

# A Review on Supply Chain Optimisation in The Apparel Industry

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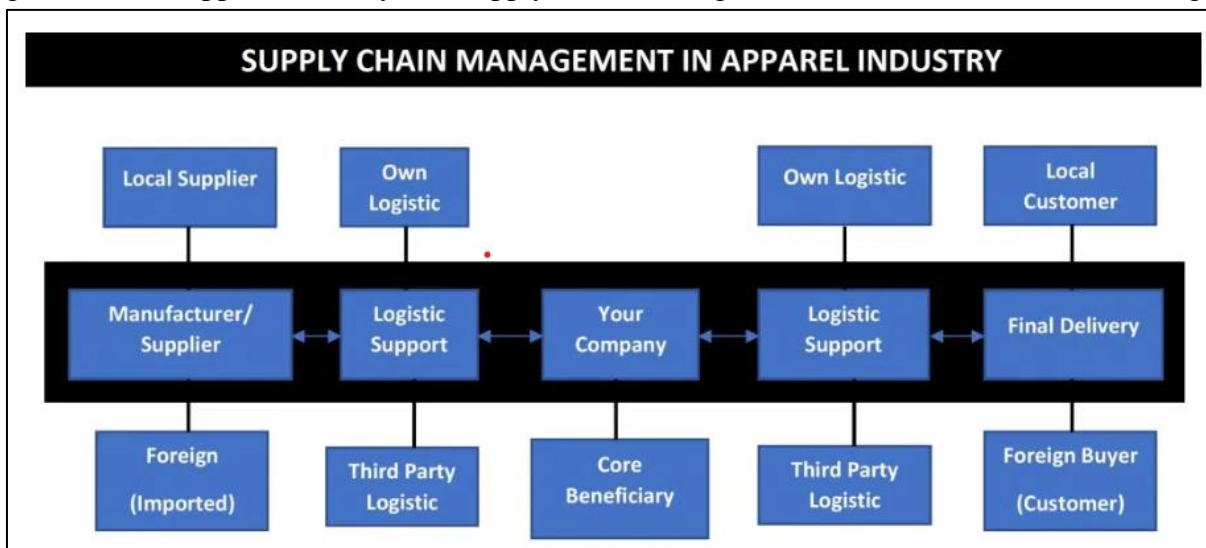
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## Introduction

Supply chain management is a crucial success factor for the apparel industry. Core focus of top management is to develop an effective supply chain management system. Supply Chain Management is the process of managing resources, the movement of resources from one party to another, one place to another place, one department to another department, and one section to another section [49]. The movement of resources should be in a way so that the availability of the right resources in the right place, at the right time, with adequate quantity, where the process cost is least [49]. Broad idea of supply chain management in the apparel industry and Supply Chain Management for Textiles and Garments is given.



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In supply chain management, the management of resources is in every manufacturing stage. The important thing is supplying the required resources at a minimum cost. Manage the flow of goods and services through the supply chain network, which is mainly related to logistics. Logistic planning is critical.

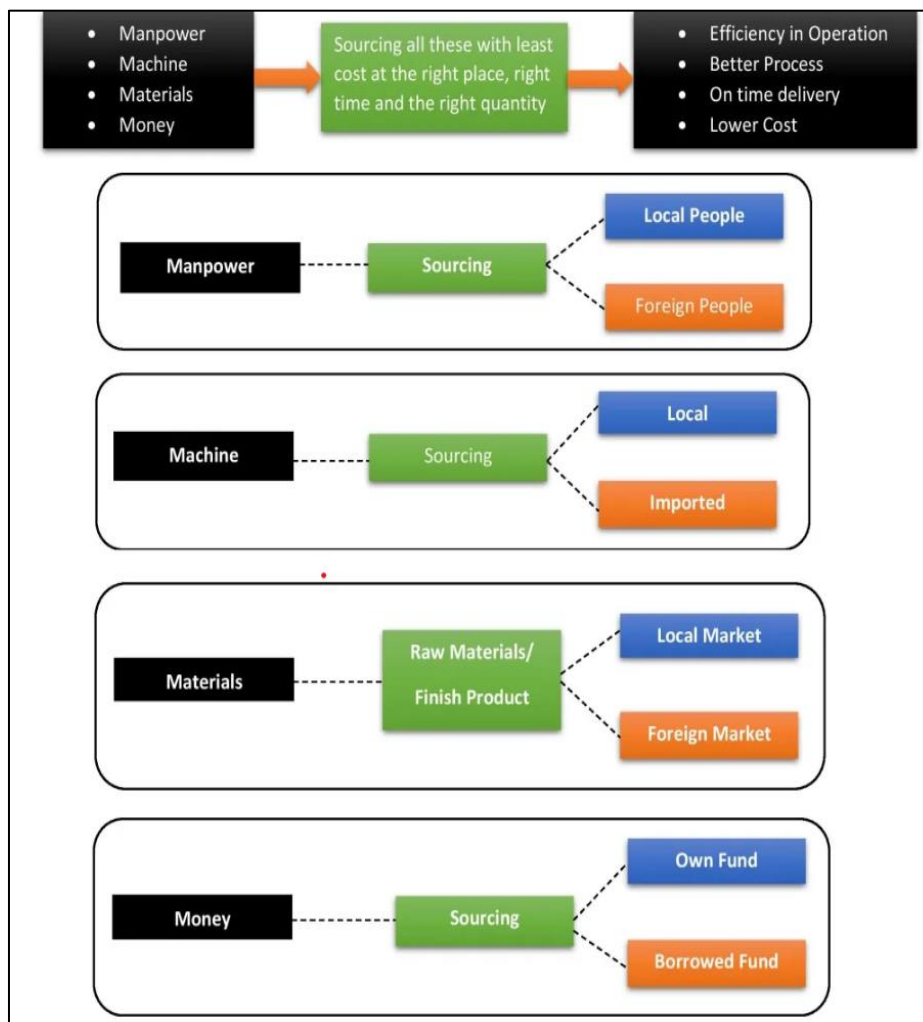
**Need of Supply Chain Management in the Apparel Industry** -The apparel industry is a vast industry producing millions of garments every day. One of the toughest challenges faced by this industry is increasing the cost of garment making and the price of both local and imported raw materials also increasing.

Manufacturers make garments for the local and export markets, but industrial-scale production is for export. The export market is highly competitive because China, Bangladesh, Vietnam, and India are all fighting to offer better prices to garment buyers to hold the export share high. Minimize the direct and indirect costs associated with the production of garments to compete in the market. And the right solution is to use supply chain management by which optimal sourcing is possible where cost is minimum. And this is the reason why supply chain management is essential for the apparel industry.

Another thing is supply chain management, but how to apply and plan for the proper supply chain management is crucial. Apparel managers should carefully develop supply chain, and be successful only having proper planning for the supply chain management. The future is very much competitive for the garments business. Those who manage Supply Chain [SC] properly will get a competitive advantage over their competitors. It is the right time to hire some Supply Chain Management [SCM] professionals and develop supply chain management for garment factory.

### Supply Chain Management is Applicable to

- Manpower
- Machine
- Materials
- Money



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### Importance of Supply Chain Management in the Apparel Industry

1. Create flexibility in operation
2. The positive effect of the mobility of resources
3. Minimization of Total Cost of owning [TCO]
4. Properly utilization of available resources
5. Ensure logistics management in raw materials sourcing and delivery of the final product.

### Stages of the Apparel Supply Chain

1. **Design** – Before a piece of clothing is created, all aspects must be designed and planned for, from the silhouette to material to embellishments.
2. **Textile Production** – Raw and synthetic materials must be spun, woven, blended, or dyed before turning them into clothing on store shelves. This process produces the highest emissions and pollutants due to the water and chemicals needed.
3. **Apparel Production** – Clothing production is taking the fabric from step two and cutting, piecing, and sewing it into the product designed in step one.
4. **Distribution** – Every company is different, but from step three, a garment will either be sent directly to retail or shipped to a distribution warehouse, often shared by multiple significant retailers. The movement of a garment within a distribution warehouse is digitally tracked at every step to maintain accurate supply records.
5. **Purchase** – Finally, the end user purchases the garment from a retail or wholesale channel.

### Apparel Supply Chain Variants

Supply chain is configured as a function of market demand and inventory considerations. There are essentially three variants.

**Push Supply Chains:** In a push supply chain model, analysts project demand for item and push them to retailers based on their predictions. Cold weather apparel begins appearing in stores as warm weather ends, and suppliers have been preparing for this increased demand long before it was present.

**Pull Supply Chains:** A pull strategy waits for demand to be present before creating the product, which decreases the cost of holding inventory that may not sell. The risk in this strategy is not being prepared when demand ramps up and not meeting consumer needs.

**Push/Pull Supply Chains:** A compromise between these two is also available. A producer may keep finished products at a distribution centre waiting for consumer demand, or a manufacturer may hold a large store of raw materials waiting for the need for future production.

**Virtual or *Ad Hoc* Supply Chain Design:** Global textile and apparel supply chains that service the U.S. economy lie somewhere between the *ad hoc* and *virtual* definition given above. They are run, for consumer products, from forecasts of independent demand at the retail level where the core competence of market power resides for the chain. A number of U.S. retailers of textile and apparel products have the most efficient and effective computer-based product distribution systems in the world. These distribution systems of companies, such as Wal-Mart and others, support something called *Distribution Requirements Planning* and represent only a fraction of the total production/distribution supply chain nodes that support

flow management for the entire supply chain network. Dependent demand for retail needs is, in the main, run under various forms of *ad hoc* design and thus circumvents much of the modern theory and tools of supply chain management. True supply chain management focuses not only on the flow of the independent demand of the final product but also on the dependent demand of all production, movement, storage, etc. flows of the components of value that generate the final product. U.S. retailers are very good at telling someone what they want and when they want it, but from that point little by way modern supply chain management is being practised up the supply chain of those developing nations producing textile and apparel products for U.S. consumption. The retail-based *ad hoc* supply chain designs for dependent demand are not so much optimised as a function of flow control of lead times, capacities, inventories and transportation cost, as they are of nationally subsidised, labour intensive, production processes that are designed to meet some national economic agenda [i.e. the Chinese/U.S. Government/Wal-Mart connection.] To make this point, consider breaking the cost of U.S. imported textile and apparel products into two terms. Call the first term a *price effect* that is associated with the subsidised, variable cost payments to textile and apparel suppliers for products. Call the second term a *supply chain design effect* that isolates the supply chain opportunity costs associated with control of lead times, production/distribution capacities, inventories and transportation costs. A look at today's magnitude of difference between these two terms shows that the current subsidised *price effect* greatly dominates the *supply chain design effect*. From the U.S. retailer's and customer's point of view, supply chain design change is not a priority to be wished for, compared to the variable cost price of receipt of the goods. Large inventory and transportation costs are easily tolerated within the comparative advantage of significantly attractive product price effects that are variable costs to U.S. retailers. It is not surprising that the current global supply chain designs for textile and apparel are being considered optimal by both buyers and suppliers for current conditions. However, are these *ad hoc* supply chain designs for dependent demand textile and apparel items adequate to meet the assumed changing needs of the 21<sup>st</sup> Century. (1)

**Efficient vs. Flexible Supply Chains:** The first step of supply chain design is to understand the pattern of product demand a given supply chain has to serve. (2) Textile and apparel products serve a wide variety of different patterns of product demand. A discussion of textile and apparel markets implies multiple approaches to optimal supply chain design. It is important for the reader to understand that one supply chain design strategy for a given product group may be a poor fit for another given product group. Industrial textile products have many variants but are, in the main, components of final products. They are price sensitive, and require more efficient, fixed path supply chain designs. In addition, a portion of home furnishing and apparel products are aimed at more functional [commodity] product markets that compete on low-price and also optimise on more efficient, fixed path, supply chain designs. A growing portion of home furnishing and apparel products are aimed at more innovative [customised] product markets that optimise around more highly flexible, variable path, supply chain designs that can deliver products with short lead times under conditions of uncertainty. Many textile and apparel products fall between the two design extremes. Efficient, fixed path, supply chain designs are optimised on the basis of material-process-working capital productivity and low unit cost. Flexible, variable path, supply chain designs are optimised around lead times under uncertainty with acceptable unit costs. Taylor points out that product customization shifts the push-pull boundary further up the supply chain. Standard, more functional products allow the boundary to be set close to the final consumer so these products can be made to stock and pushed all the way down the chain in anticipation of demand. More customised products

move the push- pull boundary up the chain, as the definition of the end product is defined early and pulled down the chain by existing customer orders. It is important to align the interaction of customer-product-process-supply chain to a given efficiency vs. flexibility supply chain design strategy for a given textile and/or apparel product.

This alignment process is divided into the following four steps:

1. Decide how to make the strategic trade- off between flexibility and efficiency,
2. Analyse existing chain design for ability to meet the strategy,
3. Use mathematical and simulation models to evaluate options,
4. Use experience insights into the nature of the business in firming design. [1]

### **Things need to know about supply chain management**

- Every function/process/operation, can apply supply chain management
- Supply chain management ensures the proper time delivery of products/resources/services to the right place for a minimum cost.
- SCM will provide a better logistic solution
- Everything is interconnected in an organization; identify the elements and processes, analyze, and plan for a better connection.
- A logical innovation in supply chain management will give a reward for an efficient business operation, ultimately leading to success.

### **Challenges of the Apparel Supply Chain**

There are several key challenges facing effective apparel supply chain management. Often, these difficulties are relevant only to fashion retailers and are absent in the supply chain for other industries and businesses.

- A looming trade war has made sourcing executives wary about future demand, compounded by increased production and sourcing costs from tariffs imposed on Chinese products.
- Human rights and labour abuses in overseas manufacturing are leading to calls for increased transparency in production.
- Demand forecasting in the apparel industry is complex and can make effective supply chain management difficult.
- Although the software is a game-changer in today's business environment, inventory management poses challenges to supply chain management in the apparel industry.

### **The Four Phases of Supply Management**

The four phases of supply management all require many perspectives & inputs best obtained through a cross-functional approach. These four phases of supply management are as follows:

- **Generation of Requirements:** The generation of requirements is a critical activity that results in identifying the optimal materials & services to purchase, together with the development of specifications & statements of work describing these requirements. Approximately 85 percent of the cost of purchased material, services & equipment is “designed in” during this phase.[50] Thus, supply management should be involved up-front during the generation of requirements to ensure that all commercial issues such as cost, availability, substitutes & so on, receive appropriate consideration.



- **Sourcing:** The objective of sourcing is the identification & selection of the supplier whose costs, qualities, technologies, timeliness, dependability & service best meet the firm's needs. The development of supply alliances is a sourcing activity.
- **Pricing:** The objective of pricing is the development of prices that appropriately reward the supplier for efforts & which result in the lowest total costs of ownership for the customer firm. While negotiations occur throughout the supply management process, their most significant role normally is during the pricing phase.
- **Post-Award Activities:** This important activity ensures that the firm receives what was ordered on time & at the price & quality specified. Post-award activities include supplier development, technical assistance, troubleshooting & the management of the contract & the resulting relationships.

### Decisions on Three Levels

Supply chain management decisions belong to three levels: strategic, tactical, or operational. Since there is no well-defined and unified use of these terms, this Section describes how they are used in this thesis. Figure: 1 shows the three levels of decisions as a pyramid-shaped hierarchy. The decisions on a higher level in the pyramid will set the conditions for lower-level decisions.[51]



Figure 1

### Application of decision support and intelligent systems

**Expert systems:** Expert systems [ES] are computer-based systems which superficially provide information similar to that expected from a human expert [3]. The application of ES in the textile and apparel industry can help manufacturers reduce environmental costs by identifying the most appropriate processes and equipment [4], and devise more efficient and objective planning in their production [5]. In fashion retailing, a fashion mix-and-match ES can be developed to automatically provide customers with professional and systematic mix-and-match recommendations, so as to enhance customer satisfaction and, sequentially, to improve sales [6,7].

**Genetic algorithms:** Genetic algorithms [GA] are population-based evolutionary searching techniques. These algorithms use probabilistic search methods based on ideas drawn from natural genetic and evolutionary principles [8]. GA is particularly suitable in solving scheduling and machine layout problems encountered in the textile and apparel production [9;10; 11;12;13;14;15]. Particularly, GA can be applied to control fabric loss arising from the variance of yardage found in individual fabric rolls during the spreading process [16]. In fashion design, GA is able to deal with the continuous changes of fashion and to reflect personal tastes using human response as a fitness value [17]. Also, GA can be applied to product

design in providing multi-solutions for design problems and in determining design schema [18]. Furthermore, GA is useful for product packing optimization as well as product assortment management [19,7].

**Artificial neural networks:** Artificial neural networks [ANN] are computational models based on the structure and function of biological neural networks [20]. Rather than using traditional computer algorithms, ANN provides answers using heuristics that are similar to the human brain. Due to robust and adaptive nature, ANN has been applied in textile and apparel chains in many ways. In the dyeing process, ANN can be modified to predict the duration required to achieve a precise depth of shade and to correct any errors related to inconsistent dyeing results [21; 22]. In determining textile quality, ANN can help eliminate human subjectivity because human judgement is influenced by eyesight, concentration, and personal preference [23;24]. In retail processes, ANN can be used to investigate the correlation between the level of sales and other significant factors, such as design elements, that may affect market demand; and, in turn, to forecast sales performance in a more accurate way [25]. This approach is particularly prominent in fashion retailing because a versatile sales forecasting system is a crucial requirement in meeting complex and fickle market demand [26].

**Knowledge-based systems:** Knowledge-based systems [KBS] are rule-based systems [27] that incorporate a database of expert knowledge with couplings and linkages designed to assist information retrieval in response to specific queries and to make quick and effective decisions [28,29]. In a textile and apparel supply chain, KBS can diagnose manufacturing problems, such as those related to cotton dyeing [30,31]. Moreover, this approach is helpful in solving management issues such as subcontracting, throughout various stages of a supply chain [32].

**Decision support systems:** Decision support systems [DSS] are computer-based systems intended to help decision makers utilise data and models to identify and solve problems [33]; practically to automate a variety of tasks and to facilitate optimal decision-making within a given supply chain. At the decision support level, DSS can be applied to the design and control of an integrated maintenance management system for a textile mill [34]. DSS can assist decision-makers of a garment manufacturer in selecting efficient ways to reduce total manufacturing costs; such as to control the cost of materials by developing feasible cutting order plans with respect to materials, machines, and labour [35].

**Fuzzy-logic systems:** Fuzzy-logic is a form of multi-valued logic that uses the mathematical theory of fuzzy sets to deal with reasoning that is approximate rather than accurate [36]. It is sometimes, though not exclusively, implemented using ANN. Fuzzy-logic can provide solutions to problems that involve the need to deal with approximations, uncertainty, and insufficient information [37]. In the fiber-to-yarn process, fuzzy-logic systems can predict the spinnability of a yarn based on fiber quality and machine settings [38]. These systems can also evaluate the mechanical and physical properties of knitted fabrics of various structures [i.e., knitting, tucking, and welting] based on individual knitting actions and tightness factors, so as to provide an alternative method to compare the results of various hand tests [39]. In the design of garment patterns, fuzzy-logic systems can help to improve a wearer's perception of the fit of a garment and to achieve a balance between the style of garments and the comfort of the wearer [40]. Such a balance

is difficult to achieve using existing pattern generation methods because these methods cannot provide suitable estimations.

**Hybrid systems:** Hybrid systems are those which employ a combination of multiple approaches and techniques from artificial intelligence. Hybrid systems as those systems that combine any two or more of the above-mentioned decision support and intelligent systems. Through the combination use of these AI technologies, the performance and benefits of the resulting systems can be strengthened and maximised. A growing number of applications of hybrid approaches are found in various areas in the textile and apparel industry. For example, hybrid systems were used to improve the forecasting systems of a distribution network [41,42], to help textile and apparel manufacturers achieve higher accuracy rates when evaluating their products [43; 44], to monitor the performance of a textile product [45], to integrate and control major textile processes effectively [46], to provide 'fashion coordination' recommendations for fashion retailers [47], and to assist a manufacturer in the selection of a suitable enterprise resource planning [ERP] system [48].

**Supply chain optimization in India vs. other countries:** Supply chain costs in India represent as much as 13 percent of the GDP. This is almost double the percentage in developed countries: in the U.S., supply chain costs amount to 8.5 percent of the GDP.[52]

ARC Advisory Group categorizes supply chain challenges in India into two groups: demand-side challenges and supply-side challenges.

Demand-side supply chain challenges in India relate to price and variety. With 28 States and 7 Union Territories differing considerably in dress, food tastes, customs, traditions, and purchasing habits, it's almost impossible for a single manufacturer to address the wide variety of consumer requirements. It is important for manufacturers to partner with local distributors and retailers who can help develop products that will appeal to local consumers at appropriate price points.

Majority of the vendors have successfully sold "no-frills," standardized products to rural segments. Big Bazaar, Hindustan Unilever, Maruti, Tata Motors, and Hero have offerings relevant to this price-sensitive segment of the population. Other successful examples of localized low-price products include Siemens' pacemakers, Godrej's Chotukool refrigerator, and General Electric's ECG.

Supply-side supply chain challenges in India mainly relate to poor infrastructure, complex tax infrastructure, weak distribution system, fragmented market, and lack of technology adoption. Though India has the second-largest road network in the world, totaling 4.2 million kilometers, most of it is of poor quality. National highways account for less than 2 percent of the total road network but carry 40 percent of traffic. The government is aware of this problem; the 12th Five-Year Plan targets significant improvements in transportation infrastructure.

India's tax structure is very complex, with products typically being taxed twice: once by the central government and then by respective state governments. Transaction taxes directly impact the cost of goods or services.

Due to the country's weak distribution network, many retailers maintain higher inventories than required. Organized retailing accounts for less than 10 percent of the country's total retail trade, resulting in an extremely fragmented market. A highly fragmented trucking industry in logistics makes it difficult for companies to manage the many carriers required to handle shipment volumes. Although outsourcing of



logistic activities to third-party logistics providers is increasing, there are very few organized providers in India.

Lack of technology adoption also remains a challenge for India's supply chain. While selling supply chain management software is starting to grow rapidly, it is doing so from a very small installed base. With the potential long-term effects of the global economic slowdown, organizations in India must continue to invest in IT to improve their competitive advantage.

Companies can meet most challenges noted above with a sound supply chain strategy, with IT as the key enabler. Though the complexities of India's supply chain may appear overwhelming, understanding and mastering them is a critical success determinant for an organization attempting to serve customers in India. An efficient review of supply chain design will help better position companies in what is becoming an increasingly competitive marketplace.

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