CHAPTER 2

REVIEW OF LITERATURE

This chapter includes supply chain management (SCM) overview, the various connotations of SCM, the objectives of a supply chain, analysis of SCM, identifying the appropriate supply chain strategy, supply chain design challenges and process, supply chain performance drivers and obstacles, supply chain performance measurements and Indian scenario. The chapter concludes with SCM for competitive Advantage.

2.1 Supply Chain Management: An Overview

The term supply chain management (SCM) was introduced by consultants in the early 1980s (Lambert & Cooper, 2000). It has its origins in the logistics literature (Bowersox ,1999) and logistics has continued to have a significant impact on the concept. The concept of SCM builds on the theories of the firm, especially transaction cost economics, Porter’s value chain and the network approach have become a useful business paradigm.

Essentially as a management strategy, the SCM is a relatively, a new concept in India. Logistics is not synonymous with SCM, but an important aspect of SCM. SCM is a newly accepted term since the 1990s. In the era of globalization, systematic implementation of SCM has become vital.

A literature review made by researcher (Croom, 2000) shows a relative lack of theoretical work compared to empirical based studies. Croom underlines that
theoretical development is critical to the establishment and the development of theory on supply chain management, despite the large amount of research conducted by the academia and the management practice tried out in different Industries, the SCM is still in its infancy. There is an interesting and attractive future ahead of SCM to be a challenge both in academia and in practice (Stevenson, 2002).

2.2 THE VARIOUS CONNOTATIONS OF SCM

- Management of Material and Information flows both in and between facilities such as Vendors, Manufacturing and Assembly plants and distribution centers (Thomas and Griffin, 1996).
- An integrated process, where raw materials are transformed into final products then delivered to customers (Beamon, 1999).
- Systematic effort to provide integrated management to meet customers needs and expectation from the suppliers of raw materials through manufacturing to end customers (Hicks, 1999).
- A supply chain is a network of facilities that procure raw materials, transform them into intermediate goods and then final products and deliver the produces to customers through a distribution system (Lee & Billington, 1992).
- A supply chain is a network of facilities and distribution options that perform the functions of procurement of materials, transformations of these materials into intermediate and finished products and the distribution of these products to customers (Ganeshan & Harrison, 1995).
- A network of autonomous or semi-autonomous business entities collectively responsible for procurement, manufacturing, and distribution activities associated with one or more families of related products (Jayashankar, Smith & Sadeh, 1996).

In addition to the above, Supply chain literature is full of definitions for supply chains. Given below are some of the notable SCM definitions:
<table>
<thead>
<tr>
<th>S No</th>
<th>Definition</th>
<th>Organization</th>
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<tbody>
<tr>
<td>1</td>
<td>SCM is the integration of key business processes from end user through original suppliers what provides products, services and information that add value for customers and other stakeholders.</td>
<td>The Global Supply Chain Forum, 2004.</td>
</tr>
<tr>
<td>2</td>
<td>SCM is the management of flow of material, fund and information from supplier’s supplier to customer’s customer.</td>
<td>Mckinsey Survey August, 2003.</td>
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<tr>
<td>3</td>
<td>“Integrated SCM is a process oriented, integrated approach to procuring, producing and delivering products and services to customers. Integrated supply chain management has a broad scope that includes sub – suppliers, suppliers, internal operations, trade customers, retail customers and end users. It covers the management of materials, information and funds flow.</td>
<td>MIT official definition, 1998.</td>
</tr>
<tr>
<td>4</td>
<td>“The integration of business process from end user through original suppliers, that provide products, services and information that add value for customers”</td>
<td>Ohio State University.</td>
</tr>
<tr>
<td>5</td>
<td>A “Supply Chain” consists of all of the entities necessary to transform ideas into delivered products and services. The SCM directs and transforms a firm’s resources in order to design, purchase, produce and deliver high quality goods and services. As goods and services flow from supplier to producer to customer to final user, SCM is particularly concerned with the interfaces between organizations. One way to view supply management is as the management of linkages between organizations.</td>
<td>Arizona State University.</td>
</tr>
<tr>
<td>6</td>
<td>Supply chain management as “the process of planning implementing and controlling efficient and cost-effective flow of materials, in-process inventory, finished goods, and related information from point-of-order to point-of-consumption, for the purpose of conforming to customer requirements”.</td>
<td>The Council of Logistics Management</td>
</tr>
<tr>
<td>7</td>
<td>Supply chain management means planning, organizing and controlling of supply chain activities. Supply chain is understood as the process starting from the procurement of raw materials to the ultimate consumption of the finished product linking across supplier user companies, or the functions inside and outside a company that enable the value chain to make products and provide services to the customer. In a nutshell it mean from the customer to the customer.</td>
<td>American production and Inventory control society dictionary.</td>
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</tbody>
</table>
The SCM aims to increase sales, reduce cost and make full use of assets by streamlining the interaction and communication of all participants along the supply chain. The SCM solutions use networking technology to link suppliers, distributors and business partners to better satisfy the end customers, while feeding real time data about customers', demand into the partners' production and distribution processes.

According to Performance measurement group studies, it is mentioned that the supply chain improvements lower costs as much as 25% in one year.

2.3 THE OBJECTIVES OF A SUPPLY CHAIN

The objective of every supply chain is to maximize the overall value generated. The value a supply chain generates is the difference between what the final product is worth to the customer and the effort the supply chain expends in filling the customer's request. For most commercial supply chains, value will be strongly correlated with supply chain profitability, the difference between the revenue generated from the customer and the overall cost across the supply chain (Chopra & Meindl, 2002). The other objectives are (Kulkarni & Sharma, 2004).

1. To reduce the physical supply chain links, 2. To define supply chain responsibilities to a specific core service competency and 3. To decrease the time and cost of getting end user customer products in volume to markets world wide. The success of a supply chain should be measured in terms of supply chain profitability and not in terms of the profits.

Hierarchy of Objectives

The classic objective of logistics is to be able to have the right product in the right quantities, at the right place, at the right moment and at minimal cost. Figure-2.1 shows the hierarchy of objectives. The 4 main areas of concern within supply chain management are (Nevem - work group, 1989). a) Flexibility b) Delivery reliability c) Delivery time / Lead time and d) Inventory level.
The two middle boxes in the lower row of Figure-2.1 i.e. delivery, reliability and delivery time, are both aspects of customer service, which is highly dependent on the first box, flexibility and on the last box inventory. Inventory is an insurance for demand uncertainty and supply. Figure-2.2 shows how the three issues described above are interdependent. To put it very simply, all depend on all.

In the course of research and industry study the authors came across on any definitions of supply chain and worse, several interpretations of supply chain. Based on the literature review (Altekar, 2005; Ammer, 1977; Bloomberg, Lemay & Hanna,

The supply chain assumes a flow of value to the customer and pricing pressure to the supplier. Reality is a lot more complex (Hughes, Ralf & Michels 1999). These researchers have identified the following 9 types supply chain, across a wide range of sectors each meets different types of business need. 1) Arm’s length open competition, 2) Commodity trading, 3) Partnering for customer delight, 4) From supplier’s suppliers to customer’s customers, 5) Lean supply chain and systems integration, 6) Competing constellations of linked companies, 7) Interlocking network supply between competitors, 8) Asset control supply dominate or die and 9) Virtual supply. No production, only customers.

2.4 ANALYSIS OF SUPPLY CHAIN

Structuring the supply chain requires an understanding of the demand patterns, service level requirements, distance considerations, cost elements and other related factors. It is easy to see that these factors are highly variable in nature and this variability needs to consider during the supply chain analysis process. Moreover, the interplay of these complex considerations could have significant bearing on the outcome of the supply chain analysis process.
2.4.1 Supply Chain Constituents and Its Types


Figure-2.3 shows an example of a supply chain. Materials flow downstream, from raw material sources through a manufacturing level transforming the raw materials to intermediate products (also referred to as components or parts). These are assembled on the next level to form products. The products are shipped to distribution centers and from there on to retailers and customers.

The success of a supply chain in simple terms, are based on two parameters. They are a) Highest customer satisfaction – perhaps with high speed and b) Lowest operating cost – with lowest inventory (Gopinath, 2006; Hill, 2001; Hammel & Kopczak, 1993; Gattorna, 2003 & Taninecz, 2000).

The relatively recent incorporation of the term network into supply chain management research can be seen as an attempt to make the concept wider. According to Lamming, (2000) that two distinct streams of research have been influential in the dependent of the concepts of supply networks. A network “is a structure where a number of nodes are related to other by specific threads (Ford, 2000). Supply networks can be defined as” sets of supply chains describing of flow of goods and services from original sources to end customer’s (Lamming, 2000).
Figure 2.3 An example of a typical Supply Chain

The SCM framework by Lambert & Cooper (2000) as shown in Figure 2.4 is interesting and challenging as it describes the interrelated nature of SCM and the need to proceed through several steps in order to manage a supply chain.
The main challenge of any business is to satisfy the customer. According to Theodore Levitt, (2006) (Famous for “Marketing Myopia”) the purpose of a “Business is to create and keep customers”.

From point of view of SCM, in satisfying customers the following major challenges remain (Figure 2.5):

a) Lead Time
b) Customization. and
c) Cost
Figure 2.5 SCM Challenges

The main focuses areas are

a) Procurement cycle
b) Manufacturing
c) Replenishment cycle and
d) Customer order cycle.

The classic objective of logistics and supply chain management are to be able to have the right products in the right quantities (at the right place) at the right at minimal cost. The four main areas of concern with in supply chain management are (Nevem – work group 1989): 1. Delivery reliability and delivery times are related to customer service. 2. Flexibility and inventory. Customer service highly dependent on flexibility and inventory. These terms and their interrelations are shown in Figure 2.1.
2.4.2 Sequential Versus Global Optimization

In sequential supply chain each party determines its own course of action independent of the other parties. For example, retailer makes a purchasing decision to optimize his own profit, and the manufacturer reacts to decisions made by the retailer (Levi, Kaminsky & Levi, 2004).

It is natural to look for mechanisms that enable supply chain entities to move beyond this sequential optimization and toward global optimization.

Figure 2.6 shows the differentiation between sequential supply chain and global optimization.

A Sequential Optimization:

B Global Optimization:

(Source: MIT Forum for Supply Chain Innovation)
From literature review (Gopinath, 2006 & Levi, Kaminsky & Levi, 2004) it is clear that the reasons for poor performance of supply chain management (SCM) in sequential supply chain trap. In sequential planning, each stage of the supply chain optimizes its profits, with no regard to the impact of its decisions on other supply chain stages. A major challenge in supply chain management (SCM) is replacing sequential planning processes with global optimization.

A major challenge in supply chain management (SCM) is replacing sequential planning processes with global optimizations. In sequential planning, each stage of the supply chain optimizes its profits, with no regard to the impact of its decisions on other supply chain stages. In contrast in global optimization the objective is to coordinate supply chain activities so as to maximize supply chain performance. To achieve excellent supply chain performance appropriate strategies should be built in.

2.5 IDENTIFYING THE APPROPRIATE SUPPLY CHAIN STRATEGY

Figure 2.7 provides a framework for matching supply chain strategies with products and industries. The vertical axis provides information on the uncertainty in customer demand, while the horizontal axis represents the importance of economies of scale either in productions or distribution.

Everything else being equal, higher demand uncertainty leads to a preference for managing the supply chain based on realized demand a pull strategy. Alternatively, smaller demand uncertainty leads to an interest in managing the supply chain based on a long-term forecast a push strategy.

Similarly, everything else being equal, the higher the importance of economies of scale in reducing cost, the greater the value of aggregating demand, and thus the greater the importance of managing the supply chain based on long-term forecast, a push based strategy. If economies of scale are important, aggregation does
not reduce cost, so a pull based strategy makes more sense. In Figure 2.7 it is shown two dimensions into four boxes. (Levi, Kaminsky & Levi, 2004).

**Box I :** High uncertainty, scale of production, assembly or distribution are not important, such as the computer Industry. Pull – based supply chain strategy is appropriate for these industries. (Example: Dell computers supply chain)

**Box II :** High uncertainty in demand and economics of scale are important. The furniture industry is an example of this situation. Hence, the supply chain followed by furniture is in some sense, a pull push strategy.

**Box III :** Low demand uncertainty and high economics of scale products in the grocery industry such as been, pasta and soup belong to the category. Indeed, a traditional push – based retail strategy is appropriate.

**Box IV :** Low demand uncertainty and low economies of scale, suggesting a pull – based supply chain strategy. Many high – volume / fast – moving books and CDs fall in this category.
Figure 2.7 Matching Supply Chain Strategies with Products.

![Diagram showing the matching of supply chain strategies with products based on demand uncertainty and economies of scale.]


The summary of various strategies of supply chain and their characteristics are shown in Table 2.1 below.

**Table 2.1 Strategies and Their characteristics**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Strategy</th>
<th>Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>High uncertainty demand and</td>
<td>Pull Strategy</td>
<td>Computer Industry</td>
</tr>
<tr>
<td>Low Economies of scale</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High uncertainty demand and</td>
<td>Pull – Push Strategy</td>
<td>Furniture, White Goods, Automobile and Auto</td>
</tr>
<tr>
<td>High economies of scale</td>
<td></td>
<td>Components.</td>
</tr>
<tr>
<td>Low demand uncertainty and</td>
<td>Push Strategy</td>
<td>FMCG Industry (Grocery, beer, soup)</td>
</tr>
<tr>
<td>High economies of scale</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low demand uncertainty and</td>
<td>Push – Pull Strategy</td>
<td>CDS, Books, Entertainment Electronics items</td>
</tr>
<tr>
<td>Low economies of scale</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The first step in devising an effective supply chain strategy is therefore to consider the nature of the demand for the products one's company supplies. Many aspects are important for example, product life cycle, demand predictability, product variety and market standards for lead times and service (the percentage of demand filled from in stock goods). Products on the basis of their demands patterns can be categorized into one of two (Fisher, 1997). They are either primarily functional or primarily innovative.

Based on type of product and supply chain a framework/matrix were formulated by Fisher (1997), products that are physically the same can be either functional or innovative. For example personal computers, cars, apparel, ice cream, coffee, cookies etc. For innovative products, there is no substitute available in the market, whereas for the functional products can be replaced by another product easily. Functional vs innovative and physically efficient vs market responsive supply chains, a matrix can be formulated shown in Figure 2.8.

**Figure 2.8 Matching Supply Chains with Products**

<table>
<thead>
<tr>
<th>Type of Supply Chain</th>
<th>Physically Efficient</th>
<th>Market Responsive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mismatch</td>
<td>Match</td>
<td></td>
</tr>
<tr>
<td>Match</td>
<td>Mismatch</td>
<td></td>
</tr>
</tbody>
</table>

Type of Products

(Source: Fisher, 1997)

The four cells of the matrix represent the four possible combinations of products and priorities.
Product Categories

Functional products include the staples that people buy in a wide range of retail outlets such as grocery stores and gas stations. Because such products satisfy basic needs, which don’t change much over time (Fisher, 1997). The main characteristics of functional products are: - Stable, predictable demand, - Long life cycles and low profit margins, low stock out, contributions (5-10%)

To avoid low margins, many companies introduce innovations in fashion or technology to give customers an additional reason to buy their offerings. Fashion apparel and personal computers are obvious examples (Fisher, 1997). The main characteristics of innovative products are: - Demand unpredictable - Large profit margins and short life - High stock out, contribution (20-60%)

Matching the Supply Chains and Products

By using the matrix (Figure 2.8) to plot the nature of the demand for each of their product families and its supply chain priorities. One can discover whether the process the company uses for supplying products is well matched to the product type an efficient process for functional products and a responsive process for innovative products. Companies that have either an innovative product with an efficient supply or a functional product with responsive supply chain tend to be the ones with problems (i.e mismatch). Most companies that introduce functional products realize that they need efficient chains to supply them. For any company with innovative products the rewards from investments in improving supply chain responsiveness are usually much greater than the rewards from investment in improving the chains efficiency. Thus, functional products require an efficient process; innovative products, a responsive process. Therefore Functional products supply chain should be physically efficient and Innovative products supply chain should be market responsive, (Fisher, 1997).
2.5.1 Supply Chain Responsiveness

Supply chain responsiveness includes a supply chain ability to do the following i.e how quickly the supply chain response to the dynamic market conditions (Chopra & Meindl, 2002).

a) Respond towards ranges of quantities demanded
b) Meet short lead times.
c) Handle a large variety of products
d) Meet a very high service level.
e) Build highly innovative products

**Figure 2.9 Cost Responsive Efficient Frontier Curve**

![Cost Responsive Efficient Frontier Curve](image)

(Source: Chopra & Meindl, 2002)

The cost responsiveness efficient frontier is the curve in Figure 2.9 showing the lowest possible cost for a given level of responsiveness. Lowest is defined based on existing technology. Not every firm is able to perform on the frontier. The efficient frontier represents the cost responsiveness performance of the best supply chains. A firm that is not on the efficient frontier can improve both its responsiveness and its cost performance by moving toward the efficient frontier. In contrast, a firm
on the efficient frontier can improve its responsiveness only by increasing cost becoming less efficient. Such a firm must then make a trade off between efficiency and responsiveness (Chopra & Meindl, 2002).

The responsiveness efficiency frontier curve shown in Figure 2.9 describing the most advantageous possible combinations of cost and flexibility in a supply chains. This curve is constantly being advanced by best practices in SCM. It is a trade off between cost and responsiveness.

**The Responsiveness Spectrum**

Supply chain range from those that focus on being responsive to those that focus on efficiency with a goal of producing and supplying at the lowest possible cost. The responsiveness spectrum and where some different supply chains fall on this spectrum are as given below (Chopra & Meindl, 2002). 1. Highly efficient – Integrated steel mill, 2. Somewhat efficient – A make to stock manufacturing of clothing 3. Some what responsive – Auto mobile products delivering variety in short time and 4. High responsive – Customer made products delivered in few days.

Many initiatives, programs and systems have been developed recently to speed up the material flow and information in the supply chain. These electronic communication systems between manufacturer and distributor have no of names in literature. a) Electronic data interchange (EDI), Quick response (QR) and Efficient consumer response (ECR).

**2.5.2 The Evolution of the Supply Chain**

A steady increase in the complexity of supply chains and a corresponding rise in the virtualization of the manufacturing process have spawned several noticeable trends in organizational dynamics. Over the decades management of the supply chain has moved through three phases, from decentralized (functional & departmental), to
centralized (corporate planning and purchasing), and finally to a combination of both (Muzumdar & Balachandran, 2001). Phase – I represents the transformation from the post world war II era through the late 1980s. Phase 2 represents the incremental changes that occurred from the late 1980s through the late 1990s. Phase 3 describes the current transformation from a linear supply chain to a network, where suppliers and customers collaborate to extract and share knowledge and value.

The current trend is swinging toward centralized planning with decentralized execution organizational structures and functional areas within organizations have transformed significantly over the past four to five decades. Figure 2.10 shows the evolution of the supply chain as occurring in multiple phases. (Fox, 1996; Cohen & Lee, 1998; Chandra & Fisher, 1994; Bhatnagar, Chandra & Goyal, 1993; Kulkarni & Sharma, 2004; Levi, Kaminsky & Levi, 2004; Lambert & Cooper, 2000).

Figure 2.10 Supply Chain Evolutions

![Figure 2.10 Supply Chain Evolutions](Source: Gopinath, 2006)
Integration:

In the previous section, the responsiveness of supply chain, products and strategies were discussed. The key to improved supply chain management lies in integration and coordination. In an enterprise, integration can simply mean that each unit of the organization will have access to information relevant to its task and will understand how its actions will impact other parts of the organization thereby enabling it to choose alternatives that optimize that organization’s goals (Fox, 1996).

In later years we have seen an increasing focus on the integration of different segments of the supply chain. For example integrates and coordination are considered as main activities of production and distribution functions (Cohen & Lee, 1988; Chandra & Fisher, 1994). Coordination, further classified into two broad level (Bhatnagar, Chandra & Goyal, 1993). They are general coordination and multi plant coordination. General coordination is the integration of different functions e.g inventory & production planning, sales and distribution. The other level of coordination identified, is that on which production decisions are coordinated among the plants of an internal supply chain.

Collaboration

In 1996, Warner – Lambert, the consumer goods manufacturer and Walmart, introduced a new concept in collaborative planning, forecasting and replenishment (CPFR). Collaboration allows a company to share information with its suppliers in real time basis. CPFR and other E – commerce initiatives for sharing information will be a major factor in how these systems are developed.

Adaptation

In global supply chain networks, efficiency and reliability are not luxuries (Chopra & Meindl, 2002). They are competitive necessities. But in a volatile environment in which costs, pricing structure, and distribution channels can rapidly
change. The efficiency and reliability of the supply chain are ensured by adaptability (Altaker, 2005; Kulkarni & Sharma, 2004).

**Supply Design and Modeling**

In the early 1990s, the phrase “supply chain management” came into use. Supply chain management is a process of integrating / utilizing supplier’s manufacturers, warehouses and retailers, so that goods are produced and delivered at the right quantizes and at right time, while minimizing cost as well as satisfying customer requirements.

Figure 2.11 shows the structure of a typical supply chain, it consists of a number of organizations. Beginning with suppliers, who provide raw materials to manufacturers, which manufacture products and keep those manufactured goods in the warehouses. Then they send them to whole sales to distribution centers that ship the goods to retailers. Different industries have slightly different structures of the supply chain network.

*Figure 2.11 A typical supply chain*

**General Areas of Supply Chain Management**

<table>
<thead>
<tr>
<th>a) Demand planning</th>
<th>b) Master planning</th>
<th>c) Procurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>d) Transportation</td>
<td>e) Manufacturing</td>
<td>f) Warehousing and distribution</td>
</tr>
</tbody>
</table>
2.6 SUPPLY CHAIN DESIGN CHALLENGES AND PROCESS

A supply chain can be used as a network of facilities and distribution options that performs the functions of procurement of materials, their transformation into intermediate and finished products and distribution to customers (Chopra & Meindl, 2002; & Taylor, 2004). Mathematical models such as a) Deterministic and b) Simulation methods have been used for determination of the location of production, sourcing, stocking and distribution facilities; (means and paths of transportation)

Business models came in a wide variety of forms but most of them fall into one of the 3 broad categories. 1) Conceptual 2) Mathematical and 3) Simulation. The fact that 3 very different kinds of business models are available begs the question of which one is best. There is no “beri” type of model. Choose the model to suit the problem combining the types increases power. The ideal is to use all 3 together as shown in Figure 2.12.

Figure 2.12 Combining the types

(Source : Taylor, 2004)

When designing a model for a supply chain, one starts by defining a real supply chain and its business objects then an input-output analysis is carried out and the conceptual models are formulated. After that the quantitative phase starts, dealing with more technical problems. For example, development and analysis of mathematical and simulation models and control theory techniques Figure 2.13 shows the research structure of supply chain modeling
Figure 2.13 Research Structure for Supply Chain Modeling

(Source: Gren and Olhager 2004)
General motors has used a comprehensive model of a production distribution system “PLANET” to decide what products to produce, where and how to produce it, which markets to pursue and what resources to use (Breitman & Lucas, 1987).

At Digital Equipment Corporation (DEC) “optimization of supply chain” model has been extensively used (Arntzen, Brown, Harrison & Trafton, 1995). This model strives to minimize a combination of cost and time elements over different time periods. It has helped digital equipment corporation (DEC) in reducing the number of plants from 33 to 12, service facilities from 34 to 17, manufacturing costs $169 million and logistics costs by $200 million.

When developing models of a supply chain, first of all a good understanding of the overall supply chain is most important. Good understanding of the business characteristics (example, performance measures, make-to-stock or make-to-order) is also essential since every industry has different business characteristics and supply chain management processes. It is better to focus on the problem area based on the specific scenario setting proper performance measure is another important task.

**Supply Chain Process**

A supply chain may be defined as an integrated process wherein a number of various business entities (i.e., suppliers, manufacturers, distribution and retailers) work together in an effort to 1) acquire raw materials 2) convert these raw materials into specified final products and 3) deliver these final products to retailers (Beamon, 1998).

As mentioned above, a supply chain is an integrated manufacturing process wherein raw materials are converted into final products, then delivered to customers.

At its highest level, a supply chain is comprised to two basic, integrated processes. 1) The production planning and Inventory control and 2) The distribution and logistics processes. A supply chain process is shown in Figure 2.14.
**Figure 2.14 The Supply Chain Process**

![Supply Chain Process Diagram](source)

(Source: Beamon, 1998).

### 2.7 SUPPLY CHAIN PERFORMANCE DRIVERS AND OBSTACLES

**Drivers of Supply Chain Performance**

Four major drivers of supply chain performance: inventory, transportation, facilities and information (Chopra & Meindl, 2002), these drivers not only determine the supply chain’s performance in terms of responsiveness and efficiency, they also determine whether strategic fit is achieved across the supply chain.

All these 4 drivers put into a framework that helps to clarify the role of each driver in improving supply chain performance: A virtual framework for supply chain decision making is shown in Figure 2.15.

The goal of a supply chain strategy is to strike the balance between responsiveness and efficiency that result in strategic fit with the competitive strategy. To reach this, a company uses the four supply chain drivers discussed earlier. They are a) Inventory b) Transportation c) Facilities and d) Information.
Obstacles in Achieving Strategic Fit

A company’s ability to find a balance between responsiveness and efficiency along the responsiveness spectrum that best matches the type of demand it is targeting is the key to achieving strategic fit (Chopra & Meindl, 2002 & Peter & Meindl, 2002). In deciding where this balance should be located on the responsiveness spectrum. Companies face many obstacles. The major obstacles that must be overcome to manage supply chain successfully are: a) Increasing variety of products, b) Decreasing product life cycles, c) Increasingly demanding customers, d) Fragmentation of supply chain ownership, e) Globalization and f) Difficulty in executing new strategies, to overcome these obstacles offers a tremendous opportunity for firms to use supply chain management to gain competitive advantage.
2.7.1 SCM Challenges and Issues

Addressing Business Challenges – SCM way

As already mentioned; the major challenges are a) Cost b) Responsiveness and c) Varieties. The following tools are used in order to meet the business challenges (Gopinath, 2006; Levi, Kaminsky & Levi, 2004 & Chopra & Meindl, 2002).

a) Cost
   i) Global outsourcing
   ii) Supply management (VMI, CFPR, QR)

b) Responsiveness
   i) Innovation in logistics (Cross Docking, 3PL and 4PL)
   ii) Innovation in information (GPS Tracking, RFID, etc)

c) Varieties
   i) Innovation in manufacturing (Mass customization, Delayed differentiation etc.)
   ii) Marketing (JIT Delivery, Differential Pricing, Every day low price)

From supply chain management (SCM) point of view satisfying customer have the following challenges : a) Time b) Customization and c) Cost. In order to meet the above challenges SCM planning process should be placed correctly. From literature SCM planning process consists of 4 steps as shown in figure 2.16. They are a) Material requirement planning (MRP) b) Demand planning c) production plan and d) order management.
Key issues in SCM

Key issues span a large spectrum of a firm’s activities, from the strategic through the tactical to the operational level. From the literature, all these issues are discussed and focused to achieve a globally optimized supply chain or managing uncertainty in the supply chain or both. i) Distribution network configuration ii) Inventory control iii) Supply contracts iv) Distribution strategies v) Strategic partnerships vi) Outsourcing and procurement vii) Product design viii) Information technology and ix) Customer value.

According to Singapore Institute of Logistics Management, the 5 key issues of logistics effectiveness are core to SCM a) Movement of product b) Movement of information c) Time/service d) Cost and e) Integration, both internal and external, both organization and systems.
To meet the above challenges and address the various issues the supply chain should be built on value chain this can be achieved by adding various value added services in the supply chain. These value added services are discussed in the subsequent sections.

2.7.2 Value Chain for Supply Chain and its Services

The value chain (Porter, 1985) identifies the linkages and interdependencies between (and among) suppliers, buyers intermediaries and end users. Its primary benefit is the ability to examine these linkages and identify the value that is created for customers (or that which may be created) and how this in turn, creates competitive advantage for a company.

Levitt (2005) who first said that “People don’t buy products, they buy benefits”. The idea behind this statement is that it is totality of the offer which delivers customers value. According to Kotler (2006), value may be defined as the ratio between, benefits and costs. Kotler, says “Today Indian manufacturers are in a very unique position. “There is growing demand and need for high quality, low cost production”. Value is defined as something that the customer is willing to pay, for value adding activities transform materials and Information into something a customer wants.

A firm’s value chain is an interconnected set of linkages among suppliers of materials and services that spans the transformation processes that convert ideas and raw materials into finished goods & services for a firm’s customers. (Monezka, Trent & Handfield, 2005; Levi, Kaminsky & Levi 2004; McGuffog, 1999; Hill 2001; Taninecz, 2000; Gattorna, 2003; Chopra & Meindl, 2002; Frazelle, 2001 & Krajewski & Rizman, 2000).
The dimensions of customer value

The customer perception on value can be broken into several dimensions
a) Conformance to requirements b) Product selection c) Price and brand d) Value
added services and e) Relationship and experiences.

Manufacturing value chain:

1) Source - Procurement
2) Make - Manufacturing
3) Store - Inventory management
4) Ship - Transportation
5) Sell - Marketing
6) Service - After sales service

All these activities are considered as value added activities in the supply
chain. (Coyle, Bardi & Langley, 1996; Cavinato, Flynn & Kauffman, 2006 &
Christopher, 2003).

Value-Added services

The following are the value added services in the supply chain management
(SCM), generally followed by many companies. 1) Stocking 2) Kitting 3) Pick and
Pack 4) Cross docking 5) Vendor managed inventory and 6) Lean supply chain.
According to Lee, (2005) addresses 3 key components in this area are: 1.
Economic packaging and transportation, 2. Concurrent and parallel processing and 3.
Standardization each to these components address

Examples are GATI cargo services, Packers and Movers, DHL services etc,
mainly concentrate on these values added activities, in their supply chain. Wal-mart
(1985) has shown sales increases of 20 to 25% and 30% Inventory turnover
improvement, through vendor managed inventory (VMI) and cross docking in the
Supply chain operations. Some of the logistics companies are offering a bundle of value added services in the supply chain.

Supply chains that want to grow and continue to improve must adopt lean supply chain. Lean operations reduces manufacturing cycle time by 70% (PRTM, 2006).

Mapping the value stream for the supply chain is another process which enhances the value in the supply chain. Mapping tools can help in the identification of pinch points and critical paths (Christopher, 2006). One of the most powerful ways of achieving resilience in the supply chain is to create networks which are capable of more rapid response to changed conditions this is the idea of agility whereby the time required to new circumstances is dramatically required.

Based on knowledge and experience from supply chain management in electronics, computer, and automobile companies (Lee & Billington, 1992). Identified 14 pitfalls in inventory management. Eight of which are found relevant to this study.

Pitfall: 1 No Supply Chain Metrics
Pitfall: 2 Inadequate definition of customer service
Pitfall: 3 Inaccurate delivery status data
Pitfall: 4 Inefficient information systems
Pitfall: 5 Ignoring the impact of uncertainties
Pitfall: 6 Simplistic inventory stocking policies
Pitfall: 7 Organizational Barriers
Pitfall: 8 Incomplete Supply Chain

These pitfalls can be avoided through increased integration and coordination. It is also suggested that this can be done using agent – based management and information.
Opportunities

Following are the opportunities available to overcome these pitfalls as suggested by Lee (2001): 1. Design for supply chain management, 2. Integrate database throughout the supply chain, 3. Integrate control and planning support systems 4. Redesign organizational incentives, 5. Institute supply chain performance management and 6. Expand view of supply chain.

2.8 SUPPLY CHAIN PERFORMANCE MEASUREMENTS

Performance measures and standards are close cousins. The two co-exist in traditional organizations as the performance measures are tightly linked with standards (Mahadevan, 1998). As stated by supply chain metric .com performance measures can be classified broadly into two categories (1) Qualitative measures (such as customer satisfaction and product quality) and (2) Quantitative measures (such as order to delivery lead time, supply chain response time, flexibility, resource utilization, delivery performance etc).

Quantitative metrics of supply chain performance can be classified into two broad categories non financial and financial. Non-financial measures are cycle time, customer service level, Inventory levels, Resource utilization. The financial performance of a supply chain can be evaluated by looking into the following items cost of raw material, revenue from goods sold, activity based costs such as material handling, manufacturing, assembling, inventory holding costs, transportation costs, cost of expired perishable goods, penalties and warranty costs, costs associated with late deliveries cost of goods returned by customers and credits for goods returned to suppliers (Rajashekaraih, 2006).

The performance is evaluated on 5 important links of the supply chain management system (a) Inbound logistics (b) Manufacturing (c) Outbound logistics (d) Marketing and (e) After sales service. These Links are to be evaluated on the
following metrics i) Quality ii) Inventory iii) Customer service iv) Cost v) Flexibility vi) Time and vii) Productivity

Supply chain performance Indicator

Performance measurement group (PMG) bench marking studies show that superior performance is attainable when a company can integrate the plan, source make, Deliver and return processes of its supply chain operations.

For example: PMG’s latest research reported in the materials management Review (2006), that discrete manufacturers with mature supply chain practices are 40% more profitable than discrete manufacturer with less mature practices. Although other factors such as Product innovation and channel management certainly contribute to this profit edge, supply chain management is a key factor.

According to PRTM studies reported in the materials management review (2004), that the supply chain performance indicator uses a performance scorecard, customized bench marks and a practice assessment helps to understand where the favorable and non favorable gaps exist in the operations.

2.8.1 General Approaches to Measure Supply Chain Performance

A variety of measurement approaches have been developed, including the following important approaches, as reported in the AMR Research (Lapide, 1998). The following approaches are considered as important: a) The Balanced scorecard, b) The logistics scorecard, c) The supply chain councils SCOR model, d) Activity based costing (ABC), and e) Economic value analysis (EVA).

a) The Balanced score card:

A new approach to strategic management was developed in the early 1990s by Dr. Robert S. Kaplan (Harvard Business School) and David Norton . The Balanced
score card is a management system (Not only a measurement system) that enables organizations to clarify their vision and strategy and translate them into action. It provides feedback around both the internal business and external outcomes in order to continuously improve strategic performance and results. The measurement usually covers 4 areas;

1. Financial : Example: the cost of manufacturing, warehousing, transportation etc
2. Customer : Example: order fill rate, Back order levels, on time delivery
3. Internal business : Example: adherence-to-plan, Forecast error

b) The logistics score card

The logistics scorecard was developed by Logistics Resources International Inc (Atlanta, GA) (Lapide, 2000) a consulting firm specializing primarily in the warehousing and transportation aspects of a supply chain. The company recommends the use of an integrated set of performance measures falling into the following categories.

1. Logistics financial performance measures (Expenses and return on assets)
2. Logistics productivity measures (e.x orders shipped per hour and transport container utilization)
3. Logistics quality measures (e.x inventory accuracy and shipment damage)
4. Logistics cycle time measures (e.x in transit time and order entry time)

The logistics scorecard is prescriptive and equally recommends the use of a specific set of supply chain performance measures. These measures however are
skewer toward logistics, having limited focus on measuring the production and procurement activities within a supply chain

c) Supply Chain Operations Reference (SCOR) model

It is a business process reference model that links process description and definition with metrics, best practices and technology. It has proven to be a powerful and robust tool set for describing, analyzing and successfully to improve business operations (Supply chain council, SCOR version 8.0, 2006).

Score Level 1 :

Defines 5 management processes where the company creates its competitive position and operations strategy.

1. Plan : Defining resources and demand, planning inventory, distribution, production and rough cut – capacity planning

2. Source: Acquiring raw materials, qualifying and certifying suppliers, monitoring quality, negotiating vendor contracts and receiving materials.

3. Make : Making the end product manufacturing, testing, packaging engineering changes, holding and releasing products

4. Deliver : Managing orders and credit, managing the warehouse and transportation, delivery, Inventories and quality, creating data bases for customers, products and prices.

5. Return : Returning raw materials and finished goods, maintenance, repair and overhaul.

SCOR has identified over 200 key performance metrics to monitor overall supply chain performance (level 1 metrics), as well as much focused metrics to help a specific process to improve (level 2 and 3 metrics). This metrics are used to build performance trends for areas under improvement, or to compare against industry best practice performance. Table 2.2 shows SCOR Level 1 Metrics
Table 2.2 Top Level Performance Attributes and Associated Level 1 metrics

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Performance Attribute Definition</th>
<th>Level 1 Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Chain Reliability</td>
<td>The performance of the supply chain in delivering: the correct product, to the correct place and customer, at the correct time, in the correct condition and packaging, and with the correct quantity and documentation</td>
<td>Delivery Performance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fill Rates</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Perfect Order Fulfillment</td>
</tr>
<tr>
<td>Supply Chain Responsiveness</td>
<td>The velocity at which a supply chain provides products to the customer.</td>
<td>Order Fulfillment Lead Times</td>
</tr>
<tr>
<td>Supply Chain Flexibility</td>
<td>The agility of a supply chain in responding to marketplace changes to gain or maintain competitive advantage.</td>
<td>Supply Chain Response Time</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Production Flexibility</td>
</tr>
<tr>
<td>Supply Chain Costs</td>
<td>The costs associated with operating the supply chain.</td>
<td>Cost of Goods Sold</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total Supply Chain Management Costs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Value - Added</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Productivity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Warranty / Returns Processing Costs</td>
</tr>
<tr>
<td>Supply Chain Asset Management Efficiency</td>
<td>The effectiveness of an organization in managing assets to support demand satisfaction. This includes the management of all assets: fixed and working capital.</td>
<td>Cash – to – Cash Cycle Time</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inventory Days of Supply</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Asset Turn</td>
</tr>
</tbody>
</table>

(Source: www.scpitteam.com)

In an article in the Business briefing (World Business Markets, April, 2004) mentioned that there are firms that reported beneficial results after using the SCOR model successfully. One enterprise in the food industry for example document a $1.5
million return on a $50,000 investment after approximately 3 months. Another –in the electronics industry has reported a $230 million projected return in 8 months after investing $million to $5 million software enabler SAP based the supply chain key performance indicators for their advanced planning system product on the SCOR model.

d) Activity Based Costing (ABC)

In a business organization, Activity based costing (ABC) is a method of allocating costs to products and services. It is generally used as a tool for planning an control. This is a necessary tool for doing value chain analysis. Cooper and Kaplan described Activity Based Costing as an approach to solve the problems of traditional cost management systems. These traditional costing systems are often unable to determine accurately the actual costs of production and of the costs of related services (Kaplan, Robert & Bruns, 1987). Hence Activity Based Costing (ABC) is considered as more accurate cost management system than traditional cost accounting (TCA). Traditional cost accounting is unable to calculate the “true” cost of a product (Taylor, 2004). To determine the “true” cost for a cost object-product, job service or customer, the following steps are involved in ABC 1) Identify activities 2) Determine cost for each activity 3) Determine cost drivers 4) Collect activity data and 5) Calculate products cost. ABC is best suited for a) overhead is high b) products are diverse complexity, volume of direct labors c) cost of errors are high and d) competition is stiff some of the process and labor intense industries. In an article in the Business week (June 2006) mentioned that Tata steel, Tata oil are already using Activity Based Costing for performance measures.

e) Economic Value Added (EVA)

The term EVA originated with the consulting firm Stern Stewart although its origins go back to the economist Marshall who, over 100 years ago developed the concept of “economic income”. Essentially EVA is the difference between operating
incomes after taxes less the true cost-of capital employed to generate those, profits. Thus EVA = Profit after tax – cost of capital employed (Stewart, 1991).

\[ EVA = \text{Profit after tax} - \text{True cost of capital employed}. \]

Thus, the economic value added (EVA) is a measure of surplus value created on an investment. Economic value added (EVA) is the financial performance measure that come closer than any other to capturing the true economic profit of an enterprise. EVA is net operating profit minus an appropriate charge for the opportunity cost of all capital invested in an enterprise. As Peter Drucker put the matter in a Harvard Business Review article, “until a business returns a profit that is greater than its cost of capital, it operates at a loss. Never mind that is pays taxes as if it had a genuine profit. The enterprise still returns less to the economy than it devours in resources. Until then it does not create wealth; it destroys it”. Hence, EVA is considered as a tool, used in performance measurements of an enterprise.

Economic value added can be used for the following purposes a) Setting organization goals b) Performance measurement c) Determining bonuses d) Communication with shareholders and Investors e) Motivation of managers f) Capital budgeting g) Corporate valuation and h) Analyzing equity securities.

In India some of Tata group of companies successfully implemented EVA in their business processes.

The major benefits of performance measurement are: a) Performance measurement enhances decision making, b) Performance measurement improves internal accountability and c) Performance measurement supports strategic planning and goal setting.
2.8.2 Some Other Common Measurements

Table 2.3 Shows some other common measurements

<table>
<thead>
<tr>
<th>Metric</th>
<th>Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Number of open orders</td>
<td>Number of order line items that have not been shipped.</td>
</tr>
<tr>
<td>2. Volume of open orders</td>
<td>Total volume on order</td>
</tr>
<tr>
<td>3. Unavailable of trucks / rail cars</td>
<td>On-hand and estimated arriving – required by schedule.</td>
</tr>
<tr>
<td>4. Month-to-date expediting costs</td>
<td>Total accumulated sum of expediting costs.</td>
</tr>
<tr>
<td>5. Days of supply</td>
<td>Volume of Inventory divided by average daily use for each critical raw material.</td>
</tr>
<tr>
<td>6. Total daily production</td>
<td>Volume of daily production</td>
</tr>
</tbody>
</table>

2.8.3 Improvements of Supply Chain Performance Measurements

Improving supply chain performance requires a multidimensional strategy that addresses how the organization will service diverse customer needs.

Supply chain measurements or metrics such as Inventory turns, cycle time, defects per million opportunities, and fill rate are used to track supply chain performance. Commonly used by supply chain management (SCM), metrics can help to understand how the company is operating over a given period of time. Supply chain measurements can cover on any areas including procurement, production, distribution, ware housing, inventory, transportation and customer service. However, a good performance in one part of the supply chain is not sufficient. Any supply chain is only as strong as its weakest link (Rajashekaraiah, 2006). The solution is to measure all key issues of the supply chain.

1. Tracking the metrics helps to observe the performance overtime and guides to optimize the supply chain. It allows management to identify problem areas,
and to compare a given company to other similar companies for industry benchmarking.

2. Certain metrics, such as inventory turns, have a widely accepted definition. Other metrics such as back orders may need to be customized for a particular industry or business model.

3. Measurements alone are not the solution to the weak areas. The solution lies in the corrective action to be taken to improve the measure. The solution comes from process improvements.

4. Measurements should have process owners. People or departments that is responsible for achieving a target on the metric. Supply chain management needs to support the process changes to achieve the desired targets.

**The Best-Method**

There can never be a one size that fits all measure, since different organizations have different priorities and different problems. Hence it is important to define metrics from different perspectives in order to create ones’ own system that is mutually exclusive and exhaustive. It may be necessary to look at the various metrics and measurement parameters and their usability in any given situation. Based on the observations, certain fine tuning may be necessary to make the metrics and parameters more relevant and useful to a given industry (Rajashekaraiah, 2006; Krajewski & Ritzman, 2000). Supply chain performance such as costs, delivery, speed and quality are linked to a firm’s key financial measures. For example inventory turns with working capital % on time delivery with Revenue, supplier lead times with working capital etc. In this regard further research is well justified and would help industries to bench mark their supply chains.

**2.8.4 Supply Chain Management – Best Practices**

Study conducted by *PRTM's performance measurement group* (2002) reveals best – in class companies have advantages in service levels due to better delivery performance and 90% shorter lead times.
Discrete manufacturers with mature supply chain practices are 40% more profitable than discrete manufacturers with less mature practices (PRTM, 2003).

Best-practice supply chain management companies enjoyed a 45% total supply chain cost advantage over their median competitors (Ramakrishnan, 006; Sahay, 2002; Singh, 2002; & Shastry, 1999).

Companies that utilized best-in-class SCM solutions have:

- Reduced inventory levels by 10-15%, reduced markdown & scraps by 10-15%
- Used resources 10-20%, more efficiently.
- Reduced markdown 10-20% done efficiently
- Improved delivery reliability by 95%
- Reduced outranges to 0-5%
- Reduced cycle time by 10-20%
- Reduced transportation cost by 10-15%

World class companies have realized the importance and thereby succeeded in (Sharma, 2004).

- Reducing inventory by 40%
- Minimizing stock outs to increase sales by 3-5%
- Reducing order through put time by 65%
- Enhancing profit before tax by 3% to 5%
- Improving customer satisfactions significantly.

2.9 SUPPLY CHAIN PERFORMANCE MEASUREMENTS - INDIAN SCENARIO

Supply chain management (SCM) has emerged as one of the most powerful business improvement tools in recent times (Saunders, 1997; Schary & Larsen, 2000; Sahay & Mohan, 2003; Quayle, 2006; Meintzer, 2001; Philippe & Dornier, 2002 &
Handfield & Nichole, 1999). Leading Indian companies are forging future supply and demand networks that create an integrated delivery system which appears seamless to final consumer. In a study by Rakesh Singh, (2002) and sponsored by the Narsee Monjee Institute of Management Studies (NMIMS), Mumbai to understand how Indian corporate manage supply chains, they discovered that not many companies have asked themselves this basic question. They were unprepared to cope up with the challenges. There is an evident gap between the firms which truly understand and implement the concept of forward-looking supply chain management and those that simply follow a trend. According to him, SCM is, to a large extent, about managing information flows. Unfortunately lack of sophistication in the information system is still one of the biggest road blocks to supply chain integration today.

The Balanced Scorecard’s real success score based on an online survey of 250 users is 15 percent (Pandya, 2002). Another 64 percent reported some progress with the scorecard, but nothing to write home about. The rest (21%) achieved nothing or limited results. Globally, the scorecard was developed to address a research finding that 9 out 10 companies that can formulate business strategy are unable to implement it. (Pandya, 2002). In India, the problem is more fundamental. But the winds of change are blowing-in slowly. Several big business groups like Tata steel, Indian hotels and Tata Consultancy Services (TCS), Birlas, Godrejs and Goenkas (RPG) are using the scorecard in part or in full. KPMG’s business consulting division, which also helps companies use the scorecard advocates that organizations should measure only those things that matter to strategy.

In India some of the leading group of companies such as “Tata, TVS, Rane, Bajaj Auto, Mahindra & Mahindra” are beginning to implement supply chain measurement systems. Some calling those as scorecards, while others call them dashboards or cockpits. Most of the companies follow a) supply chain councils – SCOR model and benchmarking and some of the companies in addition to SCOR model metrics they do apply activity based costing (ABC), economic value added (EVA) and balanced score cards.
Research group of Materials Management Review (2003) has highlighted the supply chain metrics. According to them, supply chain metrics go beyond numbers and could, if done properly, bring balance to an enterprise’s value chain. One of the metric ideas they found in research was the development of a corporate scorecard, which will list and define how the company will manage performance measurement at an operational level. The parameters could include keeping inventories down, reducing lead times between order taking (sales) and order delivery (production and logistics).

Supply chain management (SCM) performance improvement is by supply chain integration, supply chain optimization and supply chain reconfiguration—a presentation (Shah, 2003). According to him, the supply chain performance can be measured by using supply chain scorecard. Supply chain scorecard consists of the following score level metrics, shown in Table 2.4.

It is reported that the total supply chain costs can be up to 50% less in supply chain if performance improves (Rajashekaraih, 2006). In India, inventory management (measured by inventory turnover ratio) can vary enormously within each segment (e.g., in metal processing industry the worst is 2.5 and the best is 42.51) improving that there is vast potential for improvement in SCM performance.

An exclusive survey by Eicher Consultancy Services (2005) that covered India’s top 1000 companies over a period of six years ending at 2004, has tried to establish the trends to track improvement in supply chain metrics. This was reported in the materials management Review, (July 2006). The metrics chosen by the consulting service are as follows:
Table 2.4 Supply Chain Performance Evaluation

<table>
<thead>
<tr>
<th>Category</th>
<th>Criterion</th>
<th>Score level metrics</th>
<th>Actual performance to committed date</th>
<th>Equal 85%</th>
<th>Better 90%</th>
<th>Best 95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over-all</td>
<td>Supply chain reliability</td>
<td>Fill rates</td>
<td>63%</td>
<td>94%</td>
<td>96%</td>
<td>98%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Perfect order fulfillment (on time in full)</td>
<td>0%</td>
<td>80%</td>
<td>85%</td>
<td>90%</td>
</tr>
<tr>
<td></td>
<td>Flexibility and responsiveness</td>
<td>Order fulfillment lead times (customer to customer)</td>
<td>7 days</td>
<td>7 days</td>
<td>5 days</td>
<td>3 days</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Production flexibility (days of master schedule fixed)</td>
<td>45 days</td>
<td>30 days</td>
<td>25 days</td>
<td>20 days</td>
</tr>
<tr>
<td></td>
<td>Cost</td>
<td>Total logistics management costs</td>
<td>19%</td>
<td>13%</td>
<td>8%</td>
<td>3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Warranty cost, returns and allowances</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Value added per Employee productivity</td>
<td>$122k</td>
<td>$156k</td>
<td>$306k</td>
<td>$460k</td>
</tr>
<tr>
<td>Internal</td>
<td>Assets</td>
<td>Inventory days of supply</td>
<td>119 days</td>
<td>55 days</td>
<td>38 days</td>
<td>22 days</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cash-to-Cash cycle time</td>
<td>196 days</td>
<td>80 days</td>
<td>46 days</td>
<td>28 days</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Net asset turns (working capital)</td>
<td>2.2 turns</td>
<td>8 turns</td>
<td>12 turns</td>
<td>19 turns</td>
</tr>
</tbody>
</table>

(Source: Shah, 2003).

- **Cash-to-cash-cycle-time**: defined as the sum of days of receivables and days of inventory less days of payables outstanding.
- **Inventory level**: defined as days of inventory.
- **Asset turnover**: defined as the ratio of net sales to assets where assets are the sum of gross fixed assets and net working capital. This ratio is a measure of
the overall asset utilization which, as a rule improves once companies put in place supply chain management practices.

Each of these metrics was used to calculate an improvement score which has a maximum score value of 15 and a minimum value of zero. Based on the survey results the companies were categorized as follows and shown in Table 2.5

Table 2.5 Supply chain performance of companies

<table>
<thead>
<tr>
<th>No.</th>
<th>Supply chain improvement</th>
<th>Improvement score</th>
<th>No. of companies</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Best performers</td>
<td>12-15</td>
<td>66</td>
<td>6.6%</td>
</tr>
<tr>
<td>2</td>
<td>Superior performers</td>
<td>8-11</td>
<td>558</td>
<td>55.8%</td>
</tr>
<tr>
<td>3</td>
<td>Below average performers</td>
<td>4-7</td>
<td>348</td>
<td>34.8%</td>
</tr>
<tr>
<td>4</td>
<td>Poor performers</td>
<td>1-3</td>
<td>28</td>
<td>2.8%</td>
</tr>
</tbody>
</table>

The survey comments that more than two thirds of the companies that were analyzed exhibited improvement score higher than 8 and hence showed ample scope for improvement.

Another study was conducted by Economic Intelligence Group (2005). Indian top 100 manufacturing companies on net sales for the financial year ending 2004-2005. The supply chain metrics were computed from the corporate database for the past six years.

An improvement is counted if the company has performed better (A lower cash-to-cash cycle, inventory level and higher asset turnover ratio) compared to the performance, the maximum improvement score a company can set is 15, going down all the way to zero.

Ashok Leyland, Hero Honda and Tata Motor have scored 13 points among the top performers in the Auto OEM category. In auto ancillary sector, Rane Engine values showed improvement across all years and across all the parameters. The chosen metrics are i) Cash to cash cycle time ii) Inventory days iii) Asset turn over
ratio and iv) Return on capital employed (ROCE). Here again other metrics such as cycle time, cost metrics, inventory holding (Raw material & Work in process) and Quality metrics were not considered for study.

The Performance Measurements Group (PMG), a subsidiary of PRTM management consultants, have released results of the first survey in its 1900-2000 supply chain management benchmarking series. The survey is based on “Level 1” metrics from the industry standard framework, SCOR model. These process performance measures have a wide-ranging strategic significance to organizations. PMG examined best-in-class industry performance of customer-facing and internal-facing measures in supply chain management. Customer facing measures, such as upside production flexibility and delivery performance to request, quantify how well a supply chain delivers products to the customers. Internal-facing measures, including total supply-chain costs and Cash-to-Cash cycle time, quantify how effectively an organization uses resources in creating value to the customer or how efficiently a supply chain costs and Cash-to-Cash cycle time, quantify how effectively an organization uses resources in creating value to the customer or how efficiently a supply chain operates. These measures help companies to evaluate the full scope of their supply chain performance against best-in-class performers. The results are based on data from 110 subscriber organizations from North America, Europe and Asia, in chemical and Pharmaceuticals, computers and electronic equipment, defense and industrial, telecommunications equipment and packaged goods sectors. The key performance metrics chosen for the study were:

- Delivery performance to request: the percentage of orders that are fulfilled on or before the customer’s requested date.
- Upside production flexibility / material availability: the number of days required to achieve an unplanned sustainable 20% increase in production.
- Total supply chain costs: the cost as a percent of sales to manage order processing, acquire materials, manage inventory and manage order processing, acquire materials, manage inventory and manage supply chain finance, planning and MIS costs.
• Cash-to-cash time: the number of days between paying for raw materials and getting paid for product, as calculated by inventory days of supply plus days of sales outstanding minus average payment period for material.

• Best-in-class: the PMG selects the top 20% of a population and averages the results to calculate the best-in-class measure.

In an article in Materials management review mentioned that the performance of “Consumer packaged goods” supply chain are as follows: The major findings of the survey were manufacturers are more accurately adjusting forecasts and production cycles to respond to rapid changes in demand. It was found that best-in-class performers operates with less 40 days of inventory throughout the supply chain and also have cut their supply-chain management costs 4% - 5% of sales. They have adopted innovative practices such as exploiting the Internet to integrate information and decision-making around the globe.

Cash-to-cash cycle time for the best-in-class companies is less than 30 days. Companies pay their suppliers quickly, collect from their customers just as quickly and move inventory continuously. Best-in-class upside production flexibility has dipped below two weeks and in some industries it is less than a week (Anon, 1999; Material management review, 2004 & 2006).

**Best-in-class Median**

<table>
<thead>
<tr>
<th></th>
<th>Median</th>
<th>97.6</th>
<th>81.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delivery</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production Flexibility</td>
<td>8.3</td>
<td>42.0</td>
<td></td>
</tr>
<tr>
<td>Total Supply Chain Costs</td>
<td>4.9</td>
<td>9.2</td>
<td></td>
</tr>
<tr>
<td>Cash-to-Cash Cycle Time</td>
<td>24.7</td>
<td>66.6</td>
<td></td>
</tr>
</tbody>
</table>

Similar study was conducted by Korgaonkar (2001) in performance measurement of some of the industries. The major findings of his report are as follows:

• The total logistics cost in the country is estimated at 4.59% of sales.
• Nearly 60% of the logistics cost is in transportation (35%) and inventory costs (25%); the rest is due to losses (14%) packaging (11%), handling and warehousing (9%) and customers’ shipping (6%) growing number of manufacturers are taking proactive and reactive steps to control logistics cost and improve customer service.

• There is major transportation and other infrastructure bottlenecks related to supply chain management (SCM) in India, including roads, railways, ports, shipping etc.

• Several new supply chain management (SCM) related activities have started in India, these include, emergence of trucking companies, information technology including service, containerization, private warehousing, multi modal transport operators, inland container depots, container freight stations and third party logistics providers.

• The average inventory turns is 4.5 per year. Over 50% of the inventories are of raw materials, due to inadequate control on the supply side.

• Supply chain performance is far satisfactory, in respect of lead times. Inventories and deliveries. However, several action programmes have been undertaken by firms to improve supply chain performance.

• There is a growing trend to outsource supply chain related services; these include inventory management, transportation, warehousing, forwarding and clearing, information technology etc. However, service providers with adequate skills, competency and technology are limited.

110 companies were selected across various industries in India by Indian Institute of Materials Management (2003) on benchmarking practices in supply chain management. This study was conducted jointly by Indian Institute of Materials Management and Scope-e-knowledge Centre Ltd. The metrics chosen were i) cycle time metrics ii) cost metrics iii) quality metrics and iv) assets metrics. All these metrics were computed from the companies’ corporate data bank. Each segment of supply chain was compared with best-in-class supply chain within that segment against each metrics. The relationship among metrics, commonality between metrics
within the group and between the group upstream and downstream sides of supply chains were not compared and analyzed.

After conducting a detailed review of literature, the research procedure has been formulated to conduct the supply chain performance measures in selected manufacturing and fast moving consumer goods (FMCG) Industries.

In today's world, supply chain management (SCM) is a key strategic factor for increasing organizational effectiveness and for better realization of organizational effectiveness and for better realization of organizational goals such as enhanced competitiveness, better customer care and increased profitability.

The era of both globalization of markets and outsourcing has begun and many companies select supply chain and logistics to manage their operations. Most of these companies realize that in order to evolve an efficient and effective supply chain management, (SCM) needs to be assessed for its performance. The emphasis is on performance measure dealing with suppliers, delivery performance, customer service and inventory and logistics costs in a supply chain management. The process of choosing appropriate supply chain performance measures is difficult due to the complexity of these systems.

The framework presented by Gunasekaran (2002) was also reviewed. The metrics and measures are discussed in the content of the supply chain processes a) plan b) source c) make and d) delivery. The importance of these parameters was established by calculating the mean of all responses and ranking them accordingly. The affirmative responses from this study showed that effort focused on carefully managing supply chains produced financial benefits for participating. Based on the responses received from the companies, researchers (Gunasekaran, Patel & Mcgaughey, 2004) developed a framework to promote a better understanding of the importance of supply chain performance and metrics.

The role of these measures and metrics in the success of an organization cannot be overstated because they affect, strategic, tactical and operational and
control. Performance measurement and metrics have an important role to play in setting objectives, evaluating performance and determining future courses of actions. Performance measurement and metrics pertaining to supply chain management (SCM) have not received adequate attention from researchers or industries. This study is to promote a better understanding of the importance of supply chain performance measurements and metrics.

**Scope for Improvements**

It was found in the literature that various methods that are adopted to improve the supply chain performance. Some of the popular methods are as follows:

1. **Organization**
   
   Material movement should be optimum, resource efficiency maximum.

2. **Flow and Balance**
   
   Minimum delay, wastes and defects should be zero.

3. **Signaling**
   
   Minimum downtime and resources losses.

4. **Redundancy Reduction**
   
   Production process which adds value only should exist. Non-value added activities should be eliminated.

5. **Continuous Improvement**
   
   Products, processes and services with minimal expenditures.

**2.10 SCM FOR COMPETITIVE ADVANTAGE**

The source of competitive advantage is found firstly in the ability of the organization to differentiate itself in the eyes of the customer, from its competition and secondly by operating at a lower cost and hence at greater profit (Chirstopher, 2003).

Michael Porter has brought a concept to a wider audience is the value chain: Competitive advantage can not be understood by looking at a firm as a whole. It
stems from the many discrete activities a firm performs in designing, producing, marketing, delivering, and supporting its product each of these activities can contribute to a firm’s relative cost position and create a basis for differentiation. The value chain disaggregates a firm into its strategically relevant activities in order to understand the behavior of costs and the existing and potential sources of differentiation. A firm gains competitive advantage by performing these strategically importance activities more cheaply (at lesser cost) or better than its competitors (Porter, 1985).

We are now entering the era of supply chain competition. Organizations can no longer act as an isolated and independent entity in competition with other similarly stand alone organizations. Instead, the need to create value delivery systems that are more responsive to fast changing markets and that are much more consistent and reliable in the delivery of that value requires that the supply chain as a whole be focused on the achievement of these goals. Companies must recognize and develop it through their capability building and competencies that they compete (Prahalad & Hamel, 1990).

The product life cycles have become shorter necessitating greater innovation on the part of the businesses. Companies which will survive and grow in this new economic reality will have to constantly create sustain competitive advantage. Supply chain has emerged as a powerful means to create and sustain this competitive advantage.

Typically, a supply chain will cover flow of materials from company’s suppliers to its final customers – but firms are today also focusing on flow from suppliers’ suppliers to buyer’s buyers viz. the ultimate consumers (Berry & Towill, 1992; Betz, 1998; Ramakrishnan, 2006, Niebel & Baldwin 1957; Morris & Brandon, 1993; Minaham, 1998 & Morton, 1999).

Materials constitute the largest component of costs in any manufacturing company’s expenditure (range from 50% to 85%). In addition to this cost of materials, there are significant costs of materials (20-25% of cost of materials per
Costs can be controlled by either or all of the 3 avenues viz cost reduction, cost avoidance and cost efficiency. Emphasis is today on cost efficiency which is defined as “Providing a given value at the minimum essential cost”. The 5 key concepts relating to cost efficiency are as follows:

1. Cost efficiencies can be sought through improvements in a) Products b) Processes and c) Practices
2. Cost efficiency is achieved through initial cost effective design and then through continuous cost reduction efforts.
3. The approach to cost efficiency is two fold a) Elimination of waste for a given process and b) Reduction of cost through improved processes.
4. It can be done through radical business process Re-engineering (BPR) and through Continuous Improvements (Kaizen).
5. It can happen everywhere in the supply chain – Design, Materials, Production, Logistics, and Marketing.

The potential of cost reduction through supply chain is truly large. There is nothing simpler in concept but hard to practice than cost-reduction. The right cost drivers should be identified and right strategies should be placed in the process, which will result in a) Reduced costs b) Improved customer service levels and c) Redefined competitive position for the company. Supply chain is the last gold mine of profits.