Chapter -2

LITERATURE REVIEW

This chapter examines key concepts and approaches used in the research. There are various interconnected themes in this literature review, covering the themes of supply chain management and supply chain performance measurement. The review begins with a brief discussion of supply chain management, later focuses on performance measurement of supply chain that involves on the issues of: 1) Supply chain performance measurement models or frameworks 2) Performance measurement factors for supply chain in medium-sized industries 3) Modelling supply chain networks performance using various approaches and lastly on 4) Information systems for supply chain such as warehouse management systems.

2.1 Supply Chain Management (SCM)

This section outlines definitions and development of supply chain management, evolution of supply chain management, advantages of supply chain management for manufacturers and supply chain management practices.

Supply chain management is a concept that evolved in the manufacturing industries in the early 1980s. It is developed from innovations such as just in time (JIT) and total quality management (TQM) [24, 25]. Supply chain management can be seen as an example of evolutionary and cumulative innovation, which is often described as emanating from internal programs aimed at improving overall effectiveness [6]. The focus is not only limited to increasing the internal efficiency of organizations, but also has now been broadened to include methods of reducing waste and adding value across the entire supply chain [26]. Supply chain management has shifted the emphasis from internal structure to external linkages and processes, and is dependent on the interaction between the organization and its external environment, with strong feedback linkages and collective learning. It is seen as a set of practices aimed at managing and coordinating the whole supply chain from raw material suppliers to end customers which develop greater synergy through collaboration along the whole supply chain [27].
The principal objective of supply chain management is “to satisfy the end customer requirements” and the focus is on how organisations utilise the processes, technology, and capability of suppliers to enhance their own competitive advantage. Supply chain management research generally focuses on improving the efficiency and competitive advantage of manufacturers by taking advantage of the immediate supplier's capability [28].

It is important to recognize that supply chain management is complex and has proved to be difficult to implement. Its success is associated with the challenging and difficult development of a new culture based on shared learning, greater transparency and trust. With a greater reliance on suppliers and the increasing emergence of outsourcing and fierce competition, the main challenge for supply chain management is to sustain and continuously improve the coordination and integration of all interactions and interfaces in order to enhance the overall performance of the supply chain. It is, therefore important to associate the concept of supply chain management based on continuous improvement with performance measurement [6].

2.2 Supply Chain Performance Measurement (SCPM)

This section highlights on various issues of performance measurement of supply chain including performance measures, performance measurement systems, strategies, framework adopted by organizations.

Performance measurement is defined as the process of quantifying effectiveness and efficiency of action. Effectiveness is the extent to which a customer’s requirements are met and efficiency measures how economically a firm’s resources are utilised when providing a pre-specified level of customer satisfaction [29].

Development of the literature on performance measurements can be divided into two distinct phases: The first phase relates to the period until the 1980s and concentrates on financial measures such as profit, return on investment and productivity. The second phase, which commences in the late 1980s, corresponds to the emergence of new management concepts such as supply chain management. It attempts to place a greater emphasis upon the inclusion of less tangible and non-financial measures in performance measurements [30].
In SCM, the hierarchy of metrics is often used to refer to one of three different constructs:

- The individual metrics;
- The metrics sets; and
- The overall performance measurement systems (PMSs).

Performance measurement systems are described as the overall set of factors used to quantify both the efficiency and effectiveness of action. The ability to assess supply chain performance among and across interlinked organizations is an important factor of success for leading supply chains organizations and differentiates them from poorly performing supply chain members [31].

At the highest level, the performance measurement system (PMS) level integrates, coordinates metrics across the various functions and aligns the metrics from the strategic to the operational levels. The challenge is to design a structure for every activity, product, function, or relationship to the metrics (i.e., grouping them together) and extract an overall sense of performance from them. Several different approaches have been proposed for developing such an integrative system. These include:

1. The Balanced Scorecard, as presented by Kaplan and Norton [32, 33].
2. The Strategic Profit Impact model [34]; and
3. The Theory of Constraints (TOC) measurement system [35].

The development of a PMS may conceptually be separated into phases of design, implementation, and use [36]. The design phase is about identifying key objectives and designing measures. In the implementation phase, systems and procedures are put in place to collect and process the data that enable the measurements to be made regularly. In the use phase, managers review the measurement results to assess whether operations are efficient and effective, and the strategy is successfully implemented. This may also lead to challenging the strategic assumptions.

The performance of supply chain management is required to measure up with respect to some standard models or frameworks. The following is the discussion on various approaches adopted by researchers and their pros and cons:
According to Beamon (1999), three types of performance measures (resources, output and flexibility) have been identified as necessary components in any supply chain performance measurement system, and she has proposed flexibility quantitative measurement approach for supply chains [37]. However, it lacks system thinking, in which a supply chain must be measured widely across.

Gunasekaran et al. (2001) illustrate and discuss different performance measures and metrics of the supply chain management with the help of a framework that gives cohesive picture to address what needs to be measured, and how it can be dealt with. The framework is classified into strategic, tactical and operational levels of management. The metrics are also divided into financial and non-financial, so that, a suitable costing method based on activity analysis can be applied. However, due to the large number of metrics and measures given in the framework, firms find it difficult to use. Also, the framework does not provide guidelines to prioritise these metrics [2, 38].

Chan and Qi (2003) have proposed an innovative performance measurement method to contribute to the development of supply chain management from five core processes: supply, inbound logistics, core manufacturing, outbound logistics and marketing & sales. These process-based systematic perspectives are employed to build an effective model to measure the holistic performance of complex supply chains (cross organization). Fuzzy set theory is introduced to address the real situation in judgment and evaluation processes. However, this proposed model overlooks the decision making ability across strategic, tactical and operational levels [39].

Otto and Kotzab (2003) have designed suitable metrics to measure the effectiveness of supply chain management in six unique sets of supply chain metrics from six perspectives on supply chain management. Each perspective follows a particular set of goals, which consequently leads to a particular set of performance metrics. The various perspectives, which contributed the most to the development of supply chain management, are: system dynamics, operations research or information technology, logistics, marketing, organization and strategy. Each perspective has its very own notion of a supply chain, its standard problems and solutions, and its performance metrics. However, all the metrics are not used in business practice to measure supply chain performance [40].
Gunasekaran et al. (2004) developed a framework to promote a better understanding of the importance of supply chain management performance measurement and metrics. The proposed framework considers the measurement of supply chain processes (plan, source, make and deliver) with respect to strategic, tactical and operational levels and evaluates a score for prioritize for each metric by three levels: high, moderate, and less important level from an empirical study of selected British companies. It lacks identifying critical success factors for the whole supply chain system. Furthermore, for evaluating the score, the organization, suppliers and customers should come together to discuss how they would address the measurement and improvement of supply chain management performance [2].

Huang et al. (2005) have summarized the supply chain operations reference (SCOR) model, its benefits along with illustrative case stories and describe a computer-assisted tool to configure supply chain threaded diagram per SCOR specification. Supply chain configuration is an integral part in SCOR project implementation. Currently, the configuration of ‘as-is’ or ‘to-be’ threaded-diagram describing a supply chain is done manually. To automate this process, a computer-assisted configuration tool has been developed and described. However, the configuration tool can so far only deal with a single manufacturing facility of a company. It does not take into account the interactions among multiple manufacturing facilities. Thus, this research limits to only single manufacturing facility, of a company [41].

Li et al. (2005) have identified six aspects of SCM practices: strategic supplier partnership, customer relationship, information sharing, information quality, internal lean practices and postponement. This approach is connected very closely to information sharing. Sharing qualified information can lead to flexibility. In this context, SCM activities include making, sourcing, delivering time and postponement. They have identified performance outcomes as delivery dependability and time to market. Delivery reliability means capability of providing products to customer. Time to market means the time to introduce new products to market more quickly than competitors are able to do [42].

Bhagwat and Sharma (2007) have developed a balanced scorecard (BSC) for measuring and evaluating day-to-day business operations of supply chain management from following four perspectives: finance, customer, internal business
process and learning and growth. Three case studies develop and apply in small and medium sized enterprises (Medium-sized enterprises) in India. The balanced scorecard developed in this paper provides a useful guidance for the practical managers in evaluation and measuring of supply chain management in a balanced way and proposes a balanced performance measurement system to map and analyze supply chains. However, additional research is recommended in order to determine whether the proposed perspectives and measures are necessary and sufficient [43].

Chae (2009) offers an industry-oriented, practical approach to performance measurement in supply chain management contexts and proposes key performance metrics which can be easily adapted for different businesses. A list of essential key performance indicators (KPIs) is presented. Potential KPIs develop for each of the SCOR model’s four meta-process (plan, source, make and delivery) and have to be hierarchically grouped such as primary and secondary metrics. The review of industry standards and best practices in supply chain performance measurement suggests that ‘less is better’ as to developing performance metrics. Companies should focus on only a small list of KPIs which are critical for their operations management, customer service, and financial viability. The lack of this development model is the return process not considered in this work [44].

Thakkar et al. (2009) proposed an integrated supply chain performance measurement framework for the case of small and medium-sized enterprises (Medium-sized enterprises) in India using set of qualitative and quantitative insights gained during the case study research. The proposed framework integrates the features of balanced scorecard (BSC) and supply chain operation reference (SCOR) model to deliver a comprehensive performance measurement framework for medium-sized enterprises. It also outlines the detailed guidelines for the implementation and use of the framework. The research also reports a set of performance indicators for the supply chain processes like source, make and deliver in medium-sized enterprises. It also relates the measures with various supply chain cycles like procurement, manufacturing, replenishment and customer order, but it does not consider decision making levels [45].

Ilkka Sillanpää, (2010) in his thesis, has presented the framework of supply chain performance measurement. The key elements for the measurement framework are
defined as time, profitability, order book analysis and managerial analysis. The measurement framework is tested by measuring case supply chain performance. The measurement framework is a valid framework for supply chain performance measurement in manufacturing industry. The measurement framework offers guidelines for measuring the supply chain in manufacturing industry [46].

The summary of various performance measures and measurement framework dealt in literature are tabulated in the table 2.1. The abbreviations used for categorizing is as shown below

<table>
<thead>
<tr>
<th>Quality (Q)</th>
<th>Cost (C)</th>
<th>Delivery(D)</th>
<th>Flexibility (F)</th>
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<tbody>
<tr>
<td>Agility (A)</td>
<td>Responsiveness(R)</td>
<td>Non financial (NF)</td>
<td>Qualitative (QL)</td>
</tr>
<tr>
<td>Quantitative (QN)</td>
<td></td>
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</tbody>
</table>

Table 2.1: Supply chain performance measures from literature

<table>
<thead>
<tr>
<th>Author / Authors</th>
<th>Framework / Performance measures / Performance Measurement System</th>
<th>Category of Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gunasekaran,A, Patel C and Tittiroglu E (2001)</td>
<td>Strategic, operational and tactical focus [38]</td>
<td>QN, QL</td>
</tr>
<tr>
<td>Hieber(2002)</td>
<td>Supply chain collaboration efficiency; coordination efficiency and configuration [51]</td>
<td>Q, QN</td>
</tr>
<tr>
<td>Chan(2003)</td>
<td>Cost, quality, resource utilization, flexibility, visibility, trust and innovativeness [52]</td>
<td>C, Q, QN, F, A</td>
</tr>
<tr>
<td>Chan and Qi (2003)</td>
<td>Input, output and composite measures, processes of supply chain [39]</td>
<td>QN, QL</td>
</tr>
<tr>
<td>Chunhua Tian, Yeunting Chai, Yi Liu, Shouju Ren (2003)</td>
<td>Quality, cost, delivery and flexibility perspective performance measures at department, enterprise and supply chain level [53]</td>
<td>C, Q, QN, F, A</td>
</tr>
<tr>
<td>Author / Authors</td>
<td>Framework / Performance measures / Performance Measurement System</td>
<td>Category of Measure</td>
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<tr>
<td>Changrui Ren, Yueting Chai, Yi Liu, (2004)</td>
<td>Active performance management system [56]</td>
<td>QN, QL</td>
</tr>
<tr>
<td>Archie Lockamy III, Kevin McCormack</td>
<td>SCOR model [57]</td>
<td>QN</td>
</tr>
<tr>
<td>David J. Parsons, Robin J. Clark, Kevin L. Payette,</td>
<td>Relationship between productions run lengths and overall supply chain performance [58]</td>
<td>QN, Q</td>
</tr>
<tr>
<td>(2004)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2005)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Li, S., Rao, S., Ragu-Nathan, T. S., &amp; Ragu-Nathan, B.</td>
<td>Strategic supplier partnership, CRM, information sharing, quality, internal lean practices and postponement [60]</td>
<td>QL, QN, Q, C</td>
</tr>
<tr>
<td>(2005)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abhijeeet K. Digalwar, Bhimaraya A. Metri (2005)</td>
<td>Theoretical framework for the performance measures of World Class Manufacturing [63]</td>
<td>QN, Q, C</td>
</tr>
<tr>
<td>MAO Zhaofang et al.(2006)</td>
<td>Supporting evaluation level(HITS-Human, Institution, Technology, Surroundings) and operational evaluation level(TQFS –Time, quality, Finance and service) [64]</td>
<td>QL, T, Q, C</td>
</tr>
<tr>
<td>Z., Li, X. Xu, &amp; Arun kumar (2007)</td>
<td>Supply chain performance measurement approach which evaluates a supply chain from both structural and operational levels [65]</td>
<td>QN, C, Q</td>
</tr>
</tbody>
</table>

**2.2.1 Supply chain performance measurement in medium-sized enterprises**

Globalization has thrown Indian Industries in to a competitive market, where imports and multinational companies are a biggest threat. The new competition is in terms of reduced cost, improved quality products with higher performance, a wider range of products and better services all delivered simultaneously to enhance value to customers [4]. There is increasing demand for high-quality products and highly
capable business processes by large organizations which have left no choice on the medium-sized industries than to consider the implementation of new technology and innovative business strategy. Failure to meet even one of these imperatives can jeopardize industries well-being and survival. Also, if industries fail to provide the quality products and services, there is a risk of losing customers who will opt for one of their competitors. A key driver of growth is innovation that surprises and delights the customers with new, differentiated and relevant benefits.

Garg et al. discusses the issues affecting the cost and delivery performance in Indian industries, while the big companies are focusing on profit, medium-sized enterprises have products well in quality at lower price. The smaller players who are willing to work with lower profit margins are gaining both volume and market share. The price-value offering from these small players fetch customers towards them [67].

Sahay and Mohan outline the supply chain practices followed by Indian organizations. They primarily focus on the status of four major supply chain dimensions namely; Supply chain strategy, Supply chain integration, Inventory management, and Information technology. The study recommends that Indian organizations should align supply chain strategy with business strategy in order to deliver highest customer satisfaction, streamline processes for supply chain integration to achieve operational excellence, form partnerships to minimize inventory and maximize profits, and focus on infrastructure and technology deployment to build an Indian specific supply chain. Moreover, coupled with this, is the action required by the Indian government to improve the infrastructure for the smooth functioning of supply chain [68].

Quayle designs a survey to identify current trends of supply chain management practice in UK’s small to medium-sized Industrial enterprises. The analysis identifies the adaptation of supply chain management techniques and relationships between customers and smaller suppliers. The outcome indicates a lack of effective adaptation from traditional relationships to the modern collaborative electronic commerce for supply chain. Another result identifies issues which businesses need to address to improve the performance of their supply chains, and improve their competitive position by grasping the benefits of effective supply chain management [69].

To compete and sustain in this globalised world it is necessary for medium-sized enterprises to improve their operational system. The manufacturing system in
medium-sized enterprises generally consists of obsolete technology, low reliability, high changeover time, and minimum flexibility, high employee turnover, less skilled and de-motivated workforce. These organizations also lack in managerial skills for Quality Management, Inventory Management and Production Planning & Control. These factors result in high cost, inferior quality, high rejection and rework, and poor delivery performance. For sustainable growth the organization must adopt introduction of innovative products/ processes, quality & productivity improvement techniques, and effective technology management and establish a performance measurement system to assess the improvements achieved.

Also medium-sized enterprises adopt outsourcing strategy to offer competitive pricing to gain increased market share [70]. Westerlund et al., have described that a medium-sized enterprises response to globalization is closely connected to its business model, which is manifested through the firms networking strategy and the nature of the offerings [71].

With the Information Technology boom, small industries have also been influenced by them in both positive aspect (more market information, extended customer base, new market exploration, business alliances, information about new technology, cost saving, right information on right time etc.) and negative impact (short term loss of market due to increased customer awareness about quality and cost effective products, initial cost, skilled persons to operate the system) [72].

2.2.2 Modelling approaches for performance measurement of supply chain network

The selection of the modelling approach directly affects the type of problem and structure that can be investigated. Understanding the advantages and limitations of these approaches can help other researchers to choose the correct approach to study their problem [73].

“Modelling and simulation is the use of models, including emulators, prototypes, simulators, and stimulators, either statically or over time, to develop data as a basis for making managerial or technical decisions. Many efforts for modelling and simulating SC systems have been made since the 1950’s. In the 2000’s, SCM performance measurement was presented using different approaches.
2.2.2.1 Simulation modeling and supply chain

Shepherd and Günter [74] categorize SC performance measurement research into operational, design and strategic research. The operational research focused on mathematical models for improving SC performance [75, 76]. Design research focuses on optimizing performance through re-designing the SC. Design research can be categorized according to the type of research model; Deterministic analytical models [77], Stochastic analytical models [78], Economic models [79] and Simulation models [80, 68]. Strategic research evaluates how to align the SC with a firm’s strategic objectives [82].

Terzi and Cavalieri provide a comprehensive review made on more than 80 articles, with the main purpose of ascertaining which general objectives simulation is generally called to solve, which paradigms and simulation tools are more suitable, and deriving useful prescriptions both for practitioners and researchers on its applicability in decision-making processes within the supply chain context. The authors report that network SC design, SC strategic decision support, demand and sales planning, inventory planning, distribution and transportation planning, and production planning and scheduling are some of the important aspects of SCM where simulation has been applied successfully. Also, authors highlight the importance of discrete event simulation, parallel distributed simulation (PDS) and the high level architecture (HLA) in the context of SCM [83].

Santa-Eulalia et al. proposed taxonomy to organize the literature review on modelling and simulation techniques for supply chains [84]. It is divided as follows:

- SC Simulation: represents essentially descriptive modelling techniques, in which the main objective is to create models for describing the system itself.
- SC Optimization: refers to normative models, i.e. models that suggest how the system should or ought to be. Modellers develop these kinds of models mainly to discover the ideal situation concerning the modelled system (optimal behaviours).
- Basic Hybrid Approaches: it is interesting to note that in between Simulation techniques and Optimization approaches, there is a basic hybrid approach called Simulation Optimization. This technique combines characteristics of both SC Simulation (i.e. descriptive models) and SC Optimization (i.e. normative models), and it is being widely discussed in the literature.
Artificial Intelligence: descriptive and/or normative models, used to create models that try to mimic systems including human behaviour for supply chain management. Modellers employ these models to describe the system, or for optimizing it, or both.

2.2.2.2 Analytic Hierarchy Process (AHP)

Analytical hierarchy process was developed in 1972 as a practical approach in solving relatively complex problems [85]. It is used for multi criteria problems in a number of application domains such as in Flexible manufacturing systems [86], Decision making and priority theory [87], Total Productive Maintenance [88] and Facilities location [89]. The general approach of the AHP is to decompose the problem and make pair-wise comparison of all elements on a given level with related elements in the level just above it belong. A highly user friendly computer model is developed which assists the user in evaluating his/her choices.

AHP involves the following steps:

- Problem decomposition and hierarchy construction: The top level of the hierarchy is the overall objective. The next level is the criteria. Below this level are the sub criteria.
- Determine alternatives: The decision alternatives are constructed and added to the lowest level of the hierarchy.
- Pair-wise comparison: Pair-wise comparison aims at determining the relative importance of the elements in each level of the hierarchy. It starts from the second level and ends at the lowest level. The decision maker needs to express the preference between each pair of the elements.
- Weight calculation: Mathematical normalization methods are used to calculate the priority weights for each level.
- Consistency check: A consistency ratio (CR) is calculated. If it is greater than 10 per cent, then the decision maker is not consistent in making the pair-wise comparison. The decision maker should review the comparison and make adjustment.
- Hierarchical synthesis: The calculated priority weights at different hierarchy levels are integrated to allow overall evaluation of the alternatives.
• Determine priority for all alternatives: The alternative with the highest overall priority weight is chosen [90]

2.2.3 Supply Chain Information Systems & Performance Measurement

Information technology is an important enabler of efficient supply chain strategies. As compared to traditional supply chain, today’s supply chains are highly complex systems with multiple production and storage facilities. This requires an integrated information system (IS) for sharing information on various value-adding activities along the supply chain. IT is like a nerve system for SCM. This is largely caused by variability of ordering. Information sharing between members of a supply chain using EDI technology should be increased to reduce uncertainty and enhance shipment performance of suppliers and greatly improve the performance of the supply chain system. Companies need to invest large amount of money for redesigning internal organizational and technical processes, changing traditional and fundamental product distribution channels and customer service procedure and training staff to achieve IT-enabled supply chain. Literature review on warehouse management systems is dealt further.

Warehouse Management Systems

Warehousing takes up to between 2% and 5% of the cost of sales of a corporation [91] and with today’s highly competitive global business environment organizations are emphasizing on return on assets, and hence minimizing warehousing costs has become an important business issue [92]. Many firms are automating their basic warehousing functions to achieve the increase in throughput rates or inventory turns required for their warehousing operations to be cost-effective [93].

The use of information systems for warehouse management is studied extensively in literature. Complexity of warehouse management is indicated among others by amount and heterogeneity of handled products, the extent of overlap between them, amount and type of technology as well as characteristics of associated processes [94]. As the complexity increases, it becomes necessary to use Warehouse management systems for handling warehouse resources and to monitor warehouse operations. The warehouses with a high amount of processed order lines and a large amount of stock keeping units will be best supported by customized software. It is difficult to update daily operations of inventory level, locations of forklifts and stock keeping units
(SKUs) in real-time by using the bar-code-based or manual-based warehouse management systems [95].

RFID technology is adopted to facilitate the collection and sharing of data in a warehouse. Tests are performed for evaluating the reading performance of both the active and passive RFID apparatus. Implementing RFID technologies requires a thorough cost-and-benefit analysis of implementation. The costs of RFID implementation include tag reader costs, communication costs and other infrastructure costs. RFID can improve the automatic checkout process at a retail store, so it can reduce inventory costs as a result of more efficient shelf replenishment. RFID technologies can support the redesign of business processes; improve data quality; real-time data collection; synchronization and information sharing between the players of supply chain [94]. RFID implementation can also bring about additional benefits such as, reduction losses due to shop lifting and increased use of point of sale applications [96].

**Designing warehouse operations** - It is necessary to allocate warehouse resources efficiently and effectively to enhance the productivity and reduce the operation costs of the warehouse [92]. One vital area determining the efficiency of warehouse is the determination of the proper storage locations for potentially thousands of products in a warehouse. Various factors affecting the storage assignment like order picking method, size and layout of the storage system, material handling system, product characteristics, demand trends, turnover rates and space requirements have been extensively studied. It has been suggested that selecting appropriate storage assignment policies (i.e. random, dedicated or class-based) and routing methods (i.e. transversal, return or combined) with regards to above factors is a possible solution to improve the efficiency [93]. Various decision support models and solution algorithms have also been established to solve warehouse operation planning problems [94].

To effectively design the warehouse operations, which is essential to improve the performance of the warehouse lean tools such as value stream maps are used which eliminates the non value added activities.

**Value Stream Mapping** is the simple process of directly observing the flow of information and material as they occur and summarizing them visually. A Value Stream involves all the steps, both value added and non-value added, required to bring
a product or service through the process steps. A Current State Map is drawn by a cross-functional, multi-disciplined team to document how things actually operate (this is the “as-is” process vs. how it should be). Then, a Future System Map is developed to design a lean process flow through the elimination of the root causes of waste and through process improvements all leading to an Implementation Plan that details the action steps needed to support the objectives (the what, who, and when).

The benefits of Value Stream Mapping include:

- It helps visualize more than just the single-process level
- It establishes priorities for improvement efforts
- It helps to identify the waste and the source of that waste
- It is focused on no cost or expendable improvements
- It provides a common language to talk about the processes
- It is based on objective information
- It forms the basis of an implementation plan
- It shows the link between information flow and material flow

**WMS Implementation** - Implementation of Warehouse Management System (WMS) will necessarily provide an increase in accuracy, reduction in labor costs, if, the labor employed to maintain the system is less than the labor saved on the warehouse floor and a greater ability to service the customer by reducing cycle times. WMS not only leads to inventory reduction but also enhances storage capacity. An increase in accuracy and efficiency of the receiving process might lead to reduction in level of safety stock required. But the consequence of this reduction will hardly be visible to the overall inventory levels. WMS might just not affect the factors (lot sizing, lead times and demand variability) controlling the inventory levels. However, WMS is instrumental in providing a more efficient and organized way which leads to increased storage capacity [92].

The implementation of WMS for a company demands significant investment and time period (several months) which has to be justified with the benefits obtained after implementation. The justification involves the excellent analysis of the current situation of the warehouse and warehouse operation for a specific period of time tuning the WMS. The firm should be prepared to change the entire process and system storage. Only WMS implementations without changing the process does not
lead to cost savings or efficiency improvements, it will only reduce errors due to human factors.

**Cost – Benefit Analysis** It is a process by which business decisions are analyzed. The benefits of a given situation or business-related action are summed and then, the costs associated with taking that action are subtracted. Some consultants or analysts also build the model to put a value on intangible items, such as, the benefits and costs associated with living in a certain town. Most analysts will also factor opportunity cost into such equations.

In CBA, benefits and costs are expressed in money terms, and are adjusted for the time value of money, so that all flows of benefits and flows of project costs over time (which tend to occur at different points in time) are expressed on a common basis in terms of their "net present value."

### 2.3 Research Gap

- In this chapter the various literatures in the field of performance measurement of supply chain is reviewed and the gap of the research is identified. It can be seen that there is scant of literature on use of performance metrics and measurement system in Indian manufacturing industries. So, an attempt is made to address this issue.

- Literature reveals that the decisions are made at three levels: that is strategic, tactical and operational level. To support these, various models are developed for measuring performance taking different parameters which are not addressed in literature.

- Literature states that due to intense competition, information systems play a vital role in the supply chain. New technologies are emerging and they have huge impact on the supply chain performance. But the implementation of these technologies involves huge investment and hence cost justification is essential. In this regard, cost benefit analysis of an emerging technology, Warehouse management system, which is adopted only by few Indian companies are dealt.
Summary

This chapter focused on various themes of supply chain performance measurement available in the literatures. The literature pertaining to performance measurement, modeling approaches for decision making, and information systems for supply chain performance measurement was reviewed. Literature review led to identifying the research gap and setting the objectives for the research work.