CHAPTER 1 INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Indian market welcomes any new products with risks and various constraints through logistical, infrastructural and resource-based challenges. A nation’s economy grows through its transport systems and streamlined supply chain networks. Various factors such as lean processes, geographical concentration of production and globalization led to the need for optimized supply chain networks.

An international meet was organized in the year 2011 named World Economic Forum at Davos-Klosters, Switzerland. In this meeting, different company CEOs participated who belongs to various domains such as automotive, aviation, logistics. This meeting concluded with the agreement for creating awareness among the companies with regards to logistics and mitigate the risks globally in terms of global industries characterized by complexity and interdependencies. The meeting also stressed the importance of designing new models that support efficient supply chain and transport management. It is observed that there is a continuous evolution in supply chain and transport networks in order to ensure capacity, customer service through organizational trends such as globalization and specialization, speed, efficiency, information technology and volume consolidation. However, since the cost optimization is focused much later, recent studies invested on cost elimination, network robustness and the elimination of traditional buffers such as excess capacity and safety stock.

Hendricks, K. B and Singhal, V. R. [1] tracked a total of 885 operational supply chain disruptions from 1992 to 1999 in public trading companies. This research inferred that there is a significant financial impact on performance is exerted due to the drop in operating income by 107% followed by Return On Sales by 115% and Return On Assets by 92%. Bowersox, D.J. [2] mentioned that, about 60% of the supply chain cost is
incurred on logistics in turn, 15-35% of the product cost is incurred on supply chain process (Refer Fig 1.1.)

![Diagram showing logistics cost contribution to product cost]

**Figure 1.1. Logistics Cost Contribution to Product Cost**

*Source: The integrated supply chain process by Bowersox, D.J. [2]*

Thus, supply chain logistics provide huge opportunity to the global automotive industry, for cost reduction and increase margins in the profit.

The future competition between the companies would be about the supply chain what they use and not will be about the produce that they manufacture or the countries where they operate. The competition among the companies will get changed its perspective by their logistics processes. The smart automotive supply chain recognises the important business need for supply chain visibility. Visibility is considered as the important component to respond top challenges such as customer issues, globalization issues, risk and cost commitment.

**1.2 SUPPLY CHAIN: GLOBAL SCENARIO**

According to the reports produced by Global Economic Outlook, the GDP (i.e., Gross Domestic Product) of the global nations will rebound to 3.3% in 2014 against 2.9% in
2013, after adjusted for inflation World Economic Forum [3]. By the 2012, more than 50% of the Gross Domestic Products of the world countries is contributed by the developing countries. This is a sharp increase when compared to 2000 to one-third. In the upcoming decade, the shift is predicted to be slow. Within 2025, more than half of the global GDP is predicted to be contributed by emerging markets, especially China is projected to lead the global economy (Figure 1.2).

![Figure 1.2. GDP Share of Countries: Historical and 2025 Forecast](image)

**Source:** The Conference Board Global Economic Outlook 2014, May 2014 update

Note: GDP shares are converted to U.S. dollars using purchasing power parities

Wang, Y and Wenwen, H. [4] shows supply chain system and the financial logistics cost directly or indirectly influence national GDP.

The three important variables which impact the nation’s economic development are GDP, unemployment rate and inflation rate. GDP can be explained as

\[
GDP = C + I + G + (X - M) \tag{1.1}
\]

where C is consumption

I is investment

G is government spending
(X-M) is Export (X) – Import (M), which is trade gap/the net import/export.

Table 1.1 shows the contribution of logistics cost to GDP in terms of percentage for the major four markets. Clearly, China and India are spending more logistics cost than the rest of the developed markets.

<table>
<thead>
<tr>
<th>Country</th>
<th>Logistics Cost as % GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>18%</td>
</tr>
<tr>
<td>India</td>
<td>13–14%</td>
</tr>
<tr>
<td>USA</td>
<td>9.50%</td>
</tr>
<tr>
<td>Europe</td>
<td>7.10%</td>
</tr>
</tbody>
</table>

In the 1990s, the global scenario was to produce the product at the place of consumption in order to eliminate the shipment cost. But now the school of thought is to consolidate the production in one place and distribute it everywhere to take advantage of labor cost (Figure 1.3). It makes logistics as a “necessary evil”.

Figure 1.3. Globalisation Scenarios
Emerging BRIC (Brazil, Russia, India and China) markets are making progress in the battle for global dominance. As the European and Japanese presence diminishes and the BRIC auto makers steadily climb upwards, the top growth rankings will change. According to KPMG survey, 7 out of top 10 OEMs (original equipment manufacturers) most likely to grow in the next 5 years are from BRIC markets. According to Demica (2012), there is 20-30% steady growth per annum is expected in the global supply chain market in the upcoming years and up to 10% per annum within 2020. Though USA, Europe and other developed markets are the places of origin of supply chain investments as of now, the future is predicted with India and China leading the markets with full potentials.

1.3 IMPORTANCE OF SUPPLY CHAIN IN AUTOMOBILE SECTOR

In terms of macroeconomic growth, the automobile mobile industry plays an important role in driving this growth both in developed and in developing countries. The automobile industry’s evolution in China and India are commendable. Every nation in the world wants to lead in the automobile industry since it is a key factor in contributing to the economy in majority of the countries. Over the past decade from 1995 to 2005, the industry witnessed a tremendous growth of about 30% increase. By the year 2014, the global passenger car sales was expected to hit 72 million vehicles (statista.com).

The value drivers that are critically important in automobile industry are “minimized costs (90%), maximum delivery performance (87%), maximum volume flexibility and responsiveness (83%) and complexity management (67%)”. As per the value drivers mentioned above, the leaders usually focus on improving the production efficiency and inventory management continuously with best-cost country sourcing in order to cut down costs and collaborate with important suppliers and customers. The least EBIT margins are achieved by many top global automotive companies than when compared to companies in other industries where 10.4% is the EBIT margin. However, with the best-in-class delivery performance (97.3%) and inventory turnovers (18.2%), these organizations are leading in the market. There is only a little space available in supply chain practices since all the
supply chain practices are mature and the performance gap between leaders and laggards is getting reduced.

The regional functions and global functions are planned in a strategic manner at automotive companies, such as planning, manufacturing, operational procurement and delivery functions at the regional level whereas the NPD (New Production Development) and strategic procurement functions at the global level. Usually, the 10-35% of their daily activities are outsourced, next to their planning, sourcing and enabling activities that accounts up to 10% and then with 15% of their assembling, manufacturing activities.

In general, the focus area of any automobile company can be broadly grouped as follows:

- Waste reduction and thereby manufacturing cost reduction
- Work with supply chain partners to optimise the cost
- Reduction of inventory
- Sourcing the parts in the best-cost country
- Strategic collaboration with key suppliers
- Order to delivery time reduction
- Flexible manufacturing model – facility, resource and payment
- Plant capacity 80–120% flexibility
- Supply chain integration to have end-to-end visibility
- Produce to order
- Automation
- Supplier performance monitoring
- Import/export optimisation
- Intellectual property and patent royalty optimisation

IBM conducted a research in 2009 with Global Chief Supply Chain Officer study, called “The Case for a Smarter Automotive Supply Chain” Gyimesi [5]. In this case study, a total
of 400 senior supply chain executives who are working in 29 different domains and 25 countries were interviewed face-to-face. In this analysis, the responses from the participants from automobile industries were compared to the responses from the supply chain executives of their industries as well as with the responses from the global supply chain leaders. The interview results inferred that they face five primary challenges, as listed below, irrespective of the industry and also within the automotive industry (Figure 1.4):

a. End-to-end visibility

b. Cost containment

c. Risk management

d. Increasing customer demands

e. Globalisation

![Figure 1.4. Top Five Challenges of Automobile Companies](http://www.ibm.com/supply_chain_study)

Cost containment is certainly a prominent figure in the automotive agenda. But in supply chain visibility, it holds a higher rank. Cost containment is observed by the executives as a critical means to contain cost in an effective manner and overcome the challenges. Indian
auto industry is placed at sixth position in producing automobiles in terms of volume and value according to Society of Indian Automobile Manufacturers (SIAM). In the past decade, a whopping 14.4% growth is experienced in this sector. With global presence, Indian auto players are in the look-out for venturing into overseas markets as well. So, global supply chain is a significant challenge for automotive players based on India. According to most respondents, exports constitute a prominent role in their strategy. Adding to that, in the next five years, these automotive players are predicted to go double in their export share.

Supply chain management, otherwise explained as a cooperative management of information flows and materials between the supply chain partners in order to achieve the goals that cannot be achieved through individuals. The process of supply chain management improves the belief and alliance between the supply chain partners which enhances the inventory visibility and velocity of inventory management. Organisations and firms, industries in general, face stiff competition on a daily basis with emerging technological advancements and increasing competitors which lead them to invent their way of business processes and meet new customer-driven challenges.

Companies, in order to survive, succeed, and excel in this competitive world, are working on new strategies by restructuring and re-investing in supply chains, and even targeting spearheading competitiveness for special cases. In such a scenario, the automotive industry in India faces major hurdles such as increased operational complexity, shortened product life cycle, high competition and ever-changing customer needs. In spite of heavy stocks, failures in meeting the exact delivery dates within the acceptable time scales is getting common in a supply chain thus leads to its performance deficiency. Indian automotive industry has the capability today to manufacture different vehicles which are broadly categorized into three groups such as two-wheelers, cars, and heavy vehicles. Indian automobile and auto component manufacturers still have great scope in reducing their cost for logistics through implementing optimized Supply Chain Management solutions. India got introduced to SCM solutions and has been recognized widely across the globe where automobile manufacturing countries spend high cost in carrying inventory. Indian automobile manufacturers took strenuous actions in developing their supply chain networks, management of logistics cost and enhance the customer experience towards their
service. India, being a developing country, is experiencing upward trends in optimization of supply chain strategies.

Currently, an interesting evolutionary phase is in a trend among the Indian automotive companies. Companies are working towards long-term vision (towards 2025), but short-term volatility is bringing an uncertain scenario in the sector. Due to the observation of global OEMs who consider India as a future strategic hub, the competition is heavy and increasing.

The supply chain has also been playing a big role in the automotive evolution. The IBM study reveals the supply chains are going to be a source of competitive advantage for global OEMs. It would drive automobile manufacturers to go far to the extent to meet the basic performance standards such as establishing a connection between supply and demand with optimal cost. It paves the path for automotive supply chain in India to develop its best-in-class performance levels.

1.4 NEW PRODUCT LOGISTICS

This chapter explains the importance of logistics of a new product and also establishes analogy between the New Product Life cycle and Supply chain Life cycle

1.4.1 Product development

Previously, the growth of a firm is decided on the basis of either line expansion of previous products or the other brands acquisition. But in today’s world, the growth is purely on the basis of NPD (i.e., New Product Development) that stress the need towards logistics with the following reasons such as,

i) First of all, when the new product has been emphasized, then the futuristic logistics system must be designed in a way such that it can include broader variation in product lines and its coordinated stocking units. The need for enhanced system flexibility arises due to the increased expansion of product lines as a result of which
special handling needs such as transportation, packaging requirements increase. This leads to increased complexities in logistics.

ii) Due to saturation of markets, the products typically are more personalized and targeted at a specific segment of customers. In order to reach the specific customers, they need to be serviced through multiple marketing channels which results in less opportunity for consolidating the logistics volume for cost control.

iii) In logistics, it is challenging for one to predict the success or failure of a product, due to which it is important to take so much care in risk mitigation that can influence the failure of a product due to the reason being unable to support the product logistically when being introduced. Otherwise, stockpiling the inventory and anticipatory logistics can be extremely expensive in sales when it did not get materialize. New product logistics is a kind of balancing act that can exist between the availability of enough logistics and avoiding too much support or commitment during new product introduction.

1.4.2 New product life cycle

*Komoto* [6] lists out the usual competitive conditions in this framework that an automobile firm experience typically during the product life. Five stages of the product life cycle – Product Development, Introduction, Growth, Saturation-Maturity and Decline – have been listed. The product life cycle has been integrated with supply chain formation cycle in the below conceptual framework. The supply chain life cycle phase runs in parallel to product life cycle (Figure 1.5).
Introduction: Whenever a new product is introduced in markets, it is must to ensure high product availability and logistical flexibility. Since introducing a new project is primarily focused to gain a market foothold, making inventory available to customers becomes important. While planning logistical support during the introduction of a new product, a firm must also ensure rapid and consistent replenishment. Irrespective of the market positions being not sure during the introduction stage i.e., win or lose, the size of the shipments need to be small. The frequency of the orders may sound erroneous at some times and sometimes customers hedge against the possibility of ending up with potentially unsalable goods. Due to all the reasons mentioned above, high logistical costs are usual in a product’s introduction.

Growth: While the product is in growth stage and when the product is accepted in the markets, the sales can be predicted up to some level. So the trend of logistics change here from ‘serve at any cost’ to ‘balanced service/cost performance’. This stages has enormous potentials to design the logistical operations to leverage the profits.
**Saturation-Maturity**: When there is intense competition, it leads to saturation-maturity stage. During the saturation stage, the performance of logistical operations would be very much selective. Since there is a need rise to provide high quality service to important customers, the logical cost get increased. During such periods, organizations establish distribution warehouses in order to ensure multi-channel logistics services are provided for the customers. This results in nothing but high per-unit logistics cost. At maturity stage, the logistics complexity gets increased during which operational flexibility is given prominent importance.

**Decline**: During this stage, it is expected that the product sales may go down. At this point of time when the profits get decreased, the firms either go for alternative products or minimize the continued distribution. It becomes a must to position the logistical performance in order to take care of the current business without trying new areas i.e., risk mitigation in the event that a product must be eliminated. So, at this stage, there is no priority given to achieve the least per-unit logistics cost.

To summarize, before introducing a new product, complete knowledge should be gained in terms of logistical performance and flexibility to react to the rapid changes that occur in volume projections. Then one should focus on cost rationalization at growth and saturation stages in a product’s life cycle. During the decline stage, organizations need to be flexible in positioning the logistics in order to mitigate the risks of earlier product extinction. Thus one need to design the logistics system such that it has flexibility, capability to adjust to counter compete with any competitors at any stage in a product’s life cycle.

**1.4.3 Supply chain life cycle**

*Solvang, W. D. [7]* describes that in a supply chain system life cycle, there are three stages such as (1) Formation or Initiation, (2) Operation and (3) Extinction or Cessation.

In the first stage, the system is brought to live in which the design, structure and the system development is given focus followed by the second stage which usually deals with the operational performance that is composed to maintenance, management, support and upgradation of the system to suit the needs of product/customer. The third stage comes
when the supply chain system of a given product is no longer needed or becomes obsolete and deals with replacement or renovation or depleting the system Husdal [8].

Higuchi, T. [9] in supply chain life cycles, every stage is important for the next stage to happen. This is applicable for the third stage i.e., extinction also, since a new product must be developed after which. Each stage enact an important role in, business continuity in general and supply chain or logistics system success, specifically. A supply chain can be described as successful if it is capable to revert, in an appropriate manner, to the challenges that occur dynamically. These challenges may be, but not limited to increased market volatility, sudden global economic changes and steady-shortened product life cycles.

1.4.4 Supply chain during new product development

Stadtler, H. [10] When the literature is analyzed, it can be inferred that product variety and product structure are the two main product characteristics which impact on the relationship among the product features, supply chain features and the customer needs. Product structure is nothing but the product architecture, materials’ bills and product innovativeness. The supply chain variables in addition to the performance affected by the product features are listed in Table 1.2.
Table 1.2 New Products and Its Impact on Supply Chain Variables

<table>
<thead>
<tr>
<th>Product Feature(s)</th>
<th>Supply Chain Related Variable(s)</th>
<th>Performance</th>
<th>Reference(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variety and architecture</td>
<td>Sourcing, production scales, supply chain configuration</td>
<td>Operational performances</td>
<td>Salvador, F., and Forza, C. [13]</td>
</tr>
<tr>
<td>Variety</td>
<td>Manufacturing</td>
<td>Direct costs, overhead, delivery lead times, inventory</td>
<td>Fisher, M., and Ittner, C. [14]</td>
</tr>
<tr>
<td>Change in Supplier</td>
<td>Costs</td>
<td>Prasad, B. [15]</td>
<td></td>
</tr>
<tr>
<td>Manufacturing flexibility</td>
<td>Costs</td>
<td>De Silveira, G. [17]</td>
<td></td>
</tr>
<tr>
<td>Product innovativeness</td>
<td>Supply chain strategy</td>
<td>Operational performance and service level</td>
<td>Gupta, A. [18]</td>
</tr>
</tbody>
</table>

1. **Product variety:**

The current trend makes the customers look for customer products which forces the firms increase their product range i.e, increasing the variety of products being offered in the market. Product variety can be of two types such as external and internal in which the former is the range perceived by clients whereas the latter is the one proposed by companies towards to increase their diversity of components and semi-finished products. During the New Product Development process, the product variety is defined.
Fisher, M., and Ittner, C. [14] mentioned that the decisions made towards product variety affects the performance of supply chain. For example, if there is an increase in product variety, then the direct manufacturing costs, inventory levels, delivery times and manufacturing overhead costs also do increase. The concept of behavioural costs is introduced and defined by Brun, A., Capra, E., and Miragliotta, G. [19] as “those costs which arise because of the reaction of people to ‘excessive’ variety”. Particularly, the human costs and the organisational mechanism costs counteract the varieties that are available from being tackled and deployed effectively. This difference found in the varieties may be found in almost all the cases during the instance when people view that the decision to select among the options available are not relevant or it could consume more time than the expected completion time. This leads them to select the less variety than the designed one.

In order to handle a number of varieties, Salvaoor, F., Forza, C., and Rungstusanantham, M. [19] suggests some tools to be used such as web-based platforms, flexible automated systems and information systems. In a rough index proposed by Salvador, F., and Forza, C. [13] for measuring the cost of variety, it is used to measure the costs of manufacturing and the plant layout or supplier charges.

The performance of supply chain is dependent on the choice of Supply Chain Management practices with regards to the amount of impact created by the variety. For example, the impact caused by the variety in a firm is based on the inherent flexibility and centralization degree of final assembly. A framework was designed by De Silveira, G. [17] to choose the proper flexibility strategy for handling high product varieties in manufacturing. Few investigations conducted elsewhere on empirical and conceptual backgrounds led this concept to SCM concepts.

2. Product structure and innovativeness:

According to Salvaoor, F., Forza, C., and Rungstusanantham, M. [19], most SCM decisions and the performance of supply chain is affected by ‘Product design, which is the product-related drivers. Further, the information about product design is mandatorily needed for strategizing manufacturing plans and creating packaging plans during shipment. Further, Crippa, R., Larghi, L., Pero, M., and Sianesi, A. [20] mentioned that two
factors such as product architecture and bill of materials play important role in NPD and SCM. The relationship between the product architecture and SCM were investigated in the focusing the strategy used for postponing, implementation decisions and supply chain structure.

In previous studies, numerous mathematical models were proposed that can be utilized by designers when selecting the suitable bill of materials or generic bill of materials so as to reduce the cost in supply chain. In the above-mentioned models, the supply chain structure is defined in a concurrent manner with the product and a set of feasible configurations. A strong relationship is found between the product structure and product variety. The variety of products is prominently addressed in the literature regarding new product development in the main trade-off “variety – commonality” i.e., the architecture definition phase or in the platform definition phase Fisher, M., and Ittner, C. [13]. The decision of product architecture usually impact the commercial variety which can be proposed in the marketplace at the defined cost Ulrich, K. [21]. The product’s novelty is taken as core concept in many studies that investigated product innovativeness with regards to the supply chain strategy definition though some works such as Caridi, M., Pero, M., and Sianesi, A. [22], an empirical study that shed lights on the impact of product innovativeness on supply chain operation choices too.

Cost containment, one of the top challenges ranked in the automotive industry is rated at the top by most professionals say, 66% versus 55% across industries, from supply chain irrespective of their own industry. The cost containment factor is mostly focused by automotive companies close to three-quarters in order to overcome their business challenges. But in other top most supply chain companies i.e., 48% of the companies are selecting best supply chain strategies to keep their position atop and for generating maximum revenues. Though there are strong intentions over cost-cutting, but it is to be determined whether the automotive supply chains are working towards the right direction and their targets are strategically selected or not. Obviously, the results show that it is certainly not. For instance, more than 80% automotive supply chain executives implemented variable cost structures which can be aligned in accordance to the fluctuating costs whereas the other 20% have done so extensively. The same rate of adoption can be
found in top supply chains as well. But there is still more space available for the automotive executives to work on the cost reduction factor.

1.5 SUPPLY CHAIN FUNCTIONS AND STRATEGIES

The supply chain functions can be categorised into three perspectives as shown in Figure 1.6. Bowersox, D. J. [2] These are Strategic function, Tactical function and Operational function. Each function is elaborated below.

![Figure 1.6. Supply Chain Functions and Strategies](image)

**Figure 1.6. Supply Chain Functions and Strategies** Source Bowersox, D. J. [2]

1.5.1 Strategic function

The strategic level decisions impact the firm with a long-lasting effect since it deals with channel design and network strategy. This strategic level decisions are crucial in a firm’s performance such as the product design decisions, whether to manufacture in-house and what products should be outsourced, selecting suppliers and creating a strategic partnership with them, decisions on number, location and capacity of warehouses to be
implemented, manufacturing plants and the flow of material through the logistics network. This strategic level decisions is comprised of the supply chain network design. Though it is mentioned as network modelling at sometimes, there is still an requirement arrive for building supply chain mathematical model. A solution for this mathematical model is found with the help of optimization techniques which are then analyzed in order to finalize the best solution.

To be specific, the current study is going to concentrate on modelling the supply chain in order to find out the suitable place for facilities (i.e., plants, lines within the plants, warehouses and suppliers) and the best flow of products through these facility network structure. It is not possible to determine the supply chain strategies in an isolated manner as it directly affects the next chain which most organizations have i.e., development chain in which a number of activities are interlinked for a new product to be introduced. Further, it is a must to align the supply chain strategies along with the organizational goals i.e., increase in the profit or market share increase. Design and operations of a supply chain in a wholistic manner i.e., total system-wide cost reduction and increased service level, is a challenging process. Further, operating a single facility at minimum cost and enhanced service levels are challenging too. This difficulty gets increased if in case, an entire system is being considered. Global optimisation, is a process of finding the best system-wide strategy.

It is important to consider technology in developing a supply-chain-wide strategy. Information technology is important in supporting multiple-level decision making processes in a successful supply chain management, as it offers an wholistic view about the flow of information, products and services.

1.5.2 Tactical function

The decisions which are updated once in every quarter/year is included as a tactical level function. This function involves the procurement, operation decisions, inventory strategies and transportation methods, which might include the frequency of customer visits. Contrarily, inventory is piled up due to less or no-demand of most products. The ratio of
annual flow to average inventory in the manufacturer’s warehouse, otherwise called as the manufacturer’s inventory turnover ratio is usually 4. However when it comes to electronics industry, the inventory turnover in the companies would be 9 per year.

So, the manufacturers usually search for the best strategies that have dual benefits i.e., decreased inventory levels and cost whereas increased service levels upto 99% within three years. For instance, this time period is usually targeted due to the change in demand patterns or termination of a lease agreement between the existing warehouses. Additionally, when there is a change in demand, then the plant production levels, selecting new suppliers and a new flow of goods are to be changed within the entire distribution network.

It remains a complex optimization problem to find out the factors to be considered while selecting new warehouse locations, its capacities, determining the production levels in each unit and setting the transportation flows between these facilities i.e., plant > warehouse > retailer so that the cost can be minimized in terms of production, inventory and transportation. The final objective is to achieve complete service level requirements. So, these problems can be overcome through advanced technology and approaches.

1.5.2.1 Role of product design in tactical function

Roper. S. [23], in his research mentioned that when the product design is effective, it plays a critical role in the supply chain. It is obvious that some product design increases the inventory holding or transportation costs compared to other designs. This is different in some other designs which actually facilitate minimal manufacturing lead time. But, redesign a product is unfortunately an expensive and time-taking process. So, here comes the question, when the question of redesigning a product rise, for the purpose of logistics cost reduction and reduced supply chain lead times? Is there any possibility to leverage the product design in order to compensate the uncertainty in customer demand? Is it possible
to quantify the amount saved from such change in bringing the new strategy? What changes are to be brought in, within a supply chain to take advantage of the novel product design? This paper also addresses new concepts such as mass customization since it is getting popularity nowadays. This paper also question the role played by supply chain management in implementing the above-said concepts in a successful manner.

1.5.3 Operational function

Scheduling, truck loading, routing and lead time quotations and other day-to-day decisions are referred as operational level. In this, the distribution network configuration considers a number of products in order to serve the retailers who are scattered in a geographic location. Since the existing warehouses are not appropriate and there is a redesign or reorganization need proposed by the management, the challenges in predicting the demands for a specific model is getting high. However it is common for considerable price reduction in these industries which directly reduce the product value in the life cycle.

Information Technology and Decision Support Systems for supply chain management to be effective, Information Technology remains a critical factor. The area of supply chain management gains much interest, thanks to the presence and opportunities provided by this enormous amount of data and the savings potential available by using this data. The important issue behind supply chain management is not about the data acquisition, but about the type of data to be transferred i.e., which data is significant for supply chain management and what data can be ignored safely? On what frequency, this data should be transferred, analysed and what is the internet’s impact on this data? What is the role played by e-commerce? What is the infrastructure mandatory for both internal and intra-supply chain partners? Further, in the presence of both Information Technology and Decision-Support Systems, is it wise to deploy both the tools to gain competitive advantage in the market? If these tools are predicted to perform well, then the reason for not being used by others is also a question here.
Customer value: It is measure of a company’s contribution to the customer on the basis of services, products and intangibles, which forms the offerings of a company. In the last decades, customer value has overtaken other measures such as quality and customer satisfaction. It is obvious that when a firm wants to meet its customer demands and provide value addition, it must have an effective supply chain management in place. But here, the question of what determines the customer value in different industries arise along with what are the criteria to measure the customer value. Further more questions such as how IT is used to upgrade the customer value in supply chain and how does the customer value is contributed by supply chain management also arise. In what ways the supply chain management is affected due to increased trends in customer value such as relationships and experiences needs to be addressed, whereas the relationship between the brand name and product pricing (in online and in conventional world) is again an debatable question.

The companies that are successful in understanding these scenarios are focusing and giving much importance to strategic planning through determining the best facility locations and product flows. Supply chain network design is otherwise explained as a discipline which is used to find out the optimal location and size of the facilities and flow through these facilities. The below schematic explains how the Information Technology connects the material management system and deliver the value to customer by meeting the customer expectation in terms of Time, Quality & Cost

Figure 1.7. Logistics and Operations in an Organisation
1.5.4 Opportunities and challenges in automotive supply chain

With huge experience in Indian automotive sector and with the help of detailed conversations industry experts and supply chain professionals, A. T. Kearney has identified seven industry strategies that might have an impact on the evolution of the automotive supply chain. The seven actions which are recommended here are provided in order to ensure the supply chain is developed based on the challenges and opportunities in the automotive supply chain Dinesh [24]. They are as follows:

i. **Long term growth and volatility**: India, which is forecasted to be the world’s third largest auto manufacturer by the year 2025, the short-to-medium term volatility will continue in an uncertain economic environment. So, the supply chain professionals face the challenge to develop the supply chain which is not only ready to manage the long-term growth plans, but also can handle short-term volatility.

ii. **Increasing costs of supply chain operations**: The logistics cost in India which acts as a main contributor in sales is 30% higher compared to China and other such automotive markets due to various reasons that include inefficiency, high fuel and wages cost which might get escalated in future as well. So the industry needs to reduce their costs in order to protect margins.

iii. **Product proliferation**: In the upcoming 6-8 years, the automotive supply chain must expand in a massive manner up to 100% based on the market growth and explosion of customer segments.

iv. **Export growth**: In this decade, India is expected to reach exports in double digits, especially in the areas of commercial vehicles, components, compact cars and two-wheelers. This growth requires a holistic and globally integrated, tailored value chain.

v. **Talent shortfall**: There may be a shortage of senior supply chain professionals who possess functional supply chain management skills due to the reason that supply chain functions are getting more strategic.
vi. **Government regulatory opportunities and challenges**: GST (i.e., Goods and Services Tax) changes being implemented across the nation and the regulatory norms put forth mandates a redesign in supply chain strategy with competencies that suits the needs.

vii. **Aftermarket growth**: There are plenty of opportunities predicted for the automobile component suppliers and automobile manufacturers due to the growth that is expected to be in double digits for both, vehicles production and vehicles on road.

1.5.5 Supply chain operational excellence

To face the Opportunities and Challenges in Automotive Supply Chain and also to achieve Operational Excellence, the below six strategic actions have been suggested,

(i) **Collaboration across the value chain**: Since there is already high collaboration levels exist at all levels of supply chain, the auto industry must be entered to move upto the next level. The automobile manufacturers must come forward in establishing long-lasting and win-win relationships with other stakeholders for the business success and continuity towards the common goal. The upgraded collaboration must be implemented in order to (1) enhance supply chain planning process across various horizons to overcome volatility issues, (2) leverage the OEM supplier strategic partnerships so that the time can be improved to market and (3) enhance the OEM supplier partnership methods to optimize inventory and reduce throughput.

(ii) **Innovation in cost management**: If the cost efficiency is to be taken to next level, then one need to focus on innovation and an aggressive management of idle capacity. Both the suppliers as well as OEMs need to rework and restructure their relationships and commercial contracts signed earlier. A strategic supplier relationship will always improve and optimize the innovative ways to share and mitigate risks through joint investments in capital goods like tools and dies. When the market is uncertain, the suppliers need to efficiently
manage their cost pressures of underused capacity, a large supply chain cost being driven by huge capital intensity and higher interest rates in India. So, in such scenarios, the suppliers need to have flexible shift pattern strategies so as to meet short-term volatility, and manage risk by transforming into flexible production model and postponing capital investments close to actual needs.

(iii) **Managing complexity proactively:** During product proliferation, complexity is a usual scenario for which the supply chain need to be geared up. The process of supply chain planning needs to be tailor-made in order to handle multiple-part classes through segmented manner. This challenge can be addressed by using IT solutions in planning, data sharing, inventory management and decision support. In a holistic view, for controlling the proliferation complexity, it is a common expectation among the OEMs to design their own products and engineer it. Those concepts which are not visible to customers usually, such as late customization, delayed differentiation, commonality, modularization and portfolio complexity management has to be adopted in an increasing manner.

(iv) **Custom-tailored value chains and competencies for exports:** The internal supply chain must be integrated with overall network in order to leverage India’s export growth potential. It is essential for a custom-made value chain to be developed for handling complex global supply chain which is usually impacted through proactively planning the delivery lead times meeting the demands according to specific markets, complying with their regulatory norms, operating with a combination of Completely Built Units (CBU) and Completely Knocked Down (CKD) exports in addition to mandating a plan that is based on shipping schedules. In addition, there is a need arise here to emphasize the development of specific outbound CKD management competencies through the creation of a separate function for the management of CKD strategies, conjoining the operations in a supply chain and determining the best available options for outsourcing to special TPLs for end-to-end solutions. In order to enhance the export components, the suppliers have to enhance their footprint across the nations and integrate with large international OEMs for ensuring the
quality output and consistent process to be maintained for the parts manufactured across the locations.

(v) **Restructure and elevate the supply chain organisation:** It becomes mandatory for the automobile manufacturers to promote the supply chain role by thinking its structure at organizational level after defining the supply chain in a neat manner and positioning it as a strategic element with a clearly identified path to the executive level. Further, automobile manufacturers and automobile component suppliers have to ensure they take proactive approach for developing long-term skills through adequate experience and sound knowledge to capture functional expertise.

(vi) **Cost containment in the smarter supply chain:** In today’s smart automotive supply chain, the cost is reduced through complete advantages of automated functions such as intelligence, interconnectivity and increased instrumentation. With the help of these capabilities, the efficient inventory of incoming materials are maintained in addition to spare parts, completed products and its accessories that are scattered across various distribution centers and a number of dealer repair shops. It is important that the dynamic pricing, inventory management and intelligent forecasting are to be maintained for an efficient supply chain for positioning the product in market within the expected growth in the service segment since the consumers hold onto their vehicles for a longer time. In an usually smarter supply chain, a less detailed forecasting and planning is done for the spare parts. Though with the presence of hundreds of thousands of parts and millions of part-location combinations, it can simulate different scenarios and tailor replenishment strategies for each individual part. With the help of highly developed algorithms, it is easy to predict the sporadic demand fluctuations. By carrying few inventories and through reduced obsolescence and better utilization of parts, cost saving is made possible in the entire value chain.
1.6 SUPPLY CHAIN LOGISTICS AND LOGISTICS COST

Supply Chain: The supply chain consists of almost all the stages which are associated in the flow of goods starting from shifting, transformation of goods from raw materials stage to the end user who are nothing but the consumers. This is associated with information flows as well. In supply chain, usually the information and the materials flow up and down.

1.6.1 Logistics

Logistics (Operational Definition) (Figure 1.8)

Guirong, Z. [25] defines Logistics process as “According to the needs of users, transferring auto parts from suppliers to OEMs with the smallest cost”. It mainly includes transportation, storage, packaging, loading, unloading, sales and information processing, etc. From business process point of view, it is divided into two phases:

a. Phase I: Procurement of auto parts (inward), referring to upstream suppliers providing auto parts to warehouse/the automobile manufacturers/assembly line

b. Phase II: Sales logistics (outbound) which includes movement of finished goods from the automobile manufacturing location to sales point (dealer network)

Figure 1.8. Inward and Outward Logistics
1.6.1.1 Concept of Logistics Cost

In logistics, the series of activities that are involved from goods supply to demand are involved. These logistical activities require ports, the authorities who are working in ports who are involved in various logistics activities with an interest.

The following are the costs inclusive of logistics cost,

- “Cost of transport activities, for each mode”
- “Cost of storage or warehousing activities”
- “Cost of marking, identifying, recording, analysis as well as data transfer”
- “Cost of stacking/unstacking activities”
- “Cost of consolidation/deconsolidation activities (Figure 1.9)”

![Figure 1.9. Consolidation and Deconsolidation Concept](image)

(Source: The Integrated Supply chain process by Bowersox [2])

1.6.1.2 Logistics Cost Management covers large range of business activities such as packaging, transportation, inventory management, material handling, logistics information systems and warehousing. Transportation system forms the key element in logistics since the cost incurred on transportation ranges from one-third to two-third in the logistics costs of the enterprise.)
- Materials management
- Channel management
- Distribution (or physical distribution)
- Supply chain management

Supply chain from supplier to plant consists of various activities like procurement and purchasing. In any organizations, the materials start flowing from one to another when a Purchase Order (PO) is raised. In order to prepare this PO, usually purchasing department finds out suppliers who has the potentials to supply the requirements, negotiates terms and conditions, organizing the delivery from beginning to end, arranging insurance-related processes, payment and all other processes through which the materials reach the organization. Thought this was considered as a clerical job in the past, this process is currently automated in a big manner in which the procurement role acts as the main link with upstream activities. The suppliers transfer the materials to receiving area of an organization through inward transport or traffic. This process of transferring through road, rail or air i.e transport, is chosen by the managers. For choosing the best option among these, the manager analyze various factors such as the best transport operator, route design, safety and legal compliance, low costs and on-time delivery etc.,

While the receiving department of the organization check whether the materials delivered as per the Purchase Order and counter-sign the receipt. This is followed by unloading the delivery vehicles and inspecting if any materials are damaged and sorts them. From the receiving area, the next team i.e., warehouse or stores department takes in-charge in transferring the materials to storage and ensure the materials are available when there is a need. In addition to that, warehousing department also takes care of the stored materials through proper storage conditions, treatment, and packaging in order to keep the materials in good shape.

The inventory policies are set in stock control. These policies regulates the operations by considering the materials to be stored, customer service, order sizes, overall investment, order timing and many more. Internal movement of materials in an organization is generally termed as material handling. Materials handling is given prominent importance
during the instance when the operations materials need to be moved from one place to another since the aim of materials handling to enhance the efficiency of the movement of materials i.e., more preference is given to short journeys with apt equipment less or no damage along with special packaging and handling for special needs.

### 1.6.2 Warehousing

A place to store the inventory materials is called warehouse which is popularly viewed as a switching facility rather than a storage facility in logistics system design. The current research provides unified treatment of strategic warehousing after considering holistic views in supply chain network Changjiang, Z., and Jinxing, S. [26].

As a general rule, warehouses can be added to the logistical system in a situation where

$$\sum \frac{P_{\bar{V}} + T_{\bar{V}}}{N_{\bar{x}}} + W_{\bar{x}} + L_{\bar{x}} \leq \sum P_{\bar{x}} + T_{\bar{x}}$$

(1.2)

where

- $P_{\bar{V}}$ is processing cost of volume shipment
- $T_{\bar{V}}$ is transport cost of volume shipment
- $W_{\bar{x}}$ is warehousing cost of average shipment
- $L_{\bar{x}}$ is local delivery cost of average shipment
- $N_{\bar{x}}$ is number of average shipment per volume shipment
- $P_{\bar{x}}$ is processing cost of average shipment
- $T_{\bar{x}}$ is direct freight cost of average shipment

Here, the focus is on both types of warehouses, namely, consolidation and deconsolidation.
1.6.2.1 Consolidation

Consolidation is a warehousing form in which the small shipments are collated from a large number of suppliers, who supply shipments from same geographical area, which are then combined into a single, larger and economical shipment. In other words, small and flexible shipments are replaced with large and economical shipments. The consolidation warehousing has its own advantages such as least shipping costs combined with no requirement of capital investment (risk mitigated) if TPL (i.e., Third-Party-Logistics) provider is engaged.

1.6.2.2 Deconsolidation

Deconsolidation is nothing but the processes involved in breaking down a single large shipment (such ocean containers) into multiple and smaller shipments and organizing those shipments for delivering the products to various plants in order to achieve the goal of high efficiency in an economical manner. As the companies’ perspectives are eyeing on worldwide manufacturing economies, container ocean transportation is on the high rise part in overall supply chain. Deconsolidation is considered as one of the most effective strain relievers in international logistics industry. This process allows companies postpone their decisions on inland shipping till the goods are shipped to ports, so that they can get the advantage of latest demand trends. It is possible for them to sort and aggregate the
contents received in ocean containers to match any pattern of distribution according to requirement rather than guesswork.

1.7 MOTIVATION AND RESEARCH PROBLEM

The supply chain model and the logistics cost play important role in new product development stage of product life cycle. All product development proposals go through financial assessment at the development stage, and this is known as “program approval milestone” in the automobile sector. The senior management approval the program after a preliminary analysis of the financials involved since the profit margin needs to be good if the firm needs to venture into a new product introduction stage. Any automobile manufacturer produces the goods so as to reach the customer and satisfy their demands. The price of the product is one of the important factors that impact customers’ buying decision. This is largely true in India, a mass market where more importance is given for volume.

Cost reduction, due to heavy competition and increased input costs, becomes vital so as to sustain in the market and increase the profit margins. Due to the heavy competition in the market, even a small-ranged price difference impact on the product’s demand and it is open and transparent that when a small price reduction is introduced to consumers, success can be achieved easily.

Stakeholders also push to increase their ROI (Return On Investment) at crucial times. With reference to the Table 1.1, in deciding the cost of the product, more than 30% of the contributor is supply chain cost. So this has to be focused in order to reduce the cost. But this should be done only based on the interests of the customers and not against their will. We should not compromise anything when it comes to quality in products or customer service or technology. Further cost reduction is not a one-time approach, but needs to be implemented on a continuous mode. It is common that customers look for better quality product at competitive price. So supply chain cost reduction is one such challenging tasks when it comes to automobile manufacturers across the globe. When the competition changes from individual companies to overall supply chain systems, there is a need arise to focus on each and every part of supply chain in order to achieve cost reduction. The
optimization of logistical processes helped many global giants in gaining competitive advantage because of their supply chain initiatives. This was made possible through introduction and implementation of different updated supply chain approaches and practices.

The common goals of supply chain management are: reduce waste, eliminate non-value-added services in the value stream, cut down the excess inventory, improve the responsiveness, speed up supply chain communication (timeliness, accuracy of information, visibility of information), reduce cycle time (order to make, time to market) and integrate the efforts from all.

The prime motivation for this study is derived from a context where the “case firm – a global automaker” (unit of analysis) is expanding its production capacity by locating an additional assembly plant in another part of India. It was poised to launch range of new models by 2015 and its evolving supply chain strategy provided motivation for this study.

It was observed that there was an opportunity in Case Firm to increase the profit margin of new product by optimising the logistics cost. Hence, the researcher has taken this problem to study the full supply chain value stream and identify possible opportunities to optimise logistics cost. Researcher has attempted to establish logistics cost hypothetical model and thereby apply innovative, effective supply chain concepts/tools/technologies to achieve competitive logistics cost. Hence, the study is titled as “Developing Least Cost Supply Chain Model for an Autofirm : Case Based Approach”. Supply chain logistics cost directly influence the product cost and in turn profitability of the firm. The above learnings motivated me to take up this study.

1.8 OBJECTIVES AND SCOPE OF THE STUDY

The scope of the study is to establish logistics cost model and validate the model using the data collected from the “Case Firm” (Case Firm is the firm that is taken for case study). This Case Firm has a product at development stage and supply chain is at formation stage as well. Statistically proven least cost supply chain model can be used as a guiding
principle to optimize the logistics cost of the new product in order to improve the profit margin.

1.8.1 Objectives

- To study the logistics cost of the product that is under development stage
- To identify the causal factor in the supply chain value stream mapping and focus on the key factors that influence the logistics cost
- To develop the conceptual model using the key logistics factors and apply statistical tool to validate the conceptual model using the data collected from the case Firm
- To generalize Model using statistical tool
- To apply supply chain techniques to reduce the overall logistics cost for the case taken for study

1.8.2 Scope

The product that was taken for study has many variants or specifications like diesel vehicle, petrol vehicle, with manual transmission and with auto transmission. However, the Researcher has chosen one particular specification for the study.

The scope of this study is limited to the Inbound Logistics, that is, identification of factors influencing total Inbound logistic costs. Further, it concentrates on new product supply chain scenario for a recently launched model.

1.9 ORGANISATION OF THE THESIS
The first chapter deals with the introduction, to give an idea of global, Asian and Indian supply chain scenarios. Supply chain’s role in the automobile industry and how supply chain life cycle goes with new product life cycle are studied in this chapter. In this thesis, the researcher has introduced supply chain functions, logistics definition, logistics cost concepts after the definitions of supply chain, new product and logistics details. The chapter will also cover the rationale, scope, objectives and limitations of the study.

The review of literature is presented in the second chapter. The literatures are grouped into four sub-divisions: (1) logistics cost in the automobile sector, (2) new product development, (3) logistics cost reduction approaches and (4) model building and validation. These are arranged in a sequence to give a funneled-down approach for the readers. The literature survey findings are summarised, and the chapter ends with literature gap in this field, which paved the path for this thesis.

The third chapter deals with the mixed research method, where four stage research method are introduced. It covers Case study, Model Building using Structural Equation Model, Model generalization using Industrial Survey and Experimentation of model in the chosen case. The hypotheses and case selection is presented.

The fourth chapter is introduced to cover the concept of logistics cost model building, the statistical tool used for the model validation, variables used and sample size. The constructs of hypotheses model are rationalised in this chapter.

The influence of the logistics system variables and their interdependence are presented in the fifth chapter. It gives in-depth understanding of the Structural Equation model and the interpretation of SEM results. The structural model iterations and the results are summarised at the end of the chapter.

The sixth chapter focuses on Survey Research Method and it includes web-based Questionnaire, Data collection, Demography of the survey participants /company, Survey results. The survey results are analyzed for statistical significance and the results are interpreted from managerial implication perspective.
The seventh chapter is all about applying the logistics cost model to bring about cost reduction in the case taken for study. It covers all variables one by one and each variable is thoroughly analysed systematically to find out potential opportunities for logistics cost optimisation.

The last chapter comprises of replication, managerial implications, summary, discussions, conclusion, limitations of the study and further research are presented.