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CURRENT LANDSCAPE AND CHALLENGES: PRODUCT DEVELOPMENT OF ELECTRIC SCOOTERS IN INDIA

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Abstract

Electric Vehicles have been on the roads in India for more than a decade. The issue of urban traffic congestion, pollution, and energy imports has made it imperative to take strong measures to adopt green technologies. India has very large homegrown automotive OEMs and also Multinational companies from developed countries. The ecosystem for automotive manufacturing is one of the largest in the globe. This paper provides an in-depth analysis of the current landscape and challenges surrounding the product development of electric bikes in India. The Electric Vehicle in India has come a long way encouraged by policies, local design and manufacturing capabilities, and adoption by consumers. The analysis covers the strength of Indian product development capabilities, Manufacturing ecosystem, Services industries, and policy implementations. The presence of charging infrastructure and the importance of the same is studied. Insights from industry stakeholders, government policies, and consumers, this study identifies critical gaps in the product development process. A comprehensive assessment of the current status and challenges in electric scooter product development is developed with an aim to inform policymakers, industry stakeholders, and researchers about the opportunities and roadblocks in advancing green transportation solutions in India. The goal of this research would be to identify the gaps which exist to make India a product development capability centre.

Key words: *Electric Vehicles (EV), Urban Traffic Congestion Pollution consequences. Charging Infrastructure, Industry Stakeholders*

1. Introduction

Electric vehicles (EVs) represent a burgeoning market globally, driven by sustainability initiatives and technological advancements. Despite India's efforts to increase the adoption of EVs, particularly electric scooters, the country continues to

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rely heavily on imports, particularly from neighbouring China. This reliance underscores the need for a deeper understanding of the challenges and barriers hindering India's ability to indigenously design, develop, and manufacture electric scooters.

Through this research, India's transition from a service-oriented economy to an indigenous product innovation powerhouse is envisioned with a focus on electric scooters. By synthesizing insights from academia and industry, this study offers practical recommendations for policymakers, industry stakeholders, and researchers alike, paving the way for India's emergence as a global leader in product development.

2. Challenges and Opportunities

There are lot of factors that are contributing to the adoption of Electric Vehicles and especially Electric Scooter as depicted in Figure 1.0.

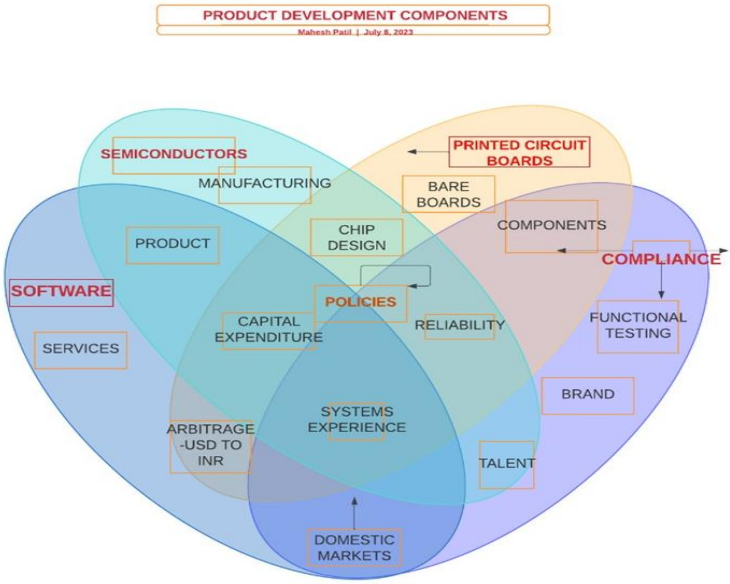

Figure 1: Factors affecting adoption of Electric Scooters

(Source: Author)

They comprise of Push factors like Regulations and incentives, Technology advancements, Infrastructure and Pull factor like reducing Battery prices. The Electric Scooter is an ecosystem comprising of Printed Circuit boards, Electric motors and Drives, Software, Semiconductors and other components.

At the same time the adoption and feasibility of electric scooters is based on the Supply Chain economics, Manufacturing and economies of scale, Regulations and other external influences.

2.1 Electric Scooter:

The Electric Scooter is explained below in the block diagram Figure 2.0 . The key components of Battery, electronics associated with the Battery and motor form the system.

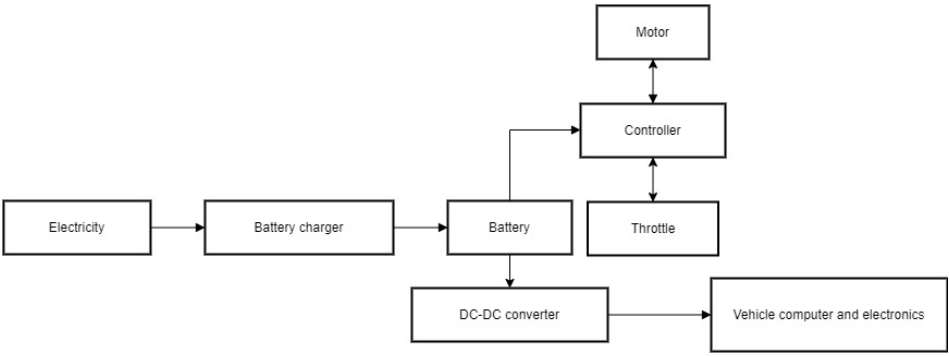

Figure 2: The key components of Electric Vehicle (Powertrain)
(Source:-Prof. Mahesh S. Khande et al May 2020)

The EV scooter with the integration of electronics, software, motor and other typical automotive parts is a challenge to be built in India even when there lies huge expertise over the decades in parts manufacturing.

The recent going back and forth on the Faster adoption and manufacturing of EV's FAME policy after more than 5 years of implementation and now linking EV growth framework to the Production linked innovation scheme points out to the inconsistency in policy frameworks in India for product building.

The rare earth material like Neodymium is available in large deposits in China and a few other countries. With China needs to take care of its domestic needs, it is imperative for other countries to ensure a reliable supply chain.

The battery cost is approximately 42-46% of the vehicle cost and this is primarily due to the import cost as Lithium is a natural resource with limited availability globally.

Also, Electric Vehicles require a good charging infrastructure and that also means 24X7 availability of Electric Power.

The ecosystem of the Electric Scooter is depicted below in Figure 3.0.

Overall, the literature underscores the importance of addressing range anxiety, expanding charging infrastructure, advancing battery technology, and implementing viable business models to support the widespread adoption of EVs and the alleviation of dependency on Chinese imports.

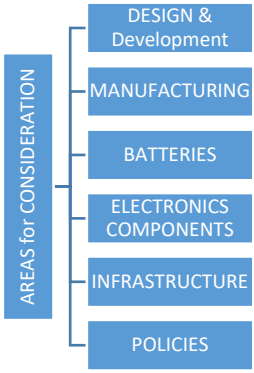

Figure 3: Electric Scooter Ecosystem Lifecycle Elements (Source: Author)

3. Methodology

The research attempts to understand India's electric scooter industry, aiming to understand the ecosystem, capabilities, barriers that define its present state and create a roadmap to achieve leadership status. With a clear focus on establishing a baseline understanding of competency levels vis-à-vis China, the research sets out to meticulously examine various dimensions of electric scooter development. A mixed methodology of qualitative and quantitative research was carried out.

The qualitative analysis was a major part of the research and the quantitative will focus on the cost factors of EV bikes in India compared to China, Trend in battery costs, and charging infrastructure availability expressed in terms of Vehicle to charger ratios. The qualitative analysis was a semi-structured discussion to elicit the responses to the questions for the study. The participants were EV users and industry experts. There were interviews with industry experts in this domain. The interviewees were entrepreneurs. Senior executives in the marketing and technology functions, design development engineers, suppliers of components, and policymakers.

Quantitative research on the EV ecosystem in India and China involved collecting secondary data from government reports, industry publications, and academic studies. This data was used to calculate the vehicle-to-charger ratio, revealing insights into the availability of charging infrastructure relative to EV populations in each country. Additionally, advancements in battery technology, such as energy density and cost per kWh, were analyzed to compare adoption and innovation trends. The total cost of ownership (TCO) for EVs, encompassing purchase price, charging, maintenance, and government incentives, was also assessed to evaluate affordability and economic feasibility in both markets.

3.1 Research Questions

The research addressed the following questions which helped achieve the objectives of understanding the barriers, baseline and understanding the status of the Electric Scooter lifecycle and develop a comprehensive Framework. A mixed methodology of qualitative and quantitative research was carried out.

1. What are the existing strengths and weaknesses in India's product development ecosystem, particularly concerning electric scooters?
2. What specific challenges and barriers exist in developing electric scooters in India, and how do they compare to successful models like those in China?
3. What policies, infrastructure improvements, and industry initiatives are needed to overcome these challenges and position India as a leader in electric scooter manufacturing?
4. How can India leverage its talent pool, manufacturing capabilities, and technological expertise to compete globally in the electric scooter market?

4. Results and Analysis

The primary instrument utilized for collecting data from EV users was a carefully crafted survey, designed and administered through SurveyMonkey, a widely used online survey platform known for its user-friendly interface and robust data management capabilities.

4.1 Qualitative Findings

The survey findings offer valuable insights into the preferences, behaviors, and perceptions of EV users, highlighting patterns and trends in EV usage across different demographic groups and geographic locations.

The survey instrument was thoughtfully developed to cover a range of pertinent topics related to EV usage, including driving habits, charging preferences, satisfaction levels, and perceptions of EV technology. Through SurveyMonkey's intuitive survey creation tools, a structured questionnaire comprising both closed ended and open ended questions was administered.

Additionally, interviews were conducted with senior personnel within the EV industry to gain expert insights and nuanced perspectives on key issues. The interview protocol, also developed, served as the guiding instrument for these discussions. It outlined a series of questions aimed at eliciting in depth responses regarding present competencies, barriers, challenges, and future outlooks.

SurveyMonkey as the digital platform for survey administration and data collection, a wide audience of EV users across diverse geographic locations were leveraged efficiently and effectively. In this study conducted early 2024 , a total of 110 participants took part in the survey, representing a diverse range of cities and users of electric vehicles (EVs). This broad sampling approach allows for insights

from a wide demographic and geographic spectrum, enhancing the richness and depth of the data collected.

Category	Concern/Statistic	Percentage (%)
Costs of Ownership	Initial cost affordable	58.18
	Overall satisfaction (including maintenance, charging, etc.)	59.6
	High initial cost	62.73
	Concerns about battery life	60
	Desire for longer battery life	50.91
	Interest in lower cost of ownership	48.18
Charging Issues	Limited range per charge	47
	Need for increased charging infrastructure	46.36
	Importance of range	39.81
	Concerns about charging time	36.11

Based on the interviews, below is the summary of the research objective questions.

Baseline Competency Levels:

Largely India has a design competency in power train design and also mechanicals. The experience in product development needs to be developed as the electric scooter is a nascent industry compared to China. Also manufacturing competency and scale is the concern.

Barriers to Indigenous Development:

The barriers are largely the availability of lithium-ion, and rare earth magnets as raw materials and Semiconductors for product development. Also, the charging infrastructure is a concern along with the policy ambiguity. The funding is largely available for large production houses but does not encourage Research and development.

Comprehensive Framework Development

The framework for indigenous leadership has to be based on supply chain risk alleviation through innovation, alternate materials, product development intellectual property. Focus on costs and hence make the EV available cheaper, build charging infrastructure, and collaborate between startups and large corporations. Also educating the population and building reliable safe vehicles are important. Policies favoring the retail segment, startups, and R&D funding will help.

4.2 Quantitative Findings

The quantitative research process provided valuable insights into the vehicle-to-charger ratio, battery technology advancements, and TCO of EVs in India and China, shedding light on the respective developments and challenges in the EV ecosystems of both countries.

Table 1: Specific Metrics for Quantitative analysis

Category	Metrics	Indicators
Product Development Capability	Annual EV numbers in India vs. China	Comparative EV growth in both countries
Charging Infrastructure	Charging stations and vehicle numbers	Vehicle-to-charger ratio
Lithium Material Availability & Battery Technology	YOY lithium battery cost and density	Cost per kWh, YOY density increase
Total Cost of Ownership	Cost of 2W, 3W, and 4W in India vs. ICE	Ownership cost (capital + operational),

China's EV market is substantially larger than India's. By 2023, China had over 20 million EVs on the road, whereas India had around 3 million EVs.

In India, the vehicle-to-charger ratio has shown fluctuations over the years, with improvements observed from 2018 to 2022 before a slight increase in 2023. The ratio ranged from 149 to 248 EVs per public charger by 2023.In contrast, China has maintained a relatively stable vehicle-to-charger ratio, ranging from 6 to 9 over the years.

The cost of battery storage (USD/KWH) has shown a significant decline over the years, from 780 in 2013 to 139 in 2023. There's an indication of a continuous decrease in cost, with fluctuations in the percentage decrease. Energy density (Watt hr/litre) has generally increased from 140 in 2013 to 693 in 2023, with fluctuations along the way.

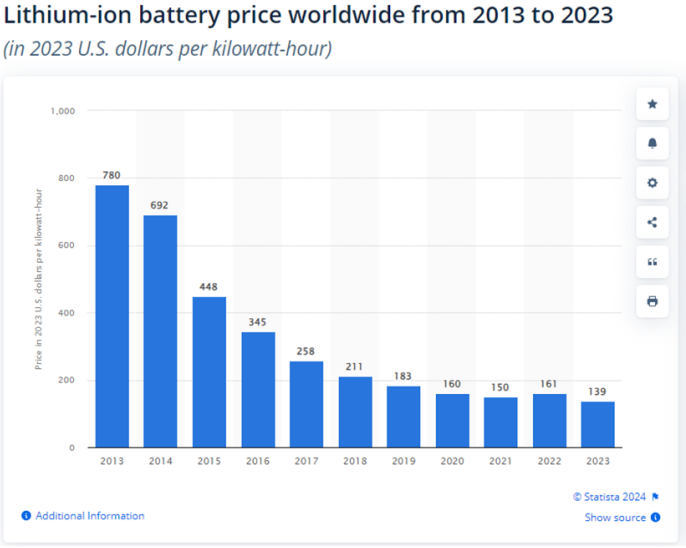

Figure 4 Lithium-ion battery price worldwide from 2013 to 2023 (Source: https://www.statista.com/statistics/883118/global-lithium-ion-battery-pack-costs)

For 2-wheelers and 3-wheelers, TCO parity already exists. A large part of the Indian population looks for low upfront costs and ease of maintenance which includes charging infrastructure and fast charging times, while for 4-wheelers, it's expected to be achieved beyond 2025. The increase in demand in all segments will cater to economies of scale.

5. Conclusion and Recommendations

The research is focused on the electric scooter industry in India, aiming to evaluate its current state, identify barriers for indigenous development, and develop a comprehensive framework for advancement

The implications of the research findings and proposed framework for the electric scooter industry in India are multifaceted and far-reaching:

1. Policy Reforms: The development of supportive regulations that incentivize domestic manufacturing, investment in infrastructure, and technological innovation must be prioritized.

2. Investment and Financing: Policymakers and financial institutions must get together to provide financial incentives, subsidies, and loans to electric scooter manufacturers, startups and also the consumers through banking institutions. Cost of Capital should be lowered for EV users of 4 wheelers.

3. Infrastructure Development: Governments, along with private sector partners, should prioritize investment in charging infrastructure and the establishment of integrated EV clusters at all major hubs like petrol stations, hotels, Malls, and other clusters.
4. Research and Development: Universities, research organizations, and corporations must collaborate to develop specialized skills in power train, battery technology, and software development. Collaboration and Partnerships: Companies should explore opportunities for mergers and acquisitions (M&A), joint ventures, and technology partnerships to access resources, expertise, and technologies.

By focusing on the identified challenges and leveraging the opportunities presented, India can achieve leadership status in electric mobility, driving innovation, Technology Leadership, economic development, and environmental sustainability.

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