

SYSTEMATIC LITERATURE REVIEW ON ELECTRICAL CAR INDUSTRY IN INDIA

Authors

Mr. Ameet Kulkarni

Research Scholar

Department of Management Studies,

Visvesvaraya Technological University, Belagavi, Karnataka, India.

ORCID Id: <https://orcid.org/0009-0005-1255-0397>

Dr. Basavaraj S. Kudachimath

Associate Professor, Department of Management Studies,

Visvesvaraya Technological University, Belagavi;

ORCID: <https://orcid.org/0000-0001-6979-41423>

Abstract

The electrical passenger car industry has emerged as a critical component of the global transition toward sustainable mobility. This paper examines the current state of the industry, focusing on market trends, technological advancements, regulatory frameworks, consumer behavior, and the challenges of infrastructure development and supply chain management.

It also highlights opportunities for stakeholders to enhance adoption and drive innovation. Through a combination of qualitative and quantitative analysis, this study provides insights into the future trajectory of the electrical passenger car industry and its potential impact on economic and environmental sustainability.

INTRODUCTION

The transportation sector is undergoing a transformative shift, driven by the advent of electric vehicles (EVs), particularly in the passenger car segment. This evolution stems from an urgent global need to reduce greenhouse gas (GHG) emissions, mitigate the impacts of climate change, and transition towards renewable energy sources. As the transportation sector accounts for approximately 24% of global CO₂ emissions, with a significant share originating from passenger vehicles, the push for electrification is both timely and critical (International Energy Agency [IEA], 2023). Consequently, electric vehicles have emerged as a cornerstone of the global sustainability agenda, catalyzing innovation and investment across industries.

The rise of EVs is underpinned by a confluence of technological advancements, policy interventions, and shifting consumer preferences. Breakthroughs in battery technology, such as lithium-ion batteries, have significantly enhanced the efficiency, range, and affordability of electric vehicles, making them a viable alternative to internal combustion engine (ICE) vehicles (BloombergNEF, 2023). Simultaneously, governmental policies such as subsidies, tax incentives, and stricter emission regulations have accelerated the adoption of EVs globally. For instance, the European Union's "Fit for 55" package and India's Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) initiative exemplify strategic efforts to boost EV penetration (European Commission, 2023; Ministry of Heavy Industries, India, 2023).

Despite these advancements, the widespread adoption of electric passenger cars faces several challenges. Key obstacles include the high initial cost of EVs, limited charging infrastructure, battery recycling concerns, and reliance on critical minerals such as lithium, cobalt, and nickel, which raise environmental and geopolitical issues (World Economic Forum, 2023). Addressing these challenges requires a collaborative approach involving policymakers, industry stakeholders, and researchers to ensure a sustainable and inclusive transition.

This paper aims to provide a comprehensive analysis of the electric passenger car industry by exploring its key drivers, challenges, and future prospects. Through a multidisciplinary approach, the study examines technological innovations, market dynamics, and policy frameworks that shape the trajectory of EV adoption. Ultimately, this analysis seeks to contribute to the growing body of literature on sustainable transportation and inform strategies for accelerating the global transition to electric mobility.

2. Methodology

The SLR was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure a rigorous, transparent, and replicable review process. The review process comprised four key stages: identification, screening, eligibility, and inclusion.

Identification: Research articles, policy papers, and industry reports published between 2010 and 2024 were sourced from multiple academic and industry-specific databases, including Scopus, Web of Science, Google Scholar, and government portals. The search strategy incorporated keywords such as "electric vehicles," "electric cars in India," "EV policies in India,"

"sustainability," and "Indian automobile industry." Boolean operators (AND, OR) and truncation techniques were used to refine the search.

Screening: Duplicate records were removed, and the remaining studies underwent an initial screening based on titles and abstracts. This stage focused on eliminating studies with no relevance to the Indian electric car industry.

Eligibility: Full-text reviews were conducted on the shortlisted articles to assess their relevance against predefined criteria. Studies were included if they focused on empirical research, policy analyses, or market evaluations specific to India. Excluded were articles that dealt exclusively with global EV trends or lacked substantial reference to India.

Inclusion: A final set of studies was selected based on their contribution to understanding the Indian electric car industry. Both quantitative and qualitative studies were included to ensure a comprehensive analysis.

Additional inclusion criteria included peer-reviewed publications, high citation impact, and relevance to themes such as market dynamics, policy impacts, technological advancements, and sustainability challenges.

Data extracted from the selected studies were systematically organized into themes for qualitative synthesis. Critical appraisal tools were employed to assess the methodological quality of each study, ensuring that the review's conclusions are based on robust evidence.

3. Findings

3.1 Market Overview

The Indian electric car market is at a nascent stage but shows significant growth potential. Current penetration levels remain low, accounting for less than 1% of total vehicle sales, but are expected to grow significantly in the coming decade. Key players include Tata Motors, Mahindra Electric, MG Motors, and Hyundai, alongside startups such as Ather Energy and Ola Electric. Notably, Tata Motors leads the segment with its Nexon EV, which has captured a majority of the market share due to competitive pricing and range.

The market is also witnessing increased foreign investment, particularly in joint ventures and technology partnerships. Additionally, several states, including Maharashtra, Delhi, and Tamil Nadu, have launched EV-specific policies offering subsidies and tax exemptions. The private sector is also stepping up, with companies like Reliance Industries and Adani Group investing in EV infrastructure and battery production.

3.2 Drivers of Growth

Policy Support: The FAME I and II schemes have allocated significant funding for EV adoption. The incentives include subsidies for EV purchases, support for research and development, and financial aid for setting up public charging stations. Additionally, several state governments have introduced supplementary incentives, such as free vehicle registration and road tax waivers for EV owners.

Rising Environmental Awareness: Increased public concern over air pollution and climate change boosts consumer interest in EVs. Cities like Delhi and Bengaluru, which face severe air quality challenges, are at the forefront of EV adoption.

Technological Advancements: Rapid advancements in battery technology, such as lithium-ion and solid-state batteries, have significantly enhanced vehicle range and durability while reducing costs. These developments have made EVs more appealing to the average consumer. Furthermore, innovations in vehicle design and connectivity features (e.g., smart dashboards, remote diagnostics) are contributing to consumer appeal.

3.3 Challenges

High Initial Costs: Electric cars remain expensive compared to internal combustion engine vehicles, primarily due to the high cost of batteries, which account for 30-40% of the vehicle's price. Despite subsidies, this cost disparity poses a significant barrier for price-sensitive Indian consumers.

Inadequate Charging Infrastructure: With less than 2,000 public charging stations nationwide as of 2024, the lack of a widespread and reliable charging network remains a critical issue. Range anxiety is a major deterrent for potential buyers.

Supply Chain Issues: Dependence on imports for critical components like batteries and semiconductors increases costs and exposes the industry to geopolitical risks. The limited domestic capacity for battery manufacturing exacerbates this problem.

Consumer Awareness: A lack of comprehensive information about EV benefits, operational costs, and maintenance requirements reduces consumer confidence. Additionally, myths around battery longevity and charging times further hinder adoption.

3.4 Opportunities

Renewable Energy Integration: Leveraging India's substantial renewable energy capacity, particularly solar and wind power, for EV charging can enhance sustainability and reduce

operational costs. Pilot projects integrating EV charging with renewable microgrids are already underway.

Localized Manufacturing: The Indian government's Production-Linked Incentive (PLI) scheme for advanced chemistry cell (ACC) battery manufacturing aims to boost domestic production and reduce import dependence. This initiative, combined with a skilled labor force, positions India as a potential global hub for EV component manufacturing.

Export Potential: India's strategic location, coupled with government support, positions it as a potential EV export hub, particularly to neighboring countries and emerging markets in Africa and Southeast Asia.

4. Discussion

The findings suggest that while India's electric car industry is progressing, addressing infrastructural and cost barriers is critical. Policy frameworks must evolve to incentivize private sector participation and public-private partnerships for charging networks. Consumer education campaigns can further accelerate adoption.

5. Conclusion Research Gaps and Future Directions

The electric car industry in India is poised for growth, supported by governmental policies, technological advancements, and increasing environmental consciousness. However, overcoming challenges related to cost, infrastructure, and consumer awareness is vital for achieving large-scale adoption. Future research should focus on holistic sustainability and equitable growth within the sector.

References

- [1] Ministry of Heavy Industries. (2021). Faster Adoption and Manufacturing of Hybrid and Electric Vehicles in India Phase II (FAME India Phase II). Retrieved from [Government of India official website].
- [2] International Energy Agency. (2023). Global EV Outlook 2023: Trends and Development in India.
- [3] Gupta, A., & Garg, R. (2022). Adoption of electric vehicles in India: Policy analysis and future prospects. *Energy Policy*, 159, 112670.
- [4] Mahindra Electric. (2024). Annual Sustainability Report.

- [5] Bose, R., & Singh, S. (2021). Challenges in electric vehicle adoption in India. *Journal of Cleaner Production*, 315, 128124.
- [6] NITI Aayog. (2020). *A Roadmap for Electric Mobility in India*.
- [7] Tata Motors Limited. (2023). *Market Report on Electric Vehicle Sales in India*.
- [8] Sharma, P., & Joshi, A. (2022). Technological advancements in EV battery systems: Opportunities for the Indian market. *Renewable Energy*, 190, 980-992.
- [9] Chawla, N., & Batra, S. (2023). A systematic review of electric vehicle adoption in India: Market dynamics and policy implications. *Transportation Research Part D: Transport and Environment*, 113, 103051.
- [10] Indian Renewable Energy Development Agency (IREDA). (2023). *Renewable Integration in EV Charging Infrastructure in India*.