifies on Combine decision making levels with financial and non-financial criteria and measures .Evaluation processes of SCPM which described on basis of decision making ability was identified[10], considering the SC (supply chain) processes with respect to decision making levels needs collaboration from all stakeholders of supply chain system to evaluate the framework [11] and inter-organizational environment via two performance measurement frameworks: the structural extended enterprise balanced scorecard and the procedural framework for the selection and implementation measures. [12] Describes Balanced score card perspectives for supply chain management and apply in SMEs in India to determine the proposed perspectives. [13] Approached Six Sigma (DMAIC) to propose a modified 2-tuple fuzzy linguistic computing (FLC) model to evaluate the performance of supply chain management. The iterative key performance indicators (KPIs) in a SC context is the proposed framework quantitatively analyzes the interdependent relationships among a set of KPIs. [14], Integrated SCPM framework for small and medium scale enterprises (SMEs) in India of qualitative and quantitative insights is focused.

3. SCPM APPROACHES BY VARIOUS AUTHORS

The SCM performance measures can be divided into financial and non-financial measures. Top management needs financial measures for management level decisions, but lower management and workers need operational measures for daily business. The framework with metrics of SC performance as fallows.

- **Financial performance measurement system:** is a traditional accounting method and focused on financial indicators in which two popular methods are
  - *Activity based casting (ABC):* involves braking down of activities in to individual tasks with estimation of time and costs
  - *Traditional cost accounting:* which method is based on the shareholder's value related to company's operating profits [15]
- **Non Financial performance measurement systems:** here without considering cost ,operational activities are more concerned, they are
  a) *Supply Chain Balanced Score Card system (BSC):* Kaplan and Nortan were introduced; observe a balanced view of both operational and financial measures.
  b) *Supply Chain Operations Reference Model (SCOR):* The first version was developed in 1996, and SCOR

was created by the supply chain council [16], here examining the SC through categorywise.

c) *Dimension and information based Measurement System (DBMS,IBMS):* SCM measures as speed, assets and service related to capture and fulfill the customers, in IBMS objective is maximizing the shareholders value for entire supply chain of an individual enterprises [17]

d) *Perspective based Measurement System (PBMS):* here six unique set of matrices were defined [18]

e) *Hierarchical based Measurement System (HBMS):* Here supply chain through appropriate management level, and measures are classified as strategic and operational level [19]

f) *Function based Measurement System (FBMS):* system measures are combined at different linkages of individual departments

g) *Efficiency based Measurement System (EBMS):* This system measures the supply chain performance in terms of efficiency.

h) *Generic Performance Measurement System(GPMS) :* in early 1980,s number of GPMS were developed, among very few are cited and discussed [20] as fallows

1) *Performance prism:* It is performance measurement frame work on the basis of five perspectives is indicated stake holder satisfaction like employees, suppliers and alliance partners. Stakeholder contributions, processes, strategies, & capabilities are also considered.
2) *Performance pyramid:* here link an organization strategy with its operations by translating objectives from the top down (customer priorities) and measures from the bottom up (manufacturing with integration of corporate objectives with operational performance indicators
3) *Medory and steeple's frame work :* here the graphical frame work is developed for auditing and enhancing performance measurement system through the success factors of the enterprises, previous state competitive priorities, and design of new system with existing system.
4) According to various authors' views of SCM performance metrics can be defined as in Table 2
5)

Table 2: Supply Chain Performance Matrices

Author	Area of measuring field	Performance measurement Factors
Ramdas K & Spekman R.E (2000), [21]	Inventory, time, order fulfillment, quality, customer focus and satisfaction.	Inventory levels, turns and costs, order-processing time and shipment accuracy, Quality as continuous improvement,
Chan and Qi, (2003) [22]	International manufacturing operations	Operation cost (financial), Product quality (non financial), Efficiency, Flexibility, Productivity, Buyer supplier partnership level
	Outbound logistics (warehousing)	Warehouse costs (non financial), Inventory flow rate & accuracy Stock capacity, Facility utilization, forecasting techniques
	Marketing and sales (customer order processing and delivery)	Total inventory: Incoming stock level, Work in progress ,Response time, Order fill rate, Order flexibility Delivery reliability: timeliness
Otto and Kotza (2003) [16]	System dynamics	Product quality, Efficiency, Flexibility, Productivity, Buyer supplier partnership level
	Operations research / information technology	Delivery performance, Logistics costs per unit, Time to deliver
	Logistics	Integration, Lead times, Order cycle time, Inventory level, Flexibility
	Marketing	Customer satisfaction, Distribution costs per unit, Market share
Gunasekaran et al. (2007) [23]	Strategic level	Perceived value of product(non fin, Variances against budget, Total cycle & cash flow time, products & services flexibility
	Tactical Level	Percentage of defects(non financial), Cost per operation hour, Capacity utilization, and delivery speed, Flexibility of service
	Operational Level	Percentage of defects(non finl.),Cost per operation hour, Human resource productivity index, Quality of delivered goods,
Haugg et al. (2005) [24]	Delivery reliability	Delivery performance, Fill rates, Perfect order fulfillment, Buyer supplier partnership level
	Responsiveness	Operation cost (finl.), Order fulfillment lead times (non finl.), Supply chain response time
	Flexibility	Production flexibility
	Cost	Cost of goods sold (financial), Total supply chain management cost, Warranty
	Assets	Cash-to-cash cycle time, Inventory days of supply Asset turns
Aramyan et al. (2007) [25]	Efficiency	Production costs (finl.), Transaction costs, Profit, Return on investment, Inventory "
	Flexibility	Customer satisfaction (non finl.), Volume & delivery flexibility,
	Responsiveness	Lead time,, Product lateness, Customer response time & complaints
	Product quality	Prodt. reliability, convenience(non fin), Production system characteristics: traceability, storage, transportation, Environmental aspects: energy, water
	Finance perspective	Cost per operation hour, Information carrying cost, Supplier rejection rate

3.1 Supply chain performance measurement systems (SCPM)

There are few models for evaluating the performance measurement of supply chains and their major categories are defined [26], researchers have classified the performance measurement systems as below

- Balanced score card (BSC) perspective (Financial, customer, internal business process, learning & growth)
- Components of performance measures (Resource, output, and flexibility)
- Location of measures in supply chain links (Plan, source, make, and deliver)
- Decision making levels (Strategic, tactical, and operational)
- Nature of measures (Financial and non-financial)
- Measurement base (Quantitative and non-quantitative)
- Traditional vs. modern measures (Function-based and value-based)
- Nature of measures (Financial and non-financial)
- Measurement base (Quantitative and non-quantitative)
- Traditional vs. modern measures (Function-based and value-based)

3.2 SCM Performance measurement Models

By the review of literature from many authors above, typology of models that identifies the main streams in the field of supply chain performance measurement. And their 3 main classifications are

- Result based (Balanced scorecard, BSC)
- Hierarchical (decision making levels) and
- Process based (supply chain operations reference Model-SCOR) frameworks as shown in table 3.

Table 2: SCM measurement models categories

Author reference	Criteria	Approaches
Kaplan and Norton [27]	Result based	Balanced score card (BSC)
Gunasekaran et al. [10]	Hierarchical	Decision making levels
Supply Chain Council (1996)	Process based	Supply chain operations reference (SCOR) model

First type balanced scorecard (BSC) approach:

The Concept of BSC is proposed by David Norton, the CEO of Nolan Norton Institute, and Robert Kaplan, and a professor at Harvard University. Kaplan [28] provides the balances of financial measures with non financial measures and between long & short term objectives. BSC measures organizational performance from four perspectives, including financial, customer, internal business process and learning and growth, in relation to four functions of accounting and finance, marketing, value chain, and human resource BSCs have two main approaches: customer perspective and financial perspective. Customer perspective is a value-adding view and financial perspective is the shareholders view.

***The second type Hierarchical model of performance measurement system*:** evaluates the company's strategic plan down to operational level, the performance through various hierarchical levels of the organization with respect to strategic, tactical and operational levels, evaluates a score for prioritize for each metric by three levels: highly, moderately and less important levels from an empirical study of selected British companies.

The third type SCOR model: It is globally accepted model, and introduced in 1996 and has been endorsed by the Supply Chain Council (SCC), Provides a systematic way to analyze SCP(supply chain performance),The SCOR model is a business process reference model, which provides a framework that includes supply chain business processes, metrics, best practices, and technology features, and attempts to integrate the concepts of business process reengineering, and best practice analysis and apply them to supply chains

3.3. Emerging Technologies in SCPM

Emerging technologies and practices in e-business will have a dramatic impact on SCM

1) Virtual marketplaces
2) Radio frequency identification tags (RFID)
3) Synchronized planning
4) Supplier performance management

1) Virtual market place: Have many names such as e-markets, net market places, and electronic markets. Will have common characteristics

- Reliance on the Internet
- Buyers and Sellers come together without an intermediary
- Neutrality (all buyers and sellers are treated the same)
- Information is provided about sellers and products

Brings together buyers and sellers through the internet. a virtual market place gives a purchaser and supplier the opportunity to re-engineer the sales administration process, improve forecasting and scheduling, renew its go-to-market approach, shorten its order-to-cash cycle, information to vendors, product specifications & its comparisons also provides technical papers, and market analysis

2) Radio frequency identification tags (RFID): Auto-ID is often coupled with automatic data capture which includes different technologies such as Bar code, Smart code, RFID, Optical character recognition OCR) (and biometrics such as (finger print and voice recognition). RFID tag consists of a microchip attached with radio antenna, the chip stored information about the product or shipment, the information stored in the tag was detected and recorded when tag was passed near reader equipped with antenna that tracked the tag's movement its digital identity to a computer system [29].

3) Synchronized planning:

Is the form of collaborative forecasting and replenishment, coordinated production, inventory and capacity plans,

information integration, and direct linkages of ERP systems, Synchronized Planning involves key steps

- Information integration
- Planning synchronization
- Workflow coordination
- New business models

Information integration*:* is the sharing of information among the members of the supply chain. includes inventory levels, production schedules, and shipment schedules. The benefits include better job scheduling and bullwhip effect reduction

Planning synchronization: defines is information sharing like collaborative planning and joint design. Procurement, design changes, new product expansion & market angles.

Workflow coordination:. Operations can be coordinated include procurement, engineering and design changes, and production planning. Which leads to early time to market, improved service, and gains in efficiency.

New business model: Are formal and informal descriptions to represent core aspects of a business including purpose, business process, target customers, offerings, strategies, infrastructure, trading practices, and operational processes and policies

4) Supplier Performance Management:

The effective supplier performance management of a company ensures a supplier's performance meets the customers' expectations It includes the management of actual performance, identification of performance gaps and agreement of actions to achieve desired performance levels. Use web based software. SCM automation

4. REQUIREMENTS AND LIMITATIONS OF SCPM

The essential requirements and its limitations are considered as per the various authors views.

4.1 Requirements for SPMS metrics to SMES (Small and Medium Enterprises)

The most essential characteristics of performance measurement and metrics requirements are

- Clearly define the actual purpose, data collection methods, route cause analysis of the whole process
- The measure is based purely on enterprises strategy and performance based.
- Set the targets on priority basis towards continuous improvement program
- Ability to face complex supply chain strategy both financial and non financial
- Make comparative analysis with other succeed company
- Involving the concepts of total quality, lean tools towards supply line multidimensional factors
- Selection of measurement system towards shorter lead time with simple technologies using SCOR models

4.2 Exiting Limitations of SCPM

The detailed review clearly finalized and focused the problems and limitations of SPMS, many enterprises are failed to succeed in this filed, because they have not finalized the performance measures linked with supply chain activities to get the maximum efficiency and effectiveness. The main reasons and factors are limited to fallowing factors

- Collection of Inconsistence and incomplete data of performance measurement and its metrics
- Lack of balanced set of financial and non financial measures approach
- Bulk metric are considered at a time which leads to confusion to give more prominence
- Failing to integrate dynamic strategies and effectives measures of standards
- Difficult to find cause and effect for the relationship with measurement system

5. CONCLUSION

Based on the previous discussions and detail study, the following three major approaches for SC performance measurement system are process centered management & time based approach in par with the decision making factors in Quantitative and qualitative measures for Innovative factors of operating conditions in supply chain line. It seems too relevant with plan, source, make deliver and return situations of SCM line, furthermore, there should be financial and non-financial metrics for SCM should be measured at multiple levels, But most of the cases non-financial metrics are more informative and involving with operator's level of process line, where we can find bulk problems to consider for SCM improvements.

The total SCPM is challenging always for continuous improvement process in SMES towards the efficiency. So along with SC performance measures focusing on system dynamics like supply chain flexibility, agility, robustness, resilience and security, relational components like trust, cooperation, adoption, communication and commitments, behavioral metrics on buyer and supplier side, scope of structural equation model of risk management and supply chain sustainability towards the strong performance measures are to be considered seriously gives higher potential for the current system for the manufacturing process is essential for their effective goals goals. By the detail study, identification of exact SCPM for the supply line activities and treat them properly with advanced lean tools can helps to achieve the efficiency by improving productivity with better customer satisfaction is possible in simple way.

6. FURTHER RESEARCH DIRECTIONS

However the Supply Chain performance measurement the framework should tested in scientific terms in real case situations will provide the access for real time works for data collection through network and validation performance level through KPI (key performance Indicators) are most powerful technical support for the future researchers in different directions.

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