

SUPPLY CHAIN MANAGEMENT IN INDIAN AUTOMOTIVE INDUSTRY : COMPLEXITIES, CHALLENGES AND WAY AHEAD

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ABSTRACT

The Indian automotive industry, comprising vehicle and component manufacturers, has grown steadily since the economic liberalization of the early 1990's. The arrival of major global auto companies has galvanised the domestic sector into adopting Supply Chain best practices. This has enhanced competitiveness leading to a quantum growth in exports. However, the Indian automotive industry has to operate in an unique environment further posing challenges to the already complex automobile supply chain. Therefore, a need is felt to continually study supply chain practices in this sector from a contemporary, practitioner's viewpoint in order to identify key factors of differentiation which would ultimately provide competitive advantage. This paper seeks to understand the present status, complexities and challenges facing the Indian automobile sector. It examines trends such as visibility and innovation, collaboration and supply networks and evolving leadership roles impacting supply chain effectiveness. Strategies for overcoming challenges are presented as also a framework for further study and analysis.

KEYWORDS

Supply Chain Management, automotive industry, Supply Chain Challenges, Assembler-supplier synergy, India

1. INTRODUCTION

Universally, the automotive industry has been accepted as a major driver of growth of a nation's economy and is a significant contributor to the global economy. The automobile has been described as 'both a form and function' based product involving high level of engineering as well as being positioned as a fashion product [1]. The industry has rightly been called as "the industry of industries", since it uses outputs of nearly all manufacturing industries [2] and supports upstream (mining, steel etc) and downstream industries (finance, insurance, after – market etc) [3]. Infusion of technology has led to incorporation of electronics (sensors, actuators) replacing mechanical design of assemblies – engine brake system, steering etc, built in test equipment, entertainment and navigation system and advancements in materials and design [4][5]. India, China and Brazil are major emerging markets with robust domestic demand and adequate local production [6][7]. Global automotive companies have lowest EBIT margins in comparison to industry leaders (10.4%) but having the highest number of inventory turns (18.2) and best in class delivery performance (97.3%) [8]. The industry is asset, material and labour intensive which calls for involved operational planning and execution at all levels of management. Government interventions have been a major driving force for development of the automobile industry in Brazil, China, South Korea and the United States at the Incubation, Penetration and Sustainability stages [3].

However, sub-optimal usage of supply chain management practices pose challenges to automakers in their quest for achieving competitive advantage, especially in emerging markets like India. Therefore there is a need to examine various aspects of automobile supply chains in an emerging market which has its own peculiarities. It is in this context that discussions in this paper seek to bring out challenges and complexities in automobile supply chains, presenting emerging trends from the global automotive industry and its applicability in Indian context. Significant issues that impact design and practices, from a futuristic viewpoint, are covered and a framework presented, concluding with suggestions for future research. This paper is exploratory in form and based on a study of contemporary published literature (including research papers, studies and surveys by reputed consulting companies and respective Governmental agencies) and secondary data. There are two major differentiating aspects of this paper, firstly, that it takes a practitioner's viewpoint in the discussions on major supply chain issues and, secondly, the suggestions and determinants for attaining competitive advantage are based on a futuristic perspective obtained by a wide scan of global supply chain practices.

Section 2 highlights the characteristics of the Indian automotive industry. Section 3 covers major issues in contemporary automotive supply chains – integration, challenges, OEM-Supplier synergy, leveraging technology and visibility and performance measurement. Section 4 enumerates some strategies to overcome challenges and presents a framework keeping in perspective emerging and futuristic trends from the global arena. Suggested directions for future research are enumerated in Section 5.

2.AUTOMOTIVE INDUSTRY IN INDIA: PRESENT SCENARIO

Although the Indian automotive industry has its genesis in the 40's, it has seen considerable growth in the last two decades mainly due to economic liberalization including 100% FDI in the sector [9]. Global auto and component manufacturing companies are motivated to establish manufacturing and R&D facilities in the country due to availability of large pool of skilled workers, low production costs, faster design and development process and emerging market status. These companies outsource most functions regionally retaining control on product development and strategic procurement [10][11]. The industry comprises various groups – assemblers, multi-national assemblers, Indian component suppliers, multi-national component suppliers, each with specific strengths and weaknesses [12], with 77% of the production value contributable to the organized sector and the rest in SME sector [7]. Presently, there are more than 30 OEMs offering more than 75 options in all categories of vehicles. India's automotive industry is the world's sixth largest producer of automobiles in terms of volume and value and has grown 14.4% in the last decade. The industry contributes 7% to India's GDP, 7-8% of the total employed population (about 13 million people), 4% of exports [13] [14], 39% of FDI inflows (USD 5.5 billion between 2009-13) and contributes 17% to total indirect taxes collected. Overall domestic sales are led by two-wheelers, (77.4% of total sales in 2012-13) followed by passenger vehicles (15.1%) and commercial vehicles (4.45%) [14]. In the last five years there has been an overall growth in automobile production (from 10.85 million vehicles in 2007-8 to 20.63 million vehicles in 2012-13). Although 2012-13 has seen almost stagnant sales, exports have increased by 10% in the same period. However, in global terms, even with export earnings of 4 billion USD (including 1.8 billion USD as exports of auto component sector), the automotive sector contributes only 2.37% of world production and is ranked a low 26th in rank in the world auto export market with a share of 0.53%. The quest of Indian automotive industry in striving for global competitiveness is evident from the fact that major automotive manufacturers are the second-largest number of recipients (after Japan) of the Deming award for quality. Significantly, India has the best-in-class fuel economy rates as well as affordable total cost of ownership [15] [16]. Realising the importance of the auto industry, which has *grown in seven 'clusters' and its contribution to economic growth*, the Indian government laid out the goals of

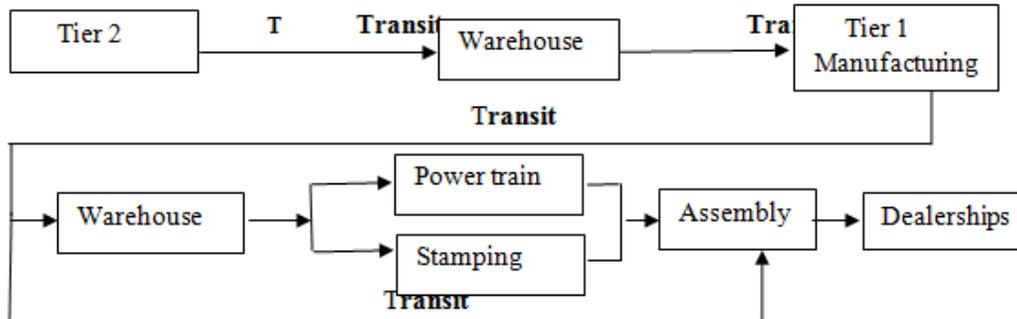
the industry in two documents – ‘Auto Policy 2002’ and ‘Auto Mission Plan 2006-16 [9]. The Government has taken active steps to realize a target of USD 145 billion in output contributing to 10% of the GDP and providing additional employment to 25 million people by 2016. The setting up of manufacturing facilities in India by large automakers such as Hyundai, Ford, Toyota etc has also ensured rapid establishment and growth of a robust auto ancillary/component sector [10]. Design, development and simulation capabilities have increased substantially and global companies like Bosch, Goetze-Werke and Johnson Control have set up facilities in the country [17]. The multi-tiered auto component industry presently contributes significantly to the overall growth of the automobile Industry and major part of exports go to the Original Equipment Manufacturers (OEMs) and Tier I suppliers and only 30% to global aftermarkets, indicative of the advancements in this sector [9]. Automakers are increasingly looking towards rural markets and the youth segment in India due to enhanced buying capacity of this segment.

The above scenario indicates that the Indian automotive industry has potential for substantial growth. This makes it imperative for the industry to attain competitive advantage through adoption of global supply chain best practices.

3. MAJOR ISSUES IN AUTOMOBILE SUPPLY CHAINS

Supply Chains have been aptly defined as a “. . . network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer” [23] and is therefore the sum total of efforts in integrating a network of firms and coordination as regards information, material and financial flows. Interestingly, the top two supply chain goals have shifted, from reducing operating costs and overall inventory levels, to concerns of how to improve customer service and speed of product delivery to markets [24].

Figure 1 schematically depicts a typical automotive supply chain which comprises of a network of smaller supply chains each with its own separate characteristics.



The complexity of the automotive supply chain may be gauged from the fact that a typical vehicle comprises approximately 20,000 components with about 1000 sub-assemblies or modules [18]. The automotive supply chain includes multitude of Tier 1, 2 and Tier 3 suppliers or manufacturers with many assembly operations and a number of dealerships. Customer demand for varied specific configurations and features add to the high level of response needed from automobile supply chains. The order lead time required by a customer is averaged at 4-6 weeks in the automobile industry [19] and there is a definite correlation between implementation of Supply Chain Management (SCM) practices and quality and conformance of design [20]. Toyota’s Production System enshrining lean thinking has long since been an industry benchmark [21] [22].

Trends in the auto industry which impacts the supply chain are depicted in Table 1 [18]. Fisher [25] profoundly enunciated that a supply chain must be tailored based on specific requirements of the product being manufactured. This is specially so for the complex automotive industry wherein, an automaker has to contend with managing a network comprising several supply chains. It is imperative that Indian auto industry align supply chain practices to business strategies for maximizing competitive advantage in an emerging market [26]. Macro economic cycles of growth, contraction and recovery, creates tremendous strain on the effectiveness of established supply chain especially in the automotive sector due to its widespread linkages with other industries.

Table 1. Trends Impacting SCM [18]

Demand-Side Trends	Supply-Side Trends
Uneven Growth	Differentiated Outsourcing
Fragmentation	Low-Cost-Country Sourcing
Accelerated Volatility	Risk Management
Importance of After market	Transparency / Accountability

Indian industry spends a high 14% of its GDP on logistics, compared to 10-11% in Europe and 9% in USA and nearly 22% of aggregate sales (equal to about USD billion) is tied up in inventories in the supply chains. The cost of logistics remains high due to various factors including lack of large specialized, integrated logistics firms (third party logistics - 3PL) using effective technologies and also inadequacy of infrastructure. This indicates that there is ample scope for Indian automotive companies to streamline their supply chain process and become more competitive [27][28][29]. Major competition between automakers in India is at the level of assemblers rather than between entire supply chains including first tier component suppliers [30].

The erstwhile factors for competitiveness based on “cheap labour, favourable exchange rates and concessional duty structures” is no longer relevant and therefore incorporating supply chain practices are imperative to meet the challenges of a dynamic system [31]. Supply Chain practices which include internal and external issues must be tailored to be a ‘strategic fit’ between competitive strategy and supply chain strategy of the company in order to achieve business excellence [32]. In the Indian automotive industry, business environmental factors and Government policies effect supply chain competitiveness to a large degree followed by cost advantage and buyer-supplier relationship. Labour and cost of raw materials are nearly same across the auto component manufacturing sector, thus these factors do not contribute to any competitive advantage [17]. The auto component industry is now perceived to operate in an integrated manner moving away from a “job fulfiller” role. Presently, supply chain implementation in India focuses on vendor development (shifting of risks and accountability to vendors), collaboration, partnerships-both upstream and downstream, outsourcing of logistics, transportation and usage of IT for order and inventory tracking and demand forecasting [33]. However, it must be ensured that JIT and lean manufacturing systems include contingency planning incase of disruptions such as during floods in Thailand and the Japan’s earthquake which widely impacted the automotive supply chain in the region [29] [34].

3.1 Integration

It has been noticed that stiff competition in the industry has led automakers to focus on efficiency of the total supply chain rather than on improvement of specific functional areas. Supply chain entities in the automobile sector are using collaborative forecast practices widely along with high visibility due to comparatively lower customer base than, for example, in the FMCG sector [33][35]. Integration of supply chain practices now extends to the product

development process. For example, product development process at Toyota is closely linked with the production system [36][37] and essentials of this framework involves close, frequent, cross-functional interactions – both informal and formal and close mentoring by supervisors of their subordinates. In the present day context of volatile demand and changing customer preferences, the automotive supply chain has to be responsive. Attaining flexible practices are adversely impacted by a host of factors – global economic volatility, identifying and adapting to emerging markets, increasing competitive rivalries and consumer preferences etc [5]. ‘Lean’ and ‘agile’ practices would enable auto supply chains to meet such challenges and a framework for a ‘Leagile’ [38] supply chain has been suggested [39], which brings out the crucial aspect of dynamically placing the ‘decoupling points’.

3.2 Supply Chain Challenges

The top five global supply chain challenges are – *visibility, cost containment, risk management, increasing customer demands and globalization* [40]. It is interesting to note that automotive supply chains, globally, lag behind other supply chains (such as retail, pharmaceutical etc) in these five parameters clearly indicating the need for and scope of considerable improvements to make them more effective and responsive. The surge in demand in the last decade has put sudden pressure on the existing Indian auto and auto component manufacturers, with hardly any integration, to quickly adopt global standards and practices and introduce or vitalize supply chain processes thus posing challenges in technological preparation and transition management [41] almost dynamically without impacting the brand image.

Supply chains in the automotive sector have to contend with peculiarities in the Indian context which are distinctly different from those in developed countries. Preference for small cars and two wheelers, lack of visibility at the customer end specially in rural markets, packaging complexities due to language and cultural diversity, quality challenges due to resource shortcomings, large number of fragmented suppliers which impede effective collaborations, complex tariffs and duties, lack of infrastructure (off highway transit is difficult) and a multi-level distribution system impacting price of products are some of the significant supply chain challenges [16][30][33]. The biggest challenge being integration of end-to-end supply chain followed by managing in-bound logistics, product and part proliferation [15]. The auto component industry, a major contributor to export and growth, is beset with frequent changes in costs of raw materials, customer demand for product quality, timely deliveries and sourcing of raw materials [12][42][43]. Multinational companies entering India face unique challenges-cultural diversities, pricing-income disparities and sourcing. Hyundai, for example adjusted well to Indian environment by tailoring the Santro with reduced engine output (for higher fuel efficiency) and competitive pricing of spare parts etc [44]. Only 50% of the workforce is considered to be of high quality with a high attrition rate averaging 40% [13]. Skill development is being undertaken by some major Tier-1 auto-component manufacturers and a good example is that of Bosch Ltd which has the Bosch Vocational Center (BVC) to impart training on quality, safety, problem solving techniques etc [31]. A survey [15] has revealed that the main strategies for overcoming SCM challenges in Indian auto industry are - increasing investment in Information Technology and process improvements (38%), vendor/dealer consolidation (31%) and improving internal infrastructure (8%). Outsourcing to logistics service providers by Original Equipment Manufacturers (OEM) is bound to increase in the future in domains of module assembly, planning, scheduling and Inventory Management.

3.3 OEM-Supplier Synergy

Increased pressures on Tier-1 suppliers are related to performance expectations, lack of strategic collaboration and lack of information [45]. The major aspect of the ‘OEM-auto component

manufacturers' linkage relates to concerns regarding responsibility for design and quality besides location, cost and module design capabilities. It is evident that 'on-site' suppliers contribute substantially in achieving overall supply chain efficiency through standardization of parts and cost effectiveness [46]. Outsourcing by OEMs has also resulted in suppliers assuming greater responsibilities in assembly and sub-assembly design and development necessitating widespread technological advancement [34]. Global suppliers, particularly, face challenges of logistics, local content and quality, innovative ability of suppliers, reliability and cost [47]. Maruti Suzuki was among the first in India to establish the Vendor Managed Inventory (VMI) model with its component suppliers which has resulted in considerable reduction in inventory held and streamlined planning and transportation schedules. Tata Motors through its 'One Part One Vendor' system aims at substantially reducing number of vendors. The trend is basically to enhance supplier-side integration by reducing the number of suppliers and having separate sub-verticals such as electrical, body frame, engine etc. with some manufacturers creating a different vendor base for each model of automobile [48]. Compatibility is a major criterion for supplier selection in the Indian context [49]. Global OEMs and component manufacturers prefer stable JIT suppliers, located in geographic proximity and those who have established JIT material supply and automated material supply [50]. Although many suppliers in India match up to world industry standards, there is a need to develop the lower-tier suppliers to ensure global competitiveness.

3.4 Leveraging Technology and Visibility

A survey conducted among top auto makers in India highlighted the fact that technology is widely seen to be a supply chain enabler, reducing inventory levels and stocking, shortening lead times and fostering a spirit of collaboration with suppliers and dealers [51]. IT managers indicate a 'lack of alignment' between business goals and IT implementation plans in majority of the companies. Although there is a high awareness among Indian Tier-1 companies, the usage of productive-enhancing tools such as data analytics, ERP, RFID etc are still at low levels [33] specially among Tier 2 suppliers due to challenges such as cultural, financial, organizational and technological barriers to be overcome [45][31]. Mahindra and Mahindra's technological initiatives in SCM and CRM called 'PACE' (Performance at Customer Elation)[51], Bajaj Auto's 'my SAP' Enterprise portal, Ashok Leyland with SCM Project 'Oscars' [10] are all aimed at improving service levels, e-payment and clearance facilities and enhancing visibility leading to better coordination and reducing non – core activities, vendor base rationalization etc. at all echelons of the supply chain. Among the auto component suppliers, TVS Industries [52] widely utilizes technology effectively in its supply chain. At Sundaram-Clayton, a major auto component manufacturer, lean manufacturing practices resulted in 2.5 to 5% lowering of product costs even during a time when commodity prices and wage costs were increasing [53]. Indigenization is the key to attain cost competitiveness in the Indian automobile industry. This essentially needs establishment of a technologically capable, innovation-driven supplier base, which is presently constrained by the 'SME-culture' and policies as also the need for large automakers (OEMs) to adapt to local conditions [47].

3.5 Performance Measurement and Quality

Establishing pragmatic, robust supply chain benchmarking and performance parameters is an imperative for Indian automotive supply chains which, may be forced to cut costs and in the bargain take 'sub-optimal' supply chain decisions in times of economic uncertainty and falling demands.[54]. Periodic and systemic view of evaluation of supply chains is necessary to be competitive in a dynamic market like automobiles [55]. A methodology called 'quick scan' applied to evaluate the best practices among suppliers and customers of 20 European automakers [56] and Tier 1 and 2 suppliers' [57] gave a clear indication of the need for doing much more in

incorporating best practices for achieving a seamless supply chain [58] and improve ‘business systems engineering’. A SAP-LAP case study [59] points to the need for measurement of vendor performance, based on supply chain effectiveness criterion as well as enhanced visibility from end to end and also the need to focus on second and third tier suppliers since they are responsible for most of the quality problems.

Applicability of various performance measurement models such as Balanced Scorecard, SCOR model etc. to Indian automotive sector has been comprehensively covered by Saad and Patel [30]. An empirical study on the role of quality in the respective supply chains in Indian automotive sector [60] reveals the significance of adopting internal and external quality processes, which contribute to “supplier loyalty, satisfaction, competitive advantage and organisational performance”. Quality remains a major area of concern with Quality Assurance Process and Service Level Agreements being “order qualifiers rather than order winners” [33]. However, Indian auto companies should keep local conditions – work culture, labour laws, managerial expertise and skill levels, market demand behavior etc. in view before incorporating any particular system or best practices.

4. WAY AHEAD FOR INDIAN AUTOMOTIVE SUPPLY CHAINS

The issues related to current SCM practices, challenges and complexities are indicative of the fact that the Indian automotive industry, is entering a very competitive phase. There is therefore a need to identify key contemporary trends which the industry is likely to face in the future and consequently, dynamically adapt respective supply chains to maintain and enhance their competitive edge.

This section enumerates some strategies for overcoming challenges, identifies future trends in the automotive supply chains and matching contemporary SCM practices. Finally, three significant aspects facing Indian automotive supply chains in the near and medium term are discussed, these being – visibility and innovation, collaboration and supply networks and evolving role of managers and leaders. A suggested framework (Figure 3) on future trends and changes which are likely to impact Indian automotive supply chains in the near future is presented.

4.1 Strategies for overcoming challenges

Some of the lessons learnt from the transformation phase of the Indian automotive industry are [41]:-

- Application of advanced supply chain concepts in a developing economy and in emerging markets.
- Importance and advantages of establishing collaborative relationships with suppliers.
- Inclusion of all stakeholders during process of change and transformation.

To overcome challenges facing the Indian automotive sector, as enumerated earlier in this paper, an innovative approach is needed. It has been suggested [24] that “splintering” a complex supply chain has advantages of reducing complexities, enhancing *visibility*, *effective application of lean techniques leading to agility to meet evolving business dynamics*. A study with a futuristic perspective [40] calls for “not simply a more efficient supply chain but rather smarter supply chain that embodies three characteristics” – Instrumented (*use of sensors and smart devices for enhancing visibility*), Interconnected (*integrating after-market, collaboration and decision-making*) and Intelligent (*use of advanced analytics, simulation and modeling*).

Indian automotive Industry has, therefore, to take concrete steps to meet challenges and enhance competitiveness. Some of the recommended changes are summarised below [9][5][61] :-

- **Global outlook.** Focus on developing and maintaining overseas markets especially in small car, LCVs and auto component sector by adopting a global outlook to supplier management, manufacturing, sales, etc.
- **Supply chain practices and product development.** This necessitates incorporation of 'Leagile' [38] practices in automotive supply chains by dynamically positioning the decoupling point and also making changes in basic vehicle design based on product platform and modular structuring of sub-systems. Matching of demand (variety) of vehicles with assemblies/components supply through increased visibility, enhancing service levels, customer relationships and skill development are some contemporary imperatives.
- **Government intervention.** Governmental interventions, such as a favourable tax regime, enhancing R&D capabilities especially related to hybrid car technologies and fuel-cell development and infrastructure are necessary to enhance the sector's competitive edge.
- **Supplier networks.** There is a need to galvanise the supplier networks, especially in the SME sector to adopt global technologies and practices. Sub-contracting should be based not only on cost but on capabilities of design, innovation and engineering. Auto makers and major suppliers should rationalise supplier base, formulate selection criteria, build in sustainability through enhanced collaboration and trust such as Ford's 'Aligned Business Framework (ABF)', a strategic supplier initiative.

4.2 Future trends and contemporary SCM practices

This section seeks to discuss some key global trends – modularity, green supply chains, reverse logistics, 'Build-to-Order' Supply Chains (BTO-SC) [62] and vehicle service networks, which are likely to impact the functioning of Indian automotive supply chains.

The 'green revolution' and 'mobility revolution' (both personal mobility and public transportation) are going to be the major drivers for the auto industry in the future [63] which in India will result in development of rural markets, feeder services between transportation modes and demand for mass mobility vehicles requiring re-alignment of present day supply chain goals. Modular product design involves breaking down a "complex system into a number of smaller, discrete, scalable, inter changeable, reusable and self contained functional components or modules which can be designed and developed separately and then assembled to form the entire system seamlessly" [64].

Modularity is increasingly becoming a norm in the automotive industry, facilitating agility, with a multi-tiered supplier network [64], comprising fewer direct suppliers having a larger role in design, development and value creation. Lucas TVS is an example of an Indian company which has focused on operational excellence with supply chain best practices of 'modular manufacturing' through their New Product Introduction Teams (NPIT) for new projects which are cross functional in nature [31]. Presently the industry faces many barriers in implementing environmentally responsive supply chains ranging from lack of awareness of reverse logistics to financial constraints [15]. The issue of global requirements of sustainability, for achieving competitive differentiation, will impact the functioning of Indian automotive supply chains adding to its complexity specially relating to extension of sustainable green supply chain practices such as recycling and reverse logistics in Tier 1 and 2 suppliers [65]. Reverse logistics is a major supply chain challenge specially in the environment in which the industry operates,

requiring a well designed, robust ‘reverse supply chain’ which comes into play in case of vehicle recalls and in India, unlike in developed countries, is seen in a negative context evoking “distrust and fear” in customers [66]. An example is the recent case of recall of Ford Eco Sport Utility vehicles soon after its launch in June 2013 (due to a problem in a glow plug module) which considerably damaged the brand value.

BTO-SC is a paradigm that has been successfully tried out in the German automotive industry [19] which may find useful application in the Indian context to meet exacting and changing customer demands. The success of the BTO-SC depends upon a robust IT infrastructure, close collaboration and integration with suppliers coupled with efficient production and scheduling process [68]. In this era of increased competitiveness and economic slowdown, vehicle service strategy is an emerging area of interest. Expanding a service network, using technology as a facilitator and skill enhancements which would ensure that more customers use OEM authorized service facility rather than workshops in the unorganized sector as is the trend in India. This calls for an entirely new supply chain paradigm to be designed and implemented [69].

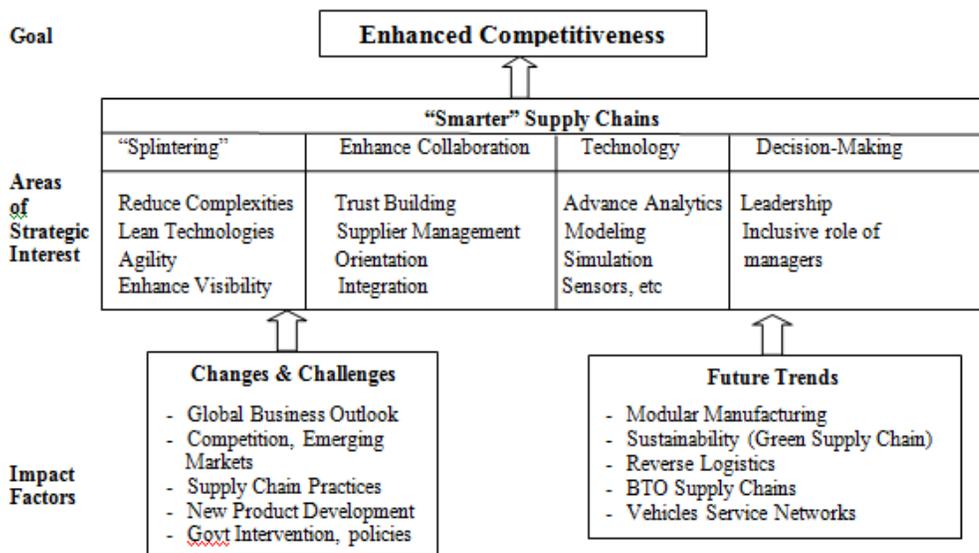


Figure 3. Proposed Framework : Enhancing Competitiveness in Automobile Supply Chains

4.3 Visibility and Innovation

An effective technology strategy is essential for attaining business goals in the automotive sector. Development of components suited for *local conditions, absorption of advanced technologies and innovativeness in manufacturing* would ensure that Indian companies attain competitive advantage [31]. Adoption of technology especially in the SME based auto component sector has been mostly ‘unbalanced’ and IT investments should not merely follow a trend or showcasing, but to actually enhance competitive advantage [35]. Developing Innovation Centres with global players will spur indigenous auto component manufacturing [13]. Bosch Ltd, an auto component multinational has set up a world-class technical centre in India which is also export-oriented having established two manufacturing facilities in India solely for this purpose. Thailand which aspires to become a major regional production base for motorcycle and auto components, has a five- strategy action plan with focus on environment, safety and sustainability and most importantly development of entrepreneurship to be achieved by establishing three Centres of Excellence (COE) and two Good Business Environments [70]. In

the large complex, global automotive supply chains, use of 'Big Data' concepts and resulting data analytics will contribute significantly in reducing in-transit inventory, safety stocks and stock-outs by better analysis of transit times, bottlenecks at ports and shipment routings [29]. A cue may be taken from Hyundai's setting up the Automobile Management Research Center in China solely to obtain timely information on the country's market since data was not easy to collect in normal course in the large developing country with a big domestic market. Innovations are needed to open up new markets such as in the Ultra Low Cost Car (ULCC) category, like the Tata Nano, and Small Commercial Vehicles (SCV) segment which can substantially boost India's export market. Technological breakthroughs such as 'Additive Manufacturing' [29] – use of 3D printers which are sure to radically change form and functions of supply chain entities and Indian companies would have to develop capabilities to absorb these technologies. This important aspect is being manifested in initiatives such as MIT's global centers for research and education, called Global SCALE (Supply Chain and Logistics Excellence) Network [71].

4.4 Collaboration and Supply Networks

The direction of assembler-supplier relationship is radically changing. Firstly, suppliers are being given greater responsibility for product design and development ensuring quality and delivery and, secondly, the assemblers are focusing on a fewer number of suppliers, deepening collaboration and integration practices with the latter [47]. This makes it imperative for making the SME-oriented suppliers more innovative, adopt modern technologies and supply chain best practices. 'Supply Networks', a concept that is being developed in the complex automobile supply chains, involves a "holistic integration of all suppliers to combine resources as well as increase flexibility and adaptability of the value creation process" [47]. Strategic sourcing which aims at identifying and selecting suppliers for a lasting partnership [72] takes supply chain collaboration to an entirely new level. In the Indian automotive sector, this calls for radical changes in the present system of focal organizations handling interaction with suppliers to ensure Flexibility and Agility in the supply chain. A comparison between Indian and Brazilian auto industries (both with similar growth trajectories in emerging markets) highlights the concept of 'follow design' and 'follow sourcing' being practiced in Brazil's automotive industry and suggests the increasing importance of global supply networks - specially of the auto component industry as relates to design, supplier selection and contract allocation [6]. Collaboration and trust-building are going to be the mainstays for development of the Indian auto manufacturing sector in the future. These trends call for a focused Supply Management Orientation (SMO) and establishing performance metrics for both suppliers and buyers [73] including issues such as long-term relationships, supplier involvement in product development, trust and collaboration, quality criterion, cost control and information sharing. The latter is an emerging trend which calls for 'super-specialists' in the industry who could, based on their core competencies, become a sub-system supplier to the entire industry [62], thus reducing need for heavy investments. This requires a new era of collaboration and trust between present-day competitors, which would also simplify current supply chain complexities.

4.5 Evolving Role of Managers and Leaders

One of the crucial aspects in SCM – the evolving leadership role of managers, needs greater study and deliberation. It has been seen that auto supply chain managers have less strategic roles than in other supply chains [40]. Therefore a review is needed in the industry to broaden the scope of responsibility of Supply Chain managers to holistically cover end-to-end visibility functions, risk management, product design and customer management. This will make them more accountable, from a supply chain efficiency view point rather than silo-like functioning. There is also a pressing need for auto supply chain managers, especially among top leadership,

to develop a spirit of change management in their organization specifically pertaining to the need to usher in collaboration and trust at both ends of the supply chain.

The important role of leadership in the performance of auto companies, specifically in GM and Toyota, has been studied [74] which cautions that “growth and profit should be mutually inclusive”. Toyota’s decline in quality standards is a case where management ambition and complexity of products led to defects increasing from 1.01 to 117 in 100 vehicles in 2009 – 10. Lessons learnt from Toyota’s problems, in the supply chain domain, are attributable to the managerial level rather than in the production system and, notably are – reduction in relationships with suppliers, highly centralised decision making and poor synergy [75].

5. RESEARCH DIRECTION

India has come a long way in adoption of new technologies and global supply chain best practices in its automotive sector. Literature pertaining to Indian auto industry is not comprehensive in nature mainly due to characteristics of evolution of the sector in an emerging market. The present need is for effective, pragmatic supply chain practices to percolate wider among channel partners of OEMs. This indicates the need for focused research in areas such as evolving supplier evaluation strategies and frameworks, changing role of supply chain managers and leaders, collaboration and trust development with both upstream and downstream entities. Some suggested areas which may be studied relate to an enhancement in OEM-supplier relationships, collaboration, improving dealer networks, demand management related strategies and development and inclusion of Third Party Logistics (3PL). The proposed framework presented in this paper enumerates factors such as *changes and challenges and future trends which are the basis of establishing ‘smarter’ supply chains leading to Global Competitiveness*. These constructs along with their respective underlying variables may be ascertained and validated by conducting suitable case studies of automakers and their suppliers.

There is also a case for carrying out comparative studies, based on ‘supply chain practices-performance’ linkages of the automotive sector in developed countries and the adoption of specific best practices for enhancing competitiveness among OEMs and component manufacturers in India. This would bring out gaps in the present context and enable consequent planning for the future.

6. CONCLUSION

The Indian industry is yet to match the supply chain standards of developed countries [76] and tremendous potential exists for national level integration of supply chains [49]. Some future trends in the auto industry have been highlighted in the paper which necessitates significant changes in supply chain practices in automotive supply chains. There is also a need for external support to the industry by way of supportive Government regulations and policies and development of infrastructure. The industry needs to focus on development of green technologies such as hybrid vehicles, low emission and fuel efficiency to meet futuristic, stringent norms, cost control throughout the automotive value chain (such as frugal engineering in the development of Tata Nano), enhance investments and efforts in R&D specially in auto component manufacturing sector and build up scale to enhance export. A sustained growth in the automobile Industry in India will contribute significantly to the country’s GDP. However this requires determination and commitment on the part of all stakeholders – Government, OEMs, suppliers and others. Since external agencies and factors are not within their control, it becomes imperative for automakers to focus on improving their respective supply chain practices laying emphasis on aligning these to meet the dynamic, evolving business environment. There is also a need for continued academic interest in this important industry which would provide a

comprehensive, meaningful theoretical framework and identify specific dimensional objectives for practitioners to implement in their sustained quest to enhance competitiveness.

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