CHAPTER 1

INTRODUCTION

Global competition, rapid technological evolution, shorter product life cycles, product varieties, increasing complexity and demand volatility are creating a new and difficult competitive environment for manufacturing enterprises, and have changed the ways traditional businesses used to function. Organizations are continuously engaged in search of new sources of competitive advantage and depend on reliability, timely delivery, better quality, enhanced customer service and cost reductions, to remain competitive in the business.

The increasing need of industry to compete with its products in a global market, across cost, quality and service dimensions, has driven the need to develop logistic and supply chain systems more efficient than those traditionally employed. Therefore, in the last two decades, logistics and supply chain has moved from an operations function to the corporate function level. There has been a growing recognition that it is through an effective management of the supply chain and logistics function that the goal of cost reduction and service enhancement can be achieved. During the past few years, supply chain excellence,
optimization and integration have become the focus and goal of many organizations worldwide.

1.1 SUPPLY CHAIN MANAGEMENT

Business depicts on creating and sustaining long-term buyer-seller relationships by stepping forward from the customary single exchange transactions. Managed supply chains are the outcomes of these strategic relationships [1]. The set of entities included in the design of new products and services, acquiring raw materials, converting them into semi-finished and finished products and distributing them to the end customer is referred to as the supply chain [2]. The above definition or a customized version of the same, for supply chain, has been used by various researchers [3], [4], [5], [6], [7]. In a highly cutthroat market, all manufacturers are struggling to make their product quality better, with the intent to reduce their product service cost, and to shorten their product delivery and response time to the market. Supply Chain Management (SCM) concept has gained lot of importance as a conventional management tool with the development of new business partnerships and the information revolution. The SCM considers the production management as a single enterprise that centers on the importance of material and information flow from raw material to customer product delivery [8].
Supply chain management is an efficient management of the complete end to end process, starting from the design of the product or service to the time when it has been sold, consumed and finally gotten rid of by the consumer. This complete process includes product design, procurement, planning and forecasting, production, distribution, fulfillment and after sales supports as depicted in Fig:1.1 [2]. A company’s competitiveness in the global economy can be increased only with the aid of effective SCM. This involves complex strategic, tactical, and operational decisions that often require an in-depth understanding of industry-specific issues, which ranges from network design to production sourcing and from production planning and inventory management to scheduling [9]. The phrase “supply chain management”, which is exploited in the early 1990’s, implies a process to develop a product at right quantity that fulfills customer’s requirements at minimum cost by integrating/utilizing all the available sources (suppliers, manufactures, warehouses, retailers) and delivery of the product at the right time [10].
In recent times, progressive firms consider supply chain integration as the main focus and objective for their development and this integration is easily accomplished by using SCM as a strategy. Even though, SCM is defined in number of terms in literature and in practice, the main philosophy which lies behind, is the same [11]. The lack of an universal definition for SCM is because of the multidisciplinary origin and development of the concept. Simchi-Levi et al. [12] defined SCM as a set of approaches that are utilized resourcefully to integrate suppliers, manufacturers, warehouses and stores, so that the products are strewn appropriately with the main intent to satisfy customer’s requirements with the reduced system-wide cost.

**Fig: 1.1 Supply chain process.**
On the other hand, Christopher [13] defined SCM as the management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at minimal cost in the supply chain as a whole. The decision making process in supply chain is an intricate one, since this includes the complex network of facilities and organizations, with different and conflicting objectives. Such decision process is broadly classified into strategic, tactical, and operational. Ganeshan et al. [14] classified SCM research on the basis of these three categories, and addressed the SCM research with operational perspective in terms of four operational problem areas, namely inventory management and control; production, planning and scheduling; information sharing, coordination, monitoring; and operation tools [11].

1.1.1 Benefits of Supply Chain Management

The benefits of supply chain management are as follows [10]:

- **Throughput improvements:** The waiting time due to non-availability of components can be prevented by the improved synchronization of material and capacity.

- **Cycle time reduction:** The cycle time can be reduced taking into consideration the constraints and applying various options in the supply chain.
• **Inventory cost reductions**: The requirement of inventory levels against uncertainty is reduced by demand and supply visibility. The capability to decide about when to buy materials based on the customer demand, logistics, capacity and other materials needed to build together enables inventory cost reductions.

• **Optimized transportation**: By optimizing logistics and vehicles loads.

• **Increase order fill rate**: The raise in order fill rate is facilitated by the Real-time visibility across the supply chain (alternate routings, alternate capacity)

• **The propagation of disturbance to downstream** can be predicted with the aid of supply chain management analysis.

• **Increase customer responsiveness**: Understanding the capability to deliver based on availability of materials, capacity and logistics.

### 1.1.2 Issues of Supply Chain Management

Supply chain management issues are categorized into two broad categories: The issues related to basic infrastructure on which the supply chain operates are called configuration (design-oriented) issues, and issues related to the actual execution of the supply chain [2, 3] are referred to as the coordination (execution-oriented) issues.
A. **Configuration-level issues include the following** [2, 3]:

a. **Procurement and Supplier Decisions**: How many and what sort of suppliers are needed? Which components should be outsourced and which should be reserved for in house? How can procurement practices be streamlined and standardized? How should long-term and short-term contracts be used with suppliers?

b. **Production Decisions**: Where and how many manufacturing sites should be equipped? How much capacity should be mounted at each of these sites? What types of products and services are going to be maintained through the supply chain? How much variety should be offered to customers? What degree of unity is required across the product assortment?

c. **Distribution Decisions**: What sort of distribution channels should a firm have? How many and where should the distribution and retail outlets be placed? What category of shipping methods and routes should be used? How should a firm utilize risk-pooling prospects?

d. **Information Support Decisions**: Do the functional units of a firm have the standard enterprise resource planning software? Should the supply chain work on standard protocols or on proprietary principles?
B. **Coordination level issues include the following** [2, 3]:

a. **Material Flow Decisions:** How much inventory of different product types should be stored to comprehend the expected service levels? Should inventory be carried in completed form or semi-completed form? How often should inventory be reloaded? Should inventory decisions be handled by the firm or by the vendor himself? Should suppliers be equipped to deliver goods just in time?

b. **Information Flow Decisions:** In what type is information shared between different entities in the supply chain: paper, voice via telephone, electronic data interchange (EDI)? How much cooperation occurs among the supply chain partners during new product development?

c. **Cash Flow Decisions:** When do suppliers get remunerated for their deliveries? What prices should be charged for products? What sort of cost reduction efforts are taken across the supply chain (or expected of suppliers)? In a global firm, in which currency will a supplier be paid?
The effective management of supply channel inventories is perhaps the most fundamental objective of SCM. Inventory control has been considered as an essential problem in the management of supplier companies for several decades. In recent years, numerous supply chain and inventory control models have been developed to support management decisions.
1.2. INVENTORY CONTROL IN SUPPLY CHAIN MANAGEMENT

Conventional inventory control theories and methods are no more adapted to the changing environment under the influence of the supply chain management. Therefore it will have immense practical implication to discover innovative methods for inventory control. Inventory levels are inflated by customer service expectations, demand uncertainty, and the complexity of the supply chain. It ought to be comparatively simple to keep up desirable customer service standards, while inventories are reduced for products with comparatively few demands and an extended product life. On the other hand, for products described by variable demand, a short life cycle, or product proliferation, a more approachable supply chain and larger buffer inventories may be required to meet a preferred customer service level [15].

It has been stated by several people that the focus point of supply chain management is inventories and inventory control. To transfer their focus from scheming logistical costs to investigate supply chains [16] few food manufacturers and grocers formed Efficient Consumer Response in the year 1992. The major competitive factor for companies focused on value creation for end consumers is the customer service. In general, firms hold inventory for two major reasons, to lessen costs and to improve customer service. The inspiration for each varies as firms stabilize the problem of having too much inventory (which can direct to
high costs) versus having very small inventory (which can lead to lost sales).

Supply chain management leads to cost savings, mainly in the course of lessening in inventory. Inventory costs have got reduced by about 60% from 1982, whereas transportation costs have fallen by 20% [17]. These cost savings have led many people to follow inventory-reduction strategies in the supply chain. A firm has to realize the nature of product demand, inventory costs, and supply chain potential to build up the most effective logistical strategy. To deal with inventory, firms make use of one of three common approaches. First of all, the majority of retailers make use of an inventory control approach, monitoring inventory levels by item. The second thing is, manufacturers are typically more concerned with production scheduling and use flow management to deal with inventories. Third, numerous firms (for the majority part those handling raw materials or in extractive industries) do not keenly deal with inventory [18].

The inventory management is influenced by the nature of demand, depending on whether demand is derived or independent. Independent demand comes up from demand for an end product. End products are found all through the supply chain. Wheat is an end product for a grain
elevator, as is flour for a miller or cereal for a grocer. By definition, a self-governing demand is uncertain, meaning that extra units or safety stock must be accepted to guard against stock outs. While managing uncertainty, the objective should be to minimize the inventory levels and also meet customer expectation. Supply chain coordination can reduce the ambiguity of intermediate product demand, in that way reducing inventory costs [15, 19].

Since Ford Harris’ renowned Economic Order Quantity (EOQ) model was first proposed in 1913, the inventory control has been rewarded immense awareness for a long time because of its significance in the cost control. To lessen the total expected inventory costs per unit time while satisfying the customer demand on time [20] is one of the major objectives. Inventory control for large-scale supply chains is well recognized [21-23] as an essential problem with several applications together with manufacturing systems, logistics systems, communication networks, and transportation systems [24]. It is essential to locate the apt mechanism for coordinating the inventory processes that are controlled by independent partners, in order to find out the right ordering quantity and inventory level amid partners in the chain. For example, the manufacturer make use of the periodic review and lot sizing
policy to manage its inventory and the retailer employs the periodic review with target stock level to control its inventory and more [25].

1.3. INVENTORY OPTIMIZATION IN SUPPLY CHAIN MANAGEMENT

The effective management of the supply chain has become unavoidable these days due to high expectation in customer service levels. The supply chain cost was immensely influenced by the overload or shortage of inventories. Thus inventory optimization has transpired into one of the most important topics as far as supply chain management is considered.

To exploit economies of scale and order in large lots, the important issues in supply chain is to optimize the inventory level by considering various costs in maintaining a high service level towards the customer. Since, the cost of capital tied up in inventory is more, the inventory decision in the supply chain should be coordinated without disturbing the service level. The coordination of inventory decision within an entity is viable, but not between the entities. So the integration of the entities to centralize the inventory control is needed.
Inventory Optimization (IO) application organizes the latest techniques and technologies, thereby assisting the improved inventory visibility, the enhancement of inventory control and its management across an extended supply network. Some of the design objectives of inventory optimization are to optimize inventory strategies, thereby enhancing customer service, reducing lead times and costs and meeting market demand. The design and management of the storage policies and procedures for raw materials, work-in-process inventories, and typically, final products are illustrated by the inventory control. The costs and lead times can be reduced and the responsiveness to the changing customer demands can be significantly improved and subsequently inventory can be optimized by the effective handling of the supply chain.

There are several reasons for manufacturers’ increasing focus on optimizing inventory by applying the latest tools and techniques for inventory control. Traditionally, competitive pressure has always driven manufacturers to seek enhanced capabilities to reduce inventory levels; to enhance service levels and supply availability; and to establish the right product inventory mix and level in each geography and channel. A key driver of the renewed focus on inventory lies in the recognition that traditional techniques are failing to reign in inventories in the wake of increased supply chain complexity. This complexity is characterized by
increased uncertainty. Demand is more volatile and therefore less predictable. This is true not only for aggregate demand but for forecasting splits and volumes across channels and markets. Traditionally three strategies have been employed by manufacturers to address uncertainty; a) increase inventory levels to hedge against uncertainty; b) develop supply chain flexibility to be more responsive to uncertainty; c) improve forecast accuracy so that less uncertainty propagates to the manufacturing floor. Inventory optimization techniques and technologies map to the flexibility and accuracy strategies.

Inventory Optimization characterizes the supply network uncertainty present in a variety of specific steps or links in manufacturing and distribution processes. Advanced mathematical models are then solved to identify optimal inventory policies, stocking locations, or quantities. The uncertainty addressed by IO include: demand uncertainty, cycle time variability and replenishment lead time variability.[88] Efficient management of the supply chain, i.e. the reduction of the costs and lead times and vastly enhanced responsiveness to the changing customer demands lead to an optimized inventory.
1.4 META HEURISTICS

An exact or optimal algorithm in the optimization context refers to a method that computes an optimal solution. A heuristic algorithm (often shortened to heuristic) is a solution method that produces a near optimal solution, but in general has a good level of performance in terms of solution quality or convergence. Heuristics may be constructive (producing a single solution) or local search (starting from one or given random solutions and moving iteratively to other nearby solutions) or a combination (constructing one or more solutions and using them to start a local search).

A meta heuristic is a framework for producing heuristics, and to develop a heuristic for a particular problem, some problem-specific characteristics must be defined, but some other heuristics developed can be general for all problems. The problem-specific may include the definition of a feasible solution, the neighborhood of a solution, rules for changing solutions, and rules for setting certain parameters during the course of execution.

The area of heuristic techniques has been the object of intensive studies in the last decades with new and powerful technique proposed to solve hard problems, resulting in many meta heuristic methods.
Therefore, on one side there is the need for sophisticated logistics Decision Support System (DSS) to enable the organizations to respond quickly to new issues and problems faced on the SCM, and on the other side there are advances in the area of meta heuristics that can provide an effective response to complex problems. This provides a fertile ground for applications of these techniques to SCM and, extends the scope for the development of computer based systems to help supply chain decisions.

Well-designed heuristics packages can maintain their advantage over optimization packages in terms of computer resources required, a consideration unlikely to diminish in importance so long as the size and complexity of the models arising in practice continue to increase. This is true for many areas in the firm, but especially to SCM related problems.

Meta heuristics have many desirable features to be an excellent method to solve very complex SCM problems: in general they are simple, easy to implement, robust and have been proven highly effective to solve hard problems. Even in their most simpler basic implementations, the meta heuristics have been able to effectively solve very hard and complex problems. Several other aspects are worth mentioning. The first one is the meta heuristics modular nature that leads to short development
times and updates, giving a clear advantage over other techniques for industrial applications. This modular aspect is especially important given the amount of time it takes currently to implement a DSS in a firm and the Meta heuristics will help to take system decisions within a certain parameters and environment and then, simulation techniques can be applied to analyze the system behavior under uncertainty. Simulation-based tools take into account the dynamics of the system and are capable of characterizing system performance for a given design (or decisions). The limitations of the simulation models are that they only represent a pre specified system, i.e. given a particular configuration, a simulation model can be used to help estimate the costs associated with operating the configuration (simulation is not an optimization tool). Therefore the combined meta heuristics simulation can provide very interesting ideas about the Supply Chain problems. The use of simulation has produced widespread benefits in the decision process within firms, and the decision making process can benefit enormously by having a system that is able to identify and evaluate the optimal or near optimal solution in the presence of uncertainties. These advances are possible by the development made in heuristic research, particularly in Meta heuristics.
1.5 CONCLUDING REMARKS

Supply Chain is concerned with the configuration, coordination, and development of successively interrelated set of operations in establishments, combining technology and human resource capacity for the finest management of operations to minimize inventory requirements and offer support to enterprises in pursuance of a competitive benefit in the marketplace. Administering the whole supply chain, happen to be a main factor for the booming business in the current global market. Industries have been concentrating mainly on the role of inventory in the supply chain faced with increasing market and global competition in recent times. To simplify inventory oscillations, which are undesirable effect, inventory control is necessary. Inventory control has been considered as an important pre-requisite in the management of supplier companies for several decades.

Inventory optimization technology reveals opportunities to cut inventory by analyzing inventory performance holistically- looking into the data from across the extended supply network. Inventory optimization techniques and technologies identify smarter inventory holding rules at an item/stock keeping location-combination level and replenishment policies that increase overall supply chain planning accuracy.
But managing inventory in complex supply chains is typically difficult, and may have a significant impact on the customer service level and supply chain system wide cost. Nevertheless, the benefits of determining these inventory control mechanisms can be enormous. Meta-heuristics can be an important tool for helping managers and consultants in the decision process. To be able to respond to the challenge of integration there is the need for sophisticated decision support systems based on powerful mathematical models and solution techniques, together with the advances in information and communication technologies. Meta heuristics can play an important role in solving complex supply chain related problems derived by the importance of designing and managing the entire supply chain as a single entity.