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Review Article

An Empirical Review of India's Automobile Manufacturing Sector in The Global Value Chain

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ARTICLE INFO **ABSTRACT**

This Review examines the automobile manufacturing sector in India, focusing on its integration into the global value chain and its pivotal role in the national economy. India's automobile industry has undergone significant transformations since the economic liberalization of 1991, which catalyzed a surge in foreign direct investments and nurtured a competitive market environment. The industry's expansion is underpinned by a robust internal market, driven by a growing middle class, rising disposable incomes, and a demographic trend favouring vehicle ownership. The study delineates the evolution of this sector into one of the world's foremost automobile production hubs. It maps the geographical and strategic facets of automotive clusters located in states like Tamil Nadu, Maharashtra, Gujarat, and Haryana, which have thrived due to conducive government policies, sound infrastructure, and the availability of skilled labor. Environmental considerations form a core component of the sector's strategy, with increasing adoption of Green Supply Chain Management (GSCM) practices aimed at reducing carbon footprints and other environmental impacts. The industry's shift toward manufacturing electric and hybrid vehicles illustrates its alignment with global sustainability trends.

Keywords: Global Value Chains, Automobile Industry in India, Economic Liberalization, Green Supply Chain Management, Electric Vehicles

1. Introduction

The automobile manufacturing sector in India stands as a significant pillar of the country's economy, contributing prominently to its industrial output and GDP. India has emerged as a major hub for automobile production, ranking as one of the largest automobile markets globally. The industry's growth trajectory has been bolstered by several factors, including a burgeoning middle class, increasing disposable incomes, and a young population showing a growing preference for vehicle ownership. Over the years, India has become one of the largest global automobile manufacturers, attracting major foreign investment, especially after the liberalization policies of 1991 that significantly reduced licensing requirements (Dasari & Koul, 2015). Historically, the sector began to evolve rapidly post-1991 economic liberalization, attracting substantial foreign direct investments (FDI) and fostering competitive domestic firms. Today, the sector encompasses a wide range of vehicles, including passenger cars, motorcycles, trucks, buses, and three-wheelers, with a robust supply chain and manufacturing ecosystem spread across the country.
The sector has also been at the forefront of adopting green supply chain practices to mitigate environmental impacts, such as reducing carbon emissions and other pollutants. Critical to this transformation is the identification and implementation of Green Supply Chain Management (GSCM), which has been recognized as vital for sustainable growth within the sector (Luthra et al., 2015). Key automotive clusters are located in states like Tamil Nadu, Maharashtra, Gujarat, and Haryana, driven by favourable government policies, infrastructure, and skilled labor availability. The Indian government has supported the industry through initiatives such as the Automotive Mission Plan and the introduction of the Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) scheme, aimed at promoting electric vehicle adoption. Moreover, in recent years, there has been a strategic shift toward electric and hybrid vehicles, reflecting global trends towards sustainability. The industry is exploring circular economy initiatives to manage waste

effectively by recycling and reusing materials, which not only helps in waste reduction but also minimizes environmental impacts (Agrawal et al., 2021). The Indian automobile manufacturing sector is marked by significant contributions to the national economy, continuous growth and adaptation to global manufacturing standards, and an increasing focus on sustainability and environmental responsibility.

Table1: A summary of key literature on the automobile manufacturing sector in India, focusing on its economic impact, market share, sustainability initiatives, and historical development

Title	Authors	Year	Key Points
Foreign Direct Investment in Automobile Sector in India	Sandeepthi Robert M, Nirmala J	2023	Discusses significant growth in FDI and its impact on the Indian Automobile sector, which ranks fifth globally in attracting FDI.
An Analytical Study on Ratios Influencing Profitability of Selected Indian Automobile Players	M.Elangovan, Dr. K.Ramasamy	2022	Analyzes profitability ratios of major Indian automobile manufacturers like TATA Motors, MRF, and Mahindra & Mahindra, showcasing the industry's growth.
A Statistical Analysis on Automobile Sales Performance in India	Kayalvizhi Subramanian, M. Othman, R. Sokkalingam, Gunasekar Thangarasu	2020	Examines the sales performance of the Indian Automobile Industry through statistical methods for the period from 2012–2018.

Significant literature focusing on various aspects of the automobile manufacturing sector in India, including economic impacts, market dynamics, sustainability efforts, and developmental history. This table1 highlights key findings from recent studies on FDI, profitability, and sales performance within the Indian automobile industry. This review comprehensively covers the integration of India's automobile industry into global value chains and its economic impact, there is less emphasis on the socio-economic challenges faced by the workforce within this sector. Additionally, the impact of rapid industrial growth on urban infrastructure and local economies in these automotive clusters has not been thoroughly explored. The adaptation of international environmental standards in the context of Indian market conditions also presents a potential gap.

The objectives of this study aim to deepen the understanding of the Indian automobile sector in several critical areas. intend to explore the socio-economic impacts on the workforce, including aspects like job creation, skill development, and working conditions. This review will evaluate the effectiveness and implementation of Green Supply Chain Management practices within the sector, comparing them to international benchmarks to identify both strengths and areas for improvement.

2. Significance in the global economy

The automobile manufacturing sector is indispensable to the global economy, providing substantial economic contributions, fostering innovation, and driving growth in numerous ancillary sectors. Its evolution continues to impact global economic patterns significantly, making it a key area of focus for policy makers and industry leaders alike. The automobile sectors of India and Pakistan have been shaped significantly by economic factors and regulatory impacts, with recent pivotal research offering in-depth insights. Sandeepthi Robert M and Nirmala J's (2023) study focuses on the surge of Foreign Direct Investment in the Indian automobile sector, emphasizing its crucial role in global markets and its impact on national economic growth (Robert M & Nirmala, 2023). In Pakistan, research by Irfan Ul Haque, Dr. Aamir Rashid, and Dr. Syed Zubair in 2021 delves into the automobile sector's role within the economy, examining its influence on global business interactions and trade dynamics, and emphasizing its strategic importance to Pakistan's economic structure (Haque, Rashid, & Zubair, 2021). B. Nayaka's 2021 study analyzes the impact of the Goods and Services Tax (GST) on the Indian automobile industry, noting significant shifts in production, sales, and exports, and detailing the tax's broader economic implications (Nayaka, 2021).

The research across both India and Pakistan highlights the critical economic roles their automobile sectors play. The infusion of FDI into India's market underlines the sector's integration into the global economy, while GST reforms present a complex landscape of challenges and opportunities. In Pakistan, the industry's influence on global trade outlines its potential as a cornerstone for economic development. These studies collectively demonstrate how regulatory environments and economic policies in both countries directly affect their automobile sectors, shaping their trajectories in the global marketplace.

3. Role in the global automobile value chain

India plays a significant and evolving role in the global automobile value chain, contributing to both regional and international markets through robust manufacturing capabilities, substantial exports, and increasing integration with global production networks. India has become a key player in the global automobile value chain, characterized by significant growth in manufacturing, especially in serving low- and middle-income groups domestically. This has been supported by strong government policies, infrastructure development, and participation in global value chains, making India the world's fourth-largest automobile market by 2017

(Miglani, 2019). India's engagement in the automobile sector's gvcs is highlighted by its role in meeting the demands of various emerging markets. The presence of multinational enterprises and foreign direct investment has integrated India more deeply into the global market, enhancing its export capabilities and technological advancements (Dowlah, 2018). Despite its growth, the Indian automobile sector faces challenges such as informality, low wages, and insecure working conditions, particularly in the lower tiers of the supply chain.

This reflects broader industrial relations issues that affect the sector's overall stability and growth (Kerswell & Pratap, 2015). India's role in Asian production networks is increasingly prominent, with significant contributions to regional supply chains, especially in ASEAN networks. This reflects India's growing competency in the automotive sector, supported by its capacity for producing and exporting automobiles (Nag, De, & Singh, 2017). India's automotive supply chain is vital for its economic contributions. However, it faces complexities due to international competition and the need for adopting advanced supply chain management practices to match global standards (Sahay, Sharma, & Sardana, 2011).

The Indian automobile industry's growth, challenges, and integration into global and regional networks have been the focus of several critical studies. Smita Miglani, in her 2019 analysis, delves into the roles of government policy and infrastructure in enhancing India's significant position within the global automobile value chains (Miglani, 2019). A study provides detailed case studies on the global value chains, particularly highlighting India's integration and role in the automobile sector, showcasing examples and outcomes of this integration (Dowlah, 2018). In 2015, Timothy Kerswell and S. Pratap discussed the challenges such as informality and labor issues within India's automobile sector as part of their broader analysis on the global value chain. Their work highlights critical internal challenges that impact the sector's performance and integration (Kerswell & Pratap, 2015). A study explores how the Indian automobile industry is increasingly becoming integrated with the Asian automotive networks, detailing the implications for trade and production dynamics within the region (Nag, De, & Singh, 2017). A study by B. S. Sahay, Vikram Sharma, and G. Sardana in 2011 examines the supply chain management practices of the Indian auto industry, comparing these practices to global standards and evaluating their effectiveness and areas for improvement (Sahay, Sharma, & Sardana, 2011). These studies collectively illuminate the multifaceted nature of the Indian automobile industry's journey within global and Asian economic frameworks. The industry's growth is significantly influenced by both enabling factors like government policies and the robustness of infrastructure, as well as challenges including labor issues and informality. The insights into India's role in global value chains and Asian production networks underline the strategic importance of aligning internal practices with international standards to bolster its standing and effectiveness in the global market.

Sandeepthi Robert M & Nirmala J, (2023), the Indian automobile sector is rapidly evolving, marked by significant advancements and integration into the global market. Key trends include a substantial increase in foreign direct investment (FDI), with the sector experiencing a 326% growth in FDI inflows during 2021-2022, emphasizing its critical role in the global automobile market. This growth is driven by India's supportive policies and its strategic position as a cost-effective manufacturing hub. Smita Miglani (2019), the Indian automobile industry has made significant strides in adopting advanced technologies and sustainable practices. There's a focus on electrification and digitization to meet future demands and stay competitive globally. By 2017, India emerged as the world's fourth largest automobile market, with ongoing growth fueled by strong government support and investment in infrastructure. B. Nayaka (2021), the industry is increasingly contributing to India's GDP and employment, supporting over 35 million jobs, making it a pivotal element in India's economic fabric. The sector's expansion is also linked to global value chains, enhancing its export potential and global footprint. Indian automobile sector's integration into the global economy is characterized by robust growth, significant FDI inflows, and strategic adaptations to technological advancements and sustainability trends.

Recent literature has provided valuable insights into global trends within the Indian automobile manufacturing sector, reflecting significant growth and policy impacts. Sandeepthi Robert M and Nirmala J's 2023 study highlights an impressive 326% increase in Foreign Direct Investment (FDI) inflows into the Indian automobile sector, emphasizing its expanding role in the global market and the robust economic contributions of this growth (Robert M & Nirmala, 2023). The substantial government support and infrastructure developments that have been pivotal in positioning India as the world's fourth-largest automobile market, detailing the specific policies and their targeted impacts (Miglani, 2019). In 2015, W. Sarwade analyzed the effects of deregulation post-1990s on the Indian auto industry, noting the sector's significant growth and India's emergence as a major exporter of automobiles, which underlines the success of these deregulation policies (Sarwade, 2015). The Goods and Services Tax (GST) and its impact on the Indian automobile industry, detailing how GST has significantly influenced production, sales, exports, and the overall economic contributions of the sector, providing a critical view of the tax reform's implications (Nayaka, 2021).

The compilation of these studies illustrates the dynamic evolution of the Indian automobile sector influenced by both internal and external economic factors. The significant increase in FDI highlights global confidence in the Indian market, while governmental policies and infrastructure investments demonstrate a targeted approach to fostering growth. The GST's introduction and the historical deregulation efforts show the complexity of regulatory impacts on the sector. These elements together underscore the strategic importance of policy frameworks in shaping the industry's trajectory within the global marketplace.

4. Automobile industry and its evolution

The evolution of India's automobile industry is a compelling narrative of growth and adaptation to global economic shifts and technological advancements. Initially limited by strict regulatory frameworks, the industry burgeoned post-liberalization in the 1990s, which eliminated many restrictive policies and licensing requirements, catalyzing a boom in the passenger car segment. This period marked the entry of numerous foreign players into the market, enhancing competition and innovation. Ranawat & Tiwari (2009), in recent years, the Indian automobile industry has positioned itself as a significant player on the global stage, with substantial exports and an expanding domestic market. This progress is largely attributed to strategic government policies that fostered industry growth by easing previous restrictions and encouraging foreign investments. The dynamic evolution of this sector reflects a broader trend of economic modernization and technological adoption, making it a crucial element of India's industrial landscape.

W. Sarwade (2015) highlights the transformative impact of liberalization policies in the 1990s, which propelled growth and international competitiveness in the Indian automobile industry. This period marked significant deregulatory impacts that stimulated the industry's emergence as a major global player (Sarwade, 2015). Mahipat Ranawat and R. Tiwari (2009) trace the evolution of India's automotive sector through four distinct phases, each influenced heavily by governmental policies. These phases range from initial protection and regulation to liberalization, highlighting the pivotal role of government interventions in shaping industry dynamics (Ranawat & Tiwari, 2009). Further studies expand on these themes, such as the work by X. Richet and J. Ruet (2008), which compares the automotive sectors of China and India, shedding light on the economic processes and technological catch-up between the two countries. Their findings emphasize the contrasting paths of sector opening and technological appropriation which are central to understanding the industry's evolution (Richet & Ruet, 2008).

A. Bharadwaj (2018) discusses the global automotive industry's evolution, noting significant technological innovations and regulatory changes that have influenced the sector. His study positions India, along with other BRIC countries, as future leaders in the global automotive market due to ongoing growth and technological advancements (Bharadwaj, 2018). R. Tiwari, C. Herstatt, and Mahipat Ranawat (2011) delve into the role of government policies in fostering the growth of India's automobile industry since the 1991 economic liberalization. They argue that the government's sustained efforts have played a crucial role in the industry's rapid adjustment to globalization, effectively managing the paradox between liberalization and regulation (Tiwari, Herstatt, & Ranawat, 2011). This study illustrates the multifaceted evolution of the Indian automobile industry, marked by significant government influence, liberalization, and integration into global markets. The cumulative research demonstrates a clear trajectory from a heavily regulated sector to a vibrant, globally competitive industry, underpinned by strategic policy interventions and economic liberalization. The Indian automobile industry's growth story is a testament to the critical interplay of policy, investment, and international market dynamics, which together have shaped its current status as a major player in the global automotive arena.

Sahoo et al., (2011), India's automobile industry, encapsulating its growth, technological evolution, and strategic management approaches. Their research highlights how Indian auto component firms have adapted their strategic technology management practices in the wake of liberalization. These adaptations have been primarily aimed at boosting business performance and enhancing the integration of new technologies. The study provides the diverse tactics employed by these firms to navigate and thrive in a rapidly changing economic environment, reflecting on how these strategies have been instrumental in their developmental journey. Richet, the automobile sectors of China and India, examining the ways in which these industries have adapted to changes in the global economy as well as shifts in domestic policies. Their work, the Chinese and Indian Automobile Industry in Perspective: Technology Appropriation, Catching-up and Development provides a comprehensive analysis of how these two nations have embraced technological advancements and strategic policy implementations to enhance their automotive industries. This sheds light on the developmental strategies that have propelled China and India towards significant roles in the global automotive market.

Nagamani & Muthusamy (2019), study on direction of Indian automobile industry highlights the industry's significant global market position through an analysis of export trends and market directions. The Indian Automobile Industry Technology Enablers Preparing for the discusses how Indian automobile firms are adopting emerging technologies to stay competitive and meet future market demands, including the shift towards electric vehicles (Nag & De, 2019). Each study contributes a unique perspective on the strategic and technological evolution of India's automobile sector. The Indian automobile industry has undergone significant strategic and technological transformations over the years. In their work, Sahoo, Banwet (2011), and Momaya explore how Indian auto component firms have adapted strategic technology management practices to boost business performance and technology absorption, particularly in response to economic liberalization. Sumathi provides a comprehensive decade-long analysis (2001-2010) of the growth metrics in the Indian automobile sector, demonstrating robust sectoral progress with detailed performance metrics and growth rates.

X. Richet and J. Ruet (2008) compare the automobile industries of China and India, focusing on technological adoption and policy responses to global economic challenges, and they detail specific technological advancements and policy impacts in both countries. Nagamani and Muthusamy (2019) discuss the direction of the Indian automobile industry, highlighting its substantial role in the global market with data on export trends and market shares. The technological enablers within the industry, particularly the shift towards electric vehicles, discussing the adoption rates and technological milestones that Indian automobile firms are setting to remain competitive in the future market landscape
These studies collectively provide a comprehensive view of the strategic and technological advancements in India's automobile industry. They highlight a progressive shift towards modernization, strategic alignment with global market trends, and adaptation to technological innovations. The industry's growth is depicted as robust, with strategic technology management playing a key role in enhancing competitive advantage in a global context. The comparative studies with China further enrich the understanding of India's positioning and strategic manoeuvres in the global automotive sector. Sturgeon et al., (2008), the institutional and regulatory environments of host countries impact the integration of automobile sectors into gvcs. This integration is facilitated by favourable policies that attract foreign direct investment and foster partnerships. Technological advancements and capabilities are crucial for automobile sectors to integrate effectively into gvcs. The ability to innovate and upgrade technology directly correlates with the performance and competitive advantage in global markets. Gereffi (2014), the growing emphasis on sustainability within the global value chains (gvcs) of the automobile sector. His research points out that there is an increasing trend towards incorporating environmental and social governance elements into these chains. This shift is partly fueled by consumer demand for vehicles that are not only more sustainable but also ethically produced. Gereffi's analysis highlights how the automobile industry is responding to these evolving market dynamics by integrating sustainability into their operational and strategic frameworks, illustrating a significant shift in industry practices towards more responsible manufacturing processes.

5. Integration of automobile sectors into global value chains

India's integration into global value chains demonstrates a multifaceted approach characterized by distinct strategies and dynamics that vary significantly across regions. The industry leverages local strengths and global trends to establish strong regional and global linkages, enhancing its competitiveness and governance within these networks. This strategic alignment with global practices is crucial for maintaining its role and influence in the international automotive landscape. A comprehensive literature review that explores how various automobile sectors, including India's, are integrated into global value chains as shown in table 7. The highlighted studies compare different integration strategies, analyze key trends, and examine governance models, providing valuable insights into the complexities and competitive factors that influence these sectors on a global scale.

Table 7: A literature review on the integration of automobile sectors into global value chains, summarizing key findings.

Title	Authors	Year	Key Findings
Case Studies on Global Value Chains in Automobiles	C. Dowlah	2018	Provides empirical examples from Brazil, Central and Eastern Europe, China, India, Mexico, and Thailand, showing different integration strategies and dynamics within global automobile value chains.
Globalisation of the automotive industry: main features and trends	T. Sturgeon, Olga Memedović, Johannes van Biesebroeck, G. Gereffi	2009	Analyzes the global automotive industry's main features and trends, noting the strong regional integration and the development of global-scale value chain linkages.
Governance and competitiveness in global value chains: A comparative study in the automobile and textile industries	José Pla-Barber, Cristina Villar	2019	Compares value chain configurations and governance models in the automobile and textile industries, focusing on competitiveness and the role of suppliers in these sectors.

The integration of the automobile sector into global value chains, detailing various strategies, governance models, and competitiveness aspects across different global regions. Each study in table 7 includes significant findings and comprehensive insights into the dynamics of global integration within the automobile industry.

6. The performance analysis of India's automobile sector

The performance of India's automobile sector within the global value chain is shaped significantly by government support, foreign direct investments, and strategic supply chain practices. Studies highlight the sector's enhanced competitiveness due to innovations and the effective integration into Asian production networks. This comprehensive performance is reflected in its substantial growth, operational efficiency, and positioning as a key player in the global market. An overview of research focused on analyzing the performance of India's automobile sector as shown in table 8. Each study examines different aspects, from government policy impacts and foreign investment influx to innovations and integration within regional networks, collectively illustrating how these factors drive the sector's success on a global scale.

Table 8: A review focused on the performance analysis of India's automobile sector,

Study	Authors	Year	Key Findings
The Growth of the Indian Automobile Industry: Analysis of the Roles of Government Policy and Other Enabling Factors	Smita Miglani	2019	Highlighted the crucial role of government support in driving the growth of India's automobile industry, making it one of the largest markets globally.
Foreign Direct Investment in Automobile Sector in India	Sandeepthi Robert M, Nirmala J	2023	Discussed the remarkable growth in FDI in the Indian automobile sector, which ranks fifth in attracting the highest FDI inflows.
Effectiveness of Supply Chains for Auto Component Manufacturing Industries	Kale Shailendrakumar Uttamrao, S. Rajashree	2009	Examined the effectiveness of the supply chain in the auto component industry, emphasizing the significant role of supply chain practices in enhancing operational efficiency.
Is Indian automobile industry getting integrated with Asian production network	B. Nag, Debdeep De, Shailendra Singh	2017	Explored India's increasing integration into the Asian production network, analyzing its role and competitiveness in the ASEAN network.
Innovation and competitiveness among the firms in the Indian automobile cluster	Rahul Z. More, Karuna Jain	2013	Studied the innovation capabilities and economic performance in the Indian automobile cluster, indicating strong innovation and competitive advantage.

These studies as shown in table 8 collectively offer a detailed look at the performance of India's automobile sector, emphasizing the impact of government policies, FDI, innovation, and supply chain effectiveness on its growth and global integration.

7. Analysis of the automobile sector's participation in the global value chain

India's automobile sector demonstrates a dynamic involvement in the global value chain, bolstered by government policies, foreign direct investment, and sophisticated supply chain management practices. Research highlights India's strategic alignment with Asian production networks and its significant role in global markets. Moreover, the studies delve into challenges like informality within the sector, which affects its integration into global networks, underscoring the complex interplay of local and global factors. Table 9 shows a detailed review of India's participation in the global value chain within the automobile sector. The compiled studies assess the influence of governmental policies, foreign investments, and supply chain practices on India's role and status in the global automotive landscape. Each piece of research contributes to understanding how India integrates and competes in this highly interconnected market environment.

Table 9: A review on the analysis of the automobile sector's participation in the global value chain, particularly focusing on India's role

Study	Authors	Year	Key Findings
The Growth of the Indian Automobile Industry: Analysis of the Roles of Government Policy and Other Enabling Factors	Smita Miglani	2019	Outlined how India's automobile sector has grown due to supportive government policies and integration into the global value chain.
Foreign Direct Investment in Automobile Sector in India	Sandeepthi Robert M, Nirmala J	2023	Detailed the impact of FDI on India's automobile sector, emphasizing its substantial role in the global market.
Is Indian automobile industry getting integrated with Asian production network	B. Nag, Debdeep De, Shailendra Singh	2017	Investigated India's growing integration into the international production network, especially within ASEAN.
Case Studies on Global Value Chains in Automobiles	C. Dowlah	2018	Provided empirical examples of global value chains in the automobile sector by focusing on emerging countries including India, highlighting diverse dynamics in global automobile structure.
Global Value Networks: Case Study of the Indian Auto Industry	Ankita Dash, R. Chanda	2020	Mapped the global value network for the Indian automotive industry, detailing how Indian firms participate in global value flows and emphasizing the strategic positioning of India within these networks.
Supply Chain Management Practices of Indian Automobile Industry	B. S. Sahay, Vikram Sharma, G. Sardana	2011	Highlighted how modern supply chain management practices are crucial for India's integration into the global value chain, focusing on operational efficiency and international competitiveness.
Informality in Automobile Value Chains in India	Timothy Kerswell, S. Pratap	2015	Provides a critical view of the informal aspects and challenges within India's automobile sector that impact its participation in global value chains.

These studies show in table 9 provide a comprehensive overview of how India's automobile sector actively participates in and contributes to the global value chain, influenced by factors like government policies, foreign investments, regional integrations, and advanced supply chain practices.

8. Factors influencing the automobile sector's performance

In India's automobile sector, various factors such as economic policies, environmental regulations, and export-import practices significantly influence performance within the global value chain. The introduction of GST has notably improved production and export dynamics, while tailored manufacturing strategies address market demands and competitiveness. Further, comparisons with international markets like China reveal insights into operational efficiencies and strategic adaptations to global business environments. the diverse factors that impact the performance of India's automobile sector, with a particular focus on how these elements integrate and enhance the sector's role in the global value chain. Each study provides a unique perspective on economic policies, competitive strategies, and cross-national performance metrics, offering a comprehensive understanding of the sector's dynamics as shown in table 10.

Table 10: A review of factors influencing the automobile sector's performance, focusing on economic factors, Environment and export-import policies:

Study	Authors	Year	Key Findings
Analysis of Goods and Services Tax (GST) impact on Indian Automobile Industry	B. Nayaka	2021	Examined how the introduction of GST impacted production, sales, and exports in the Indian automobile sector, showing increased vehicle registrations and exports post-GST implementation.
Evidence of manufacturing strategies in Indian industry: a survey	G.S Dangayach, S. G. Deshmukh	2003	Highlighted how manufacturing strategies in the Indian automobile sector are tailored to economic factors such as market demand and competitive

			priorities, also addressing the role of advanced manufacturing technologies.
On supply chain competitiveness of Indian automotive component manufacturing industry	D. Joshi, Bimal P. Nepal, A. Rathore, Dipti Sharma	2013	Explored the determinants of supply chain competitiveness in the Indian automotive component industry, emphasizing how economic factors and global business environments shape competitive strategies.
A Cross-Country Comparison of Performance of Chinese and Indian Automobile Companies	Y. Deng, A. D. Zoysa, S. Bhati	2015	Compared the operational and financial performance of Chinese and Indian automobile companies, focusing on how policy and economic factors influence profitability, inventory management, and market competition.

These studies as shown in table 10 collectively provide a thorough empirical assessment of the various economic and policy-related factors that influence the performance of the automobile sector. They discuss the impacts of market dynamics, regulatory changes, and global economic conditions on production, market competitiveness, and strategic industry responses.

9. Technological innovations and advancements

The Indian automobile manufacturing sector is increasingly leveraging technological innovations to bolster its position within the global value chain. Studies have shown that advancements in manufacturing technologies and supply chain management practices have significantly enhanced the sector's global competitiveness. These innovations not only aid in adapting to advanced manufacturing techniques but also improve the integration and efficiency of India's role in global automotive networks. A review of the technological advancements within India's automobile sector, illustrating how these innovations are pivotal in shaping the industry's competitiveness and its integration into global value chains. The studies listed detail the progression from technological adaptation at the workforce level to the strategic implementation of advanced practices across the sector as shown in table 11.

Table 11: A review focusing on technological innovations and advancements in India's automobile manufacturing sector

Study	Authors	Year	Key Findings
Innovation and competitiveness among the firms in the Indian automobile cluster	Rahul Z. More, Karuna Jain	2013	Explored how innovation within Indian automobile clusters enhances global competitiveness and interacts with global value chains, particularly through technological capabilities.
Supply chain management in indian automotive industry: complexities, challenges and way ahead	Souresh Bhattacharya	2014	Discussed the integration of supply chain best practices due to global auto companies, enhancing competitiveness and impacting the global value chain.
Workers orientation towards advanced manufacturing technology: a study of the Indian automobile industry	A. Gurtoo, A. Tripathy	2001	Investigated workers' adaptation to Advanced Manufacturing Technologies (AMT) in the Indian automobile industry, highlighting its crucial role in meeting global competition.
Global Value Networks: Case Study of the Indian Auto Industry	Ankita Dash, R. Chanda	2020	Analyzed India's role in global value networks, noting the challenges and opportunities created by technological advancements in the automobile sector.
Evidence of manufacturing strategies in Indian industry: a survey	G.S Dangayach, S. G. Deshmukh	2003	Provided insights into the manufacturing strategies in India's automobile sector, emphasizing innovation and technological advancements to compete globally.

These studies as shown in table 11 provide a detailed understanding of how technological innovations and advancements in India's automobile sector have contributed to its positioning and performance within the global value chain, highlighting the industry's evolution and adaptation to new technologies and competitive strategies.

Conclusion & Discussion

The exploration of India's automobile manufacturing sector reveals a dynamic integration within the global value chain, significantly propelled by economic liberalization and strategic state support. These transformations have fostered a competitive ecosystem where both local and foreign enterprises thrive. Key regions such as Tamil Nadu, Maharashtra, Gujarat, and Haryana have emerged as pivotal manufacturing hubs, drawing on robust infrastructure and skilled labor to optimize production and quality. This study has shown that the sector's growth is further driven by internal demand, backed by a growing middle class and increased disposable incomes, which enhances the appeal of the domestic market for global players. The analysis suggests that while the sector has made formidable strides in aligning with global standards and expanding its export capabilities, it continues to face challenges like regulatory changes and the need for technological upgrades. The future of India's automobile industry appears robust, contingent on continued innovation, regulatory support, and an adaptive approach to global market dynamics. Ensuring sustained growth will require ongoing investments in technology and infrastructure, alongside strategic policy frameworks that support the industry's expansion and integration into the global economy.

Future scope

- Investing in emerging technologies such as electric vehicles (EVs), autonomous driving, and connectivity solutions to stay competitive in the evolving global market.
- Developing more robust supply chains that can withstand global disruptions through diversification and increased local sourcing.
- Continued governmental initiatives to support the industry, especially in areas like tax incentives, infrastructure development, and favourable trade agreements.
- Emphasizing sustainability through the adoption of green manufacturing practices and the reduction of carbon footprints to align with global environmental standards.
- Expanding into new markets by leveraging India's cost advantages and improving quality standards to meet international expectations.

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