

# **Chapter 1**

## **Introduction**

### **1.1 INTRODUCTION**

This chapter discusses about the overview of the supply chain management and its key processes. The objectives, decision phases and key issues in the supply chain are discussed. This is followed by the overview on Demand Management, Forecasting and Supply chain management and the role of forecasting in supply chain. The components of forecasting are also discussed which are followed by the types and behavior of products. Finally the objectives of this research work and its layout are presented in this chapter.

### **1.2 SUPPLY CHAIN MANAGEMENT- AN OVERVIEW**

Supply Chain Management represents the convergence of at least three main streams of knowledge and Practical experience of the business environment for almost 60 years. The synthesis of these streams into one powerful movement, supply chain management which is sweeping across the present-day industrial world has been brought about by forceful competition trait of the modern-day markets. Business enterprises are forced to invest in and focus attention on their supply chains due to the introduction of products with shorter life span, and the delicate expectations of customers. This has motivated the continuous evolution of the supply chain and the techniques to manage along with continuing advances in communications and transportation technologies. Successful supply chain strategies must take into account the interactions at the various levels in the supply chain to reduce cost and improve service levels.

In the 1960s and 1970s, the manufacturing and supply strategy of multinational companies focused on vertical integration. But in the 1980s, large organizations started to concentrate on their core businesses than the non-core arms of the business. Organizations revealed manufacturing technologies and strategies that helped them to reduce costs and to compete better in different markets environments. Strategies such as Just-in-time manufacturing, Kanban, Lean manufacturing, Total Quality Management,

and similar techniques became very popular, and vast amounts of resources were invested in implementing these strategies. On the other hand, most of the companies have reduced manufacturing costs as much as possible practically in the last few years. Most of these companies are realizing that effective supply chain management is the next step they need to take in order to increase their profit and the share in the market.

In the 1990's, outsourcing was the focus of many industrial manufacturers; firms considered outsourcing everything from the procurement function to production and manufacturing. Executives were forced to focus on stock value, and huge pressure was placed on the organization to increase profits. Certainly in the mid 1990s, there was a remarkable increase in purchasing volume as a percentage of the firms' total sales.

In the late 1990s, business to business automation was considered a trend that would have a reflective impact on supply chain performance. These market places promised increased market research for buyers and suppliers, reduced procurement costs and paperless transactions. At that time, manufacturers were desperately looking to outsource their procurement functions. Business to business market place is frequently highly fragmented, with a large number of suppliers competing in the same market place and offering similar products.

In the beginning of the 21<sup>st</sup> century, the explosion of outsourcing and the emergence of competent but lower cost manufacture was witnessed. It is then recognized in the global marketplace that a whole system's supply/value chain approach has to be taken embracing service and manufacturing.

Supply chains vary significantly in complexity and size but the fundamental principles are same for all operations whether they are large or small, manufacturing or service, private or public sector. Supply chain management takes into consideration every facility that has an impact on cost and plays a role in making the product conform to customer requirements. The objective of supply chain management is to be efficient and cost effective across the entire system. The main purpose is to provide best value to the customer by measuring, planning and managing all the links in the chain.

The objective of the business is to convert customer demand by optimizing the utilization of resources to deliver effective customer service. This is applicable to all organizations regardless of whether they are in manufacturing or service sectors. Enterprise Resource Planning (ERP) systems provide a single up-to-date database incorporating manufacturing, finance and human resource applications extended to include tracking of orders and inward goods, work in progress and delivery of finished goods. The system is assessable to all departments for planning and execution of supply chain activities.

The internet has provided potential solutions and has enabled extensive connectivity. Internet enables people working in different areas of the supply chain to be in consistent connection. It is not required to restrict operations within the traditional organizational boundaries since information transactions have become so easy. These new capabilities offer the facility for the supply chain partners to share information in real time.

The processes in the supply chain are becoming more and more intricate both in terms of variety of products and variability of operations. In a favorable condition, high volume and low variety of products and low variation in manufacturing processes will deliver products at a lower cost in comparison to a situation with low volume, high variety and high variation. The need for complex chains with many variables has aroused due to the increase in customer contacts and choice.

Global environment forces involve the stress created by foreign competitors as well as the opportunities created by foreign customers. The presence of foreign competitors in home markets can affect their business significantly even if companies do not do overseas business. Hence it became a requirement for the companies to move into foreign markets to defend domestic markets successfully.

Due to global market, the desire for the products became universal, and many companies are willing to sell them globally. As companies become global, their competitors also must become global in order to compete and this is clearly a self-amplifying trend for an industry. In this way, many companies are becoming global citizens with universal products and the opportunity to hire talented employees worldwide.

### **1.2.1 WHAT IS A SUPPLY CHAIN?**

A supply chain is global network used to deliver products and services from raw materials to end customers through an engineered flow of information, physical distribution and cash. A supply chain in this view comprises a network of both entities and processes. A supply chain doesn't have to be global, but the massive chains add global in scope absolutely.

Supply chain management is the integration of key business processes from end user through original suppliers that provides products, services and information that add value for customers and other stake holders. A supply chain consists of all parties involved, directly or indirectly, in fulfilling a customer request. Within each organization, such as a manufacturer, the supply chain includes all functions involved in receiving and filling a customer request.

A typical supply chain involves a variety of stages such as Customers, Retailers, Wholesalers/Distributors, Manufacturers and Component/Raw material suppliers. Each stage in a supply chain is connected through the flow of products, information and funds. These flows may occur in both directions and may be managed by one of the stages in the supply chain. The appropriate design of the supply chain depends upon both the customer needs and the way by which the organization fulfils that need. Generally, traditional supply chains operate on a multi-echelon distribution model in which supplies move from the downstream suppliers and manufacturers through a series of large and small intermediaries to reach upstream customers.

### **1.2.2 KEY SUPPLY CHAIN MANAGEMENT PROCESSES**

The definition of supply chain seems fairly solid when the chain is considered as linked organizations-supplier; producer and customer connected by product, information and payment flows. But the supply chain is more accurately viewed as a set of linked processes that take place in the extraction of materials for transformation into products for distribution to customers. Those processes are carried out by the various functional areas within the organizations that constitute the supply chain. When considered as a set

of processes rather than a succession of companies, the supply chain becomes just a little more difficult to identify.

### **1.2.3 STAGES OF EVOLVING SUPPLY CHAIN MANAGEMENT**

The advances made over the past few decades in supply chain management are generally reproduced in each supply chain's development.

#### **1.2.3.1 MULTIPLE DYSFUNCTIONS**

The lack of any disciplined management in the internal chain as well as external chain is called the dysfunction. The nucleus firm lacks internal definitions and goals and has no external links other than transactional ones.

#### **1.2.3.2 SEMI FUNCTIONAL ENTERPRISE**

The nucleus firm undertakes initiatives to improve effectiveness, efficiency and quality within functional areas. While some or all functions engage in initiatives designed to increase efficiency within their departmental walls, there is little or no overlap in decision making from one department to another.

#### **1.2.3.3 INTEGRATED ENTERPRISE**

The firm breaks the barrier walls and brings functional areas together in processes such as sales and operation planning with a focus on companywide processes rather than individual functions.

#### **1.2.3.4 EXTENDED ENTERPRISE**

The firm integrates its internal network with the internal networks of selected supply chain partners to improve efficiency, product/service quality or both. The starting point is generally one inside/outside partnership points that way toward the completely networked enterprise.

## **1.2.4 CREATING VALUE THROUGH SUPPLY CHAIN MANAGEMENT**

### **1.2.4.1 FINANCIAL VALUE**

SCM efforts are generally aimed to improve financial performance by reducing costs. Squeezing excess costs out of an enterprise certainly has the potential to provide value to one or more stakeholders. Care needs to be taken when spending less in one area of the business will simply mean spending more elsewhere thereby possibly creating a net loss. Cost cutting, therefore need to aim for net gains at bottom line.

Many of the improvements in supply chain performance require investments of money up front to realize greater revenues, profits or both down the line. If an improvement in the supply chain brings in more revenue, than the cost of the investment, then it's fully justified. The ultimate aim must always be for creation of value at the customer's end of the chain.

### **1.2.4.2 CUSTOMER VALUE**

Quality is a highly variable concept and applies to all products and services. Decisions all along the chain have to be coordinated to get the appropriate level of quality through the right design, right production and the right materials. Immense competition for this market drives supply chain managers to develop collaborative design processes that result in specifications for products of good quality.

For some products or customers, availability is of vital value and the supply chain has to be designed to deliver products and services right on time.

### **1.2.4.3 SOCIAL VALUE**

Supply chains deliver products and services that are entrenched in a social and cultural environment. Business produces what society demands, in other words, what businesses produce also shapes culture and society. It also adds to the society by avoiding or reducing negative environmental side effects of activities such as extraction, processing and construction.

### **1.2.5 SUPPLY CHAIN MANAGEMENT STRATEGIES**

Strategic decisions made by companies embrace whether to outsource or carry out a supply chain function in-house, the location and capacities of production and warehousing amenities, the products to be manufactured or stored at various locations, the various ways of transportation to be made available along different shipping legs, and the type of information system to be adapted. An organization must make sure that the supply chain design supports its strategic objectives and increases the supply chain surplus during this period. Supply chain design decisions are classically made for a matter of years and are very expensive to amend on short notice. Accordingly, when companies make these decisions, uncertainty in anticipated market conditions over the next few years must be taken into account.

#### **1.2.5.1 SUPPLY CHAIN RISK MANAGEMENT STRATEGIES**

The potential disruptions that challenge supply chain strategists include the following key dangers

1. Mode of transportation failure as a shipwreck, pipeline pumping stations that close down due to power outage, workman strikes or similar disruptions.
2. Harm to products, facilities or markets caused by adverse weather, fire, floods, vandalism or terrorist activities
3. Loss of key asset or supplier
4. Non compliance with regulations that happened unintentionally, ordinances, licensing requirements and the like
5. Real and intellectual property theft
6. Surprise or sudden change in partnership by a critical customer.

### **1.2. 6 THE OBJECTIVES OF A SUPPLY CHAIN**

Maximizing the overall value generation should be the objective of every supply chain. The value of the supply chain is the difference between the worth of the final product to the customer and the supply chain's cost incurred in filling the customer's request. The

surplus of the supply chain will be strongly correlated with the profitability of the supply chain, the difference between the revenue generated from the customer and the overall cost across the supply chain. The total profit to be shared across all supply chain stages and intermediaries is the supply chain profitability. The higher the supply chain profitability, the more successful is the supply chain. Each and every flow of information, product or funds generates costs within the supply chain. Hence the appropriate management of these flows is a key to supply chain success. Effective management of supply chain assets and product, proper handling of information and fund flows to maximize total supply chain surplus results in an effective supply chain management.

### **1.2.7 DECISION PHASES IN A SUPPLY CHAIN**

Successful supply chain management requires many decisions relating to the flow of information, product and funds. Each and every decision should be made to raise the surplus of supply chain. Depending on the frequency of each and every decision and the time frame during which a decision phase has an impact, these decisions fall into three categories. As a result, uncertainty over the decision horizon should be considered under each category of decisions.

#### **1.2.7.1. SUPPLY CHAIN STRATEGY OR DESIGN**

In this phase, a company decides how to structure the supply chain over the next several years. Strategic decisions made by companies include whether to outsource or perform a supply chain function in-house, the location and capacities of production and warehousing facilities, the products to be manufactured or stored at various locations, the modes of transportation to be made available along different shipment legs and the type of information system to be utilized. A firm must ensure that the supply chain configuration supports its strategic objectives and increases the supply chain surplus during this phase.

#### **1.2.7.2. SUPPLY CHAIN PLANNING**

For decisions made during this period, the time frame considered is a quarter to a year. Hence, the supply chain's design determined in the strategic phase is fixed. The objective

of planning is to maximize the supply chain superfluous that can be created over the planning horizon specifying the constraints recognized during the strategic or design phase. Organizations initiate the planning phase with a forecast for the future year of demand in various markets. Planning includes making decisions regarding which markets will be supplied from which locations, the subcontracting of manufacturing, the inventory policies to be followed and the timing and size of marketing and price promotions. In the planning phase, companies must include ambiguity in demand, exchange rates, and competition over this time horizon in their decisions. As a consequent of the planning phase, companies identify a set of operating policies that over-see the short-term operations.

### **1.2.7.3. SUPPLY CHAIN OPERATION**

In this phase companies make decisions regarding individual customer orders daily or weekly in this time period. Supply Chain configuration is considered fixed and planning policies are already defined at the operational level. The objective of the supply chain operations is to handle oncoming customer orders in the best possible manner. Since operational decisions are being made in the short term, there is less ambiguity about demand information. The goal during the operation phase is to explain the reduction of uncertainty and optimize performance.

### **1.2.8 KEY ISSUES IN SUPPLY CHAIN MANAGEMENT**

The key issues of Supply chain management that covers a large scale of firm's activities, from the strategic through the tactical to the operational level are given below.

- i. The strategic level handles the long – lasting decisions that affect the firm. This incorporates decisions concerning the number, location, and capacity of warehouses and manufacturing plants, flow of material through the logistics network, etc.
- ii. The tactical level includes decisions that are typically updated anywhere between every quarter and once every year. These consist of some of the purchasing decisions, production decisions, inventory policies, transportation strategies etc. Also, tactical level decisions include the frequency of the visits of the customers.

- iii. The operational level comprises of day-to-day decisions such as scheduling, lead time quotations, routing, truck loading etc.

### **1.2.9 GLOBALIZATION OF THE SUPPLY CHAIN**

An established global supply chain creates many benefits, which includes the facility to source from a global base of suppliers who may tender better or cheaper commodities that were accessible in the company's home country. Globalization also leads difficulty to the chain, since facilities are farther apart making coordination much more difficult within the chain.

Globalization has also added increased competition by making the once –protected national players to compete with companies from around the globe. On the other hand, many more firms are now aggressively pursuing their competitors business in most industries. This aggressive environment makes supply chain performance a key to maintaining and growing sales while also adding more strain on supply chains and thus forcing them to choose their trade-offs even more accurately.

### **1.3 DEMAND MANAGEMENT**

One of the major problems affecting supply chains is uncertainty and variability of customer demand is one particular troublesome type of uncertainty. Surprise and sudden changes in demand can upset the processes all along the chain. Scheduling plant operations, determining service capacity requirements, ordering supplies, managing inventory, fulfilling orders with the right amounts at the right time and staffing all hinge on the level and timing of demand. Forecasting is one process of bringing some order to scheduling supply chain processes. Others include technologies that track sales up the chain, possibly right to the cash register, to trigger operations and orders required to replenish inventories. A demand management is considered to be successful if the demand and supply are in balance preventing unwanted accumulations of inventory on the one hand and shortages on the other.

### **1.4 FORECASTING AND SUPPLY CHAIN MANAGEMENT**

Forecasting is a vital component of Supply Chain Management. The supply chain

involves everything that pertains to producing a product or service from a company's suppliers all the way to the customers. Forecasts help determine the amount of inventory level to be kept on stock, how much raw material should be procured, and how much of a product should be produced. Forecasts that are not accurate can lead to costly inventory buildup or stock outs. Both of these events are harmful in a business world, where customer service is of the utmost importance.

The basis of all strategic and planning decisions in a supply chain is the forecast of future demand. The objective of forecasting is 'to minimize uncertainty and to identify and evaluate risk'. Forecasting is involved in a wide range of business management problems. In addition to production and distribution decisions, a company also uses forecasts of future demand as the basis for many other decisions made in supply chain, such as in Production for Scheduling, inventory-control, aggregate planning, in Marketing for Sales-force allocation, promotions, new product introduction, in Finance for plant/ equipment investment, budgetary planning and in Personnel for Workforce planning, hiring and layoffs.

A company must consider the demand forecast over the coming period and then decide on the timing of various promotions. The promotion information is then used to update the demand forecast. Hence, it can be said that all the decisions of a firm are interrelated. Forecasting and the accompanying managerial decisions are extremely difficult when either the supply of raw materials or the demand for the finished product is highly variable. One example of such a product with variable seasonal demand is chocolate; the majority of chocolate sales take place close to holiday season. On the other hand, mature products with stable demand are usually easiest to forecast since there is not much variation in the sales. Staple products at a supermarket, such as milk fit this description.

Good forecasting is very important for any firm, since the time period for sales is narrow and if a firm has either over or under produced, it has little chance to recover and ensure that supply matches demand.

### **1.4.1 ROLE OF FORECASTING IN A SUPPLY CHAIN**

Demand forecasts form the basis of all supply chain planning. Operating performance within each member and across members of a supply chain is significantly influenced by Supply chain sales forecasting management. Organizations working together in a supply chain must improve forecasting management performance as well as supply chain forecasting management performance.

The four dimensional forecasting management functions like functional integration, approach, systems and performance measurement can be extended to incorporate a supply chain orientation.

Initiatives such a Collaborative planning, Forecasting and Replenishment reflect the four forecasting management dimensions and provide an approach to forecasting which addresses factors that influence forecasting management performance and supply chain forecasting management performance.

### **1.4.2 THE ROLE OF IT IN FORECASTING**

IT in forecasting plays a natural role, with the large amount of data involved, the frequency with which forecasting is performed and the significance of getting the highest-quality results possible.

Commercial demand planning modules come with a variety of forecasting algorithms which can be quite advanced and are sometimes proprietary. Most demand planning applications make it moderately simple to test the various forecasting algorithms against historical data to determine the one that provides the best fit to the observed demand patterns.

A good IT system should help track historical forecast errors so they can be incorporated into future decisions. A well structured forecast, along with a measure of error, can significantly improve decision making.

Forecasting and IT have an extensive history. The classic supply chain IT package has a forecasting module feeding forecasts to a planning module. The module sets schedules

and inventory levels, which are then fed to an execution system that actually executes these plans. Thus, forecasting is the heart of IT in the supply chain.

## **1.5 DEMAND FORECASTING**

Demand Forecasting is the practice of estimating the quantity of a product or service that is likely to be procured by a consumer over a specified time horizon. Demand forecasting has grown to be crucial in making decisions with regard to production, sales, investment, expansion, employment of manpower etc., both in the short run as well as in the long run. It seeks to scrutinize and measure the forces that determine sales for existing and new products. Companies map their business, production or sales in anticipation of future demand.

Demand Forecasting is generally associated with forecasting sales and manipulating demand. A firm can make use of the sales forecasts made by the industry as a powerful tool for formulating sales policy and sales strategy. Thus it is an important component of the strategic decision making field of the company. To make good forecast, in-depth understanding of the different forecasting methods is of utter importance for practical implementation.

Forecasting is a prediction of what will occur in the future. It is an uncertain process that is critical to survival in today's international business environment. Rapid technological advances have given consumers greater product diversity as well as more information on which they make their product choices. Managers try to forecast with as much accuracy as possible, but that is becoming increasingly difficult in today's fast-paced business world.

### **1.5.1 IMPORTANT FEATURES OF DEMAND FORECASTS**

The important features and characteristics of Demand Forecasting are listed below.

- Demand forecasts are in terms of definite quantities.
- It is undertaken in an uncertain environment.

- A forecast is made for a specific time horizon which would be sufficient to make a decision and execute into action.
- It is based on historical information and the past sales or any other data.
- It tells us only the approximate demand for a product in the future.
- It is based on certain assumptions.
- It cannot be 100% accurate as it deals with future anticipated demand.

Demand forecasting is required to identify whether the demand is subject to cyclical fluctuations or not, so that the production and inventory policies etc. can be suitably formulated. They can become action guides to select the course of action which will improve the organizations earnings. When external economic factors like the size of market, competitor's attitudes, movement in prices, consumer tastes, possibilities of new threats from substitute products etc., influence sales forecasting, internal factors like money spent on advertising, pricing policy, product improvements, sales efforts etc., help in manipulating demand. To make use of demand forecasting in an active rather than a passive way, management must be acquainted with the degree to which sales are a result not only of external economic environment but also of the action of the company itself.

Demand Forecasting is one of the most significant aspects of managing a business. Finding the precise balance of supply and demand allows a company to produce enough to meet the demand of its customers. If the company overestimates demand, it runs the risk of producing too much, leaving it with unsold commodities. If the company produces too little, it runs the risk of not achieving the demand and losing sales. On the most fundamental level, businesses use historical price and demand information to forecast future demand. For example, shipment orders provide management with some insight regarding the level of demand for the company's products.

### **1.5.2 FACTORS AFFECTING DEMAND FORECAST**

Past Demand, Planned advertising or marketing efforts, State of the economy, planned price discounts, Product's life cycle, Competitor's efforts and prices, Quality, Credit Policy and sales effort are the numerous factors related to demand forecast.

### **1.5.3 COMPONENTS OF DEMAND FORECASTING**

There are two main factors that help determine the type of forecasting method that will be used. They are as follows:

#### **1.5.3.1 TIME FRAME**

The length of the forecast depends on product market changes and vulnerability to technological changes. The classifications are generalizations. Short, mid and Long range is all relative to the business and what is being forecast.

Short to Mid-Range forecasts are usually anywhere from daily to up to two years of time frame. They are commonly used to determine production and delivery schedules and to establish inventory levels.

Long-Range forecasts are generally over two years into the future. They are generally used for strategic planning. Strategic planning determines where the company is headed in the future. It is used to establish long-term goals, plan new products, enter new markets and develop new facilities & technology.

#### **1.5.3.2 BEHAVIOR AND THE POSSIBLE EXISTENCE OF PATTERNS**

Demand sometimes behaves in random and irregular ways. Sometimes it exhibits predictable behavior. The main types of predictable behavior are trends, cycles, and seasonal patterns.

A *trend* pattern is a gradual, long-term, upward or downward movement in demand. A current trend is the steady increase in sales of personal computers over the past few years.

A *cycle* is an up-and-down movement in demand that repeats itself over a longer time span. Automotive sales often behave in a cyclical pattern.

A *seasonal pattern* is a repetitive movement in demand that occurs periodically. Sales of winter sports equipment are seasonal by nature.

Regression is used frequently in forecasting by establishing a mathematical relationship between two or more variables. The simplest form of regression is linear regression. Multiple regressions are also used frequently.

## **1.6 TIME-CRITICAL DECISION MODELING AND ANALYSIS (THE MODEL AND THE DEFINITIONS ARE REPRODUCED FROM DEMAND PLANNING ARTICLE FROM INTERNET)**

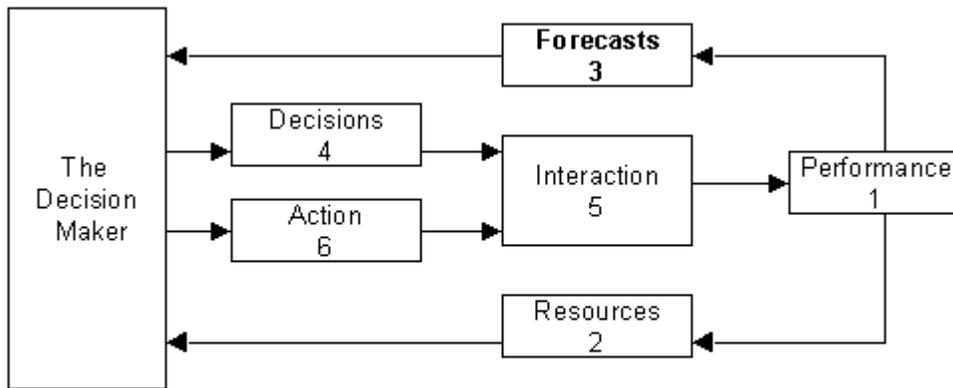
The ability to model and perform decision modeling and analysis is an essential feature of many real-world applications ranging from emergency medical treatment in intensive care units to military command and control systems. Prevailing formalisms and methods of inference have not been effective in real-time applications where tradeoffs between quality of the decision and computational tractability are crucial. Practically, an efficient approach to time-critical dynamic decision modeling should provide unambiguous support for the modeling of temporal processes and for dealing with time-critical situations.

One of the most essential elements of being a high-performing manager is the ability to lead effectively one's own life, then to model those leadership skills for employees in the organization. A vital objective of the site is to integrate the various forms of business topics to link them closely to each other and to the supporting fields of statistics and economics. However, the topics and exposure do reflect choices about what is important to understand for making decision in the business.

Almost all executive decisions are based on forecasts. Each and every decision becomes operational at some point in the future, so it should be based on forecasts of future circumstances.

Forecasts are needed all the way for an organization and they should definitely not be produced by a remote group of forecasters. Forecasts are needed repetitively, and as time moves on, the impact of the forecasts on actual performance is measured; original forecasts are updated; and decisions are modified, and so on.

For example, many inventory systems cater to uncertain demand. The inventory parameters in these systems require estimates of the demand and forecast error distributions. The two stages of these systems, forecasting and inventory control, are often examined independently. Most studies tend to look at demand forecasting as if this were an end in itself or at stock control models as if there were no preceding stages of computation. Nevertheless, it is important to understand the interaction between demand forecasting and inventory control since this influences the performance of the inventory system. This integrated process is shown in the following figure:



**Forecasting Within an Organization:  
Forecasting and Managerial Decision Making**

**Fig 1: Forecasting and Managerial Decision (Courtesy: Internet-Demand Planning article-URL: <http://home.ubalt.edu/ntsbarsh/stat-data/Forecast.htm#rgintroduction>)**

Forecasting models are used by the decision-maker in the decision-making process. The decision-making often uses the modeling process to investigate the impact of different courses of action retrospectively; that is, "as if" the decision has already been made under a course of action. Hence the sequence of steps in the modeling process, in the above figure must be considered in reverse order. For example, the output (which is the result of the action) must be considered first.

It is helpful to break the components of decision making into three groups: Uncontrollable, Controllable, and Resources. As indicated in the above activity chart, the decision-making process has the following components.

Forecasting activity is an iterative process. It starts with effective and efficient planning and ends in compensation of other forecasts for their performance

**System**-Systems are formed with parts put together in a particular approach in order to pursue an objective. The relationship between the parts determines what the system does and how it functions as a whole. Hence, the relationships in a system are often more important than the individual parts. In general, systems that are building blocks for other systems are called subsystems.

**The Dynamics of a System**- Static system is the one that does not change. Many of the business systems are dynamic systems, which mean their states change over time. The time period over which the system is studied is the time horizon. The variables are changeable values on the system.

**Resources**- Resources are the constant elements that do not change during the time horizon of the forecast. Resources are the factors that define the decision problem. Strategic decisions usually have longer time horizons than both the Tactical and the Operational decisions.

**Forecasts**- Forecasts input come from the decision maker's environment. Uncontrollable inputs must be forecasted or predicted.

**Decisions**- Decisions inputs at the known collection of all possible courses of action.

**Interaction**-Interactions among the above decision components are the logical, mathematical functions representing the cause-and-effect relationships among inputs, resources, forecasts, and the outcome.

Interactions are the most important type of relationship involved in the decision-making process. When the outcome of a decision depends on the course of action, one or more aspects of the problematic situation is changed with the intention of bringing about a desirable change in some other aspect of it. There may be sets of constraints which apply to each of these components. Therefore, they need not be treated separately.

**Action**-Action is the ultimate decision and is the best course of strategy to achieve the desirable goal.

**Decision**-making involves the selection of a course of action in pursue of the decision maker's objective .The way that our course of action affects the outcome of a decision depends on how the forecasts and other inputs are interrelated and how they relate to the outcome.

**Statistical Forecasting**- The selection and implementation of the proper forecast methodology has always been an important planning and control issue for most firms and agencies. Often, the financial well-being of the entire operation rely on the accuracy of the forecast since such information will be used to make interrelated budgetary and operative decisions in areas of personnel management, purchasing, marketing and advertising, capital financing etc. For example, any significant over-or-under sales forecast error may cause the firm to be overly burdened with excess inventory carrying costs or else create lost sales revenue through unanticipated item shortages. When demand is fairly stable, e.g., unchanging or else growing or declining at a known constant rate, making an accurate forecast is less difficult. If, on the other hand, the firm has historically experienced an up-and-down sales pattern, then the complexity of the forecasting task is compounded.

There are two main approaches to forecasting. Either the estimate of future value is based on an analysis of factors which are believed to influence future values, i.e., the explanatory method, or else the prediction is based on an inferred study of past general data behavior over time, i.e., the extrapolation method. It is possible that both approaches will lead to the creation of accurate and useful forecasts, but it must be remembered that, even for a modest degree of desired accuracy, the former method is often more difficult to implement and validate than the latter approach.

Ideally, organizations which can afford to do so will usually assign crucial forecast responsibilities to those departments and/or individuals that are best qualified and have the necessary resources at hand to make such forecast estimations under complicated demand patterns. Clearly, a firm with a large ongoing operation and a technical staff

comprised of statisticians, management scientists, computer analysts, etc. is in a much better position to select and make proper use of sophisticated forecast techniques than a company with more limited resources. Notably, the bigger firm, through its larger resources, has a competitive edge over an unwary smaller firm and can be expected to be very diligent and detailed in estimating forecast

## **1.7 SUPPLY CHAIN NETWORKS AND INVENTORY CONTROL**

A supply chain is a network of facilities that purchases raw materials, make over them into intermediate goods and then final products, and deliver the products to customers through a distribution system. To achieve an integrated supply chain management, one must have a standard description of management processes, a framework of relationships among the standard processes, standard metrics to measure process performance, management practices that produce best-in-class performance, and a standard alignment to software features and functionality, together with user friendly computer-assisted tools.

Highly effective coordination, dynamic collaborative and strategic alliance relationships, and efficient supply chain networks are the key factors by which corporations survive and succeed in today's aggressive marketplace. Thus all existing supply chain management models rightly focus on inventory control policies and their coordination with delivery scheduling decisions.

### **1.7.1 INVENTORY CONTROL**

Inventory control decisions are very important for some of these departments such as Production, Marketing, and Accounting departments. Inventory control decision-making has a massive impact on the productivity and performance of many organizations, because it handles the total flow of materials. Proper inventory control can minimize stock out, thereby reducing capital of an organization. It also enables an organization to procure or produce a product in economic quantity, thus reducing the overall cost of the product.

Demand forecasting is part of an organizations overall inventory control activities. Inventory control is the process of ensuring whether your firm has an adequate supply of products and a wide assortment of them to meet your customers' needs. One of the main objectives of inventory management is to avoid stock outs. A stock out occurs when you run out of a product a customer wants to buy. The Internet has made process easier than ever for Customers to simply look elsewhere to buy the product.

To help avoid stock outs, most companies maintain a certain amount of safety stock on hand. Safety stock is a backup inventory that serves as a buffer in case the demand for a product surges or the supply of it drops off for some reason. Maintaining too much inventory, ties up money that could be spent other ways—perhaps on marketing promotions. Inventory also has to be insured, and in some cases, taxes must be paid on it. Products in inventory can also become obsolete, deteriorate, spoil, or shrink. Shrinkage is a term used to describe a reduction or loss in inventory due to shoplifting, employee theft, paperwork errors, or supplier fraud.

## **1.8 CHARACTERISTICS OF FORECASTS**

The characteristics of Forecasts are listed below

- i. Forecasts are usually inaccurate and should thus include both the expected value of the forecast and a measure of forecast error. Unfortunately, most firms do not maintain any estimate of forecast error.
- ii. Long –term forecasts are usually less accurate than short-term forecasts. Long term forecasts have a larger standard deviation of error relative to the mean than short term forecasts.
- iii. Aggregate forecasts are usually more accurate than disaggregate forecasts, as they tend to have a smaller standard deviation of error relative to the mean.
- iv. In general, the farther up the supply chain of a company is, the greater is the distortion of information it receives and larger is the forecast error. Collaborative forecasting based on sales to the end customer helps upstream enterprise reduce forecast error.

## **1.9 BEHAVIOR OF THE TYPES OF PRODUCTS**

### **1.9.1 FAST MOVING CONSUMER GOODS (FMCG)**

Fast Moving Consumer Goods (FMCG) refers to non-durable consumer goods required for daily or frequent use. This sector covers a wide gamut of products such as detergents, toilet soaps, cold-drinks, creams, food products etc. Typically, a consumer buys such kind of product at least once a month. Though, individual items are of small value but all consumer goods products put together amount for a significant part of the consumer's budget. The consumer tries to keep a limited inventory of these products as many of these products are perishable. Since most of consumer goods product demands are due to requirement at the consumer end, purchase decisions may be influenced by the availability of product in the racks.

Fast Moving Consumer Goods (FMCG) have a short shelf life, either as a result of high consumer demand or because the product deteriorates rapidly. Some such as meat, fruits and vegetables, dairy products, and baked goods—are highly perishable. Other goods such as alcohol, toiletries, pre-packaged foods, soft drinks, and cleaning products have high turnover rates. An excellent example is a newspaper—every day's newspaper carries different content, making one useless just one day later, necessitating a new purchase every day.

### **1.9.2 SLOW MOVING ITEMS**

Slow moving items, by their very nature, are often subject to trends in demand. The trends may be short-term, as a consequence of changing market conditions, or long-term related to the life-cycle of the part. There are three phases of a service part's life history such as initial, normal and final. The initial phase is often a time of growth in demand, as more original equipment begins to fail. The normal phase may be more stable, but still subject to shorter-term trends, perhaps reflecting wider market trends. The final phase is generally one of long-term decline in demand, as the original equipment is replaced by newer models and the service parts are required less frequently. The nature of the trend in demand is not always clear, particularly during the normal phase of demand, when noise in demand may mask trends. Therefore, forecasting may be enhanced by

improving the selection process between trended and non-trended series, and between different types of trended series. In many organizations, service parts are voluminous, amounting to thousands or tens of thousands of items.

### **1.9.3 UNDERSTANDING THE MARKET FOR NEW PRODUCTS**

Understanding the marketing environment and conducting marketing research can help to explore marketing opportunities. The company must then measure and forecast the size, growth, and profit potential of each new opportunity. Sales forecasts prepared by marketing department are used by finance department to raise cash for investment and operations; by manufacturing department to establish capacity and output; by purchasing department to acquire the right amount of supplies; and by human resources department to hire the needed workers. If the forecast is off the mark, the company will face excess or insufficient inventory. Since it is based on estimates of demand, managers need to identify what they represent by market demand. Each demand measure serves a specific purpose. A company might forecast short-run demand to order raw materials, plan production, and borrow cash.

A company can add new products through acquisition or development. When acquiring, the company can buy other companies, patents from other companies, or a license or franchise from another company. But firms can successfully make so many acquisitions. At some point, they need organic growth or the development of new products from within. For product development, the company can create new products in its own laboratories, or it can contract with independent researchers or new-product development firms to develop specific new products or provide new technology. New products range from new-to-the-world products that create an entirely new market to minor improvements or revisions of existing products. Most new-product activity is dedicated to improving existing products. It is increasingly difficult to classify blockbuster products that will transform a market, but continuous innovation can force competitors to play catch-up and also expand the brand meaning. Fewer than 10 percent of all new products are truly innovative and new to the world. These products incur the greatest cost and risk. Although radical innovations can hurt the company's bottom line in the short run, if they succeed, they can create a greater sustainable competitive advantage than ordinary

products and produce significant financial rewards as a result. New-product introductions have accelerated, and in retailing sectors like consumer goods, electronics, autos, and other industries, the time to bring a product to market has been reduced into half. In an economy of rapid change, continuous innovation is of utmost importance. Highly innovative firms are able to identify and quickly seize new market opportunities. They create a positive attitude towards innovation and risk taking, routinize the innovation process, practice teamwork, and allow their people to experiment and even fail.

### **1.10 MEASURES OF FORECAST ACCURACY**

In continuation with the forecasting, Demand forecasting is an important concern for manufacturing companies. Most of the decision making processes need accurate forecasts in order to choose proper actions relevant to production planning, sales budgeting, new product launches, promotion planning, etc. For this reason, over the years, practitioners and academics have devoted careful attention to how forecasting can be improved to increase forecast accuracy. Forecasting management is a complex issue and companies can decide to lever on different factors to redesign their forecasting process.

Every occurrence of demand has a random component. A good forecasting method should capture the systematic component of demand and not the random component. The random component manifests itself in the form of a forecast error. Forecast errors contain valuable information and must be analyzed carefully since error analysis is used to determine whether the current forecasting method is predicting the systematic component of demand accurately and all contingency plans must account for forecast error.

Statistical demand forecasting systems use statistics and probability theory to predict future demand. They do so by projecting demand forward, based on the history of prior demand. But statistical forecasting methods are blind to the effects of the many factors that may deviate from history.

Such deviations may include:

- Price changes or promotions

- Short supply of products
- Random changes in buyer behavior
- Changes of weather and
- Other factors that can occur between the moments you generate a statistical demand forecast and the time you record actual demand.

To manage and improve inevitable forecast errors, many demand forecasting and inventory planning systems use a process called “exception management.”

### **1.11 RISK MANAGEMENT IN FORECASTING**

Having discussed about demand forecasting and its accuracy, the risks associated with forecast error must be considered when planning for the future. Errors in forecasting can cause significant misallocation of resources in inventory, facilities, transportation, sourcing, pricing and even in information management. Forecast errors during network design may cause too many, too few, or the wrong type of facilities to be built. Plans are determined from forecasts so the actual inventory, production, transportation, sourcing and pricing plans that a company produces and follows depend on accurate forecasting. Even on an operational level, forecasting plays a role in the actual day-to-day activities that are executed within a company.

A wide range of factors can cause a forecast to be inaccurate, but a few occur so often that they deserve specific mention. Long lead times require forecasts to be made further in advance, thus decreasing the reliability of the forecast. Seasonality also tends to increase forecast error. Forecast errors increase when product life cycles are short, because there are few historical data to build on when producing a forecast. Firms with a few customers often experience very lumpy demand that is harder to forecast than demand from many small customers, which tends to be smoother.

Two strategies used to alleviate forecast risk are increasing the responsiveness of the supply chain and utilizing opportunities for pooling of demand. Increased responsiveness allows the firm to reduce forecasting errors and thus decrease the associated risk.

Improved responsiveness and pooling often come at a cost. Increased speed may require capacity investment, whereas pooling tends to increase transportation cost. To achieve the right balance between risk mitigation and cost, it is important to tailor the mitigation strategies.

## **1.12 MOTIVATION FOR RESEARCH**

In view of the above facts mentioned, the focus is made upon the development of models for demand forecasting better than the existing models. The new models produce demand forecast values which can be used in various industries upon experimentation. The slow moving items forecasting does not have a consistent method without complicated calculations. The forecast accuracy measure is still an area of concern in meeting the KPI targets and hence the new formulae would help in overcoming the situation.

## **1.13 OBJECTIVES OF RESEARCH WORK**

The following are the objectives of this research work.

1. To develop new models for Demand Forecasting using a dynamic way for calculating forecasts with better forecasting predictions for normal products, slow moving items, product with seasonal effects and new products for Consumer Goods Industry.
2. To develop new methodology for measuring the Forecast accuracy. The measures should also be compatible to various types of data, with different scales.

Thus the objective of this research is to develop forecasting models for demand for different varieties of products and to develop a new method for measuring the forecast accuracy.

## **1.14 LAYOUT OF THE THESIS**

First Chapter of the thesis introduces the business concepts of Supply Chain Management associated with Demand Planning and Demand Forecasting. It also deals about Demand Management, role of forecasting in Supply Chain Management and the techniques used in demand forecasting. It also discusses in details about the Time-Critical Decision

Modeling and Analysis for the understanding of the Demand Forecasting. It deals about the characteristics of forecasting and the components of forecasting .It also includes the motivation for the research work and the objectives of the present work and layout of this thesis.

Second chapter focuses on the literature review on Supply Chain Management with special emphasis on Demand Forecasting of varieties of products such as Fast Moving Consumer Goods (FMCG), slow moving products and new products. It also discusses about the various forecasting measures available and the literature associated with it.

Third chapter describes the methodology and the results of the dynamic model that has been developed for forecasting demand for normal products. The intention of the model is to determine the demand forecast in a better way and to enhance the forecasting process.

Fourth chapter discusses about the model developed for forecasting slow moving items. The new models developed for slow moving items have been compared with the basic models such as Croston, Syntetos Boylan Approximation etc. The models have been analyzed for products with short as well as long demand histories.

Fifth Chapter discusses about the demand forecasting model for products with seasonal demands that has been developed in this work. The results and analysis has been interpreted and the best model for the respective product has been determined.

Sixth Chapter describes the model proposed for forecasting new products. The Bass model has been modified and the methodology for forecasting new products has been discussed and the results are verified.

Seventh chapter discusses the method proposed for a better measure of forecast accuracy. The accuracy formulae have been compared with the existing measures and the results are recorded.

Eighth chapter deals with the summary of the findings and conclusions of the research work, scope for the future work and significant contribution to the literature.