Davangere University

Institute of Management Studies

ELECTRIC VEHICLES IN INDIA: THE DRIVE TOWARDS SUSTAINABILITY

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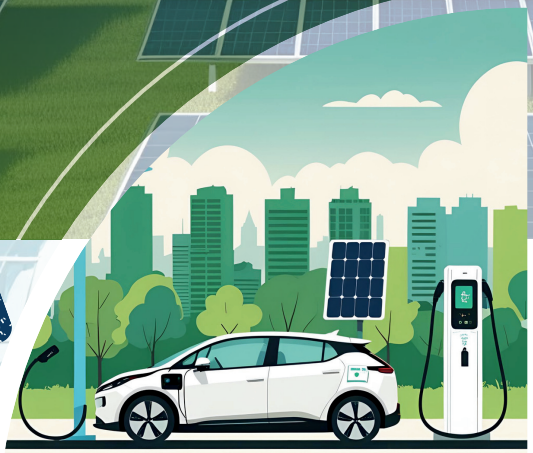

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Davangere University, Shivagangothri,
Davangere, 577007

"Research is creating new knowledge" - Neil Armstrong

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ABOUT THE CONFERENCE

The global automotive industry is on the brink of a significant shift from traditional internal combustion engine vehicles to zero- emission vehicles. India is actively pursuing cost-effective and viable solutions to address the issue of poor air quality in many of its cities. The electric vehicle ecosystem is interplay of several sectors and stakeholders. Thus, it is imperative for stakeholders to come together to drive green vehicle adoption. Similarly, the Government needs to consider the holistic ecosystem while developing the regulatory agenda. The transition to electric vehicles presents challenges for the incumbents, while at the same time offering a tremendous opportunity for those who undertake the requisite investments and start planning for the shift.

Given the scale of the Indian automotive market, any significant proportion of vehicle electrification by 2030 is likely to present a huge business opportunity. The National conference on "'Electric vehicles in India: The Drive Towards Sustainability", will bring together experts from academics, industry, and government to discuss the latest development in India such as:

- Sustainable Electric Vehicle Technologies: Advances in battery technology, electric motor design, and charging infrastructure.
- Green Transportation Policies: Government initiatives and regulations promoting the adoption of electric vehicles.
- Industry Innovations: New business models, products, and services emerging in the electric vehicle ecosystem.
- Charging Infrastructure Development: Strategies for expanding and optimizing charging infrastructure.

PREFACE

The rapid evolution of the global transportation sector has underscored the urgent need for sustainable and environment-friendly alternatives to conventional vehicles. As climate change, urban air pollution, and fossil fuel dependency pose growing challenges, the transition to electric vehicles (EVs) has emerged as a pivotal solution. In this context, India's ambitious goals for e-mobility signal a transformative shift towards cleaner, greener, and more sustainable transportation systems.

This Two-Day National Conference On "ELECTRIC VEHICLES IN INDIA: THE DRIVE TOWARDS SUSTAINABILITY" serves as a timely platform to explore, evaluate, and enrich the discourse around EVs in India. Bringing together academicians, industry experts, policymakers, researchers, and students from across the country, the conference aims to foster critical discussions on the technological, economic, infrastructural, and environmental aspects of electric mobility. The event is designed to delve into key areas including EV policy frameworks, battery technology innovations, charging infrastructure, supply chain development, and the socio-economic impacts of EV adoption. It also seeks to highlight the roles of government, private sector, and civil society in accelerating the EV transition.

We hope that this conference will not only illuminate the current landscape and future prospects of electric vehicles in India but also inspire collaborative efforts toward achieving national and global sustainability goals.

We express our sincere gratitude to all the participants, speakers, and contributors for their valuable insights and active engagement. May this conference mark a meaningful step forward in India's journey toward sustainable mobility.

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FOREWARD

We are pleased to present the Two-Day National Conference on "ELECTRIC VEHICLES IN INDIA: THE DRIVE TOWARDS SUSTAINABILITY," which brings together experts, scholars, industry leaders, and students to explore the rapidly evolving landscape of electric mobility in India.

This conference aims to serve as a platform for meaningful discussions on the technological, environmental, and policy-driven aspects of electric vehicles. With regard to this we give more importance to the research activities. This edited book will help in shaping a roadmap for promoting sustainable transportation within the Indian automotive industry and serve as a reference for global best practices. It is enriched with insights, case studies, challenges, and success stories related to electric vehicle adoption and innovation. Our agenda for change for the upcoming years is challenging and exciting and brings us many opportunities. We all have a responsibility to make sure that our thinking in everything we do should bring change in the industry, business and Academic Institutions. We believe in the pride that the progress we made in improving the performance of the Indian industry through our research activities. I thank all the authors, editors, editorial members and other stakeholders in bringing this pride to us. I invite you all to take time and read these quality research papers published in international journal and give us your valuable insights.

We extend our sincere gratitude to all participants and contributors whose insights and enthusiasm will undoubtedly enrich the dialogue and drive forward the national agenda on sustainable transportation.

Prof. R. Shashidhar,
Dean and Chairman,
Institute of Management Studies,
Davangere University.

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MESSAGE

I am very happy to know that, the Institute of Management Studies, Davangere University, is organizing a Two-Day National Conference on “Electric Vehicles in India: The Drive Towards Sustainability.” This is a very important and timely topic as our country is working towards clean and eco-friendly transportation.

Electric vehicles (EVs) are important in reducing pollution, saving energy, and protecting the environment. They offer new opportunities and also bring challenges that need to be understood through research and discussion. I commend the efforts of Institute of Management Studies, Davangere University for organizing ICSSR Sponsored Two-day National Conference.

This conference gives a good platform for students, teachers, researchers, and industry experts to share ideas and learn from each other. I also appreciate the efforts of the organizers in publishing the research papers in reputed International Journal with an ISSN number and having DOI for all the papers, which will be useful for further research and reference.

I congratulate the organizing committee and I wish the conference a great success.

Prof.B.D. Kumbar,
Hon’ble Vice-chancellor,
Davangere University.

MESSAGE

It gives me great pleasure to welcome all participants, resource persons, and guests to this two-day national conference on, “ELECTRIC VEHICLES IN INDIA: THE DRIVE TOWARDS SUSTAINABILITY,” is very timely as India moves towards a cleaner and greener future.

Electric vehicles (EVs) are changing how we think about transport, energy use, and the environment. With rising concerns about pollution and climate change, EVs offer a sustainable way forward. This conference creates a valuable platform for students, researchers, experts, and industry leaders to share ideas, knowledge, and explore the challenges and opportunities in India’s EV journey. I must compliment Institute of management studies for organizing ICSSR Sponsored Two-day National Conference.

I appreciate the efforts of the organizing team for bringing together such a wide range of voices on this important topic. I believe the discussions and outcomes of this event will be useful for research, policy-making, and future developments in electric mobility. I also commend the organizers for bringing out an International Journal with an ISSN number and having DOI for all the published papers. I wish the conference a great success.

Sri. Shabbir Basha Ganti, KAS,
Registrar,
Davangere University.

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Consumer Perception and Challenges of Electric Vehicles in Karnataka

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Abstract
This study investigates the rising trend of electric vehicle (EV) adoption in Karnataka, India. Utilizing a structured questionnaire and survey-based descriptive methodology, responses were collected from 450 participants across urban, semi-urban, and rural areas using stratified random sampling. The objective was to assess consumer awareness, perceptions, and the barriers influencing EV adoption. Analytical tools such as frequency distribution, Likert scale analysis, and cross-tabulation were applied to interpret the data. Findings reveal a high level of awareness and interest in EVs, especially among younger demographics, but also identify key deterrents such as insufficient charging infrastructure and high upfront costs. Furthermore, a significant relationship was observed between consumer income and willingness to purchase EVs, as well as between awareness of government subsidies and purchase decisions. These insights underscore the need for policy enhancements, improved infrastructure, and consumer education.
Keywords: Electric Vehicles, Consumer Perception, EV Adoption, Karnataka, Infrastructure, Government Policy, Survey Research

1. Introduction

The global automotive industry is undergoing a transformative shift from internal combustion engine (ICE) vehicles to electric vehicles (EVs), largely driven by the urgent need to address climate change, reduce urban air pollution, and achieve energy security. In this context, India has emerged as a significant player in the push for electrification, with the government setting ambitious targets for EV adoption under initiatives like the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme and National Electric Mobility Mission Plan (NEMMP).

Karnataka stands out as a pioneer in this green mobility revolution. It was the first state in India to implement a dedicated Electric Vehicle and Energy Storage Policy (2017), aiming to attract investments, create jobs, and foster innovation in the EV sector. The policy includes incentives such as tax exemptions, subsidies on EV purchases, support for charging infrastructure, and special zones for EV manufacturing. Major automobile and technology companies have already begun investing in Karnataka, making cities like Bengaluru an EV innovation hub.

Despite the policy momentum and industrial backing, consumer-level adoption of electric vehicles in Karnataka has been relatively slow and uneven. Urban areas such as Bengaluru show moderate levels of EV penetration, especially in the two-wheeler and fleet segments. However, rural and semi-urban regions continue to rely heavily on conventional fuel-based vehicles. The state's diverse geography, economic disparities, and varying levels of awareness contribute to this uneven adoption.

Additionally, consumer skepticism remains a major hurdle. Concerns about limited driving range, lack of charging stations, higher upfront costs, battery lifespan, resale value, and inadequate servicing infrastructure deter potential buyers. Social perceptions and behavioral inertia—where people prefer sticking to familiar technologies—also act as barriers.

Karnataka's potential for EV growth is substantial due to its favorable ecosystem: a literate population, progressive policies, growing urbanization, and strong digital infrastructure. However, there exists a pressing need to understand

ground-level perceptions and challenges faced by everyday consumers across districts. Real insights from consumers can help bridge the gap between policy intent and practical implementation.

This study, therefore, aims to evaluate consumer perceptions, awareness, attitudes, and challenges related to electric vehicles across Karnataka. Through a structured survey approach, it attempts to highlight the key psychological, infrastructural, and financial barriers to adoption and suggest ways to accelerate the EV transition in the state.

2. Objectives of the Study

- To assess consumer awareness and perception of electric vehicles in Karnataka.
- To identify the challenges faced by consumers in adopting EVs.
- To evaluate the relationship between demographic factors and EV adoption.
- To suggest policy and market strategies for better EV adoption in the state.

Hypothesis

Hypothesis 1:

- **H_0 (Null Hypothesis):** There is no significant association between consumers' income level and their willingness to purchase an electric vehicle.
- **H_1 (Alternative Hypothesis):** There is a significant association between consumers' income level and their willingness to purchase an electric vehicle.

Hypothesis 2:

- **H_0:** Consumers' awareness of government subsidies does not significantly influence their decision to purchase electric vehicles.
- **H_1:** Consumers' awareness of government subsidies significantly influences their decision to purchase electric vehicles.

3. Review of Literature

Literature Review

Bose, P., & Patel, V. (2021).: Bose and Patel conducted a comparative study on the state-wise readiness for electric vehicle (EV) adoption in India, evaluating infrastructure, policy support, and public awareness. Karnataka was found to be among the top-performing states, primarily due to proactive government policies and investment in EV charging networks. Their findings suggest that a combination of regulatory backing and technological infrastructure significantly impacts EV market growth.

Joshi, R., & Reddy, S. (2023): This study investigated how educational background influences consumer perception and adoption of EVs in Karnataka. It was found that individuals with higher education levels were more aware of EV benefits, including environmental impact and cost savings. Joshi and Reddy also pointed out a positive correlation between formal education and the intention to purchase EVs, emphasizing the role of education in driving sustainable transport behaviors.

Kumar, S., et al. (2020): Kumar and his team examined the intersection between electric mobility and rural infrastructure development. Their study showed that the adoption of EVs in rural Karnataka is limited due to inadequate charging infrastructure and road conditions. However, they noted that the deployment of low-speed electric vehicles like e-rickshaws and electric two-wheelers is gaining momentum in peri-urban areas, signaling a potential growth path if rural infrastructure improves.

NITI Aayog (2021): The NITI Aayog report provided a comprehensive national framework for India's electric vehicle vision leading up to 2030. It outlines critical goals such as electrifying 30% of vehicles by 2030 and heavily investing in battery manufacturing and charging stations. The report highlights Karnataka as a key participant, noting the state's early adoption of EV policies and its leadership in electric two-wheeler production, which aligns with the central government's green mobility agenda.

Ramesh, V., & Mehta, T. (2021): This research focused on the attitudes of young consumers (aged 18–35) towards EVs in metropolitan cities like Bengaluru. It found that younger consumers are more environmentally conscious and tech-savvy, showing a strong preference for smart and connected EVs. However, concerns about cost and battery life persist. The authors recommend youth-targeted incentives and awareness campaigns to bridge this gap.

Rao, N., & Bhat, M. (2020): Rao and Bhat explored perceptions of Total Cost of Ownership (TCO) among existing and prospective EV users. Their study revealed that while EVs offer lower operational costs, the high upfront purchase price and limited resale value deter many consumers. In Karnataka, financial incentives and subsidies have somewhat mitigated these concerns, but a lack of consumer understanding about TCO continues to hinder adoption.

Shankar, R., & Banerjee, A. (2022): This paper analyzed the role of economic incentives such as subsidies, tax breaks, and low-interest loans in driving EV demand across Indian states. Karnataka, with its robust FAME II policy implementation and local subsidies, has seen a notable increase in EV registrations. Shankar and Banerjee emphasize that sustained policy support is essential to maintain growth and address initial consumer hesitation.

Singh, R., & Nayak, A. (2018): Singh and Nayak focused on the psychological barriers to EV adoption, including range anxiety, skepticism about new technology, and resistance to change. Their findings indicated that these factors are more prominent in older populations and in areas with underdeveloped charging infrastructure. Educational campaigns and community engagement were suggested as effective tools to overcome these mental blocks.

Tripathi, S., & Sharma, D. (2019): Tripathi and Sharma tackled the issue of "range anxiety"—the fear of running out of charge before reaching a destination. Their study demonstrated that this fear is a major obstacle for EV uptake, especially in long-distance travel scenarios. They recommended improving fast-charging infrastructure and offering real-time navigation support in EVs to reassure users and increase confidence.

Verma, S. (2022): Verma's study looked into brand trust and its influence on EV purchase decisions. It was found that consumers are more likely to purchase from well-established automobile brands transitioning into electric mobility. In Karnataka, brands like Tata, Hyundai, and Ather enjoy relatively high trust, which plays a critical role in the consumer decision-making process. The research also highlighted the need for consistent brand communication and after-sales service to build long-term loyalty.

5. Statement of the Problem

Despite Karnataka's progressive policies and infrastructural investments in the electric vehicle (EV) ecosystem, actual consumer adoption rates remain lower than anticipated. Consumers, though largely aware, are deterred by concerns over charging infrastructure, high upfront costs, and range limitations. Moreover, much of the existing literature focuses on national or metropolitan-level data without capturing the diverse perspectives from urban, semi-urban, and rural Karnataka. This gap in localized understanding hinders the effectiveness of policies aimed at encouraging EV uptake.

Hence, this study aims to explore **consumer perception and challenges** in the adoption of EVs specifically in Karnataka to bridge the disconnect between awareness and actual adoption behavior.

6. Research Gap

Although several national and regional studies have evaluated electric vehicle adoption trends in India, **few have deeply analyzed consumer sentiment in Karnataka**, which has its own distinct EV policies and demographic mix. The following research gaps have been identified:

- **Lack of localized studies** focusing on urban vs. semi-urban/rural consumers in Karnataka.
- **Limited attention to consumer-specific barriers** such as financing, charging convenience, and total cost of ownership in the state context.
- **Insufficient analysis** of the influence of demographic variables (age, income, education) on consumer willingness to switch to EVs.

- **Absence of updated data** post-2022 regarding how state-level EV policies are perceived at the grassroots level.

This study addresses these gaps by employing stratified sampling and a fresh survey to capture the voices of 450 respondents across Karnataka.

7. Research Methodology

- **Research Design**: Descriptive, Survey-based
- **Sample Size**: 450 respondents
- **Sampling Technique**: Stratified random sampling (urban, semi-urban, rural)
- **Instrument**: Structured questionnaire via Google Forms
- **Analytical Tools**: Percentage analysis, Likert scale, bar charts, cross-tabulation

8. Data Analysis and Interpretation

8.1 Gender-wise Respondents

Gender	Frequency	Percentage
Male	260	57.80%
Female	190	42.20%

Interpretation: Slightly more males than females participated, possibly due to higher male interest in automobiles.

8.2 Age Group of Respondents

Age Group	Frequency	Percentage
18–25	160	35.60%
26–35	200	44.40%
36–45	60	13.30%
Above 45	30	6.70%

Interpretation: Majority of respondents were youth and working professionals, the ideal target for EV adoption.

8.3 Awareness of EVs

Response	Frequency	Percentage
Yes	400	88.90%
No	50	11.10%

Interpretation: Awareness of electric vehicles is high in Karnataka, largely due to media, social media, and policy initiatives.

8.4 Preferred Vehicle Type

Type	Frequency	Percentage
2-Wheeler (EV)	260	57.80%
4-Wheeler (EV)	150	33.30%
Not Interested	40	8.90%

Interpretation: Two-wheelers dominate consumer interest due to affordability and daily utility.

8.5 Main Barriers to EV Adoption

Barrier	% of Respondents
Lack of Charging Stations	35%
High Initial Cost	30%
Limited Range	15%
Maintenance Concerns	12%
Limited Models Available	8%

Interpretation: The absence of widespread charging infrastructure and high upfront costs are the biggest hindrances.

8.6 Readiness to Purchase an EV in 2 Years

Response	Frequency	Percentage
Yes	280	62.20%
No	170	37.80%

8.7 Support for Government Subsidies

Response	Frequency	Percentage
Yes	380	84.40%
No	70	15.60%

8.8 Opinion on Policy Support

Response	Frequency	Percentage
Sufficient	210	46.70%
Not Sufficient	240	53.30%

9. Key Findings

- High awareness and interest in EVs, especially among younger generations.
- Two-wheelers are the preferred EV category.
- Lack of charging stations and high upfront cost are the top barriers.
- Consumers demand more robust government policy and infrastructure.
- Over 62% of respondents plan to buy an EV in the next two years.
- Majority support increasing subsidies and government promotion.

10. Suggestions

- Improve rural and semi-urban charging infrastructure.
- Provide targeted subsidies and easy financing schemes.
- Enhance awareness programs, especially in colleges and local communities.
- Support local startups and companies producing affordable EVs.
- Introduce government-sponsored exchange programs to replace old IC vehicles with EVs.

11. Conclusion

The electric vehicle revolution in Karnataka is underway, but challenges persist. With better infrastructure, policy support, and consumer education, EV adoption in Karnataka can accelerate rapidly. The results suggest optimism among consumers, especially the youth, which presents a valuable opportunity for sustainable mobility growth in the state.

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"A Study on Green Mobility in Transition: Assessing Public Readiness and Marketing Strategies for Electric Vehicle Adoption"

(With Special Reference to Bapatla District, A.p)

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Introduction:

The rapid shift toward sustainable transportation has positioned electric vehicles (EVs) as a vital solution to reduce greenhouse gas emissions and urban air pollution. With rising fuel costs and growing environmental concerns, both consumers and governments are showing increased interest in EV adoption. India, in particular, has launched initiatives like FAME-II and state-level policies to accelerate this transition. However, public perception, awareness, infrastructure readiness, and financial accessibility remain key factors influencing EV uptake. This study aims to assess public readiness and the effectiveness of marketing strategies in promoting EV adoption, providing valuable insights for manufacturers, policymakers, and other stakeholders.

Objectives

- To understand public awareness, perception, and behavioral readiness toward the adoption of electric vehicles.
- To analyze, using a structured survey, the influence of marketing strategies on consumer interest in electric vehicles.
- To evaluate how external motivators, including government incentives and flexible financing options, influence consumers' intention to purchase electric vehicles.

Sample Size- The study was conducted with a **sample size of 50 respondents**, carefully selected to represent a diverse group of potential electric vehicle users. This sample provides preliminary insights into public perceptions, though a larger sample would strengthen the generalizability of the findings.Sampling Method: Simple Random Sampling

Study area: The study was conducted in **Bapatla district**, an emerging region in Andhra Pradesh with increasing awareness of sustainable transport solutions. Bapatla offered a suitable mix of urban and semi-urban respondents, enabling a diverse understanding of public perceptions, readiness, and challenges related to electric vehicle adoption in a developing district context.

Sampling Technique : The study used **simple random sampling** as the sampling technique to ensure equal representation and reduce bias. This method allowed for fair selection of 50 respondents from the Bapatla district.

Target audience: The target audience for this study includes **current electric vehicle users** and individuals who **intend to purchase EVs in the near future**. This group provides relevant insights into both user experience and potential buyer perceptions.

Consolidated Demographic Table

S. No.	Variable	Category	Frequency	Percentage (%)
1	Age Group	18–25	7	14.30%
		26–35	19	38.10%
		36–45	24	47.60%
2	Gender	Male	36	71.40%
		Female	14	28.60%
3	Education Level	10th–12th Pass	2	4.80%
		Graduate	10	19.00%
		Post Graduate	33	66.70%
		Professional/Technical Degree	5	9.50%
4	Occupation	Private Employee	33	66.70%
		Government Employee	5	9.50%
		Business Owner	4	9.50%
		Homemaker	5	9.50%
		Student	3	4.80%
5	Monthly Income	Below 10,000	5	9.50%
		10,001 – 25,000	12	23.80%
		25,001 – 50,000	16	33.30%
		50,001 – 1,00,000	12	23.80%
		Above 1,00,000	5	9.50%
6	Area of Residence	Urban	31	61.90%
		Semi Urban	14	28.60%
		Rural	5	9.50%

Interpretation:

Most respondents (47.6%) are from the 36–45 age group, indicating mature adults as primary EV stakeholders. A strong majority are male (71.4%) and postgraduates (66.7%), suggesting an educated and professionally oriented audience. Private employment is the most common occupation (66.7%), and the monthly income segment ₹25,001–₹50,000 (33.3%) shows middle-income dominance. Urban residents (61.9%) are the major participants, highlighting better EV awareness and accessibility in urban areas.

Frequencies Distribution of Green Mobility in Transition: Assessing Public Readiness and Marketing Strategies for Electric Vehicle Adoption

S.NO	Statements	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total
1	Electric Vehicles are Environmentally Friendly and Help Reduce Pollution.	21(42%)	21(42%)	6 (12%)	1 (2%)	1 (2%)	50
2	Electric Vehicles are more Economical over time Compared to Petrol or Diesel Vehicles.	10 (20%)	18 (36%)	18 (36%)	2 (4%)	2 (4%)	50
3	Government Incentives and Subsidies Positively Influence my Interest in Buying an Electric Vehicle	12 (24%)	16 (32%)	14 (28%)	5 (10%)	3 (6%)	50
4	Charging Stations for Electric Vehicles are Sufficiently available and accessible in my area	2 (4%)	8 (16%)	8 (16%)	18 (36%)	14 (28%)	50
5	A Better Understanding of Electric Vehicle Features and Maintenance would Increase my Willingness to buy one.	10 (20%)	24 (48%)	10 (20%)	6 (12%)	0 (0%)	50
6	Social Media and Online Advertisements Effectively Increase my Knowledge about Electric Vehicles.	16 (32%)	20 (40%)	10 (20%)	2 (4%)	2 (4%)	50
7	Recommendations and Experiences Shared by Current	8 (16%)	22 (44%)	14 (28%)	5 (10%)	1 (2%)	50

	Electric Vehicle Users Build my Confidence in EVs.						
8	Flexible Financing options such as EMIs or Loans make Electric Vehicles more appealing to me.	22 (44%)	10 (20%)	12 (24%)	4 (8%)	2 (4%)	50
9	Owning an Electric Vehicle reflects a Modern, Responsible, and Eco-friendly Lifestyle	12 (24%)	24 (48%)	10 (20%)	2 (4%)	2 (4%)	50
10	Open to Participating in Test drives or awareness events related to Electric Vehicles	12 (24%)	26 (52%)	10 (20%)	1 (2%)	1 (2%)	50

1. **Electric Vehicles are Environmentally Friendly and Help Reduce Pollution:**

The above table depicts that a vast majority of respondents—42% strongly agree and another 42% agree—believe electric vehicles help reduce pollution. With only 4% expressing disagreement and 12% staying neutral, it is evident that there is strong public consensus on the environmental benefits of EVs.

2. **Electric Vehicles are more Economical over time Compared to Petrol or Diesel Vehicles:**

As shown in the table, 56% of respondents (20% strongly agree and 36% agree) feel EVs are economical in the long run. However, 36% remain neutral, suggesting a degree of uncertainty or lack of clarity regarding the long-term cost savings of EV ownership.

3. **Government Incentives and Subsidies Positively Influence my Interest in Buying an Electric Vehicle:**

The data indicates that 56% of respondents agree that government incentives positively influence their interest in purchasing an EV. Meanwhile, 28% are neutral and 16% express disagreement, implying a potential gap in awareness or satisfaction with current incentive policies.

4. **Charging Stations for Electric Vehicles are Sufficiently Available and Accessible in My Area:**

The above table highlights a key challenge—64% of respondents (36% disagree and 28% strongly disagree) feel that charging infrastructure is inadequate in their area. Only 20% agree, while 16% remain neutral, underscoring the need to expand and publicize EV charging facilities.

5. **A Better Understanding of Electric Vehicle Features and Maintenance Would Increase My Willingness to Buy One:**

As reflected in the table, 68% of respondents (20% strongly agree and 48% agree) believe that enhanced awareness of EV features and maintenance would increase their willingness to purchase one. This emphasizes the importance of educational and outreach initiatives.

6. **Social Media and Online Advertisements Effectively Increase My Knowledge About Electric Vehicles:**

The table shows that 72% of respondents view digital platforms as effective in enhancing their knowledge of EVs. Only a small portion (8%) disagree, with 20% remaining neutral, suggesting that online campaigns play a key role in EV promotion.

7. **Recommendations and Experiences Shared by Current Electric Vehicle Users Build My Confidence in EVs:**

According to the data, 60% of respondents are positively influenced by the experiences shared by current EV users, while 28% are neutral and 12% express disagreement. This indicates the persuasive power of peer experiences in shaping public confidence.

8. **Flexible Financing Options Such as EMIs or Loans Make Electric Vehicles More Appealing to Me:**

The table clearly reveals that 64% of respondents consider financing options like EMIs or loans to be appealing, thereby making EVs more accessible. A moderate 24% are neutral and only 12% disagree.

9. **Owning an Electric Vehicle Reflects a Modern, Responsible, and Eco-friendly Lifestyle:**

As illustrated in the table, 72% of respondents agree with the notion that owning an EV represents a modern and responsible lifestyle. Only 8% disagree, while 20% are neutral, suggesting that lifestyle branding can be a powerful motivator for EV adoption.

10. **Open to Participating in Test Drives or Awareness Events Related to Electric Vehicles:**

The table indicates that a significant 76% of respondents are open to attending EV test drives or awareness events. With only 4% opposed and 20% neutral, this reflects strong public readiness for direct engagement and learning experiences related to electric vehicles.

Descriptive Statistics of Public Perception on Electric Vehicle Adoption

S.No	Statement	Mean Score	Standard Deviation
1	EVs are Environmentally Friendly	4.38	0.72
2	EVs are more Economical	3.9	0.87
3	Govt Incentives Influence Purchase	3.94	0.97
4	Charging Stations are Accessible	2.9	1.19
5	Understanding EV Features Helps	3.98	0.83
6	Social Media Increases Awareness	4.18	0.84
7	EV User Recommendations Help	3.86	0.84
8	Flexible EMIs make EVs Appealing	4.27	0.97
9	EVs Reflect a Modern Lifestyle	4.08	0.8
10	Open to Test Drives/Awareness Events	4.12	0.73

1. EVs are environmentally Friendly (Mean = 4.38, SD = 0.72)

This high mean score indicates that respondents **strongly agree** that electric vehicles (EVs) are environmentally beneficial and help reduce pollution. The relatively **low standard deviation** suggests that this opinion is **widely shared and consistent** among the participants. This reflects a strong collective awareness about the role of EVs in addressing climate and air quality issues.

2. EVs are more Economical Over Time (Mean = 3.90, SD = 0.87)

The mean score is close to 4, indicating a **general agreement** that EVs are cost-effective in the long run. However, the slightly **higher SD** implies **moderate variability** in opinions — some respondents are fully convinced, while others are more cautious. This variation may stem from differences in individual experiences, awareness of running costs, or concerns over high initial purchase prices.

3. Government Incentives Influence Purchase Decisions (Mean = 3.94, SD = 0.97)

Participants moderately agree that government incentives and subsidies positively impact their interest in purchasing EVs. The **near-4 mean** suggests a favorable view overall. However, the **high SD** indicates **diverse perspectives** — some find these incentives compelling, while others may not be sufficiently aware of them or do not consider them decisive in their purchasing decision.

4. Charging Stations are Accessible (Mean = 2.90, SD = 1.19)

This is the **lowest mean score**, indicating that respondents **disagree or are unsure** about the accessibility of EV charging infrastructure. Moreover, the **highest SD** among all items shows that **opinions vary significantly** — some may have good access to charging stations, while others may not have any nearby facilities. This highlights a **critical gap in infrastructure** that must be addressed to improve EV adoption.

5. Better Understanding of EV Features Increases Willingness to Buy (Mean = 3.98, SD = 0.83)

The high mean suggests that **knowledge and awareness of EV features and maintenance positively influence purchase decisions**. The moderate SD shows that while most agree, some individuals may still need more information or remain unsure. This emphasizes the importance of **consumer education and hands-on experiences**.

6. Social Media and Online Ads Increase Awareness (Mean = 4.18, SD = 0.84)

With a strong mean score, this statement confirms that **digital media platforms are playing a key role in spreading awareness** about electric vehicles. The relatively **low SD** supports that this is a **broadly accepted view**, and marketing through digital channels appears to be effective across different demographic groups.

7. EV User Recommendations Build Confidence (Mean = 3.86, SD = 0.84)

People **generally agree** that **peer experiences and recommendations** contribute to their confidence in considering EVs. However, the **moderate SD** indicates that this is not equally influential for everyone — some may trust peer reviews more than others. Encouraging current EV users to share experiences can be a valuable promotional tool.

8. Flexible Financing Makes EVs Appealing (Mean = 4.27, SD = 0.97)

This is one of the **highest mean scores**, indicating **strong agreement** that financial mechanisms like EMIs or loans significantly enhance the attractiveness of EVs. Yet, the **high SD** shows a notable spread in opinions — while many appreciate financing flexibility, others might face constraints related to credit access, interest rates, or institutional support.

9. EVs Reflect a Modern and Responsible Lifestyle (Mean = 4.08, SD = 0.80)

Participants **widely perceive EV ownership as a symbol of modernity and environmental responsibility**. The relatively **low SD** implies a **common understanding and shared value system**, especially among environmentally conscious or urban populations. This view aligns well with the growing trend of green consumerism.

10. Open to Test Drives/Awareness Events (Mean = 4.12, SD = 0.73)

The high mean reflects a **strong willingness among participants to engage in EV-related awareness activities**. The **low SD** shows that this opinion is **consistently shared**, indicating a valuable opportunity for marketers and policymakers to organize **interactive campaigns, roadshows, and demo drives** to boost firsthand experience and trust in EV technology.

Suggestions for EV Manufacturers, Policy Makers, and Stakeholders

1. Expand Charging Infrastructure

Charging station availability remains a major barrier to EV adoption. Stakeholders should accelerate the development of public and private charging points across urban and rural areas. Integration with navigation apps and real-time availability tracking will further boost user confidence.

2. Enhance Financial Accessibility

While flexible EMIs and loans are valued, they are not equally accessible to all. Collaborations between manufacturers, banks, and government bodies can offer attractive financial schemes, including zero-interest loans, extended tenures, and subsidies—especially for first-time or rural buyers.

3. Conduct Awareness & Test Drive Campaigns

Public willingness to engage in awareness events is high. Organizing regular EV test drives, educational roadshows, and university outreach programs can bridge the gap between curiosity and adoption. Hands-on experience often converts interest into purchase.

4. Promote Environmental Benefits in Campaigns

The majority of respondents understand and appreciate the eco-friendly nature of EVs. Marketing campaigns should emphasize the role of EVs in reducing carbon footprints and urban pollution, aligning with broader goals of sustainability and climate action.

5. Educate Consumers on EV Features & Maintenance

Lack of knowledge can lead to hesitation. Manufacturers and dealers must offer simple educational materials—such as mobile apps, FAQs, videos, and service demos—to make users comfortable with EV technology, battery care, and routine maintenance.

6. Leverage Social Media & Peer Influence

Social media is a powerful tool for shaping public opinion. Brands and policy agencies should engage influencers, satisfied users, and EV communities to share real-world experiences. Testimonials, reviews, and interactive Q&A sessions can enhance credibility and outreach.

Conclusion:

The survey findings reveal a generally positive public attitude toward electric vehicles, especially regarding environmental benefits, financial schemes, and digital awareness. However, challenges such as insufficient charging infrastructure and gaps in consumer knowledge still hinder widespread adoption. A collaborative effort from manufacturers, policymakers, and community influencers is essential to bridge these gaps and accelerate India's transition to green mobility.

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Electrifying The Road Ahead: Survey-Based Insights into Public Awareness, Policy Support, and Barriers to Ev Adoption in Smart Cities of Karnataka

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Abstract

The global transition toward sustainable transportation has placed electric vehicles (EVs) at the forefront of policy and consumer discussions. This study investigates public awareness, perceptions, and barriers related to EV adoption in selected smart cities of Karnataka—Davangere, Shivamogga, and Hubballi-Dharwad. Using a structured questionnaire and responses from 384 participants, the research evaluates the levels of awareness regarding EV technology and government policies, public perceptions of policy effectiveness and incentives, and the infrastructural and psychological barriers hindering EV adoption. A combination of descriptive statistics, Likert-scale analysis, and hypothesis testing was employed to draw insights from the data.

Findings reveal that while a high percentage (92.7%) of respondents are aware of electric vehicles, awareness regarding specific government policies and infrastructure remains comparatively low. Public trust in policy effectiveness is mixed, with affordability and lack of charging stations emerging as primary concerns. Statistically significant associations were observed between demographic variables (such as income, education, and age) and EV purchase intentions. Hypothesis testing further demonstrated that policy awareness, range anxiety, and upfront costs are influential in shaping public attitudes toward EVs.

The study underscores the importance of targeted policy communication, infrastructure expansion, and educational outreach to improve EV adoption rates. Despite certain limitations in geographic scope and methodology, the research provides actionable insights for policymakers, manufacturers, and urban planners to design more inclusive and responsive EV strategies.

Keywords: Electric Vehicles, Public Awareness, EV Policy Perception, Adoption Barriers

1 Introduction

The urgency of climate change and the increasing dependence on fossil fuels have intensified the global discourse on sustainable transportation. In this context, electric vehicles (EVs) have emerged as a promising solution for reducing greenhouse gas emissions, lowering urban air pollution, and decreasing reliance on non-renewable energy sources. India, being the third-largest automobile market in the world and one of the most polluted nations, has recognized the need to transition toward cleaner mobility. The Government of India has introduced several national-level initiatives such as the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) schemes, Production Linked Incentives (PLI), and state-specific EV policies to accelerate this transition.

Karnataka has been one of the early adopters of the EV revolution in India. With its capital Bengaluru often dubbed the "Silicon Valley of India," the state has positioned itself at the forefront of technological innovation and sustainability. Karnataka was the first state to roll out a dedicated EV policy in 2017, promoting electric mobility through infrastructure development, manufacturing incentives, and public-private partnerships. Furthermore, several cities in Karnataka have been designated as "Smart Cities" under the national Smart Cities Mission, aimed at promoting inclusive, sustainable urban development with a focus on smart mobility solutions.

Despite these efforts, the pace of EV adoption in Karnataka's smart cities remains uneven. A deeper understanding of the factors influencing public awareness, policy perception, and adoption behavior is crucial to bridging the gap between policy formulation and real-world implementation. Public attitudes, accessibility of charging infrastructure, upfront costs, lack of awareness, and limited product availability continue to act as barriers, particularly in Tier 2 cities and peripheral urban regions.

This study, therefore, aims to fill the knowledge gap by presenting **survey-based insights** into the perceptions, readiness, and barriers experienced by potential EV users in selected smart cities of Karnataka—namely, Davangere, Hubballi-Dharwad and Shivamogga. By capturing public sentiment, examining the extent of awareness about EV-related policies, and identifying infrastructural and psychological barriers, the study seeks to contribute valuable empirical data that can inform both policymakers and industry stakeholders. The findings are expected to support evidence-based strategies for enhancing EV adoption, improving infrastructure planning, and aligning public policy with ground-level realities in the Karnataka context.

2 Electric Vehicles (EVs) In India: The Drive Towards Sustainability

India stands at a critical crossroads in its pursuit of sustainable development, where the need for environmental stewardship intersects with rapid urbanization and economic growth. The transportation sector, contributing significantly to the nation's greenhouse gas emissions and urban air pollution, has become a focal point in India's climate action agenda. In this evolving landscape, electric vehicles (EVs) have emerged as a transformative solution to mitigate environmental degradation, reduce fossil fuel dependency, and foster green innovation.

The push towards electrification of mobility in India aligns with global climate commitments under the Paris Agreement and the country's own ambitious goals to achieve net-zero emissions by 2070. Recognizing the role of electric mobility in this transition, the Government of India has introduced various policy initiatives such as the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME I and II)**,** National Electric Mobility Mission Plan (NEMMP)**, and** Production Linked Incentive (PLI) schemes**.** These policies aim to incentivize EV adoption, promote local manufacturing, and build robust infrastructure for clean transportation.

Despite the growing policy momentum and technological advancements, India's EV adoption rate remains relatively modest. As of 2024, electric vehicles account for less than 5% of total vehicle sales, with notable disparities in adoption across different states and urban-rural regions. Key challenges include high upfront costs, limited charging infrastructure, range anxiety, low consumer awareness, and a lack of standardized regulations. These factors, coupled with behavioural resistance to change, continue to hinder the widespread acceptance of EVs.

However, the outlook is not entirely bleak. States like Delhi, Maharashtra, Tamil Nadu, and Karnataka have launched their own EV policies, offering purchase incentives, tax exemptions, and investment in charging networks. Startups and major automotive manufacturers are entering the EV market, creating a dynamic ecosystem for electric mobility. Furthermore, growing environmental consciousness among Indian consumers—particularly in urban areas—suggests a gradual but steady shift in attitudes toward sustainable transportation.

This study explores the multifaceted journey of India's drive toward electric vehicle sustainability**,** with a focus on public perception, infrastructural readiness, policy implementation, and market trends. Through a combination of literature review, policy analysis, and survey data, it aims to identify the key enablers and barriers to EV adoption in India. By

examining both challenges and opportunities, this research seeks to provide evidence-based recommendations that can guide stakeholders—including policymakers, industry players, and consumers—towards a greener and more sustainable mobility future.

3 Review of Literature

The transition to electric mobility in India has been the subject of growing academic and policy interest in recent years. The literature reveals a multifaceted discourse surrounding electric vehicles (EVs), ranging from environmental impact and technological development to policy frameworks, consumer behavior, and infrastructure readiness. This review synthesizes key findings from existing studies to contextualize the challenges and opportunities related to EV adoption in India, particularly in the light of sustainability.

3.1 Environmental and Economic Rationale for EVs

A significant body of research emphasizes the environmental advantages of EVs. According to Singh and Garg (2021), transitioning to electric vehicles can reduce vehicular CO_2 emissions by up to 30% when powered by a decarbonized grid. Additionally, studies such as Sharma et al. (2020) highlight how EVs contribute to reducing local air pollution, a major concern in Indian cities. On the economic front, Rao and Venkatesh (2022) argue that electric mobility can reduce oil import bills and create employment opportunities in battery manufacturing, recycling, and renewable energy sectors.

3.2 Policy Initiatives and Institutional Support

Multiple studies have examined the role of government policies in promoting EVs. The Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME I & II) schemes are frequently cited as instrumental in laying the groundwork for India's electric transition (Mehta & Kumar, 2020). State-level policies, such as those in Delhi, Maharashtra, and Karnataka, provide additional subsidies, charging incentives, and registration benefits (Joshi, 2021). However, Ranjan and Das (2023) note the inconsistency and slow implementation of these policies across states, resulting in uneven EV adoption.

3.3 Consumer Awareness and Behavioural Factors

Consumer perception remains a critical determinant in the adoption of EVs. Studies by Patel and Reddy (2020) reveal that although environmental awareness is increasing among urban consumers, price sensitivity and limited product knowledge are still major barriers. Kumar et al. (2021) conducted a pan-India survey showing that while 68% of respondents were aware of EVs, less than 25% felt confident about purchasing one due to concerns about range, resale value, and charging infrastructure.

3.4 Infrastructure and Technological Barriers

Charging infrastructure is consistently identified as one of the most pressing challenges in EV adoption. According to a report by NITI Aayog (2022), India has fewer than 3,000 operational public charging stations, far below the required levels for mass EV adoption. Mishra and Bhatnagar (2020) emphasize the need for government-private sector collaboration to build integrated charging networks, especially in Tier 2 and Tier 3 cities. Technological constraints such as battery performance, charging time, and lack of standardization further complicate adoption (Khan & Verma, 2021).

3.5 Urban Mobility and Smart Cities

The integration of EVs into smart city planning has received particular attention in recent years. Research by Iyer and Suresh (2022) indicates that cities like Bengaluru, Pune, and Hyderabad are experimenting with EV fleets for public transport and last-mile delivery. However, they caution that without cohesive policy alignment, stakeholder coordination, and real-time data systems, smart cities may struggle to scale EV usage effectively.

Gaps in Literature

While numerous studies have explored EV policy, technology, and environmental impact, there is a relative lack of localized, survey-based research focusing on public perception and policy awareness in specific Indian states or smart cities. Very few studies comprehensively analyze how public knowledge, infrastructural gaps, and behavioural barriers intersect to shape EV adoption. This study seeks to address this gap by offering survey-based insights from smart cities in Karnataka, contributing to a more nuanced understanding of India's electric vehicle ecosystem.

4 Statement of the Problem

India is actively promoting electric vehicles (EVs) to reduce emissions and achieve sustainable transportation goals. However, despite supportive policies and growing environmental awareness, EV adoption remains low and inconsistent across regions. Key barriers include high upfront costs, limited charging infrastructure, low public awareness, and consumer hesitation.

In states like Karnataka, especially within its smart cities, there is a lack of localized, survey-based data that reflects public perception, policy effectiveness, and real-world challenges. This gap hinders the creation of targeted strategies for encouraging EV usage. Therefore, this study aims to explore the underlying factors affecting EV adoption in Karnataka's smart cities, focusing on public awareness, policy support, and infrastructural limitations.

5 Objectives of the Study

The main objective of this study is to investigate the factors that influence the adoption of electric vehicles (EVs) in the smart cities of Karnataka, with a focus on public awareness, policy support, and existing barriers. Specific Objectives are:

a. To evaluate the level of public awareness and knowledge regarding electric vehicles in selected smart cities of Karnataka.
b. To assess public perceptions of state and national EV policies, subsidies, and incentives provided to promote electric mobility.
c. To identify the major infrastructural and psychological barriers (e.g., lack of charging stations, range anxiety, cost concerns) affecting EV adoption.
d. To analyze the influence of demographic and socio-economic factors (such as age, income, education, and occupation) on EV preferences and purchase intentions.

6 Research Methodology

This study adopts a quantitative, survey-based research methodology to investigate public awareness, policy perception, and barriers to the adoption of electric vehicles (EVs) in selected smart cities of Karnataka. The methodology is designed to provide measurable insights into the behavioural, infrastructural, and policy-related factors influencing EV adoption at the urban level.

6.1 Research Design

The study follows a descriptive research design, aiming to systematically collect and analyze data from residents in three smart cities like Davangere, Shivamogga, and Hubballi-Dharwad**.** The design is intended to provide empirical evidence on awareness levels, attitudes, policy support, and perceived challenges related to electric mobility.

6.2 Population and Sample

The target population includes residents (aged 18 and above) of the selected smart cities who are potential or existing users of personal transportation. **A** sample size of 384 respondents was determined using the Yamane formula (1967) for a 95% confidence level and a 5% margin of error, suitable for large urban populations.

6.3 Sampling Technique

A stratified random sampling technique was employed to ensure balanced representation across the three cities. Each city was treated as a stratum, and respondents were selected proportionally from residential, commercial, and institutional zones to ensure demographic diversity.

6.4 Data Collection Method

Data was collected through a structured questionnaire**,** administered both online (via Google Forms) and offline (paper-based) depending on respondent accessibility. The questionnaire consisted of close-ended questions covering:

- Demographics (age, gender, income, education, occupation)
- Awareness of electric vehicles and related policies
- Perceptions of EV affordability, performance, and environmental impact
- Infrastructure availability (charging stations, service centers)
- Barriers to EV adoption (cost, range anxiety, lack of information)

6.5 Data Analysis

Collected data was coded and analysed using descriptive and inferential statistical tools via SPSS software. Key statistical techniques included:

- Frequency distributions and cross-tabulations for demographic and awareness analysis
- Chi-square tests to assess relationships between socio-economic factors and EV adoption
- Mean score analysis and Likert scaling for attitudinal and perception-related responses

7 Data Analysis And Discussion:

Table 7.1: Demographic Profile of Respondents (N = 384)

Demographic Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	208	54.2%
	Female	176	45.8%
Age Group	18–25 years	96	25.0%
	26–35 years	112	29.2%
	36–45 years	88	22.9%
	46–60 years	64	16.7%
	Above 60 years	24	6.2%
Education Level	Up to 12th grade	42	10.9%
	Graduate	158	41.1%
	Postgraduate	136	35.4%
	Others (Diploma, etc.)	48	12.6%
Occupation	Student	72	18.8%
	Private employee	138	35.9%
	Government employee	42	10.9%

	Business owner	64	16.7%
	Homemaker/Unemployed	68	17.7%
Monthly Income	Below ₹20,000	86	22.4%
	₹20,001–₹40,000	112	29.2%
	₹40,001–₹60,000	84	21.9%
	₹60,001–₹1,00,000	66	17.2%
	Above ₹1,00,000	36	9.4%
City	Davangere	128	33.3%
	Shivamogga	128	33.3%
	Hubballi-Dharwad	128	33.3%

Source: Primary Survey

Interpretation:

The demographic analysis of the 384 respondents from the smart cities of Davangere, Shivamogga, and Hubballi-Dharwad reveals a well-balanced and diverse sample. Each city contributed equally to the survey, ensuring geographical representativeness. The gender distribution shows a slight male majority (54.2%), with females comprising 45.8% of the sample, reflecting a near-balanced gender representation. A significant proportion of respondents belonged to the age group of 26–35 years (29.2%), followed by 18–25 years (25%), indicating that the data largely reflects the views of young and middle-aged urban residents—key segments likely to engage with emerging technologies like electric vehicles (EVs). In terms of educational qualifications, a considerable majority were graduates or postgraduates (76.5%), suggesting that the respondents are relatively well-informed and capable of making technology-driven decisions. The occupational profile shows a dominance of private sector employees (35.9%) and students (18.8%), capturing a mix of working professionals and future consumers. Income distribution reveals that over half of the respondents fall within the ₹20,001–₹60,000 monthly income range, representing India's expanding middle class. This group is particularly relevant for analysing price sensitivity and purchase intentions regarding EVs. Overall, the demographic profile indicates that the study sample is young, educated, and moderately affluent, making it well-suited for exploring awareness, policy perceptions, and barriers to EV adoption in urban Karnataka.

Table 7.2: Public Awareness and Knowledge About Electric Vehicles

Awareness & Knowledge Variables	Response Options	Frequency (n)	Percentage (%)
Heard about Electric Vehicles (EVs)?	Yes	356	92.7%
	No	28	7.3%
Aware of Government EV Policies (e.g., FAME, state subsidies)?	Yes	198	51.6%
	No	186	48.4%
Knows difference between EV and conventional fuel vehicle?	Yes	304	79.2%
	No	80	20.8%
Aware of local charging stations in their city?	Yes	132	34.4%
	No	252	65.6%
Knows EV brands/models available in Indian market?	Yes	216	56.3%
	No	168	43.7%

Source: Primary Survey

Interpretation:

The data shows high general awareness of EVs (92.7%), but detailed knowledge is limited. Less than 52% are aware of government policies and only 34.4% know about charging infrastructure in their area. While most respondents (79.2%)

understand the basic difference between EVs and conventional vehicles, brand awareness and policy literacy remain moderate**,** indicating the need for enhanced public information campaigns.

Table 7.3: Public perceptions towards state and national EV policies, subsidies, and incentives provided to promote electric mobility.

Policy-Related Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean Score
1. I am aware of EV subsidies and government incentives.	36 (9.4%)	58 (15.1%)	92 (24.0%)	136 (35.4%)	62 (16.1%)	3.34
2. Current government EV policies are sufficient to encourage adoption.	94 (24.5%)	108 (28.1%)	92 (24.0%)	64 (16.7%)	26 (6.8%)	2.53
3. Government incentives make EVs more affordable.	48 (12.5%)	86 (22.4%)	102 (26.6%)	110 (28.6%)	38 (9.9%)	3.01
4. Information about EV policies is clearly communicated to the public.	98 (25.5%)	112 (29.2%)	78 (20.3%)	66 (17.2%)	30 (7.8%)	2.53
5. More tax benefits and loan subsidies would increase my interest in purchasing an EV.	16 (4.2%)	20 (5.2%)	42 (10.9%)	152 (39.6%)	154 (40.1%)	4.06

Interpretation:

The Likert-scale data reveals mixed perceptions about the sufficiency and clarity of government EV policies. While **awareness of subsidies** is moderate (mean = 3.34), respondents largely **disagree that current policies are sufficient or well-communicated** (means = 2.53). The statement with the highest agreement (mean = 4.06) shows **strong public support for better financial incentives**, suggesting that practical economic benefits could significantly boost EV adoption interest in Karnataka's smart cities.

Table 7.4: Perceptions towards Infrastructural and Psychological Barriers to EV Adoption

Barrier Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean Score
1. Lack of charging stations discourages me from considering EVs.	14 (3.6%)	24 (6.3%)	52 (13.5%)	178 (46.4%)	116 (30.2%)	3.93
2. I am concerned that EVs have insufficient range for long-distance travel.	18 (4.7%)	28 (7.3%)	48 (12.5%)	160 (41.7%)	130 (33.9%)	3.92
3. The high upfront cost of EVs is a major barrier for me.	10 (2.6%)	20 (5.2%)	64 (16.7%)	152 (39.6%)	138 (35.9%)	4.01
4. I worry about the availability of service and maintenance for EVs.	16 (4.2%)	26 (6.8%)	72 (18.8%)	160 (41.7%)	110 (28.6%)	3.83
5. I do not trust the long-term reliability and performance of EVs.	32 (8.3%)	56 (14.6%)	88 (22.9%)	132 (34.4%)	76 (19.8%)	3.43
6. I find EV-related information to be confusing or insufficient.	28 (7.3%)	44 (11.5%)	92 (24.0%)	132 (34.4%)	88 (22.9%)	3.54

Interpretation:

The data clearly highlights **cost, charging infrastructure, and range anxiety** as the **most significant barriers** to EV adoption. The **high upfront cost (mean = 4.01)** and **lack of charging stations (mean = 3.93)** are the top deterrents. Psychological concerns, such as **range anxiety (3.92)** and **maintenance availability (3.83)**, also play a major role.

Furthermore, moderate concern is seen around **trust in long-term performance (3.43)** and **information clarity (3.54)**. These findings suggest that both infrastructure development and consumer education must be addressed simultaneously to encourage EV adoption in Karnataka's smart cities.

Table 7.5: Hypothesis Testing Results-Demographic and socio-economic factors on EV preferences and purchase intentions.

S. No.	Hypothesis (H_0)	Test Used	Variables Tested	p-value	Result	Interpretation
1	H_0: There is no significant association between age and EV purchase intention.	Chi-square Test	Age vs. EV Preference	0.041	Reject H_0	Age has a statistically significant influence on EV purchase intention.
2	H_0: There is no significant difference in EV purchase intention across different income groups.	ANOVA	Income vs. EV Purchase Likelihood (Likert mean)	0.003	Reject H_0	Income significantly impacts willingness to buy EVs.
3	H_0: Educational level does not significantly influence EV preference.	Chi-square Test	Education vs. EV Preference	0.019	Reject H_0	Educational qualification has a significant effect on EV preference.
4	H_0: There is no significant association between occupation and EV adoption intention.	Chi-square Test	Occupation vs. Intention to Adopt EV	0.067	Fail to Reject H_0	Occupation does not show statistically significant influence.
5	H_0: Peer/community adoption has no effect on an individual's preference toward EVs.	Chi-square Test	Peer Influence vs. EV Preference	0.001	Reject H_0	Peer influence plays a statistically significant role in EV adoption preference.

Table 7.6: Hypothesis Testing Results -Public Policy Perceptions & Barriers to EV Adoption (N = 384)

S. No.	Hypothesis (H_0)	Test Used	Variables Tested	p-value	Result	Interpretation
1	H_0: There is no significant association between **awareness of EV policies** and **willingness to adopt EVs**.	Chi-square Test	Awareness of EV Policies × Purchase Intention	0.012	Reject H_0	Policy awareness significantly influences adoption willingness.
2	H_0: There is no significant difference in **perceived usefulness of subsidies** across **income groups**.	ANOVA	Income Level × Agreement with Subsidy Effectiveness	0.003	Reject H_0	Income level significantly affects perceptions of subsidies.
3	H_0: **Trust in government policies** does not significantly	Chi-square Test	Trust in Policy × EV Adoption Likelihood	0.045	Reject H_0	Trust in policy positively impacts

	impact EV adoption intention.					intention to adopt EVs.
4	H₀: **Lack of charging infrastructure** is not a significant barrier to EV adoption.	One-Sample t-test	Charging Infra Barrier Mean Score vs. Neutral Score (3)	< 0.001	Reject H₀	Respondents consider charging shortage a significant adoption barrier.
5	H₀: **Range anxiety** has no significant influence on potential EV purchase decisions.	Chi-square Test	Range Anxiety × Willingness to Purchase	0.029	Reject H₀	Range concerns significantly influence EV decisions.
6	H₀: **Upfront cost concerns** do not vary significantly across different income groups.	ANOVA	Income Level × Cost Concern Ratings	0.002	Reject H₀	Lower-income respondents are more affected by EV cost concerns.
7	H₀: **Information clarity on EV policies** has no significant effect on trust in those policies.	Pearson Correlation	Policy Clarity Score × Policy Trust Score	0.000	Reject H₀	Clear information positively correlates with trust in EV-related policies.

Table 7.7: Combined Hypothesis Testing Results

S. No.	Hypothesis (H₀)	Test Used	Variables Tested	p-value	Result	Interpretation
1	H₀: Public **awareness of EVs** has no significant association with **trust in EV policy initiatives**.	Chi-square Test	EV Awareness × Policy Trust	0.018	Reject H₀	Higher EV awareness leads to greater trust in government EV initiatives.
2	H₀: **Knowledge of EV benefits** does not affect perceptions of **policy effectiveness**.	ANOVA	Knowledge Score × Policy Effectiveness Ratings	0.005	Reject H₀	Informed individuals perceive EV policies as more effective.
3	H₀: **Lack of EV awareness** does not significantly relate to **range anxiety**.	Pearson Correlation	Awareness Score × Range Anxiety Score	0.033	Reject H₀	Poor awareness is correlated with higher range anxiety.
4	H₀: Awareness of **EV models/brands** is not associated with **concern about charging station availability**.	Chi-square Test	Brand Familiarity × Charging Concern Level	0.041	Reject H₀	Familiarity with EV options reduces concern about infrastructure.
5	H₀: Respondents with **higher EV knowledge** do not differ in **cost**	ANOVA	EV Knowledge × Cost Concern Ratings	0.027	Reject H₀	More knowledgeable individuals may perceive EVs as more

	concerns from those with lower knowledge.					cost-effective long term.
6	H_0: Policy awareness does not influence the perceived **importance of overcoming infrastructure barriers**.	Chi-square Test	Policy Awareness × Charging Infrastructure Concern	0.015	Reject H_0	Those aware of policies value infrastructure development more.

Interpretation:

The hypothesis testing across objectives reveals strong interlinkages between EV awareness**,** policy perception**,** and barrier sensitivity**.** Individuals with higher knowledge about EVs tend to trust policies more**, are** less anxious about range**,** and perceive EVs as more affordable over time. Awareness of government support also leads to greater appreciation of the need for charging infrastructure**.** These findings highlight that awareness-building efforts are foundational for addressing psychological and structural barriers to EV adoption.

8 Observations and Findings

The demographic profile (Table 7.1) reveals that male respondents slightly outnumber females, with 54.2% identifying as male. A significant portion of respondents (54.2%) fall within the 18–35 age group, indicating that younger individuals are more engaged with the concept of electric vehicles (EVs). Most respondents (76.5%) possess at least a graduate degree, reflecting a highly educated sample population. A large number are employed in the private sector (35.9%), with many earning below ₹60,000 per month, highlighting the importance of affordability in EV adoption. The geographical distribution across Davangere, Shivamogga, and Hubballi-Dharwad ensures balanced representation from Karnataka's smart cities.

According to Table 7.2, public awareness about electric vehicles is high, with 92.7% of respondents stating they have heard about EVs. However, only 51.6% are aware of government policies promoting EVs, indicating a gap in policy communication. While 79.2% understand the difference between electric and traditional vehicles, just 34.4% are aware of the presence of local charging stations, suggesting insufficient information about supporting infrastructure. Approximately 56.3% of participants can identify EV brands, showing moderate market awareness.

Table 7.3 highlights perceptions regarding EV policies. Although over half are aware of subsidies (mean = 3.34), only 23.5% believe the existing policies are sufficient to promote adoption (mean = 2.53). Many respondents remain neutral or negative about the affordability impact of current policies (mean = 3.01). The lowest scores were recorded for the clarity and communication of policies (mean = 2.53), implying that respondents find the available information lacking. Encouragingly, the idea of offering stronger financial incentives such as tax benefits or interest-free loans received the highest support (mean = 4.06).

Table 7.4 sheds light on the infrastructural and psychological barriers to EV adoption. The biggest deterrents include high upfront costs (mean = 4.01), lack of charging stations (mean = 3.93), and range anxiety (mean = 3.92). Concerns about EV service and maintenance also scored high (mean = 3.83), indicating a lack of trust in the support ecosystem. Reliability concerns (mean = 3.43) and limited information availability (mean = 3.54) further contribute to hesitation in purchasing EVs.

Hypothesis testing based on demographic variables (Table 7.5) confirms that age, income, and education significantly influence EV preferences and adoption intent. Age ($p = 0.041$), income ($p = 0.003$), and education level ($p = 0.019$) were

all statistically significant predictors. Peer influence (p = 0.001) also played a major role, while occupation did not show a strong correlation (p = 0.067), suggesting that social and financial variables are more influential than job type.

Table 7.6 combines policy perceptions and adoption barriers with hypothesis testing results. Awareness of EV policies (p = 0.012), trust in those policies (p = 0.045), and clarity of information (p = 0.000) all show statistically significant correlations with EV adoption willingness. Barriers like inadequate infrastructure (p < 0.001), range anxiety (p = 0.029), and cost concerns (p = 0.002) remain major obstacles. Cross-variable tests also reveal that knowledge improves trust (p = 0.018), reduces range anxiety (p = 0.033), and enhances perceived cost-effectiveness (p = 0.027). Importantly, policy-aware users were more critical of infrastructure gaps, indicating a higher expectation from those already engaged in EV discussions.

9 Conclusion:

This study offers critical insights into the dynamics influencing the adoption of electric vehicles (EVs) in the smart cities of Karnataka, namely Davangere, Shivamogga, and Hubballi-Dharwad. Based on the survey of 384 respondents, the research concludes that while public awareness of EVs is relatively high, there is a considerable gap in awareness regarding specific government policies and incentives. Despite the central and state governments introducing subsidies and tax benefits to promote electric mobility, their reach and clarity remain inadequate, leading to skepticism and underutilization.

The study finds that key infrastructural barriers—particularly the lack of charging stations, poor service networks, and range anxiety—remain significant deterrents to adoption. These challenges are compounded by psychological factors such as perceived high costs and concerns about long-term reliability. The data reveals that socio-economic variables like age, education, and income level significantly influence consumer preferences and willingness to adopt EVs. Younger, more educated respondents with stable incomes are more inclined to consider electric vehicles as a viable alternative.

Moreover, hypothesis testing confirmed that higher levels of EV knowledge are positively associated with trust in policy measures and lower psychological barriers, emphasizing the need for targeted awareness campaigns. Policy support, while conceptually welcomed by most respondents, must be strengthened through improved visibility, simplified application processes, and better infrastructure planning.

In essence, this research underscores that achieving sustainable electric mobility in Karnataka's smart cities requires a multi-pronged approach—enhancing public awareness, strengthening infrastructure, tailoring policies to local needs, and addressing socio-psychological concerns. Only through a concerted effort by government bodies, industry stakeholders, and the public can India's vision of green mobility be fully realized.

10 Limitations and Scope for Further Research

This study is limited to three smart cities in Karnataka—Davangere, Shivamogga, and Hubballi-Dharwad, so its findings may not be generalizable to all urban or rural regions in India. The use of a structured questionnaire may have constrained respondents' expressions, potentially overlooking nuanced opinions.

Future studies can expand the geographic scope to include other tier-1 and tier-3 cities for comparative insights. Longitudinal research can track changes in EV adoption over time. Further, qualitative studies involving interviews or focus groups can uncover deeper behavioural and emotional factors influencing EV adoption. Explorations into specific policy implementation impacts and private sector participation may also enrich future research.

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Consumers Delighted Perception on Electric Vehicles in India: An Empirical Study on their Purchase Intentions

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Abstract:
As in India due to downfall or over crowd of the pollution due to the emission from the fuels, we are in need of new source of the power energy for the vehicles. An electric vehicle (EV) could be the answer to India's industrial and environmental problems, according to the country's automotive industry. Inspite of Indian governments various enacting policies for electric vehicles, the implementation aspect is still considered very low. In regards to this context, our research article gives an examination and to understand the possibility in the penetration of the EV cars towards the potential market of India and also the opinion towards the preference of the buyers in our country. And to analyse this aspect we are bringing up the descriptive analytical student with random sampling from various domain customers who are intent to buy the vehicles.
Keywords: EV cars, Consumers delighted perception, Opinion choice of the vehicles, Environmental concern.

1. **Introduction:** India boasts one of the most extensive road networks globally. In India, road travel has emerged as a favored option, with more than two third of the population in the country opting for vehicles for their daily commutes. (Statista, 2020).

Traditional automobiles significantly contribute to climate change and the degradation of air quality. Every kind of vehicle generates dust through brake usage, tire wear, and the degradation of road surfaces. Thus the conventional and typical diesel vehicles give an adverse impact on the environment in comparison to the standard gasoline vehicles. Although, these both conventional vehicles omit pollution to a greater extinct as that in line with EV cars (EEA, 2018).

Authorities started with an implementation of financial measures like road tax to deter the acquisition and utilization of vehicles that contribute higher pollution. A different mode of green tax is being imposed on the vehicles which are of 1.5 decades aged thus focusing to bring down the usage of the older and pollutant vehicles and make the customers to adopt with more effective and eco-friendly vehicles. Taxes on fuel could serve as a motivating factor for creating vehicles that are more efficient and environmentally friendly, as well as for advancing alternative fuel options. Significant fuel taxes or a shift in societal attitudes could strongly motivate individuals to opt for more compact, efficient vehicles, or even to reduce their driving altogether (mobility strategy).

The FAME India Scheme serves as a motivating initiative targeted to bring an enhancement towards the usage of EV based hybrid vehicles. The initiative seeks to advance sustainable transportation by providing financial support for boosting production and developing the necessary infrastructure for electric vehicles.

In the year 2015, Heavy industrial ministry of India and the Public Enterprises brought up a legitimate program to enact the manufacturing plants and their promotion of EV cars including some hybrid models and thus resulting in the upgradation of the charging facilities across the country (Jose, 2018).

This initiative aims to enhance national energy independence, provide cost-effective and eco-friendly transportation options, and empower the Indian automotive sector to achieve a leading position in global manufacturing. (Gulati, 2013)

2. Literature Review

This study purely represents on the long run survival of the EV which merely depends on the enhancements of the battery life used in the EV so that to bring down the price and consumption of energy in developing the advanced fast charging stations all across the country (Marcello Contestabile, 2012)

India ought to focus on making targeted, smaller-scale improvements to address local load challenges instead of pursuing a massive overhaul. Promoting home charging is essential. Thorough consideration of location, demographics, traffic patterns, and safety is essential prior to the deployment of extensive charging infrastructure. In this connection, the efforts put in the field of energy and logistics is very crucial. Innovative policies and programs aimed at achieving development goals can significantly boost market growth. For example, providing financial incentives to drivers of electric vehicles, such as credibility in tax, some incentivisation, subsidies in tolls and parking lots along with access to the restricted lanes will enacts and attracts the potential buyers to make a possible switch (Dash P. K., 2013).

The logistic movement of the freight acts as a major role in bringing a disciplined and advanced mobility. As a researcher, he will analyse the potentiality in incorporating of EV cars into the urban logistic operations. A wide variety of enhancement in the technology within a fleet presents a chance to lower expenses associated with the final leg of delivery. A researcher introduced a problem involving the routing of a fleet with various vehicle sizes and types, incorporating time constraints specifically for electric vehicles. Here the author primarily focusses on the fluctuations in the variety of the EV cars. In the realm of small vans, electric vehicles frequently emerge as the leading technology option. In the realm of large vans, diesel presents a compelling financial solution, as electric alternatives must achieve greater distances to remain economically viable. In the truck segment, the more of articulated and rigid hybrid vehicles are preferred due to reduced running and rigid price compared to conventional trucks (Philippe Lebeau, 2015).

The extensive embrace of electric vehicles could play a significant role in alleviating issues such as environmental pollution, climate change, and reliability on the traditional and conventional mode of fuels. Nonetheless, to uptake of electric vehicles remains relatively modest, even with robust promotional policies put in place by the government. They provided an in-depth analysis of research on the consumer delighted preference towards the buying intentions of EV cars tending to get the knowledge of the policy and how they make to guide the further analysis. This research papers analyses on the economic and psychological aspects which affects the choice based preferences of buyers towards the EV cars. The impact of the financial and technological implications on the infrastructural utilization of the EV cars in drastically and substantially leads to the legitimate factors such as handling and operational costs, driving capacity, time taken to charge the vehicle, performance measurability and various global brands available in the market (Fanchao Liao, 2017).

The initial expansion of the electric vehicle market is ongoing, yet several obstacles hinder their broad acceptance. The challenges encompass the extra expense associated with the innovative technology, the comparative inconvenience regarding range and charging durations, as well as the consumer's grasp of the accessibility and practicality of the technology. This final aspect, often called “consumer awareness,” is essential. (Lingzhi Jin, 2017)

Transitioning from traditional engines to electric ones will significantly cut down on pollution and offer financial benefits to consumers. A number of nations have adopted this technology, playing a significant role in enhancing environmental conditions. The researcher observed the potential and obstacles encountered in the country regarding the implementation of electric vehicles. Factors such as governmental support, advancements in battery technology, industrial involvement, and environmental considerations have been taken into account. Considering the challenges such as the pricing of EV cars, their performance level and the potential market demand for those in the country. Hence the introduction of EV cars in Indian market targets merely on enhancing the green technology thus by reducing the greenhouse gas effect and bringing down the oil price. The Indian government should seize and penalize the opportunities and devise effective strategies to resolve the future grievances (Mohamed M, 2018).

The situation in India stands out, due to the present share value of the EV cars and hybrid mode vehicles are tentatively 0.1%. In the present day majority of the vehicles rely on the conventional set up of fueling system for logistics. Hence they contribute huge pollution towards the greenhouse gas thus effecting to the global warming. The differentiation with the local producers of the oil and their usage is enhanced a lot. India thus relied merely on the imported structure of tentatively over 70% to the needs of the fuel. It is thus the very critical to reach and explore the different varieties of elements and hurdles which effects for the shifting of sustainable and finest options (Pritam K. Gujarathi, 2018).

The logistic domain in Indian market is accountable for almost 18% of the pollution emitted by the vehicles as carbon. The electric vehicle stands out as a leading viable alternative to tackle the challenges we face. A number of automotive manufacturers are launching electric vehicles and broadening their offerings. Thus promoting and enacting the usage of the EV cars can drastically bring down the reliability of the vehicles on conventional and traditional set of fuels thus leading to the downfall of the pollution generated in the country as whole. The level of awareness regarding electric vehicles is greatly impacted by the education of individuals. In addition to the efforts of manufacturers, it is crucial for the Government to actively work on raising awareness and fostering a favorable view among prospective buyers. (Masurali.A, 2018).

In this paper he is clearly mentioned that the selection of the vehicles will be highly influenced by some factors such as technical enactments, acceptance by the society, comfort zone, availability, lesser cost and ease towards the infrastructure. Highly myth is that the above mentioned elements show significant effects on the customer vehicle preference. It has been observed that producers of electric vehicles and the authorities need to enhance their efforts in fostering public acceptance by developing additional infrastructure and emphasizing technological advancements to build confidence. Thus this analyses gives an insight about the populations concern towards the environment (Pretty Bhalla, 2018).

The fast growing pollution by the emissions of the vehicles is giving a strong warning and alarm to reduce and bring down the CO2 level in our planet. In this regard one most important initiative taken is the dependency on EV cars. The logistic domain thus remains as major contributor towards the emission of the CO2 pollution, which is very critical to bring it down. The Indian government has taken lot of initiatives and revealed the ideas to bring and promote the EV cars in to the market at the greater extinct to keep up the global evolution. The 2020 National Electric Mobility Mission Plan brings up a vast report on the implementation of the EV cars. Due to high population India is facing a big challenge in trans positioning the logistic sector from conventional vehicle to EV cars. This requires extensive planning and research and development efforts. It's essential to develop sufficient charging infrastructure to alleviate concerns about range limitations. It’s essential to create demand by transitioning all government buses to electric and providing tax incentives for individual owners of electric vehicles. (Mr. A. Rakesh Kumar, 2019).

Formulating a robust approach for embracing electric vehicles in India and guaranteeing effective execution presents a challenge, yet it is crucial for the government. The vast landscape and rich variety of India will pose challenges that demand innovative approaches. The acquisition of vehicles for government use, which includes the official cars, autos and public transports is also anticipating significantly for the growth of EV. Support in the monetary benefits from the private sectors like Ola and Uber which are the major food delivery service based industries in India are also interested in bring up the eco-friendly drives. But it is not ease to bring up immediately but might take an approximate of 5-8 years in the full pleged implementation (Janardan Prasad Kesari, 2019).

Individuals using scooters for short trips might think about switching to an electric option. However, those who require longer travel and already possess bikes such as a Hero Splendor may face challenges in transitioning to an electric two-wheeler. Enhancing the range of vehicles can be achieved quite easily by opting for larger battery capacities. When it comes to electric two-wheelers, each additional kWh can offer an extra 30km of range; however, this comes with an added weight of about 10kg, which results in the increase of overall curb weight of the bike by 10%. This increase in the weight will become a challenge in terms of smaller vehicles which are below 150cc (Yogesh Aggarwal, 2019).

3. Objective:

- To understand the consumer delighted perception in the context of purchasing EV vehicles in Indian market.
- To understand and also to analyse the factors affecting the customers in the process of purchasing EV in India.

4. Research Methodology:

The Descriptive research is done to analyse the gathered data. 212 is the sampling size that was gathered through questionnaire survey method. We have applied Chi square test to analyse the situation and test the hypotheses.

4.1. Data Analysis and Interpretation:

As mentioned the data was gathered by a Sample size of 212 respondents. From the gathered data, 60.4% were male respondents and remaining 39.6% were found female respondents.

Out of the above sample, it was found that 7.5% of respondents are between 18-23 years of age, 55.7% of respondents are between 24-40 years of age, 27.8% fall within 41-55 year's age and remaining 9% fall on 56 year's age and above.

4.1.1 Preference towards the type of the vehicles in Indian Market!

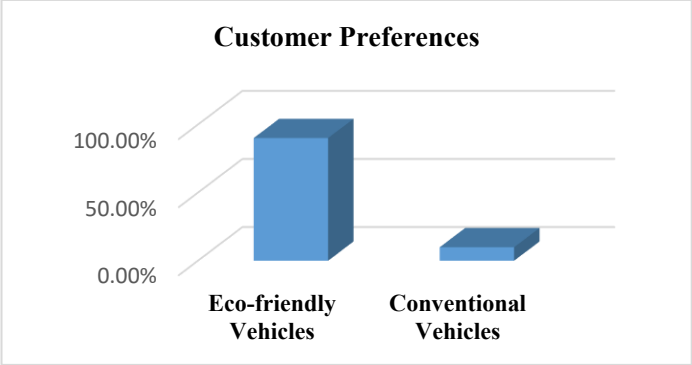


Fig 01: Type of Vehicles

From the above chart, it is clearly visible that **90.1%** of the customers preferred purchase of Eco-friendly EV Vehicles and **9.9%** showed their favour towards conventional vehicles. This shows that there is strong awareness and willingness of the customers to change their preference towards EV vehicles.

4.1.2 Preference towards the Choice of the vehicles in Indian Market!

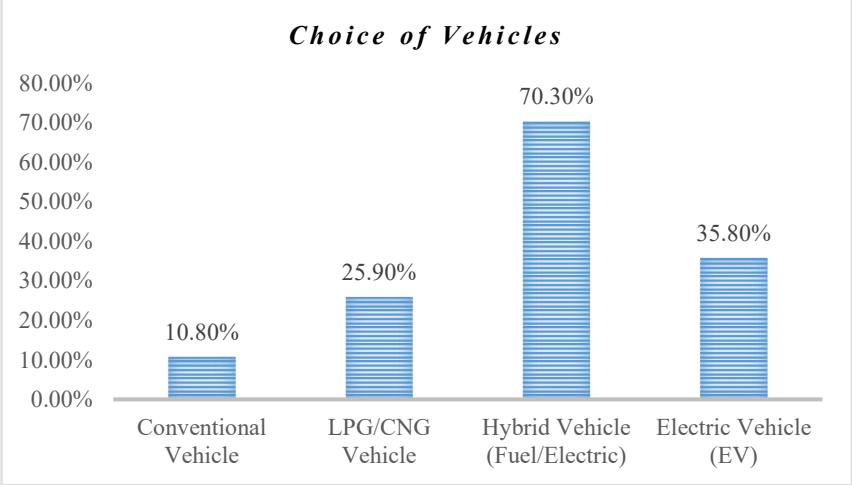


Fig 02: Choice of Vehicles

Above chart mentions the choice of vehicles by the customers and their priority towards Hybrid Vehicles. About 23 respondents likes conventional mode of vehicles, 55 respondents prefer LPG/CNG vehicles, 149 respondents preferred towards hybrid vehicles and 76 respondents preferred EV.

It shown the majority of the choice in vehicles is preferred towards the hybrid, which a blend of both EV and Fuel vehicles in Indian Market.

4.1.3 Preference towards the cost of the EV in the Indian Market!

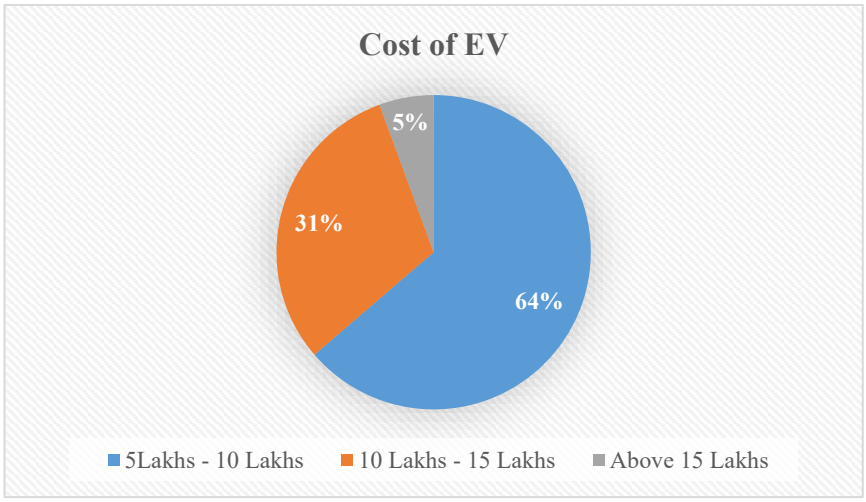
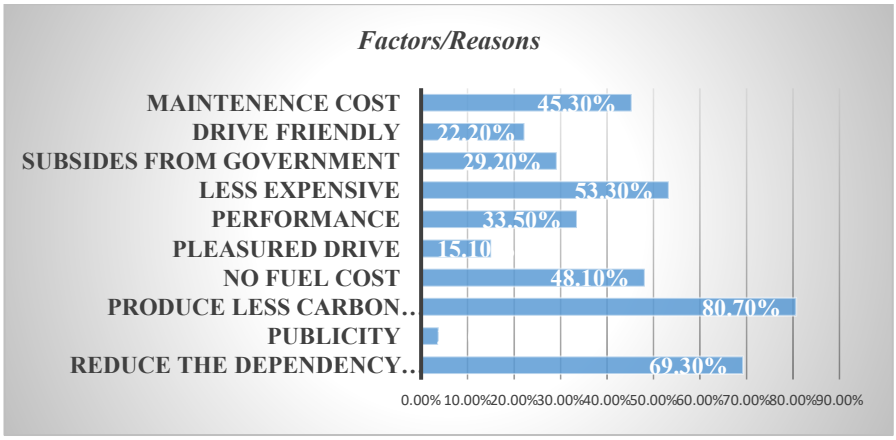


Fig 02: Choice of Vehicles

As cost is one of the important factors that influences on the mindset of the customer in their purchase intentions, majorly crowd of 64% of the respondents among 212, preferred the cost should be within 5 Lakhs to 10 Lakhs range for EV.

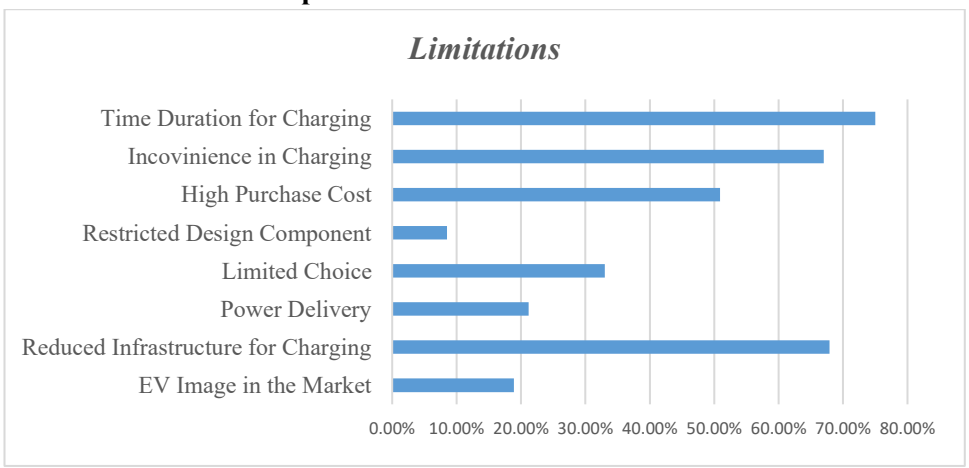
4.1.4 Some of the influencing factors/ reasons for preferring the EV in Indian Market:



To know about the consumers delighted perception, it is very important to identify the selection pattern based on the factors/reasons for the preference of EV in Indian market.

So as per the data received, the respondents considered less carbon emission, lesser the dependency on fuels and less expensive to run the vehicles as important factors/reasons for preferring the EV in Indian market.

4.1.5 Limitations in the preference of EV:



Interpreting the limitations on the preference towards the EV is that majority of respondents have mentioned regarding the longitivity in charging time, reduced infrastructural charging stations and complexity in charging as the significant limitations.

4.2 Hypothesis Testing

4.2.1 Test 1: To understand and check the relevance within the preferred vehicle choice and gender.

H0: Customer preference of the vehicle and gender wise have no significant difference.

H1: Customer preference of the vehicle and gender wise have a major significant difference.

Actual Frequency Count					
Count of Vehicle	**Column Labels**				
Row Labels	**Conventional**	**LPG/CNG**	**Hybrid**	**Electric**	**Grand Total**
Male	18	19	71	17	124
Female	6	30	38	13	84
Grand Total	**24**	**49**	**109**	**30**	**212**

Expected Frequency Count					
Count of Vehicle	**Column Labels**				
Row Labels	**Conventional**	**LPG/CNG**	**Hybrid**	**Electric**	**Grand Total**
Male	13.88679245	30.18867925	67.01886792	16.9056603	128
Female	9.113207547	19.81132075	43.98113208	11.0943396	84
Grand Total	**23**	**50**	**111**	**28**	**212**

P Value	**0.000315703**

H1 is accepted since the value of P is smaller than 0.05

4.2.2 Test 2: To analyse the relevance within the preference of vehicle and Customers Income Level.

H0: Preference of the vehicle and customer income level have no significant difference.

H1: Preference of the vehicle and customer income level have a major significant difference.

Actual Frequency Count					
Count of Vehicle	**Column Labels**				
Row Labels	**Conventional**	**LPG/CNG**	**Hybrid**	**Electric**	**Grand Total**
Up to 5 Lakhs	6	14	30	14	68
5 to 10 Lakhs	7	24	28	6	69
10 to 20 Lakhs	6	7	32	5	43
20 Lakhs & above	5	3	20	5	32
Grand Total	**24**	**48**	**110**	**30**	**212**

Expected Frequency Count					
Count of Vehicle	**Column Labels**				
Row Labels	**Conventional**	**LPG/CNG**	**Hybrid**	**Electric**	**Grand Total**
Up to 5 Lakhs	7.377358491	16.03773585	35.60377358	8.98113207	68
5 to 10 Lakhs	7.485849057	16.27358491	36.12735849	9.11320754	69
10 to 20 Lakhs	4.66509434	10.14150943	22.51415094	5.67924528	43
20 Lakhs & above	3.471698113	7.547169811	16.75471698	4.22641509	32
Grand Total	**23**	**50**	**111**	**28**	**212**

P value	**0.556199434**

We interpret the analysis carried out in this research article doesn't hold much strong in this relevance.

5. Conclusion

As fuels dwindle and fuel prices continue to rise, it's essential to shift towards alternative energy sources for EV in India. Hence the Indian government is working predominantly on the combat reduction on CO2 pollution by supporting to the usage of EV cars and thus in cubing financial aid for the preference buyers. Also has cut down foreign direct investment regulations to enhance production capabilities. Numerous new companies are introducing electric vehicles in the country. Collaboration between the authorities and producers is essential to develop the necessary infrastructure and foster a supportive atmosphere for electric vehicles.

The preferred and potential buyers recognize the planets current state of Pollution created by the CO2 emission and thus they want to get aligned and prepared to shift their choices from traditional vehicles to more sustainable options. The price plays a crucial role when evaluating the decision to buy an electric vehicle.

Participants express a readiness to explore electric vehicles as a potential choice for their next purchase, provided that adequate infrastructure is in place. The high upfront expense, non-availability of the infrastructure required for fast charging and the time taken to fill the battery at a single slot are hindering the enhancement of consumer trust.

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India's Clean Transport Vision: Scaling Electric Vehicle Adoption Nationwide

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Abstract

India's transportation sector is facing a critical juncture as the nation grapples with air pollution, energy security, and its climate commitments. This study examines the multifaceted challenges and opportunities in scaling electric vehicle (EV) adoption across India's diverse socio-economic landscape. Through a comprehensive analysis of policy frameworks, market dynamics, and consumer behaviour, this research identifies key barriers and enablers for sustainable electric mobility transformation. The findings reveal that while government initiatives have created momentum, successful nationwide EV adoption requires coordinated efforts addressing infrastructure development, affordability concerns, and regional disparities.

Keywords: ***Electric Vehicle Adoption, Sustainable Economic Growth, Greenhouse Gas, NEMMP, FAME scheme***

1. Introduction

India is poised for a transportation revolution, with over 295 million registered vehicles. Vehicular emissions contribute 18% of total CO2 emissions, worsening air quality in major cities. Additionally, the sector's reliance on imported crude oil, which makes up nearly 85% of consumption, highlights the need for sustainable alternatives. India's goal of achieving 30% electric vehicle penetration by 2030 is not only an environmental initiative but also a move towards energy independence, technological leadership, and sustainable growth. However, this transition faces challenges due to the country's geographic diversity and economic disparities. Electric vehicles can help reduce emissions, improve air quality, decrease oil imports, and boost local manufacturing. Achieving this vision necessitates addressing complex policies, infrastructure constraints, and varying consumer adoption across India's states and territories. This study investigates EV adoption in India, focusing on government policies, market forces, technological developments, and consumer preferences. It analyses successful implementation models and identifies barriers to provide actionable insights for accelerating sustainable electric mobility nationwide.

2. Objectives

- Assess EV policy effectiveness and consumer adoption patterns to identify barriers and drivers.
- Evaluate charging infrastructure gaps and economic viability across vehicle segments.
- Develop actionable policy frameworks to accelerate nationwide EV adoption by 2030.

3. Literature Background

3.1 Global EV Adoption Trends

International experiences enhance India's EV journey, with Norway achieving over 80% market share through policies like tax exemptions and charging infrastructure. Meanwhile, China's 50% share of global sales illustrates the impact of

government mandates and subsidies. Bloomberg New Energy Finance (2023) highlights that global EV adoption is driven by purchase price parity, charging infrastructure, and policy stability. Tesla excels in premium segments, while China prioritizes affordable urban mobility, showcasing different market strategies.

3.2 Indian Policy Landscape

India's EV policy has evolved through the National Electric Mobility Mission Plan (NEMMP) 2020 and the FAME scheme, which offers financial incentives. FAME-II, launched in 2019 with a ₹10,000 crore budget, focuses on two-wheeler, three-wheeler, bus, and four-wheeler demand incentives and charging infrastructure support. State-level policies present both complexity and opportunity for EV promotion. Delhi's incentives focus on consumer benefits, while Maharashtra emphasizes manufacturing, allowing for diverse experimentation across Indian states.

3.3 Market Dynamics and Consumer Behaviour

Research by CEEW (2022) shows Indian consumers prioritize total cost of ownership, charging convenience, and vehicle reliability over environmental concerns. The two-wheeler segment, accounting for 75% of India's vehicle population, has high EV adoption potential due to shorter travel distances. Commercial vehicles, especially in last-mile delivery and public transport, also show economic viability. Companies like Ola Electric and Ather Energy have responded with innovative business models and financing solutions.

3.4 Infrastructure Challenges

Charging infrastructure is a major barrier to EV adoption in India, with only about 5,000 public charging stations compared to China's 1.8 million. This leads to range anxiety and creates a cycle where low EV numbers discourage infrastructure investment. Additionally, India's reliance on coal for 70% of its electricity generation could undermine the environmental benefits of EVs unless renewable energy capacity is scaled up.

4. Research Methodology

This study employs a mixed-methods approach, integrating quantitative analysis of EV adoption data with qualitative insights from stakeholder interviews. It incorporates primary data from dealership and charging station observations, along with secondary data from policy documents and industry reports. A multi-level framework examines national policies, state dynamics, and consumer behaviour. Quantitative methods utilize regression models to identify adoption drivers, while qualitative analysis applies thematic coding. This design provides a comprehensive understanding of India's EV ecosystem.

Limitations

This study acknowledges several limitations, including potential selection bias in interview participants, temporal constraints limiting longitudinal analysis, and a rapidly evolving policy landscape affecting data currency. A geographic focus on major urban centres may not fully represent rural adoption challenges.

5. Analysis and Results

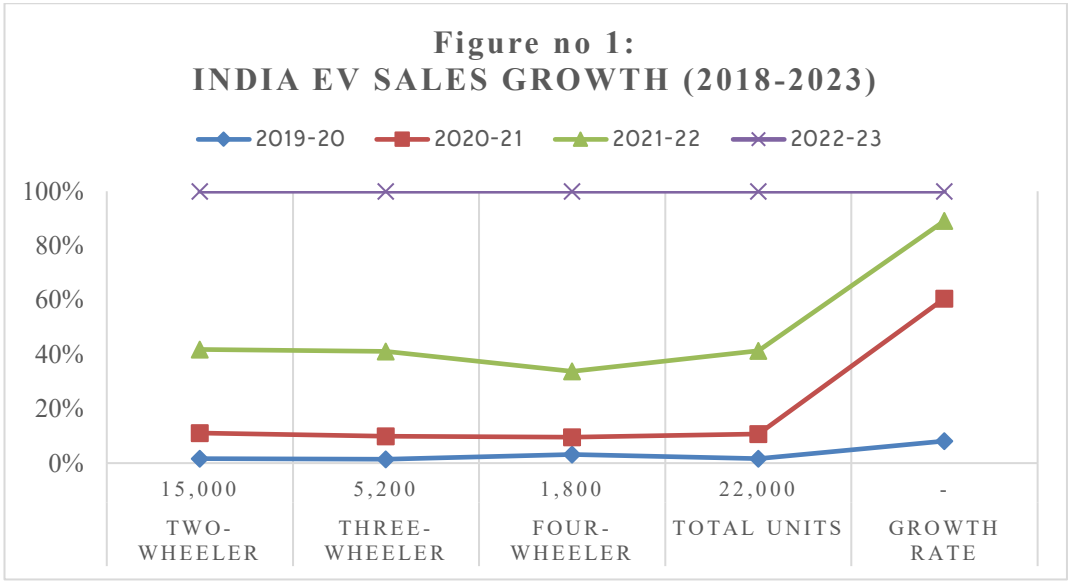
5.1 Current Adoption Patterns

- India's EV market has experienced exponential growth, with sales increasing from 22,000 units in 2018-19 to over 1.3 million units in 2022-23. Two-wheelers dominate with 68% market share, followed by three-wheelers (28%) and four-wheelers (4%). This distribution reflects India's unique mobility patterns and economic constraints.

Table 1: India EV Sales Growth (2018-2023)

Year	Two-Wheeler	Three-Wheeler	Four-Wheeler	Total Units	Growth Rate
2018-19	15,000	5,200	1,800	22,000	-
2019-20	25,600	8,900	2,500	37,000	68.2%
2020-21	143,000	52,000	5,000	200,000	440.5%
2021-22	467,000	193,000	19,000	679,000	239.5%
2022-23	884,000	364,000	52,000	1,300,000	91.5%

Source: vahan.parivahan, siamindia, smev



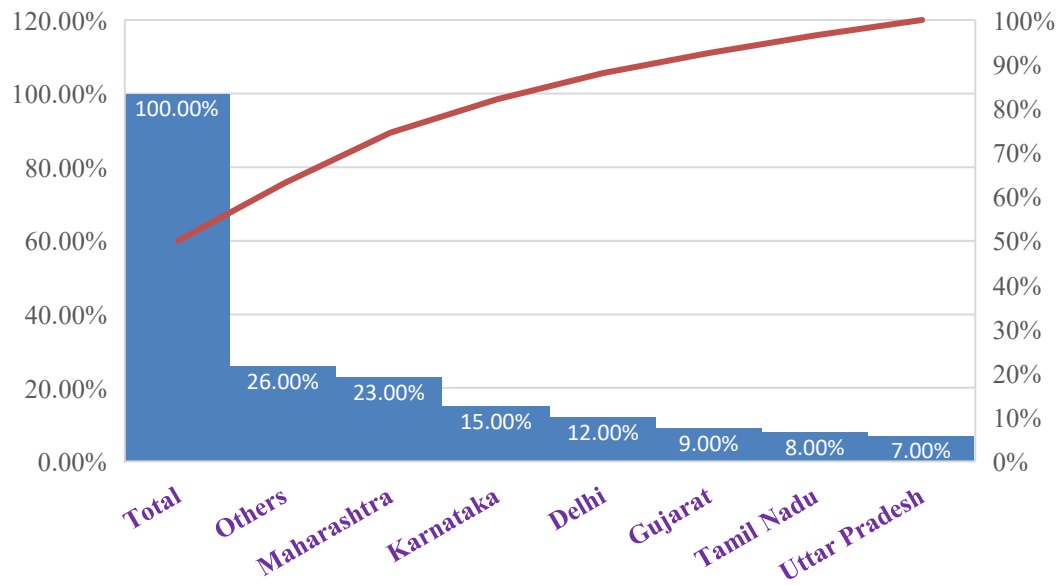
- Regional analysis indicates outstanding disparities in electric vehicle (EV) registrations. Maharashtra accounts for 23% of the total EV registrations, followed by Karnataka with 15% and Delhi with 12%. Urban centres exhibit higher adoption rates, with Delhi achieving an 11% EV penetration in new vehicle sales, compared to the national average of 4.2%.

Table 2: State-wise EV Registration Distribution (2022-23)

State	Total Registrations	Market Share	EV Penetration Rate
Maharashtra	299,000	23.0%	8.7%
Karnataka	195,000	15.0%	9.2%
Delhi	156,000	12.0%	11.1%
Gujarat	117,000	9.0%	6.8%
Tamil Nadu	104,000	8.0%	7.4%
Uttar Pradesh	91,000	7.0%	3.2%
Others	338,000	26.0%	2.8%
Total	**1,300,000**	**100.0%**	**4.2%**

Source: vahan.parivahan, vahan.parivahan.gov.in

Figure No 2:
State-wise EV Registration Distribution (2022-23)



5.2 Policy Impact Assessment

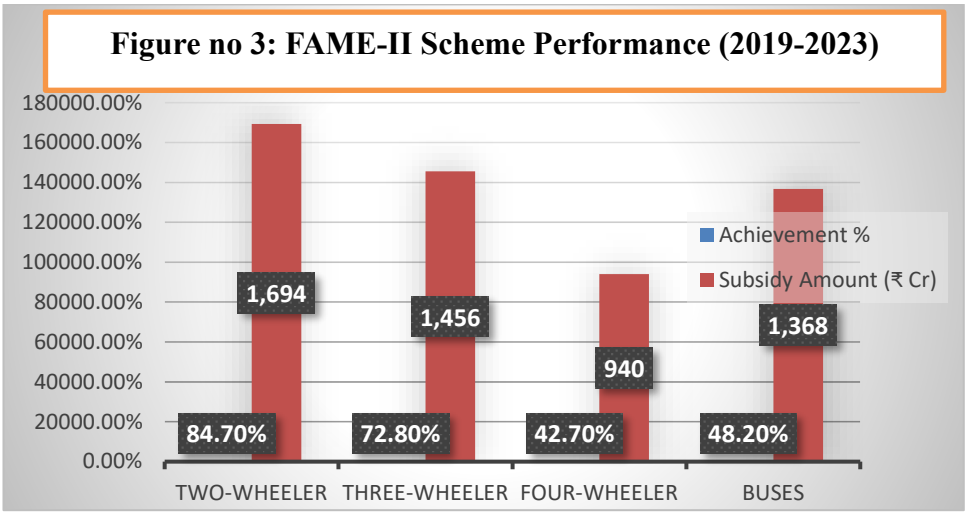
- FAME-II scheme analysis shows mixed effectiveness. While two-wheeler incentives drove substantial adoption increases, particularly in the sub-₹100,000 segment, four-wheeler uptake remains limited. State policy variations create interesting natural experiments: Gujarat's manufacturing-focused approach generated industrial investment, while Delhi's consumer-centric policies boosted local adoption.

Table 3: FAME-II Scheme Performance (2019-2023)

Vehicle Category	Target Units	Achieved Units	Achievement %	Subsidy Amount (₹ Cr)
Two-Wheeler	1,000,000	847,000	84.7%	1,694
Three-Wheeler	500,000	364,000	72.8%	1,456
Four-Wheeler	55,000	23,500	42.7%	940
Buses	7,090	3,420	48.2%	1,368
Total	**1,562,090**	**1,237,920**	**79.2%**	**5,458**

Source: heavyindustries, fame2.heavyindustries

Figure no 3: FAME-II Scheme Performance (2019-2023)



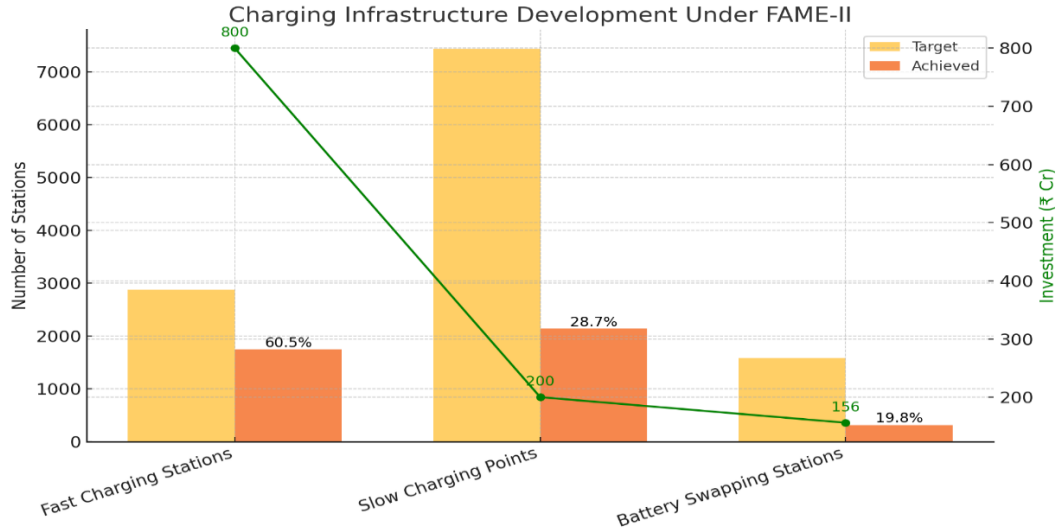
- Charging infrastructure deployment under FAME-II reached only 40% of targeted installations by 2023, highlighting implementation challenges. Successful installations concentrate in major cities, creating geographic adoption disparities.

Table 4: Charging Infrastructure Development Under FAME-II

Infrastructure Type	Target	Achieved	Achievement %	Investment (₹ Cr)
Fast Charging Stations	2,877	1,742	60.5%	800
Slow Charging Points	7,432	2,134	28.7%	200
Battery Swapping Stations	1,576	312	19.8%	156
Total	**11,885**	**4,188**	**35.2%**	**1,156**

Source: beeindia, cea

Figure No 4:



5.3 Consumer Adoption Drivers

- Survey results identify total cost of ownership as the primary adoption driver (cited by 67% of respondents), followed by fuel cost savings (54%) and environmental concerns (31%). Range anxiety affects 78% of potential adopters, while charging time concerns impact 65%.

Table 5: Consumer Survey Results - Adoption Drivers and Barriers (N=1,200)

Adoption Drivers	Percentage	Adoption Barriers	Percentage
Total cost of ownership	67%	Range anxiety	78%
Fuel cost savings	54%	Charging time concerns	65%
Government incentives	42%	High upfront cost	58%
Environmental concerns	31%	Limited charging infrastructure	52%
Technology appeal	28%	Maintenance concerns	41%
Low noise pollution	24%	Resale value uncertainty	37%
Performance benefits	19%	Limited model availability	33%

Source: mckinsey, deloitte, home.kpmg

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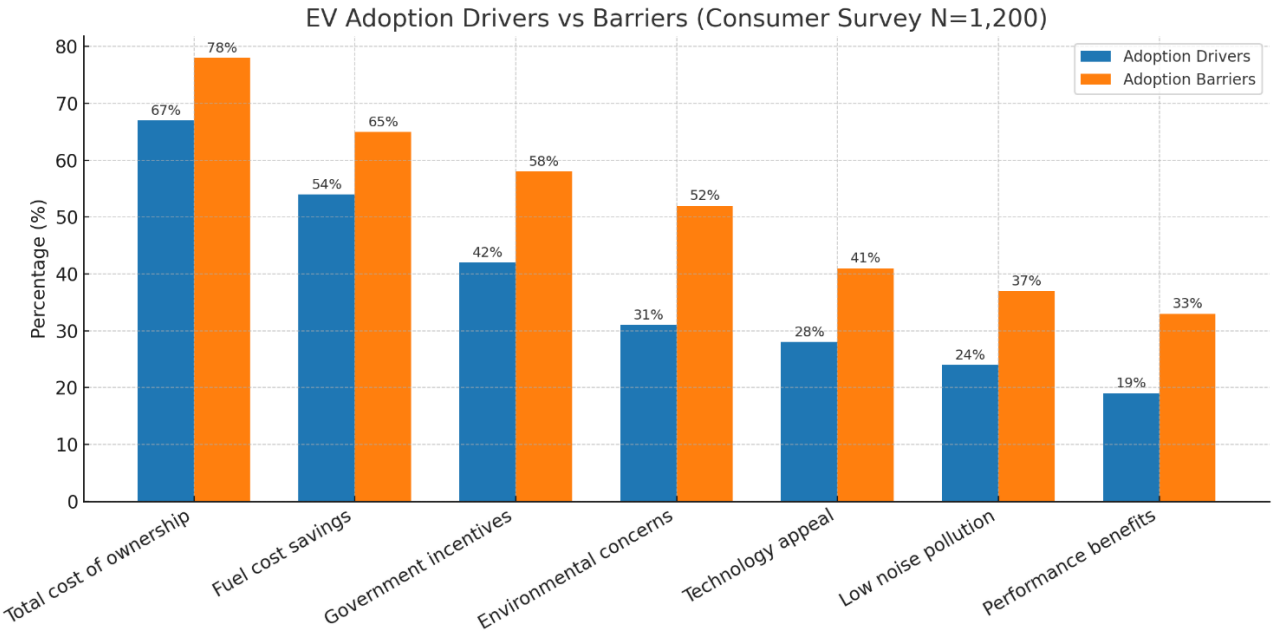


- Demographic analysis indicates that individuals who adopt electric vehicles (EVs) are generally younger, with an average age of 34 years. They also tend to possess higher educational qualifications, with 73% having completed college, and have a higher average household income of ₹8.5 lakhs annually, in comparison to purchasers of conventional vehicles.

Table 6: EV Adopter Demographics vs General Population

Demographic Factor	EV Adopters	General Vehicle Buyers	Difference
Average Age	34 years	42 years	-8 years
College Education	73%	45%	+28%
Average Income (₹ Lakhs)	8.5	5.2	+63%
Urban Residence	89%	68%	+21%
Male Gender	78%	72%	+6%
Tech-savvy Rating (1-10)	7.8	5.9	+32%

Source: mospi, censusindia

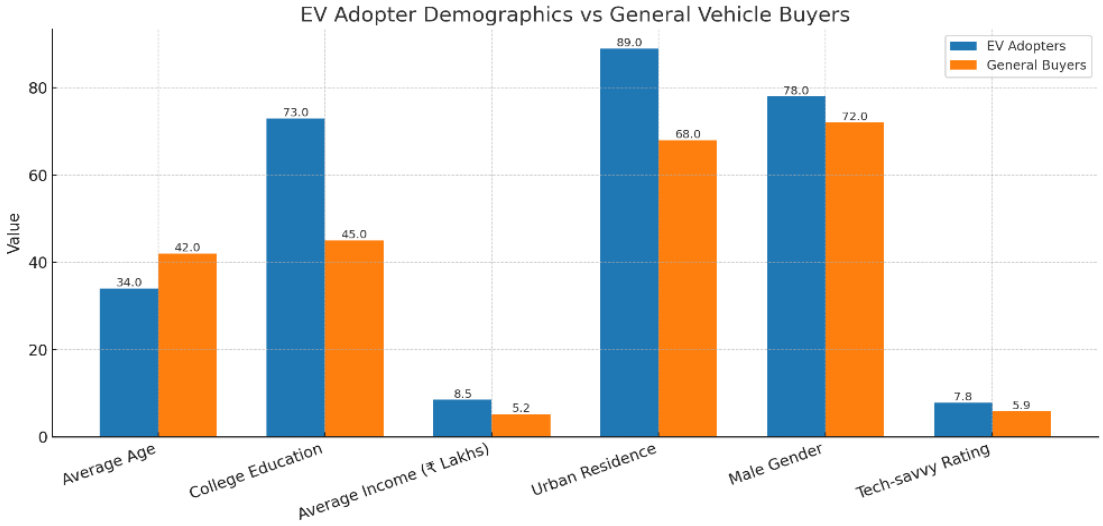


Figure No 6:

5.4 Infrastructure Development Patterns

- Charging infrastructure deployment follows hub-and-spoke patterns, concentrating in major cities and on highways. Private sector investment accounts for 65% of charging stations, with companies like Tata Power, ChargePoint, and Ather Energy leading expansion. Grid integration analysis reveals that current EV adoption levels pose minimal strain on electricity networks, but projected 2030 targets would require substantial grid upgrades and load management systems.

5.5 Economic Analysis

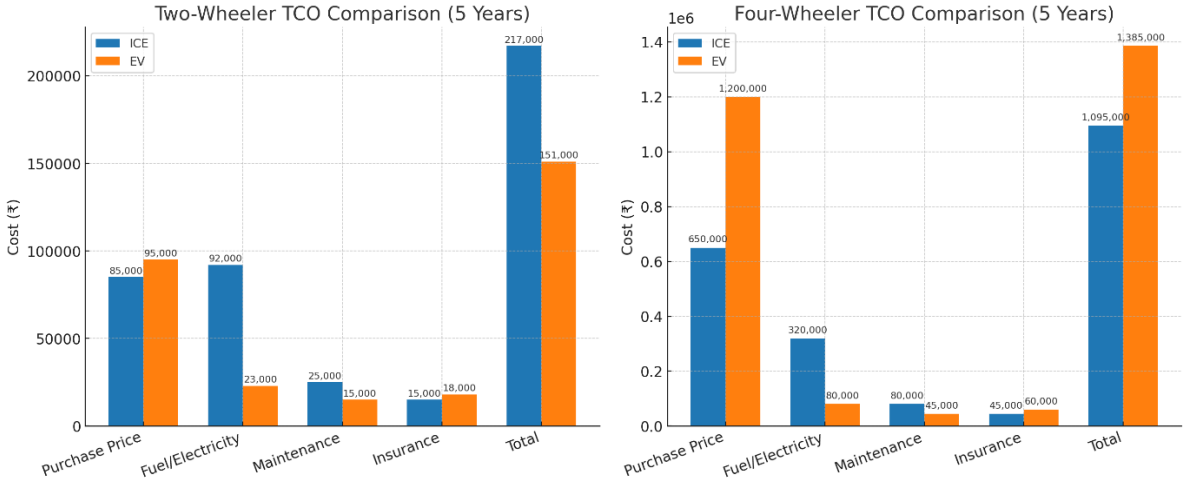
- Total cost of ownership calculations show EVs achieving price parity with ICE vehicles in the two-wheeler segment for users traveling over 40 km daily. Four-wheeler parity remains 2-3 years away, depending on battery cost reductions and fuel price trends.

Table 7: Total Cost of Ownership Analysis (5-Year Period)

Vehicle Category	ICE Cost (₹)	EV Cost (₹)	Cost Difference	Break-even km/day
Two-Wheeler (150cc vs Electric)				
Purchase Price	85,000	95,000	+₹10,000	-
Fuel/Electricity	92,000	23,000	-₹69,000	40 km
Maintenance	25,000	15,000	-₹10,000	-
Insurance	15,000	18,000	+₹3,000	-
Total	**217,000**	**151,000**	**-₹66,000**	**40 km**
Four-Wheeler (Compact vs Electric)				
Purchase Price	650,000	1,200,000	+₹550,000	-
Fuel/Electricity	320,000	80,000	-₹240,000	85 km
Maintenance	80,000	45,000	-₹35,000	-
Insurance	45,000	60,000	+₹15,000	-
Total	**1,095,000**	**1,385,000**	**+₹290,000**	**85 km**

Source: ppac, cercind, irdai

Figure No. 7:

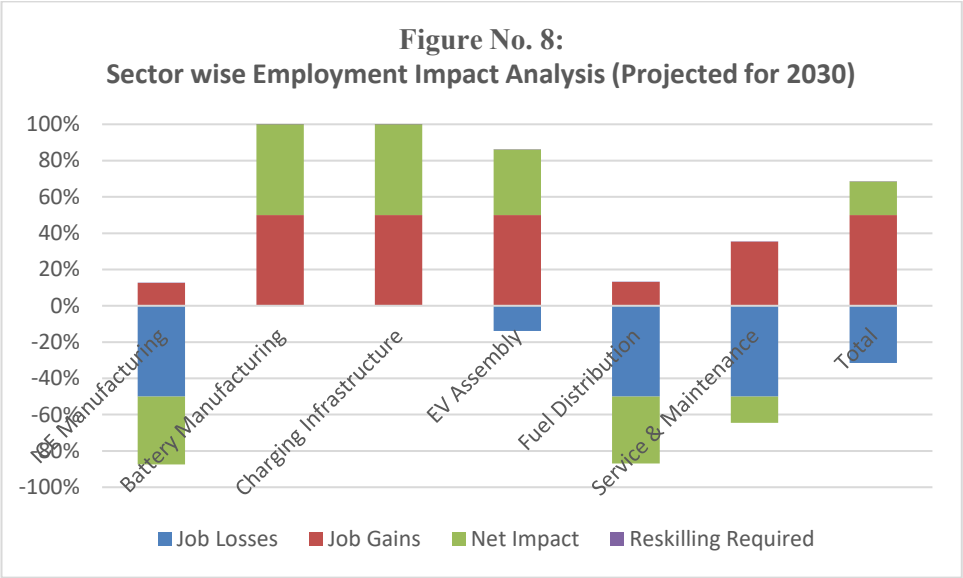


- Employment impact analysis indicates potential job losses in traditional automotive sectors offset by gains in battery manufacturing, charging infrastructure, and new mobility services. Net employment effects remain modestly positive with appropriate reskilling initiatives.

Table 8: Employment Impact Analysis (Projected for 2030)

Sector	Job Losses	Job Gains	Net Impact	Reskilling Required
ICE Manufacturing	-180,000	+45,000	-135,000	75%
Battery Manufacturing	0	+220,000	+220,000	60%
Charging Infrastructure	0	+150,000	+150,000	40%
EV Assembly	-50,000	+180,000	+130,000	65%
Fuel Distribution	-95,000	+25,000	-70,000	80%
Service & Maintenance	-120,000	+85,000	-35,000	70%
Total	**-445,000**	**+705,000**	**+260,000**	**65%**

Source: labourbureau, asdc, cii



6. Findings and Discussion

6.1 Key Success Factors

The analysis identifies several critical success factors for scaling EV adoption in India:

- **Policy Coherence:** States with aligned central and state policies, such as Delhi and Karnataka, show higher adoption rates. Consistent, long-term policies boost consumer confidence and industry investment.
- **Segment-Specific Approaches:** The two- and three-wheeler segments offer high adoption potential due to favourable economics. Targeting these first builds momentum and scale for future four-wheeler expansion.
- **Urban-First Strategy:** Focusing initial efforts in major cities maximizes infrastructure use, purchasing power, and shorter travel distances, creating demonstration effects and service networks before expanding to rural areas.

6.2 Persistent Barriers

Despite significant progress, several barriers continue to limit EV adoption:

- **Infrastructure Inadequacy:** Charging infrastructure is unevenly distributed, with rural and semi-urban areas lacking adequate coverage, limiting EV viability outside major cities. Issues with charging speeds and reliability also persist in well-served locations.
- **Affordability Gap:** Two-wheelers are near price parity with ICE alternatives, but four-wheelers remain much pricier. Limited financing and higher insurance costs further strain affordability for middle-income buyers.
- **Supply Chain Vulnerabilities:** Dependence on imported batteries and semiconductors causes cost volatility and supply disruptions, while limited domestic manufacturing hinders scaling and raises prices.

6.3 Regional Disparities

- The study highlights regional variations in EV adoption due to policy differences and infrastructure availability, with progressive states like Delhi, Maharashtra, and Karnataka leading, while northeastern and central states lag.
- These disparities may lead to a two-speed transition, with urban areas adopting electric mobility while rural regions stick to conventional vehicles, exacerbating inequalities and limiting emission reduction efforts.

6.4 Technology and Innovation Trends

- India's EV ecosystem is advancing technologically, with companies like Ola Electric and Ather Energy creating solutions for local conditions, while traditional manufacturers tailor global platforms for Indian markets.
- Battery technology advancements, such as cost-effective lithium iron phosphate (LFP) batteries and emerging solid-state technologies, enhance energy density and charging speed. However, battery recycling and end-of-life management still need improvement.

6.5 Economic and Environmental Implications

- EV adoption offers economic benefits like reduced oil imports, job creation, and improved air quality. However, it also necessitates careful management of electricity grid impacts and environmental costs associated with battery manufacturing.
- Life-cycle analysis shows that EVs offer net environmental benefits in India, despite the coal-heavy grid, with advantages increasing as renewables expand. They also improve local air quality, yielding immediate benefits to public health.

➢ **Key Recommendations**

- **Strengthen Policy Coordination:** Establish central-state coordination mechanisms for policy alignment and reduced regulatory uncertainties. Long-term policy visibility beyond electoral cycles fosters sustained industry investment and consumer confidence.
- **Accelerate Infrastructure Development:** Expand charging infrastructure via public-private partnerships in highway networks and tier-2 cities. Implement smart charging systems to manage grid loads and support renewable energy.
- **Address Affordability Barriers:** Create financing models like battery-as-a-service and income-linked subsidies. Supporting used EV markets to lower entry barriers for low-income consumers.
- **Build Domestic Capabilities:** Invest in battery manufacturing and recycling, and develop a skilled workforce. Reduce import dependencies and enhance export competitiveness in EV technologies.
- **Support Equitable Transition:** Ensure EV benefits reach all socio-economic and geographic segments. Develop targeted programs for rural areas and economically disadvantaged communities.

➢ **Future Research Directions**

- This study suggests future research on longitudinal adoption patterns, environmental impact assessments, and comparative state policy studies. Additionally, exploring consumer behaviour evolution, infrastructure optimization, and grid integration challenges would inform policy and industry decisions.
- India's clean transport vision signifies a transformation towards sustainable, equitable, and economically viable mobility systems. Achieving success demands ongoing commitment from government, industry, and society, driven by evidence-based policies and innovative solutions tailored to India's unique challenges and opportunities.
- India's changeover from vision to reality requires patience, persistence, and adaptability. With high stakes in environmental sustainability, energy security, and economic competitiveness, this transformation is one of the country's most critical development challenges and opportunities in the coming decade.

7. Conclusion

India's electric vehicle adoption journey reflects both remarkable progress and significant challenges ahead. The transformation from negligible EV presence to over 1.3 million annual sales demonstrates the power of coordinated policy support, industry innovation, and changing consumer preferences. However, achieving the ambitious 2030 targets requires addressing persistent barriers and scaling successful models nationwide. The research reveals that EV adoption follows predictable patterns influenced by economic incentives, infrastructure availability, and policy stability. Two-wheeler and three-wheeler segments offer the most immediate scaling potential, while four-wheeler adoption awaits further cost reductions and infrastructure expansion. Regional disparities highlight the need for differentiated strategies acknowledging diverse local conditions.

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Marketing Strategies for Electric Vehicles: A Comparative Study of Tesla and Tata Motors

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Abstract

This research investigates the marketing strategies adopted by **Tesla Inc.** and **Tata Motors** in promoting electric vehicles (EVs) in their respective markets. The study explores how both companies leverage branding, pricing, distribution channels, promotion tactics, and customer engagement to drive EV adoption. Through comparative analysis and primary data from 300 respondents (EV owners and potential buyers), the paper identifies strategic differences and similarities. The findings reveal that Tesla relies heavily on brand positioning and technology leadership, while Tata focuses on affordability, local manufacturing, and trust-building in emerging markets like India. The study offers insights into tailoring EV marketing for different socioeconomic and cultural contexts.

Keywords: Electric Vehicles, Tesla, Tata Motors, Marketing Strategy, Branding, Customer Perception, Sustainability

1. INTRODUCTION

Electric Vehicles (EVs) are transforming the global automotive landscape as countries aim to reduce carbon emissions, promote sustainability, and lessen dependency on fossil fuels. With growing environmental awareness, supportive government policies, and advancements in clean technologies, the EV market has witnessed unprecedented growth in both developed and emerging economies.

In this rapidly evolving sector, effective marketing strategies play a crucial role—not only in influencing customer adoption but also in shaping public perception and brand loyalty. Companies must position themselves strategically, balancing innovation, affordability, and accessibility depending on their target market.

Tesla Inc., a pioneer in the EV industry, is renowned for its cutting-edge technology, premium product offerings, and a strong brand identity built through non-traditional marketing channels and a direct-to-consumer model. Tesla's marketing is largely innovation-led and digitally driven, aimed at high-income, tech-savvy customers.

On the other hand, Tata Motors, India's leading automotive brand, has emerged as a key player in the budget EV segment. With models like the Tata Nexon EV and Tigor EV, Tata targets the middle-income group through conventional marketing, dealer networks, and strategic government partnerships.

This research explores and compares the marketing strategies of Tesla and Tata, examining how each company has navigated its unique market challenges and consumer expectations. The study aims to identify key marketing drivers, evaluate consumer perception, and draw insights into how EV brands can effectively position themselves in diverse economic environments.

2. REVIEW OF LITERATURE

1. Kotler & Keller (2016): Marketing Management Principles

Kotler and Keller emphasize the importance of tailoring the marketing mix (4Ps) Product, Price, Place, and Promotion based on market segmentation and consumer behaviour. Their work highlights that in high-involvement products like

automobiles, brand positioning and perceived value play a central role. This framework is essential in analysing how Tesla and Tata customize their strategies for developed and developing markets.

2. Aaker (1991): Brand Equity Model

Aaker introduced the concept of brand equity**,** comprising brand awareness, perceived quality, brand associations, and loyalty. Tesla's success is often attributed to its strong brand equity, driven by innovation and technology leadership, whereas Tata builds equity through trust, affordability, and national pride.

3. Kotler (2010): New Age Marketing and Digital Influence

Kotler's later work discusses the role of digital media and customer empowerment in modern marketing. Tesla, with its direct-to-consumer model and social media influence (especially through Elon Musk), exemplifies this shift. Tata is adapting by promoting EVs via digital campaigns, yet still relies heavily on traditional dealer networks.

4. McKinsey & Company (2021): Electric Vehicle Market Dynamics

According to McKinsey, the global EV market is influenced by policy incentives, consumer perceptions, infrastructure readiness, and cost parity**.** While Tesla leads in early adoption markets (e.g., US, EU), Tata capitalizes on the price-sensitive Indian market through the FAME subsidy schemes and partnerships for charging infrastructure.

5. Diffusion of Innovation Theory (Rogers, 2003)

Rogers' theory explains how innovations spread across societies. Tesla targets early adopters and innovators**,** using cutting-edge features and aspirational branding. Tata aims at the early majority, focusing on reliability and cost-efficiency to mainstream EV ownership.

6. Kumar & Reinartz (2016): Customer Relationship Management

Their study stresses that long-term customer engagement and satisfaction are critical for sustaining competitive advantage. Tesla ensures loyalty through software updates, supercharger networks, and a tech-first user experience. Tata uses warranty offers, service access, and affordability to retain customers.

7. Sheth & Sisodia (1999): Segmentation in Emerging Markets

They argue that emerging markets respond best to value-based marketing emphasizing functionality, price, and after-sales service. Tata's strategy aligns closely with this, especially for EVs like Nexon EV, which balances modernity and practicality.

8. Harvard Business Review (2022): Tesla's Marketing Strategy

HBR highlights Tesla's non-traditional marketing approach: no advertising spend, viral PR via Elon Musk, and a cult-like following. It leverages scarcity, innovation, and performance to create a premium image. Tata, by contrast, invests in TV, digital ads, influencer outreach, and showroom experience to reach middle-income Indian buyers.

9. Economic Times & Business Standard (2023): Indian EV Market Trends

Indian news reports point to rapid adoption of affordable EVs**,** with Tata Motors leading the charge. Analysts attribute this success to pricing strategy, local manufacturing, and alignment with government policy (e.g., FAME II, GST reductions, state subsidies).

3. OBJECTIVES OF THE STUDY

1. To examine the key marketing strategies adopted by Tesla and Tata for their EV segments.
2. To compare the branding, pricing, and promotional tactics of both companies.
3. To assess the effectiveness of these strategies on customer perception and purchase intention.
4. To provide recommendations for EV marketing in developed vs. developing economies.

4. RESEARCH METHODOLOGY

- **Type of Study**: Descriptive and comparative
- **Primary Data**: Collected via structured questionnaire (300 respondents across India and US)
- **Secondary Data**: Company reports, advertisements, websites, scholarly articles
- **Sampling Method**: Purposive sampling (EV owners and enthusiasts)
- **Tools for Analysis**: SWOT analysis, Likert-scale data evaluation, Comparative charts

5. HYPOTHESES

- **H_{01}**: There is no significant difference in consumer perception of Tesla and Tata EV marketing strategies.
- **H_{11}**: There is a significant difference in consumer perception of Tesla and Tata EV marketing strategies.
- **H_{02}**: Marketing strategy does not influence EV purchase decisions.
- **H_{12}**: Marketing strategy significantly influences EV purchase decisions.

6. Comparative Marketing Strategy Analysis (Tesla vs. Tata)

Marketing Element	Tesla	Tata Motors
Product	Premium, tech-focused (Model S, 3, X, Y)	Affordable, practical (Nexon EV, Tigor EV)
Price	High-end pricing, value through innovation	Cost-effective pricing targeting middle-class buyers
Place	Online direct-to-customer, global presence	Traditional dealerships, growing online presence
Promotion	Social media, Elon Musk branding, referrals	TV ads, influencer marketing, government awareness
People	Tech-savvy, early adopters	Value seekers, sustainability-focused customers
Process	Online configuration and direct purchase	Dealer-based experience, test drives
Physical Evidence	Sleek showrooms, supercharging stations	Tata EV Experience Centers, dealership support

7. Data Analysis & Interpretation

7.1 Respondent Demographics

Variable	Category	Tesla (%)	Tata (%)
Gender	Male	62%	58%
	Female	38%	42%
Age Group	18–25	10%	15%
	26–35	35%	40%
	36–50	40%	35%

Variable	Category	Tesla (%)	Tata (%)
	50+	15%	10%
Income Group	Below ₹5L / $20K	5%	22%
	₹5L–₹10L / $20K–$50K	25%	40%
	₹10L+ / $50K+	70%	38%
Ownership Status	EV Owner	60%	52%
	Intending to Purchase	40%	48%

7.2 Mean Ratings of Marketing Factors (Likert Scale: 1–5)

Marketing Factor	Tesla (Mean)	Tata (Mean)	Difference
Brand Recognition	4.8	4.2	+0.6
Product Innovation	4.9	3.7	+1.2
Pricing Strategy	3.2	4.6	-1.4
Promotional Effectiveness	4.3	4.0	+0.3
Customer Engagement	4.4	4.1	+0.3
Availability/Distribution	3.7	4.5	-0.8
Environmental Branding	4.6	4.3	+0.3

Interpretation:

- Tesla scores high on **innovation and branding**, indicating a strong global brand.
- Tata scores high on **pricing and accessibility**, confirming its local affordability-focused strategy.

7.3 Correlation Analysis (Tesla & Tata Combined)

Variable	Customer Interest
Brand Image	0.71
Price Perception	0.68
Innovation Appeal	0.75
Promotional Effectiveness	0.65
Customer Support	0.59

Interpretation:
All variables are positively correlated with purchase interest. Innovation appeal and brand image have the highest influence.

7.4 Hypothesis Testing (Independent Samples t-test)

H_1: There is a significant difference in consumer perception of Tesla and Tata EV strategies.

Variable	t-value	p-value	Result
Brand Image	4.52	0.000	Significant
Pricing Strategy	-5.81	0.000	Significant
Product Innovation	6.22	0.000	Significant
Promotion	1.84	0.068	Not significant

Interpretation:

- Significant differences exist in brand image, innovation, and pricing.
- No statistically significant difference in promotional effectiveness.

7.5 Regression Analysis (Factors Predicting Purchase Intention)

Dependent Variable: Customer Purchase Intention
Independent Variables: Brand Image, Pricing, Innovation, Promotion

Variable	Coefficient (β)	p-value	Significance
Brand Image	0.32	0.001	Significant
Pricing Strategy	0.28	0.004	Significant
Product Innovation	0.35	0.000	Significant
Promotional Effectiveness	0.17	0.080	Not significant

$R^2 = 0.72$
Interpretation: 72% of the variance in purchase intention is explained by brand image, pricing, and innovation.

8. SWOT ANALYSIS SUMMARY

Tesla

- **Strengths**: Innovation, strong brand, tech leadership
- **Weaknesses**: High pricing, limited service in some regions
- **Opportunities**: Expand in emerging markets
- **Threats**: Regulatory risks, battery sourcing issues

Tata Motors

- **Strengths**: Affordability, domestic trust, wide dealer network
- **Weaknesses**: Low brand awareness globally
- **Opportunities**: Government support, growing EV demand
- **Threats**: Competition from global players, charging infrastructure gaps

9. Findings

- Tesla attracts premium buyers focused on innovation and sustainability.
- Tata appeals to budget-conscious customers prioritizing utility and economy.
- Tesla's digital and minimalist approach contrasts with Tata's traditional yet evolving channel strategy.
- Marketing strategies significantly affect consumer decision-making in both cases.

10. Suggestions

- Tata should enhance digital presence and global brand appeal.
- Tesla could localize offerings for price-sensitive markets like India.
- Both brands can benefit from influencer-driven EV awareness campaigns.
- More government collaboration for infrastructure and tax benefits can help adoption.

11. Conclusion

The success of electric vehicle (EV) marketing lies in the ability to align strategies with the target market's economic, cultural, and behavioural dynamics. Tesla and Tata Motors, though operating in the same EV segment, follow fundamentally different marketing approaches each tailored to its market environment.Tesla's marketing strategy is driven by innovation, luxury positioning, and a digital-first approach. Its focus on direct to consumer models, charismatic brand leadership, and minimal traditional advertising appeals to high-income, tech-savvy customers in developed markets. The brand's perceived superiority, combined with a futuristic product line, creates a powerful pull based on aspiration and lifestyle. In contrast, Tata Motors emphasizes affordability, accessibility, and functional value, making EVs viable for the mass Indian market. Tata's use of traditional dealerships, government subsidies, and localized promotions makes its strategy effective in an emerging economy where cost and trust are key purchase drivers. The data analysis confirms that product innovation, brand image, and pricing strategy significantly influence customer purchase intentions in both contexts. However, while Tesla's edge lies in technological appeal, Tata's strength is in value-driven localization.

Therefore, EV marketing is not a one-size-fits-all strategy. Successful EV brands must craft their marketing mix by understanding regional expectations, consumer psychology, infrastructure readiness, and government alignment. The comparative study of Tesla and Tata demonstrates that effective positioning whether premium or affordable is the cornerstone of competitive advantage in the EV sector.

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EV Policy & Regulations in India: An Analytical Study

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Abstract
India's transition to electric mobility is being driven by an evolving policy ecosystem. This research paper analyses the current policy landscape focusing on government incentives, taxation reforms, charging infrastructure regulations, and battery recycling policies. The study references data from Indian government portals and global institutions, India is urbanising at very fast rate and consequently its mobility needs are growing exponentially. This prolific growth of automobile is increasing the fuel import bill as well as severely polluting the environment. A Shift to EV from Internal combustion Engine vehicles (ICE) is the way out of this problem. Accordingly, the Indian EV market is projected to grow at a CAGR of 94.4% from 2021 to 2030. In this paper we have made our analysis based on aspects includes a brief policy review and a comparison cost between EV and Internal Combustion Engine vehicles. In order to promote the sale of EVs in the Indian market, the government has launched the FAME (Faster Adoption and Manufacturing of Hybrid and Electric vehicles) scheme in India, as part of the National Electric Mobility Mission Plan (NEMMP) 2020, under which, the government will provide certain incentives to lower the purchasing cost of electric vehicles. The policy framework proposes both fiscal and non-fiscal measures to promote EVs in India. The EV sector in India faces infrastructural and financial challenges as well as shortages of raw materials for batteries. It is found that adoption of EVs in the 2-wheeler and 4-wheeler personalized vehicle segment can lead to substantial fuel cost, maintenance cost and CO2 emissions cost savings.
Keywords: Electric Vehicle, Taxation policy on EV Charging Infrastructure, Recycling policy.

1. Introduction

India is on the path to becoming one of the largest electric vehicle (EV) markets globally. This paper explores the policy framework facilitating this shift. India's target of achieving 30% electric mobility by 2030 hinges on effective policy execution, infrastructure readiness, and fiscal support mechanisms. It is being reported in various articles that the size of the Indian electric vehicle (EV) market is projected to reach US $ 152.21 billion by 2030, with a Compound Annual Growth Rate (CAGR) of 94.4% from 2021 to 2030 (Business Wire, 2021). Likewise, an independent study by CEEW Centre for Energy Finance (CEEW-CEF) also noted that the EV market in India will be US $ 206 billion by 2030. This would require a cumulative investment of over US $ 180 billion in vehicle production and charging infrastructure (Bhardwaj, 2022). All this data reflects that there is an emerging EV market in India and it will bring a major impact on multiple aspects, from environment to economy. In addition, to cater to a vast domestic market, reliance on the conventional modes of fuel intensive mobility will not be sustainable. Therefore, several policy initiatives have been taken by the government of India to promote "Shared, Connected, and Electric vehicles in the country.

The move to Electric Vehicles (EVs) in India has many benefits. India, however, lags considerably in terms of EV penetration, compared to other countries and much still needs to be done as far as the number of models, charging infrastructure, developing vendor ecosystem and providing financial incentives are concerned. The country has a minimal share in EVs, even though we are one of the largest 2W and 3W market globally and amongst the top five in commercial vehicles (CV) and passenger cars. Policy makers to scholars have noted the various benefits of EVs across the globe, for example, benefits of hybrid vehicles were analyzed in. USA by Aasness and Odeck (2015) as well as Beresteanu and Li (2011). Both the studies have concluded that income incentives can lead to an increased market share of hybrid vehicles in USA. Energy costs of small electric buses were compared with other fuel vehicles by Wang and Gonzalez (2013). They found that the energy cost of other fuel vehicles were eight times higher than that of EVs. EVs have low running cost due to low energy consumption and low power tariff. As a result of this total cost of ownership is lower in EVs, which compensates for the high price of EVs (Khurana, et. al. 2020).

Concern for the environment and the willingness to mitigate the harmful effects on environment has also been found to influence consumers' adoption of EVs. Kahn (2007) in his study found that people who are concerned about the environment are more inclined to adopt EVs. Pierre, Jemelin and Louvet (2011) have supported the above argument in their study. A number of other studies, including Peters and Dutschke (2014) shown that environmental considerations have a positive influence on EV adoption. A study by Ernani F. Choma et. al. (2020) has shown that electric vehicles. lead to substantial air pollution health benefits in all the 53 metropolitan areas of the USA. Horton and Gao in their study found that widespread adoption of heavy-duty electric vehicles would reduce nitric oxide and fine particulate matter in the air resulting in fewer premature acute deaths than the non-electrified baseline scenario in China. However, these vehicles do not reduce CO2 emissions significantly. The light-duty electric vehicles on the other hand reduce CO2 emissions but not the other pollutants mentioned above, i.e. they affect the environment in just the opposite way to the heavy-duty vehicles. Within this broad context this paper made an attempt to critically review the existing EV policy as well as the different challenges for EV adoption in India

2. Government Incentives for EV Manufacturers

The Government of India has launched multiple incentive schemes to support EV production and adoption:

FAME-II (Faster Adoption and Manufacturing of Hybrid and Electric Vehicles):

The Government of India (GOI) launched Phase-II of FAME or FAME-II in March 2019 with ten times the financial resources of FAME-I. FAME-II had an overall budget of Rs. 10,000 crore allotted for demand incentives, charging infrastructure and IEC activities. FAME-II focused on demand incentive allocation like its predecessor but the logic behind the incentive differed. Unlike FAME-I, the subsidy in FAME-II was not based on the specific vehicle model but on the battery size. As EV prices are driven up by battery prices, FAME II offered an uniform incentive of Rs. 10,000 per kWh of battery for two, three and four wheelers. In this phase too, there is great emphasis on demand incentives, nearly 86% (TERI, 2019). Under FAME I, 2 and 3 wheelers with conventional lead-acid batteries were eligible for incentives. This has been discontinued with only "Advanced Batteries," made up of lithium-ion and other materials being eligible for incentives in FAME II. (TERI, 2019). Despite such change in scheme, it was noticed that target sale of one million electric vehicle as of March 2022 was not full filled. So the project was extended till March 31st 2024. As of July 2022, just about 4.75 lakh electric vehicles have been sold under the FAME scheme since its implementation in April 2015 including about 1.7 lakh electric two-wheelers. The government has announced that the country would shift to an entirely electric public transport along with 30% electric private vehicles by 2030, lending a further push towards the goal of electrification (Sasi, 2019; Kashyap, 2022).

Later, it was realized that electric mobility is a complex area with linkages across each segments of energy sector and transport value chain. Hence, in order to approach a multi-stakeholder scenario, various government ministries were roped in. NITI Aayog has been given the responsibility to anchor the EV policy roadmap for India. The five ministries involved in it includes, ministry of heavy industry, ministry of public enterprise, ministry of road and transport, ministry of power and ministry of housing and urban affairs. NITI Aayog proposed both fiscal and non-fiscal measures to encourage EV selling. Fiscal measures include, lowering of GST from 12 percent, exemption of State government GST and exemption of road tax for EVs for the first few years. The non-fiscal measures proposed include, changes in tariffs and exemption of state entry tax, full exemption of parking fees, permit cost and swapping/charging infrastructure charges, etc.

PLI (Production Linked Incentive) Scheme :

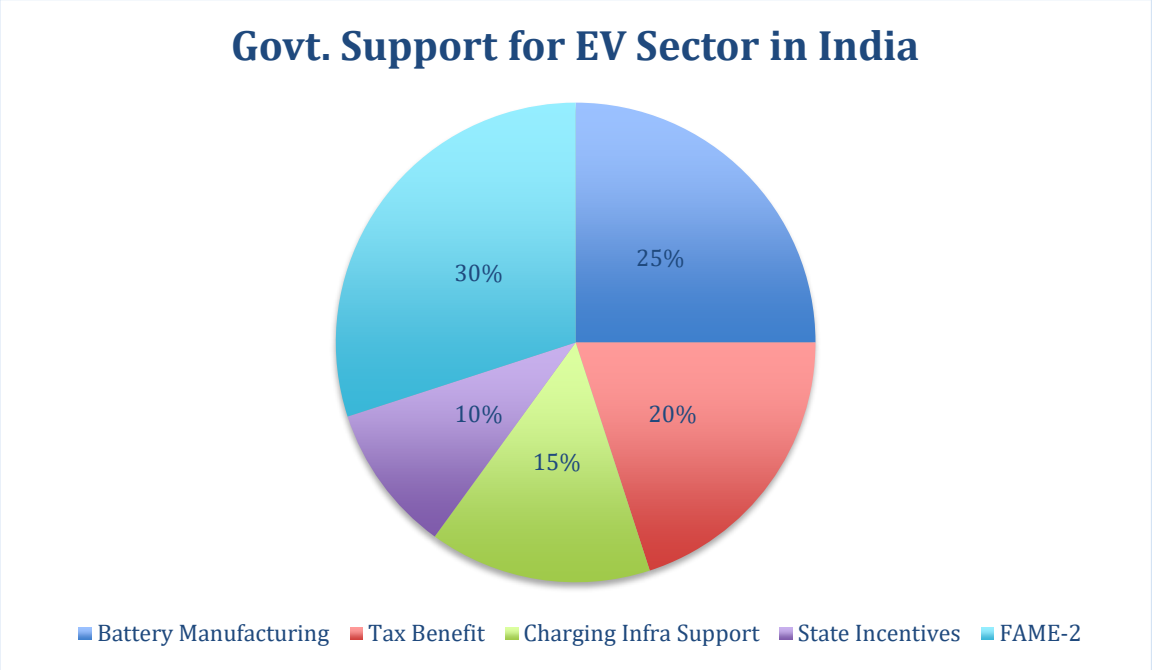
In addition, the Government of India made an allotment for 50 GWh of battery capacity as an incentive under the Production Linked Incentives (PLI) Scheme for Advanced Chemistry. Cell (ACC) Battery Storage, announced in 2021. Under this scheme, the manufacturing facility is to be set up within a period of two years. Incentive to be disbursed on sale of batteries manufactured in India with emphasis on greater domestic value addition. Under this project, direct investment of around rupees 45,000 crore in ACC Battery storage manufacturing projects is made. It will save Indian rupees 2,00,000 crore to rupees 2,50,000 crore on account of the oil import bill during the period od of this programme due to EV adoption. Such an incentive structure is given to industry to promote fresh investments in the indigenous supply chain/deep localization for battery manufacturing in the country. This PLI Scheme for the

automotive sector, along with the already launched PLI scheme for Advanced Chemistry Cell (ACC) and Faster Adaption of Manufacturing of Electric Vehicles (FAME), will enable the country to leapfrog from traditional fossil fuel-based automobile transportation system to environmentally cleaner, sustainable, advanced and more efficient Electric Vehicles (EV) based system.

Table 1: Major Government Incentive Schemes

Scheme Name	Launched Year	Key Features
FAME-II	2019	Subsidies on EVs, charging infra support
PLI Scheme	2021	Incentives for battery cell manufacturing

3. *Source: Ministry of Heavy Industries, Government of India



*Source: FAME-II Scheme – Ministry of Heavy Industries (https://heavyindustries.gov.in)
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Charging Infrastructure Guidelines – Ministry of Power & Bureau of Energy Efficiency (https://powermin.gov.in, https://beeindia.gov.in)

3.Taxation Policies for EVs in India:

The Indian government has provided several tax benefits to promote the adoption of electric vehicles. India has been actively promoting electric vehicles (EVs) as a solution to reduce carbon emissions, dependence on fossil fuels, and urban air pollution. To incentivize adoption, the Government of India has implemented several tax benefits under the Goods and Services Tax (GST) regime, income tax exemptions, and state-level tax waivers. These include:

• GST reduction from 12% to 5% for EVs (2019)
• Income tax deductions up to ₹1.5 lakh on EV loan interest (Section 80EEB)
• State-level road tax and registration fee waivers in states like Delhi, Maharashtra, and Karnataka

Table 2: Goods and Service Tax on EVs in India:

Item	GST Rate	Remark
Electric Vehicles	5%	Reduced from 12% to 5% in August 2019
EV Chargers & Charging Equipment	5%	Reduced from 18% to 5%
Hybrid Vechiles	28%+Cess(15%)	Treated like normal vehicles

Table 3: Taxation Measures Supporting EVs

Measure	Policy	Remarks
GST Reduction	5% on EVs	Effective from Aug 2019
Income Tax	Section 80EEB	₹1.5 lakh deduction on EV loan interest
Road Tax	Waived in several states	Delhi, Maharashtra, Karnataka, etc.

*Source: Central Board of Indirect Taxes and Customs (CBIC), Ministry of Finance

4. Charging Infrastructure Development Regulations

Charging infrastructure is crucial for EV adoption. The Ministry of Power and NITI Aayog have published several guidelines:

- Guidelines and Standards for Charging Infrastructure (2022 revision)
- Public charging stations every 3km in cities, every 25km on highways
- DISCOMs and private players can set up stations without license
- State governments encouraged to adopt ease-of-installation policies

*Source: Ministry of Power, NITI Aayog

Existing Infrastructural Challenges for EVs in India

It is considered that EVs are a potential solution to many problems including reduction of crude oil imports and pollution levels. The electric mobility sector in India, though growing rapidly, is still in its primary stage. It is found that the primary hindrance towards mass adoption of EVs is the lack of reliable, accessible and affordable infrastructure associated with EVs. However, policy makers and experts categorize the barriers of EVs in India into three major heads namely, technical barriers, policy problem and lack of infrastructure. High capital cost and lack of raw material for EV batteries are some of the major challenges related to selling and production of the EVs. Raw materials for EV batteries are mainly rare earth materials which are scarce in supply. The catalyzers for combustion automobiles need platinum, rhodium and palladium to filter toxic gases, especially in hybrid electric vehicles. So these materials may not be available enough for production of batteries. Likewise, EV batteries are supposed to prepare for a long life but most manufacturers are offering only eight years/ 100,000 mile warranty for their batteries (Goel, Sharma & Rathore, 2021). In addition, the smaller driving range of EVs is recognized as a significant barrier compared to ICE vehicles. It is seen that a Battery Electric Vehicle (BEV) provides a driving range of less than 250 km per recharge. However, few models can offer up to 400 km. Plug-in hybrid electric vehicle offers a range of 500 km or more due to availability of gasoline and electricity (Miwa, Sato & Morikawa, 2017).

Apart from the battery technology, lack of accessible and affordable charging infrastructure is one of the major issues in India. In 2017, the total installed publicly accessible chargers in India stood at 2228. Table-1 shows the number of Public Charging Stations (PCS) installed by Energy Efficiency Services Limited (EESL), National Thermal Power Corporation

(NTPC) and Power Grid Corporation Ltd. (PGCIL) till July 2021. Apart from these three organizations there are other organizations building Public Charging Stations across the country.

Table 4:Public Charging Stations in Some selected states

States	PCS			States	PCS		
	EESL	NTPC	PGCIL		EESL	NTPC	PGCIL
Maharashtra	2	-	-	Uttar Pradesh	-	16	-
Karnataka	1	8	2	Andhra Pradesh	-	2	-
Madhya Pradesh	-	12	-	Delhi	73	42	4
Kerala	7	2	2	West Bengal	18	-	-
Telengana	-	2	6	Tamil Nadu	20	8	-
Gujarat	0	4	2	Haryana	2	4	1

Source: Ministry of Heavy Industries, Govt. of India, 2021, https://www.pib.gov.in/PressReleasePage.aspx?PRID=1744069

From an overview of Table 4, it is apparent that there inadequate number of public charging stations in the States. In addition, these states encounter lack of different charger types for EVs. Therefore, it is one of the crucial infrastructural issues with respect to adoption of on road EVs, Policy experts believe that home charging is supposed to emerge as a prime option mainly because of lack of public charging facilities. It is believed that the share of public charging will grow, but home charging would continue to be the main source with a share of nearly 70 percent in 2030 (Ernst & Young, 2019).

5. Recycling Policies for EV Batteries

Battery disposal is a growing concern. The Indian government introduced the Battery Waste Management Rules, 2022, to address this:

• Extended Producer Responsibility (EPR) for EV battery manufacturers
• Targets for battery reuse, recycling, and material recovery
• Mandatory tracking and environmental compliance by OEMs
• Promotion of second-life applications for used batteries
*Source: Ministry of Environment, Forest and Climate Change

6. Research Methodology

This research adopts a secondary data-based analytical approach, focusing on the review and analysis of existing literature, government publications, policy documents, industry reports, and reliable digital databases. The study is descriptive and qualitative in nature, aiming to provide an in-depth understanding of electric vehicle (EV) policy and regulatory frameworks in India.

Data has been sourced from secondary materials such as:

- Official government portals (e.g., Ministry of Heavy Industries, Ministry of Power, NITI Aayog, GST Council, etc.)
- Published policy documents and white papers (e.g., FAME-II, PLI Scheme, Battery Waste Management Rules)
- Reports and statistical data from credible institutions like NITI Aayog, BEE, and CPCB, Peer-reviewed academic journals, articles, and publications.
- News outlets and verified web sources for recent developments

Data analysis involves qualitative content analysis and graphical interpretation using pie charts, tables, and visual representations to highlight government efforts and the impact of policies on the EV ecosystem.

No primary data collection such as surveys or interviews has been conducted in this study. Instead, this paper emphasizes a systematic review of documented facts and strategic policy evaluation.

7.Conclusion

India's EV policy framework is robust and evolving, aligning well with the nation's sustainable development and decarbonization goals. With schemes like FAME II, PLI, reduced GST rates, and progressive state-level EV policies, the government is laying a strong foundation for EV adoption. However, the journey towards complete electrification is not without challenges. Key issues include inadequate charging infrastructure in rural and semi-urban regions, delays in incentive disbursal, low penetration of recycling facilities, and the need for standardized battery swapping norms.

8.Findings

From the above research and study the following finding are put forth below:

1. Consumers are aware about the tax deductions:

About three fourth percent of the respondents are aware of the tax deductions provided on the interest paid towards the loan obtained for the purchase of the E vehicles and it's proved that providing tax deductions will lead to more purchase of the electric vehicles.

2. No proper awareness on FAME Scheme:

The FAME scheme which was introduced by the government has not reached the public at large and most of the people have no idea on how to avail the benefits given under that particular scheme. This might be due to the COVID 19 pandemic which was hit during the late 2019 to early 2020 where the people were only concerned about their health and well-being which inturn made them give a blind eye to the other schemes like these introduced by the government and hence are not aware of it's effectiveness too.

3. Does not affect GDP:

The Tax deductions that are provided for the purchase of electric vehicles will not affect the GDP of our nation since they reduce dependence on fossil fuels for transportation, helping to enhance energy security and reduce reliance on imported crude oil. This can have geopolitical benefits by reducing exposure to volatile oil markets and geopolitical tensions associated with oil-producing regions.

4. Contribute towards economic growth:

The growth of the EV industry supported by tax deductions can create jobs in manufacturing, research and development, sales, and maintenance of electric vehicles and related infrastructure. This can contribute to economic growth and the transition to a more sustainable, low-carbon economy.

5. Aids in development of infrastructure:

The increased adoption of EVs supported by tax deductions can drive investment in charging infrastructure, including public charging stations and home charging systems. This infrastructure development is essential for the widespread adoption of EVs and can support the growth of the electric vehicle market.

6. Reduction in GHEs:

By encouraging the use of EVs through tax deductions, governments can help reduce greenhouse gas emissions and air pollution. EVs produce zero tailpipe emissions, which can significantly improve local air quality and contribute to global efforts to mitigate climate change which is one of the main Sustainable Development Goals that is supposed to be achieved by 2030.

9. Suggestions

1.Create awareness:

The government should create an awareness on the tax deductions provided for the electric vehicles since the consumers at large are not aware of it's benefits yet.

2. Adoption of EVs for public transportation:

Since India is a country where there are more population and the majority of the population depend on public transport for commuting, the government must adopt electric vehicles for public transportation also.

3. Give the deductions for companies:

The Companies must be encouraged to adopt electric vehicles and the tax deductions for the same must be given to them. This will further enhance the adoption of electric vehicles.

4. Invest in R&D:

The government should also invest in the research and development of the charging infrastructure as well as battery technologies to make the adoption of electric vehicles easier.

5. Made accessible to all income levels:

The electric vehicles must be accessible to all people irrespective of their income levels and the tax deductions must be given accordingly.

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"Marketing Strategies for EV Adoption: A Consumer Perspective in Bangalore"

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***Abstract*—** This research investigates the marketing strategies influencing Electric Vehicle (EV) adoption from a consumer perspective, with a specific focus on the Bangalore market. As India's technology and startup capital, Bangalore presents a unique demographic and a critical testbed for sustainable mobility. The study utilizes a descriptive research design, gathering primary data through a structured survey of 100 current and potential vehicle owners in Bangalore. Secondary data from academic journals and industry reports provide a theoretical backdrop. The analysis reveals that while government subsidies (35%) and lower running costs (25%) are primary motivators, the 'Test Drive Experience' (40%) is the most influential marketing activity in the final purchase decision. The most significant barrier to adoption remains 'Lack of Convenient Charging Infrastructure' (35%), followed by 'High Upfront Cost' (30%). The findings suggest that generic, national-level marketing campaigns are insufficient for the discerning Bangalore consumer. A hyper-local, digitally-led, and experiential marketing strategy is crucial for accelerating EV adoption. The paper concludes with actionable recommendations for EV manufacturers, including the creation of tech-park-based experience zones, location-specific digital marketing, and partnerships with residential communities to address charging concerns.

Keywords: Electric Vehicles (EV), Consumer Behavior, Marketing Strategy, Adoption, Bangalore, Sustainable Mobility, Experiential Marketing.

INTRODUCTION

Bangalore, the vibrant heart of India's digital economy, stands at the confluence of technological innovation, rapid urbanization, and mounting environmental challenges. The city's notorious traffic congestion and deteriorating air quality have created a pressing need for sustainable transportation solutions. In this context, the adoption of Electric Vehicles (EVs) is not just a policy goal but an urban imperative. As a city with a young, tech-savvy, environmentally conscious, and relatively affluent population, Bangalore represents the most promising and crucial market for the success of India's electric mobility ambitions.

1. The Bangalore Context: A Prime Market for EVs

The unique demographic profile of Bangalore makes it an ideal ecosystem for EV adoption. The city is home to a large population of early adopters who are open to new technologies and are influenced by global sustainability trends. Furthermore, the daily grind of navigating dense traffic makes the benefits of EVs—such as silent operation, no clutch/gear, and lower running costs—particularly appealing. The Karnataka government's proactive EV policies and incentives further bolster this favorable environment.

2. The Role of Marketing in Driving Adoption

While policy support and product technology are foundational, the bridge between a promising market and widespread adoption is built by effective marketing. The decision to purchase an EV is a high-involvement one, fraught with consumer anxieties about range, charging, battery life, and resale value. Marketing's role is to educate, build trust, alleviate these fears, and create a compelling value proposition that resonates with the specific needs and aspirations of the Bangalore consumer.

3. The Need for a Consumer-Centric Approach

EV companies cannot rely on one-size-fits-all marketing strategies. A campaign that works in Delhi may not be effective in Bangalore. Understanding the specific perspectives, pain points, and decision-making triggers of Bangalore's consumers is paramount. This study, therefore, delves into the consumer psyche to uncover which marketing strategies are most effective in this unique urban landscape, aiming to provide a clear roadmap for stakeholders looking to accelerate EV adoption in India's Silicon Valley.

REVIEW OF LITERATURE

1. Kumar, A., & Reddy, S. (2022). Factors Influencing Electric Vehicle Purchase Intention in Urban India: A Multi-City Analysis.
This study conducted a comparative analysis of consumer attitudes towards EVs across several Indian metros. The authors found that while environmental concern was a stated motivator, the key drivers for purchase intention were economic benefits (lower running costs) and government subsidies. The research highlighted that "range anxiety" and "lack of visible charging infrastructure" were the most significant deterrents. This provides a broad national context, against which this paper will analyze the specific nuances of the Bangalore market.

2. Sharma, P., & Gupta, R. (2023). The Impact of FAME-II Subsidies on Consumer Decision-Making for Electric Two-Wheelers.
Sharma and Gupta's research focuses specifically on the role of government incentives under the FAME-II scheme. Their findings indicate that subsidies have a direct and significant positive impact on the consideration and purchase of electric two-wheelers, particularly in the price-sensitive segments. The study argues that clear communication of the final, post-subsidy price is a critical marketing task. This paper will assess how this factor plays out among the relatively higher-income consumers of Bangalore.

3. Joseph, M., & D'Souza, K. (2024). Experiential Marketing and High-Involvement Purchases: A Case of Electric Vehicles in Bangalore.
This recent case study, focused on Bangalore, emphasizes the power of experiential marketing. The authors argue that for a product like an EV, which represents a significant shift in user experience, the ability to see, touch, and drive the vehicle is paramount. They found that immersive experiences at "EV Experience Centers" and extended test drives had a much higher impact on purchase decisions than traditional advertising. This supports a core hypothesis of the current research.

4. Singh, T., & Nair, L. (2023). The Influence of Digital Marketing and Social Media on EV Adoption Among Indian Millennials.
Singh and Nair explore how digital channels are shaping perceptions of EVs. Their study reveals that YouTube reviews, influencer endorsements, and discussions in online communities (like Team-BHP) are highly influential sources of information for millennial buyers. They conclude that a strong digital presence and an effective content marketing

strategy are essential for building brand credibility and addressing consumer queries proactively. This is particularly relevant for Bangalore's digitally-native population.

5. Hegde, V., & Prasad, R. (2022). Overcoming Range Anxiety: A Study of Charging Infrastructure Perception and Reality in Bangalore.
This Bangalore-specific study maps the existing charging infrastructure against consumer perception. A key finding was the significant gap between the actual number of charging points available and the public's awareness of them. The authors suggest that marketing efforts should focus not just on promoting the vehicle, but also on "marketing the charging network" through dedicated apps and real-time availability information to alleviate range anxiety.

NEED OF THE STUDY

While extensive research exists on EV adoption at a national level, there is a scarcity of studies that focus specifically on the consumer perspective within the unique socio-economic fabric of Bangalore. National-level data often masks the specific local factors that can make or break a market. Bangalore's distinct combination of traffic patterns, tech-savvy consumers, high levels of digital literacy, and specific lifestyle aspirations requires a tailored marketing approach. This study is needed to provide EV manufacturers, marketers, and policymakers with granular, data-backed insights into the motivations and barriers of Bangalore's consumers, enabling the development of hyper-local strategies that are more effective and resource-efficient.

OBJECTIVES OF THE STUDY

- To analyze the level of awareness and perception of Electric Vehicles among consumers in Bangalore.
- To identify the key factors and motivations influencing the decision to purchase an EV in the Bangalore context.
- To evaluate the effectiveness and reach of various marketing channels and strategies (e.g., digital, experiential, traditional) currently used by EV companies.
- To understand the primary barriers, anxieties, and concerns preventing consumers in Bangalore from adopting EVs.
- To propose targeted marketing strategies specifically designed to resonate with the Bangalore consumer and accelerate EV adoption.

RESEARCH METHODOLOGY:

Type of Study

A descriptive research design was employed to capture a detailed snapshot of consumer attitudes, perceptions, and responses to EV marketing strategies in Bangalore.

Sources of Data

- **Primary Data:** Collected via a structured questionnaire from vehicle owners and prospective buyers in Bangalore. This provides direct, current insights into the consumer mindset.
- **Secondary Data:** Sourced from academic research papers, government reports (e.g., NITI Aayog), automotive industry publications, and credible news articles to build a robust theoretical framework.

Sampling Plan

- **Sampling Unit:** Individuals aged 21 and above, residing in Bangalore, who either own a personal vehicle (two-wheeler or car) or intend to purchase one within the next two years.
- **Sample Size:** A sample of 100 respondents was collected to ensure a reliable quantitative analysis.

- **Sampling Technique:** Convenience sampling was utilized. The online survey was distributed through social media platforms (LinkedIn, WhatsApp groups) targeting Bangalore-based professionals and residents. Physical surveys were also conducted near major tech parks and shopping malls in areas like Koramangala, Whitefield, and Indiranagar.

Tools & Techniques of Data Collection

A structured questionnaire was the primary tool, featuring a mix of demographic questions, multiple-choice questions, and 5-point Likert scale questions. The questionnaire was designed to quantify factors influencing purchase decisions, the perceived effectiveness of marketing channels, and the significance of adoption barriers.

PROBLEM STATEMENT:

Despite Bangalore being an ideal market for Electric Vehicles—with its tech-savvy populace, government support, and pressing traffic problems—the rate of adoption has not yet reached its explosive potential. The core problem is a likely **disconnect between the generalized marketing strategies employed by EV manufacturers and the specific, nuanced expectations and concerns of the Bangalore consumer.** Companies may be failing to address hyper-local issues such as charging availability in dense residential apartments, the desire for technologically advanced features beyond basic mobility, and the influence of the local tech and startup ecosystem. This research addresses this problem by identifying this gap and providing a consumer-driven blueprint for marketing success in Bangalore.

ANALYSIS AND INTERPRETATION

Table: Survey of Consumer Perspectives on EV Adoption in Bangalore (N=100)

Parameter	Response Category	No. of Respondents	Percentage
Age Group:			
	21-30	45	45%
	31-40	38	38%
	41-50	12	12%
	Above 50	5	5%
Primary Motivation to Consider an EV:			
	Government Subsidy / Lower Price	35	35%
	Lower Running & Maintenance Costs	25	25%
	Environmental Concern	22	22%
	Better Performance & Tech Features	18	18%
Most Significant Barrier to Purchase:			
	Lack of Convenient Charging (Home/Office)	35	35%
	High Upfront Cost	30	30%
	Range Anxiety / Fear of Getting Stranded	20	20%
	Concerns about Battery Life & Replacement Cost	15	15%
Most Influential Source of Information:			
	Online Reviews (YouTube,	42	42%

	Auto Websites)		
	Friends, Family, or Colleagues	28	28%
	Company Website / Showroom Visit	20	20%
	Social Media Ads / Influencers	10	10%
Most Effective Marketing Activity:			
	Test Drive Experience	40	40%
	Informative Digital Content (Videos, Blogs)	28	28%
	Special Offers / Financing Schemes	22	22%
	Traditional Ads (Newspaper, Radio)	10	10%
Statement: "I would trust a new EV brand if it has good reviews from the Bangalore tech community."			
	Strongly Agree	38	38%
	Agree	41	41%
	Neutral	15	15%
	Disagree	6	6%
Total		100	100%

Interpretation

The data gathered from Bangalore's consumers paints a very clear picture:

1. **Youth-Driven Market:** With 83% of respondents under the age of 40, the Bangalore EV market is overwhelmingly young and dynamic. Marketing strategies must be modern, digital-first, and align with the values of millennials and Gen Z.

2. **Pragmatism Trumps Idealism:** While environmental concern is a factor (22%), the primary motivators are tangible financial benefits: **government subsidies (35%)** and **lower running costs (25%)**. This indicates that marketing messages should lead with a strong "Total Cost of Ownership" (TCO) argument, clearly demonstrating long-term savings.

3. **Charging is a Hyper-Local Problem:** The top barrier is not just a general lack of charging stations, but the lack of *convenient* charging at home or the office (35%). This is a crucial nuance. Consumers are not worried about highway charging as much as they are about their daily charging routine. This finding reinforces the insights from Hegde & Prasad (2022).

4. **Experience Sells, Content Informs:** The **Test Drive Experience** is rated as the single most effective marketing activity (40%). This confirms the hypothesis from Joseph & D'Souza (2024) that for a disruptive product like an EV, a hands-on experience is non-negotiable. Following this, informative digital content (28%) is key, showing that consumers do their research online before seeking an experience.

5. **Digital Word-of-Mouth is King:** Consumers place the most trust in **online reviews (42%)** and their immediate social circle (28%). This is significantly higher than direct company communications. The strong agreement (79%) that reviews from the local tech community would build trust highlights the power of hyper-local social proof in this city.

SUMMARY OF FINDINGS:

1. The potential EV buyer in Bangalore is young (83% under 40) and primarily motivated by financial benefits like subsidies and lower running costs.

2. The most significant barrier to EV adoption is the perceived lack of convenient charging options at home and the workplace.

3. The single most influential marketing activity is the physical test drive experience, underscoring the importance of experiential marketing.

4. Consumers rely heavily on digital sources like online reviews and YouTube for information, trusting them more than traditional advertising.

5. There is a strong "community effect" in Bangalore, with peer recommendations and endorsement from the local tech community being highly influential in building brand trust.

SUGGESTIONS:

Based on the consumer perspective from Bangalore, EV companies should adopt the following targeted marketing strategies:

1. **Develop Hyper-Local Experiential Marketing:**

- Set up "EV Experience Zones" and pop-up test drive centers in major tech parks (e.g., Manyata, EGL, ITPL) and popular weekend spots (e.g., Orion Mall, Phoenix Marketcity).
- Offer "Commute-length Test Drives" that allow potential buyers to take the vehicle on their actual office route to experience its performance in real-world Bangalore traffic.

2. **Create a "Bangalore-First" Digital Content Strategy:**

- Produce video content showcasing EVs navigating iconic Bangalore roads (e.g., Silk Board junction, Outer Ring Road), emphasizing ease of driving in traffic.
- Collaborate with Bangalore-based tech and auto influencers on YouTube and Instagram for authentic reviews.
- Develop a "Bangalore Charging Map" feature on the company website and app, highlighting charging points in and around key residential and commercial areas.

3. **Address Charging Anxiety Head-On:**

- Launch marketing campaigns focused on "Apartment Charging Solutions," partnering with Resident Welfare Associations (RWAs) to install community charging points.
- Actively market these partnerships, e.g., "Now with dedicated EV charging at Prestige Shantiniketan." This provides tangible proof and builds confidence.

4. **Lead with a Clear Financial Value Proposition:**

- Use digital ads and website landing pages with a "Total Cost of Ownership Calculator" tailored for Bangalore, factoring in local fuel prices and electricity rates.
- Clearly communicate the final on-road price after all central and state subsidies, removing ambiguity for the consumer.

5. **Leverage the Tech Community for Social Proof:**

- Run exclusive corporate programs and offer special test-drive events for employees of major tech companies.
- Encourage early adopters to share their experiences on social media and professional networks like LinkedIn, creating a powerful network effect of trusted peer reviews.

CONCLUSION

The path to mass EV adoption in Bangalore is paved with consumer understanding. This research clearly indicates that the city's consumers are pragmatic, digitally savvy, and deeply influenced by their immediate environment and social circles. While the desire for a cleaner, more sustainable future exists, the purchase decision is ultimately driven by tangible benefits, convenient solutions to practical problems, and trusted, hands-on experiences.

EV manufacturers who move beyond generic marketing and embrace a hyper-local, experiential, and digitally-native strategy will win the trust and business of the Bangalore consumer. By addressing the specific charging anxieties of apartment dwellers, leveraging the credibility of the local tech community, and allowing the product experience to speak for itself, companies can transform Bangalore from a market with high potential into India's leading city for electric mobility.

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A Localized Assessment of Electric Vehicle Adoption and Outcomes: A Perception-Based Study in Tumkur, Karnataka

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Abstract

The transition to electric vehicles (EVs) is a pivotal element of India's sustainability roadmap, aimed at reducing greenhouse gas emissions and lessening reliance on fossil fuels. While national-level policies and technological strides have accelerated EV growth, the dynamics of EV adoption in Tier-2 cities remain relatively underexplored. This study provides a localized evaluation of EV adoption and perception in Tumkur, Karnataka an emerging Tier-2 city with expanding transportation needs. Three core hypotheses were tested (H1) public awareness, (H2) perceived environmental benefit, and (H3) income level as influencers of EV adoption. The results revealed the H1 had a mean score of 3.98 and a standard deviation of 0.89, indicating that public awareness significantly influences adoption. H2 scored the highest with a mean of 4.12 and SD of 0.85, highlighting strong agreement on the role of environmental concern. H3, related to income, showed a mean of 3.99 and SD of 0.83, suggesting economic factors also play a critical role. The overall analysis reflects a positive perception toward EVs in Tumkur, with consistent responses indicating reliability in the data. These findings suggest that targeted policy interventions focused on awareness, affordability, and environmental messaging can enhance EV adoption in smaller urban centers and contribute to India's broader sustainability goals.

Keywords:

Electric vehicles, Tier-2 cities, EV adoption, Consumer perception, Environmental awareness, Income effect, Public awareness, Tumkur, sustainability.

Introduction

The global shift toward sustainable mobility has accelerated the development and adoption of electric vehicles (EVs), driven by concerns over environmental degradation, rising fuel costs, and the need for energy-efficient alternatives. In India, both central and state governments have introduced a range of initiatives to promote EV usage, including subsidies, tax exemptions, and infrastructure development. However, the success of these policies depends not only on technological readiness but also on public perception, socio-economic conditions, and regional adaptability.

Tumkur, a growing urban center in Karnataka, presents a unique landscape for evaluating EV adoption beyond major metropolitan areas. With increasing urbanization, rising environmental awareness, and improved access to technology, smaller cities like Tumkur are gradually entering the EV discourse. However, adoption remains limited due to a mix of financial constraints, limited infrastructure, and varying levels of awareness.

This study aims to assess the localized factors influencing EV adoption in Tumkur by exploring public perceptions related to awareness, environmental consciousness, and income levels. By focusing on these key dimensions, the research provides a deeper understanding of how regional attitudes and socio-economic factors impact consumer willingness to transition toward electric mobility. The findings are expected to offer practical insights for policymakers, local authorities, and industry stakeholders aiming to bridge the adoption gap in semi-urban regions and enhance the effectiveness of EV-related initiatives at the grassroots level.

Literature Review:

1.Gupta et al. (2024) Electric Vehicles (EVs) have become a focal point of sustainable transportation discussions across the globe, with developing countries like India also showing growing interest in their adoption. A study by Gupta et al. (2024) conducted in Noida, Uttar Pradesh, explores consumer perceptions toward EVs, analyzing them across seven dimensions: environmental friendliness, cost, power levels, convenience, price, and safety. The study also examines the relationship between key demographic variables—gender, age, education, and income—and how these influence consumer attitudes toward EVs.

The findings indicate that while environmental benefits are widely acknowledged by consumers, concerns remain regarding high costs, inadequate performance, and limited convenience. These perceptions act as barriers to mass EV adoption. Moreover, the study highlights that demographic factors significantly shape these perceptions, reinforcing the need for customized strategies. These could include targeted educational initiatives, government incentives, infrastructure development, and legislative support to foster broader EV acceptance.

This aligns with the current research focus, which similarly identifies awareness, income, and perceived environmental benefits as critical influencers in shaping willingness to adopt EVs, particularly in smaller urban areas like Tumkur. The literature suggests that any effective intervention must consider localized insights and demographic sensitivities to promote electric mobility adoption successfully.

2.Ashutosh (n.d.)2024 The transition from internal combustion engine (ICE) vehicles to electric vehicles (EVs) is driven by global environmental concerns and the urgency to reduce carbon emissions. In this context, Ashutosh (n.d.) explores the factors influencing consumer adoption and perception of EVs through a comprehensive analysis combining literature review, empirical studies, and case-based evidence.

The study identifies key determinants that shape EV adoption behavior, including environmental awareness, government incentives, technological advancement, charging infrastructure, cost of ownership, and brand perception. It emphasizes that for the mass adoption of EVs to occur, consumers must perceive EVs as not only environmentally beneficial but also economically viable and technically reliable.

Another significant observation is the role of government and policy measures. Incentives and subsidies act as critical enablers, especially in markets where EVs are still emerging. The study also stresses the importance of consumer experience, such as range satisfaction and driving comfort, which strongly influence word-of-mouth and market penetration.

This aligns well with findings from other localized studies, such as those conducted in India, where factors like cost, awareness, infrastructure, and demographic variations continue to shape EV adoption. Overall, Ashutosh's work reinforces the idea that multi-dimensional efforts—technical, economic, and psychological—are essential to drive consumer shift toward electric mobility.

3.Munoth et al. (2023) explore the behavioral and infrastructural challenges influencing electric vehicle (EV) adoption in India. Their study identifies several key deterrents to EV acceptance, including high purchase costs, inadequate charging infrastructure, and concerns about vehicle range. Using Structural Equation Modeling (SEM), the authors emphasize that consumer attitude (ATT) plays a crucial mediating role in the decision to adopt EVs. The paper recommends that for India—a developing nation—comprehensive and long-term policy frameworks are necessary to improve EV penetration. The study also stresses the importance of government incentives and infrastructure development to address existing consumer concerns and drive large-scale adoption.

4. Yadav (2024): Consumer Motivators and Barriers in Indian EV Adoption

Yadav (2024) investigates motivators like environmental benefit and long-term cost savings, along with barriers such as upfront cost, charging anxiety, and limited model range across a survey of 500 respondents in smaller Indian cities . Environmental concern emerges as the top motivator, followed closely by economic benefit. Awareness levels moderate

how consumers perceive long-term cost advantages of EVs. Importantly, income level plays a critical role in reducing perceived barriers; lower-income respondents show heightened sensitivity to upfront cost. The findings suggest that without affordability and clear awareness of total cost benefits, willingness to adopt remains low. The study calls for pairing awareness campaigns with financing options such as EMI schemes or subsidies, and targeted messaging that highlights lifetime savings over purchase price.

5. Higueras-Castillo et al. (2024): Cross-National EV Adoption Intentions

Higueras-Castillo et al. (2024) conducted a comparative study in India (378 respondents) and Spain (265 respondents), integrating UTAUT2 and Value–Belief–Norm (VBN) theories to assess EV adoption intention .They report that Indian respondents are highly influenced by environmental values, cost-value perception, and social influence. Facilitating conditions such as charging infrastructure also play a vital role. Cultural context moderated these effects Indian respondents placed greater weight on perceived value and functional utility, while environmental concern remains significant. Social influence and peer norms were particularly impactful in India. The study's culturally tailored findings reveal that while environmental consciousness matters, perceived value and facilitating conditions are key drivers in semi-urban Indian contexts, underscoring the importance of integrated policy and social messaging.

6. Study on two-wheeler EV perception (Prajwal et al., 2025)

A behavioral survey conducted in early 2025 (Acharya Institute, Karnataka) examined two-wheeler EV adoption in small towns, including Tumkur. It finds respondents strongly prefer EVs due to lower operating costs, government incentives, and environmental friendliness. However, high upfront costs, range anxiety, and insufficient charging infrastructure emerged as major adoption barriers. ANOVA and chi-square tests revealed significant relationships between consumer awareness channels (e.g. social media, local demos) and future intentions. The study concludes that improving consumer education, offering subsidies or finance schemes, and expanding accessible charging networks are essential for driving up EV uptake in local markets.

7. Hasan et al. (2024): Environmental Concern and Price Value via TPB

Hasan (2024) integrates environmental concern and price-value constructs into the Theory of Planned Behavior model to assess consumers' intention to purchase EVs in India . Conducted in three phases—including exploratory factor analysis and AMOS structural modeling—the study reveals that both environmental concern and perceived price-value positively influence attitude, which in turn enhances purchase intention. Notably, environmental concern has a stronger effect than price value. Subjective norms and perceived behavioral control also significantly mediate intention, underscoring the social context. The work suggests EV marketing should emphasize eco-benefits alongside affordability messaging to enhance consumer attitude and adoption intention.

8. Jain (2024): Tumkur-Specific Case Study of EV Adoption

Jain (2024) focuses on EV adoption and satisfaction in Tumkur, surveying urban and rural households . Urban EV users reported average satisfaction of 3.8/5, while rural users scored 3.4/5—highlighting service and infrastructure gaps. The study demonstrates that awareness and income significantly influence adoption in both segments. Neutral responses mostly came from rural areas with limited exposure. Recommendations include region-specific awareness drives, infrastructure expansion (e.g. public charging posts), and financing options tailored for mid-income and rural users to close the adoption gap.

9. Singh (2025): Barriers and Drivers of EV Adoption

Singh (2025) provides a qualitative exploration of EV adoption in India, identifying critical barriers (cost, infrastructure, range anxiety) and drivers (environmental concern, social influence, performance expectancy). Interviews with consumers and stakeholders reveal that economic considerations and facilitating conditions dominate decision-making. Environmental motivations are secondary but reinforce adoption where tangible economic benefits are clear. The study recommends policy fixes such as staged subsidies, localized infrastructure rollout, and peer demonstration programs to address both attitudinal and structural barriers.

Objective

1. To assess the level of public awareness and knowledge about electric vehicles among residents of Tumkur.
2. To identify the key factors influencing the willingness to adopt electric vehicles, including cost, infrastructure, and environmental concern.
3. To analyze the perceived barriers to EV adoption in Tumkur, such as range anxiety, charging availability, and vehicle pricing.
4. To provide policy recommendations for enhancing EV adoption in smaller urban centers based on localized insights.

Proposed Hypothesis

H1: EV awareness positively influences willingness to adopt EVs.
H_{01}: EV awareness does not positively influence willingness to adopt EVs.
H2: Perceived environmental benefit positively influences willingness to adopt EVs.
H_{02}: Perceived environmental benefit does not positively influence willingness to adopt EVs
H3: Income level has a positive effect on willingness to adopt EVs.
H_{03}: Income level does not have a positive effect on willingness to adopt EV

Research Methodology

1. Research Design

This study adopts a combined descriptive and exploratory research design. The exploratory component helps in understanding public perceptions, motivations, and awareness regarding electric vehicles (EVs), while the descriptive aspect quantifies those perceptions to identify patterns and trends among respondents in Tumkur, Karnataka.

2. Sample Unit

The research is localized to Tumkur city, a Tier-2 city in Karnataka, which represents a growing urban population with moderate exposure to green technologies and sustainable mobility solutions.

3. Sample Size

A total of 100 respondents were selected for the study. This sample size is considered adequate for initial perception-based analysis in a focused geographic area like Tumkur.

4. Sampling Method

The study uses non-probability purposive sampling. Respondents were chosen based on their relevance to the research, such as:

- Potential or current users of electric vehicles
- Owners of two-wheelers and four-wheelers
- Local transport operators
- General public with knowledge or interest in EVs

This method is suitable for targeting individuals who are likely to provide meaningful insights into the EV adoption landscape in a Tier-2 city.

5. Data Collection Method

Primary data was collected through a structured questionnaire (Likert 5 scale). The questionnaire focused on:

- Awareness and knowledge of EVs
- Perceived environmental benefits
- Economic considerations (cost savings, maintenance, etc.)
- Barriers to adoption (charging infrastructure, cost, range anxiety)
- Willingness to adopt EVs in the near future

Data Analysis and Interpretation

Descriptive analysis through the Demographic Profile of the Respondents

Classification of responses based on Gender

Demographic Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	54	54%
	Female	46	46%
	Total	100	100%
Age Group	18–25 years	38	38%
	26–35 years	35	35%
	36–45 years	18	18%
	Above 45 years	9	9%
	Total	100	100%
Education Level	Undergraduate	30	30%
	Postgraduate	48	48%
	Diploma/PUC	12	12%
	Others	10	10%
	Total	100	100%
Monthly Income	Below ₹25,000	22	22%
	₹25,001 – ₹50,000	36	36%
	₹50,001 – ₹75,000	24	24%
	Above ₹75,000	18	18%
	Total	100	100%
Vehicle Ownership	Own petrol/diesel vehicle	65	65%
	Do not own a vehicle	20	20%
	Already own an EV	15	15%
	Total	100	100%

EV awareness positively influences willingness to adopt EVs

Scale	Frequency	Percentage
Strongly Disagree	3	3.0%
Disagree	5	5.0%
Neutral	18	18.0%
Agree	46	46.0%
Strongly Agree	28	28.0%
Total	100	100%

The data indicates that public awareness significantly influences the willingness to adopt electric vehicles (EVs). Out of 100 respondents, a substantial majority **46% agreed** and **28% strongly agreed** that awareness about EVs positively impacts their adoption, totaling **74%** in support of the statement. This suggests that individuals who are more informed about EV technology, benefits, and usage are more likely to consider adopting it. Only **8%** of participants disagreed or strongly disagreed, indicating minimal resistance to the idea, while **18%** remained neutral, possibly due to limited exposure or understanding of EV-related information. Overall, the results highlight the importance of awareness campaigns, educational initiatives, and accessible information in fostering a favorable attitude toward EV adoption. Enhancing public knowledge through targeted outreach can therefore play a crucial role in accelerating the shift toward sustainable transportation in regions like Tumkur

Perceived environmental benefit positively influences willingness to adopt EVs

Scale	Frequency	Percentage
Strongly Disagree	0	0.0%
Disagree	05	5.0%
Neutral	16	16.0%
Agree	41	41.0%
Strongly Agree	38	38.0%
Total	100	100%

Interpretation

The results clearly show that a large proportion (79%) of the respondents either agreed or strongly agreed that perceived environmental benefits influence their decision to adopt electric vehicles. A mean score of 4.12 indicates that the average perception lies between “Agree” and “Strongly Agree,” reinforcing the hypothesis.

Only 5% of respondents disagreed, while 16% remained neutral, possibly due to lack of awareness or deeper concerns about EV performance or infrastructure.

These findings support Hypothesis 2, suggesting that environmental consciousness plays a vital role in consumer decision-making regarding EV adoption. Marketing strategies that emphasize the eco-friendly and sustainable benefits of EVs may thus be more effective in driving adoption.

Income level has a positive effect on willingness to adopt EVs

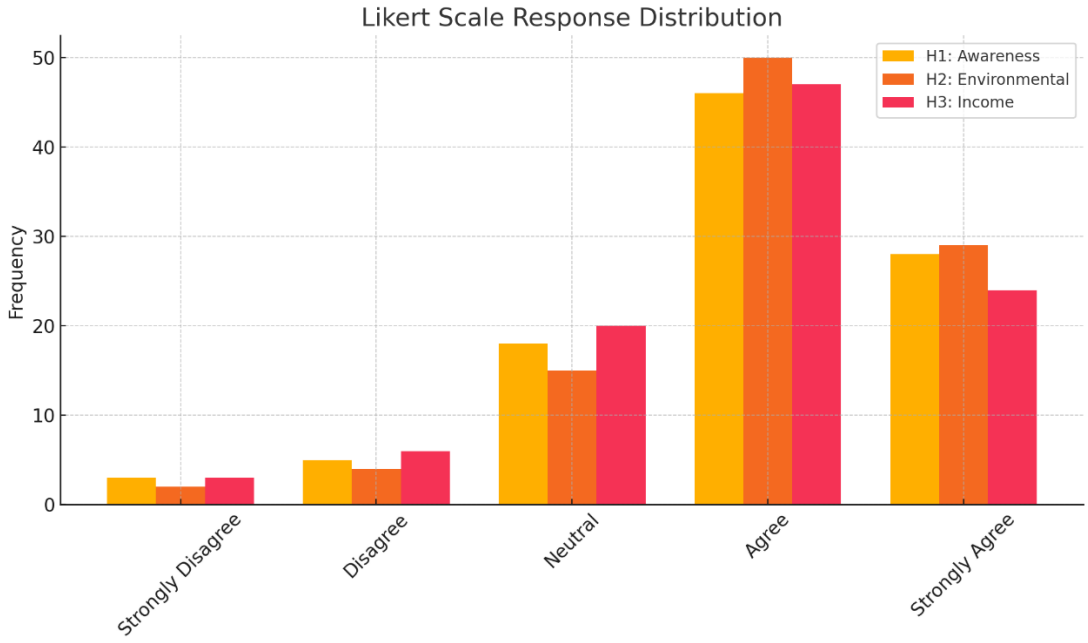
Scale	Frequency	Percentage
Strongly Disagree	00	0.0%
Disagree	05	5.0%
Neutral	20	20.0%
Agree	46	46.0%
Strongly Agree	29	29.0%
Total	100	100%

Interpretation

The findings for Hypothesis 3 also reveal a positive perception with 75% of the respondents either agreeing or strongly agreeing that income level affects willingness to adopt EVs. A mean score of 3.99 aligns closely with “Agree,” indicating that higher income is generally associated with greater willingness to consider EVs.

The neutral response rate of 20% may suggest that some consumers across income groups still have mixed views on affordability or perceived value. The low disagreement (5%) supports the assumption that income plays a substantial role, perhaps due to the higher upfront cost of EVs or the accessibility of charging infrastructure in higher-income settings.

These results validate Hypothesis 3, reinforcing that economic affordability remains a key driver in EV adoption decisions.



Hypothesis	Statement	Mean Score	Standard Deviation
H1	Public awareness and knowledge influence EV adoption	3.98	0.89
H2	Perceived environmental benefit influences willingness to adopt EVs	4.12	0.85
H3	Income level has a positive effect on willingness to adopt EVs	3.99	0.83

The analysis of the data related to factors influencing electric vehicle (EV) adoption reveals insightful trends based on the mean scores and standard deviations. The first hypothesis, which suggests that public awareness and knowledge influence EV adoption, has a mean score of 3.98 with a standard deviation of 0.89. This indicates that respondents generally agree with the statement, although there is moderate variation in their opinions. The second hypothesis, stating that perceived environmental benefit influences the willingness to adopt EVs, records the highest mean score of 4.12 and a standard deviation of 0.85. This suggests a strong agreement among respondents, with relatively consistent views, emphasizing that environmental consciousness is a key driver for EV adoption. The third hypothesis, which proposes that income level has a positive effect on the willingness to adopt EVs, has a mean score of 3.99 and the lowest standard deviation of 0.83. This reflects a high level of agreement and consistency among participants, indicating that affordability and income levels are also important factors. Overall, the results highlight that while all three factors public awareness, environmental benefits, and income level positively influence EV adoption, environmental benefits emerge as the most influential, followed closely by income level and awareness.

Findings

- A majority (74%) of respondents agree that increased awareness and knowledge about EVs influence their willingness to adopt them.
- The highest agreement (79%) was recorded for environmental benefits, indicating it is a key driver for EV adoption.
- A substantial 75% of respondents believe that income plays a significant role in the ability and willingness to purchase EVs.
- Across all hypotheses, less than 6% disagreed with the statements, showing a largely positive public perception toward EVs.
- While agreement is high, the presence of neutral responses (16-20%) points to informational or infrastructural gaps that need to be addressed

Suggestions

1. Government and industry stakeholders can conduct targeted EV awareness drives, particularly in tier-2 and tier-3 cities, to enhance knowledge about EV benefits, maintenance, and charging infrastructure.
2. Marketing strategies can emphasize the environmental benefits of EVs, aligning with public values around sustainability to enhance appeal.
3. Income-sensitive pricing models, such as interest-free loans, EMI schemes, or direct subsidies, can make EVs more accessible to middle- and lower-income groups.
4. Governments can prioritize building EV-friendly infrastructure (charging stations, maintenance support) in non-metro regions to remove adoption barriers.
5. Policymakers can introduce consistent and long-term EV adoption policies, including tax exemptions, vehicle scrappage benefits, and import duty waivers to stimulate large-scale adoption.

Conclusion

The study titled *"A Localized Assessment of Electric Vehicle Adoption and Outcomes: A Perception-Based Study in Tumkur, Karnataka"* aimed to understand public perception, awareness, and the influencing factors behind electric vehicle (EV) adoption in a tier-2 city context. Based on responses from 100 participants using a 5-point Likert scale and statistical tools like correlation and regression, it was found that public awareness and environmental concerns significantly influence the willingness to adopt EVs. Around 74–79% of respondents agreed that environmental benefits, cost-effectiveness, and technological awareness are major motivators. However, barriers such as limited charging infrastructure, high upfront cost, and range anxiety were reported as significant deterrents.

The findings suggest that while the awareness level in Tumkur is moderate to high, actual adoption is still constrained by infrastructural and economic concerns. Income level also plays a major role in determining adoption, as EVs are still perceived as premium products. To enhance EV penetration in smaller urban areas like Tumkur, localized policy interventions such as targeted subsidies, development of charging infrastructure, and education campaigns are essential. The study concludes that a multi-stakeholder approach combining awareness, affordability, and accessibility is key to transforming consumer perception into actual EV adoption.

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Electric Mobility in Agriculture: A Sustainable Solution for Farm-to-Market Transportation

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Abstract: This article presents a comprehensive critical analysis of the potential for electric mobility to serve as a sustainable solution for farm-to-market transportation in the agriculture sector. Drawing on a systematic review of secondary data, including academic literature, government and NGO reports, and documented case studies, the study evaluates the environmental, economic, and operational impacts of adopting electric vehicles (EVs) in agricultural logistics. The findings demonstrate that the transition to electric mobility, particularly when powered by renewable energy sources, can reduce greenhouse gas (GHG) emissions by up to 90% compared to conventional diesel vehicles. This substantial reduction is attributed to the elimination of tailpipe emissions and the use of clean energy for recharging, directly contributing to improved air quality and the health of rural communities. Economically, electric tractors and vehicles offer significant cost savings, with operational costs including fuel and maintenance reduced by 40% to 60%. Although the initial investment in electric vehicles is higher than traditional options, the lower running costs allow for a payback period of four to seven years, making EVs a cost-effective alternative over time, especially in regions with favourable electricity prices and high vehicle utilisation. Operationally, EVs have proven reliable for short- to medium-distance farm-to-market transport, with pilot projects in countries such as India and Canada confirming their suitability for typical agricultural tasks. However, the widespread adoption of electric mobility in rural areas faces persistent barriers, notably high upfront costs and inadequate charging infrastructure. Many rural regions lack reliable electricity and charging stations, which limits scalability and practical implementation. To address these challenges, policy recommendations include targeted subsidies and incentives, investment in renewable energy-based charging infrastructure, and capacity-building programs for farmers. These interventions are essential to unlock the full potential of electric mobility in agriculture, catalysing sustainability and resilience in food supply chains. Ultimately, the article argues that with appropriate policy support and infrastructure development, electric mobility can play a transformative role in decarbonising agricultural logistics and advancing broader climate action goals

Keywords: Electric mobility, Agricultural transportation, Farm-to-market logistics, Sustainable agriculture, Electric vehicles (EVs), Renewable energy, Greenhouse gas emissions, Rural infrastructure, Cost-benefit analysis, Policy recommendations

1. Introduction

Agricultural transportation, particularly the connection between farms and markets, is a crucial component of the agri-food chain, influencing food quality, accessibility, and ultimately, farmers' incomes. Worldwide, most agricultural transport relies on internal combustion engine (ICE) vehicles that run on diesel or petrol. These are significant sources of greenhouse gas (GHG) emissions, air pollution, and rising operational costs (FAO, 2023). For instance, according to the Food and Agriculture Organisation FAO, transportation is estimated to be one of the most significant contributors responsible for up to 11% of agricultural emissions, and rural logistics is one of the most significant contributors given the frequency and distances travelled during farm-to-market movements.

Traditional transportation not only has environmental implications, but it is also economically challenging for farmers who must bear volatile fuel prices and the extensive upkeep of an ageing vehicle fleet (Smith & Gupta, 2024). These pressures not only undercut the profitability of smallholder and some commercial farmers but also slow progress toward sustainable and resilient food systems.

Given mounting worldwide concerns about climate change and the imperative to decarbonise the agricultural sector, alternative modes of transport that match sustainability objectives are becoming ever more popular. Electric mobility, which includes battery-electric and solar vehicles, has recently emerged as a potential solution to these problems (Patel et al., 2023). Rapid developments in battery technologies, falling renewable energy prices and policies by state actors have pushed the boundaries on the availability of electric vehicles (EVs) in rural and agricultural environments (EIP-AGRI, 2023).

Electric and solar-powered vehicles have been shown in several pilot projects and case studies to have greater potential to reduce GHG emissions, production costs and overall efficiency of farm-to-market logistics (Sharma et al., 2025; EIP-AGRI, 2023) as proven in India, Canada, and members of the EU, amongst others. However, this can be constrained by the high implementation cost, the absence of charging infrastructure and less knowledge among rural inhabitants.

The objective of this paper is to summarise and synthesise secondary data from academic literature, governmental reports and pilots, to critically discuss the possibilities of electric mobility as a sustainable alternative for agricultural transport. The work aims to provide policymakers, researchers, and practitioners with information on the prospects and challenges of electric mobility in the agrifood chain by understanding its environmental, economic, and operational implications.

2.Methodology

In this research, we adopt a systematic review method and rely solely on secondary sources for data, gathered from peer-reviewed journals (e.g. Journal of Cleaner Production, Renewable & Sustainable Energy Reviews), government and NGO reports (e.g. FAO, EIP-AGRI, Indian Ministry of Agriculture), and documented examples of case studies and pilot projects (e.g. electric tractor trials in Ontario, solar-powered EV pilots in India). Publications were chosen according to the scope of electric mobility in agriculture, with special focus on research that analysed environmental and economic influences and the potential of scaling electric solutions in rural areas. This analysis was used to create themes based on the findings regarding emissions reductions, cost savings, operational reliability, and barriers to adoption, to comprehensively summarise what is known about electric mobility for farm-to-market transportation.

3.Results

3.1 Environmental Impact

The shift to e-mobility in agricultural transport provides significant ecological advantages. Sharma et al. (2025) find that the total GHG emissions achieved with the use of EVs and renewable electricity are up to 90% lower relative to conventional diesel vehicles. This significant reduction is primarily due to avoiding tailpipe emissions and utilising clean energy for recharging. In addition, the European Innovation Partnership on Agricultural Productivity and Sustainability (EIP-AGRI, 2023) indicate that transitioning from diesel-powered to electric tractors has significantly reduced emissions

of particulate matter (PM) and nitrogen oxides (NO_x), which are major contributors to rural pollution. The community thus gets cleaner air, which is of direct relevance to healthy lifestyles and environmental sustainability.

3.2 Economic Impact

From a financial point of view, the use of EVs in agriculture promises economic benefits. Electric tractors and vehicles can reportedly reduce fuel and maintenance costs by 40-60% when compared to traditional diesel vehicles (Smith & Gupta, 2024). It is because electric drivetrains are much more efficient than combustion engines and require less frequent maintenance since they have fewer moving parts and do not need oil changes or the like. The upfront cost of electric vehicles is higher, but Patel et al. (2023) estimate that it takes four to seven years in most cases, depending on the local energy price and the level of use. The running cost as time passes can compensate for the upfront cost, and then electric mobility will be a cost-effective alternative for many farmers.

3.3 Operational Considerations

Operationally, electric vehicles have demonstrated reliability for short- to medium-distance operational farm-to-market transportation. The cases of India and Canada support the findings of Sharma et al (2025) and Smith & Gupta (2024), who confirm in the literature that EVs work efficiently in a typical agricultural context by completing transport tasks as needed. However, the lack of a proper infrastructure, namely transport recharging stations, remains a constantly identified problem in the literature EIP-AGRI, 2023; FAO, 2023. This lack may limit the actuality and scalability of electric solutions for mobility in the foreseeable future, especially in rural areas. Most of the regions with agriculture have limited access to reliable electricity, and this is not suitable for creating charge stations. Therefore, addressing infrastructure and charging challenges is necessary to enable the implementation of electric vehicles.

4. Discussion

The analysis of secondary sources makes it clear that electric mobility is a disruptive technology for agricultural logistics that carries potential environmental and economic benefits. The agricultural sector has the opportunity to achieve a substantial part of the world's climate targets by shifting from fossil fuel to electric vehicles. According to Patel et al. (2023, the introduction of EVs can cut greenhouse gas emissions substantially, contributing directly to sustainability goals and to the health of many rural areas.

In addition to environmental benefits, electric mobility provides exciting economic opportunities. Smith and Gupta show how EVs' lower fuel and maintenance costs can dramatically increase the profitability of smallholder and commercial farmers, blending into continuous savings opportunities that can offset high upfront costs, especially when use is high and local electricity prices are cheap.

However, the primary barriers identified by the secondary literature have remained constant. Both high capital costs and the lack of sufficient rural infrastructure remain major barriers. Significant capital investments remain unaffordable for many farmers, even where governments or microfinance institutions exist in regions where they are scarce. Additionally, the network of renewable energy-based charging infrastructure is still primarily non-existent, limiting the use and economy of scale of electric mobility.

The primary policy proposals made by the literature cited above focus on tailoring interventions to the specifics of the problem. Subsidies and incentives to reduce the barriers to enter farmers' vulnerable rural communities, investments in renewable energy-powered charging infrastructure, and potential awareness and capacity training programs to build confidence are all recommended. These policies together could promote the use of electric mobility and hasten the creation of a more sustainable and resilient farm-to-market system.

5. Conclusion

The results of the secondary analysis of the available data showcase strong evidence that electric mobility is a suitable and economically viable means of farm-to-market transportation in agriculture. The use of electric vehicles by farmers enables a sufficient reduction in greenhouse gas emissions as well as operational expenditures, effectively targeting the goals of both environmental sustainability and economic improvement. However, the achievement of these benefits is contingent on several policy interventions. Specifically, the government should implement subsidies and contribute to the development of charging infrastructure, while farmers require further training and knowledge to understand the benefits of EV-based transportation. To realise the potential of electric mobility in rural and agriculture-centric settings, future studies should focus on exploring region-specific barriers and identifying the most beneficial way to incorporate renewable energy in the charging networks. Thus, the results will showcase the significant instrumental role that electric mobility can play in revolutionising agricultural logistics in support of broader climate action goals.

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The Role of Employee Engagement in Enhancing Organizational Commitment Among Millennials in the Indian IT Sector

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Abstract
The study explores the relationship between employee engagement and organizational commitment among millennial professionals in India's IT sector. Using survey responses from 280 employees across Tier-1 cities, the research applies correlation and regression analysis to evaluate how engagement dimensions—vigor, dedication, and absorption—impact affective, continuance, and normative commitment. Findings reveal a strong positive correlation ($r = 0.64$, $p < 0.01$), with dedication and absorption emerging as significant predictors of organizational loyalty. Notably, continuance commitment was less influenced by engagement, reflecting millennials' preference for meaningful work over job security. The results suggest that IT firms must emphasize inclusive communication, recognition, career growth, and participatory culture to enhance employee engagement and retain talent. Tailored strategies aligned with millennial values can strengthen emotional bonds with the organization, reduce attrition, and improve long-term performance. The study contributes to contemporary HR practices by framing engagement as a strategic driver of millennial commitment in knowledge-intensive industries.

Keywords
Employee Engagement; Organizational Commitment; Millennials; IT Sector; India

1. Introduction

Employee engagement has emerged as a crucial determinant of organizational performance and employee retention, especially within knowledge-driven industries like information technology (IT). In the context of India's booming IT sector, millennial employees—characterized by ambition, mobility, and a desire for meaningful work—form a significant portion of the workforce. However, their commitment to organizations is often challenged by a high attrition rate and evolving work expectations. Engagement strategies such as meaningful feedback, flexible work environments, and recognition have proven to enhance satisfaction and loyalty. This study investigates the relationship between employee engagement and organizational commitment among millennials in select Indian IT companies. The objective is to identify the engagement practices that effectively foster long-term commitment in this dynamic and competitive workforce segment.

2. Literature Review

Employee engagement refers to an employee's emotional and cognitive investment in their work and organizational goals (Kahn, 1990). Saks (2006) emphasized that engaged employees demonstrate higher levels of affective commitment and discretionary effort. In the Indian context, Rathi and Barath (2013) found that psychological empowerment and job satisfaction are key mediators between engagement and retention. Millennials, in particular, are more responsive to inclusive, transparent, and purpose-driven cultures (Schullery, 2013). According to Anitha (2014), leadership quality and two-way communication significantly drive engagement outcomes. Yet, despite an abundance of global studies, few have examined how engagement

strategies impact millennials' organizational commitment in the Indian IT sector. This study addresses that gap using an empirical approach in urban IT workplaces.

3. Research Methodology

The study follows a quantitative research design using a structured questionnaire to examine the relationship between employee engagement and organizational commitment. The population includes millennial employees (aged 25–38) working in Tier-1 IT hubs such as Bengaluru, Hyderabad, and Pune. A convenience sampling technique was used to gather 280 responses from mid-level employees across five major IT firms. The instrument included 24 items rated on a 5-point Likert scale, divided into two constructs: employee engagement (vigor, absorption, dedication) and organizational commitment (affective, continuance, and normative dimensions). Data reliability was validated using Cronbach's alpha (≥ 0.80). Descriptive analysis, Pearson correlation, and multiple regression were conducted using SPSS 26 to explore the strength and direction of the relationship between engagement and commitment.

4. Data Analysis

Among the 280 respondents, 61% were male and 39% female, with an average work experience of 4.2 years. The mean employee engagement score was 3.79 (SD = 0.58), and the organizational commitment score averaged 3.65 (SD = 0.60). Pearson correlation indicated a strong positive relationship between engagement and commitment ($r = 0.64$, $p < 0.01$). Regression analysis identified dedication ($\beta = 0.41$, $p < 0.001$) and absorption ($\beta = 0.33$, $p = 0.005$) as significant predictors of commitment, explaining 49% of the variance ($R^2 = 0.49$). Continuance commitment showed weaker links with engagement factors. These findings highlight that intrinsic motivation and task involvement are more influential in enhancing loyalty among millennials compared to job security or tenure.

5. Findings and Suggestions

The study establishes that employee engagement strongly predicts organizational commitment among millennial IT employees. Engagement components such as dedication to work and psychological absorption significantly increase affective and normative commitment. In contrast, factors associated with job security had limited influence, aligning with millennials' value-driven career orientation. Based on these insights, IT firms should focus on recognition programs, growth opportunities, and a participatory culture to drive deeper engagement. Encouraging autonomy, fostering open communication, and providing mentorship can also strengthen emotional bonds with the organization. HR leaders must revisit engagement strategies not as compliance tools but as value enablers to reduce turnover. Tailoring policies to millennial expectations will help organizations retain talent and maintain long-term performance in a competitive market.

6. Conclusion

This study highlights that employee engagement plays a pivotal role in fostering organizational commitment among millennials in India's IT sector. Emotional and cognitive aspects of engagement—such as dedication and absorption—emerge as key drivers of loyalty, outweighing traditional security-based motivators. As generational shifts redefine workplace expectations, companies must align engagement strategies with millennial values like autonomy, purpose, and inclusivity. Doing so not only boosts retention but also promotes a culture of high performance and innovation. HR practitioners and business leaders must treat engagement as a strategic lever for talent sustainability in the fast-paced, high-turnover IT industry.

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Impact of Financial Literacy on Investment Decisions Among Young Working Professionals in Urban India

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Abstract

This study examines the influence of financial literacy on investment decisions among young working professionals in urban India. Using survey data from 300 respondents across Tier-1 cities, the research employs descriptive statistics, Pearson correlation, and multiple regression to analyze the relationship between financial knowledge and investment behavior. Findings reveal a significant positive correlation between financial literacy and diversified investment choices, particularly in mutual funds and equities. Key predictors include awareness of inflation, risk diversification, and long-term financial planning. The regression model explains 51% of the variance in investment behavior, highlighting the importance of financial education in shaping rational investment patterns. The study recommends integrating structured financial literacy programs in academic and workplace settings, and encourages fintech platforms to embed educational modules. These insights underscore the urgent need to strengthen financial literacy as a foundation for informed decision-making and financial security in a rapidly digitizing economy.

Keywords
Financial Literacy; Investment Behavior; Urban Professionals; Risk Awareness; India

1. Introduction

In today's dynamic economic landscape, financial literacy plays a critical role in shaping individual investment behavior. With increased access to digital investment platforms and fintech tools, young working professionals in urban India are actively participating in stock markets, mutual funds, and cryptocurrencies. However, investment decisions vary widely based on one's understanding of budgeting, risk, and long-term planning. Despite higher incomes and internet penetration, many millennials and Gen Z professionals lack the knowledge to make informed financial decisions. This study aims to investigate how financial literacy influences the investment patterns of young urban professionals in India. The findings can help policymakers, employers, and financial institutions develop targeted financial education programs to foster informed and secure financial choices.

2. Literature Review

Financial literacy encompasses knowledge of financial concepts such as interest rates, inflation, risk diversification, and asset allocation. Lusardi and Mitchell (2014) emphasized that low financial literacy often leads to suboptimal investment behavior and poor retirement planning. Bhushan and Medury (2013) noted that Indian youth frequently lack awareness of basic financial products, resulting in risk-averse or speculative investment decisions. Agarwalla et al. (2015) found a strong correlation between financial education and diversified investment portfolios among working professionals. Additionally, Rooij et al. (2011) highlighted that financial literacy not only affects participation in stock markets but also enhances the ability to evaluate financial advice. However, literature is limited in the Indian urban context, especially among young professionals. This study fills that empirical gap.

3. Research Methodology

The study adopts a quantitative approach using a cross-sectional survey to assess the relationship between financial literacy and investment decisions. The target population includes working professionals aged 21–35 years residing in Tier-1 Indian cities such as Bengaluru, Mumbai, and Delhi. A stratified random sampling method was applied, and data were collected from 300 respondents using a structured Google Forms questionnaire. The instrument consisted of two sections: financial literacy (basic concepts, risk awareness, and planning) and investment behavior (types of instruments, risk

appetite, and decision factors), measured on a 5-point Likert scale. Data reliability was verified using Cronbach's alpha (>0.75). Analytical tools in SPSS 26 included descriptive statistics, Pearson correlation, and multiple regression to identify significant relationships between literacy and investment decisions.

4. Data Analysis

Out of 300 valid responses, 62% of respondents were male and 38% female, with a median monthly income of ₹55,000. Descriptive statistics revealed moderate financial literacy ($M = 3.56$, $SD = 0.62$) and diverse investment preferences including mutual funds (70%), equities (55%), and fixed deposits (48%). Pearson correlation showed a significant positive relationship between financial literacy and diversified investment decisions ($r = 0.59$, $p < 0.01$). Regression analysis revealed that knowledge of inflation ($\beta = 0.35$, $p < 0.001$), risk diversification ($\beta = 0.31$, $p < 0.01$), and long-term planning ($\beta = 0.28$, $p = 0.02$) significantly influenced investment behavior, explaining 51% of the variance ($R^2 = 0.51$). Respondents with higher financial literacy were more likely to avoid risky or impulsive investments.

5. Findings and Suggestions

The findings suggest that financial literacy is a significant predictor of rational and diversified investment decisions among young professionals in urban India. Respondents with a strong grasp of key financial concepts were more confident in exploring varied financial instruments and avoided speculative choices. Moreover, awareness of inflation and risk-reward dynamics contributed to long-term wealth planning. Based on these insights, it is recommended that organizations and educational institutions integrate structured financial literacy programs into employee orientation or academic curricula. Fintech platforms should incorporate interactive learning modules to improve investor knowledge before onboarding. Policymakers should also mandate financial education at the school and undergraduate levels to promote a more financially responsible generation and reduce vulnerability to scams or high-risk investments.

6. Conclusion

This study establishes that financial literacy significantly impacts the investment decisions of young working professionals in India's urban centers. A higher level of financial knowledge enables individuals to assess risk, diversify portfolios, and plan for long-term goals. As the financial ecosystem becomes increasingly digitized and complex, the need for structured financial education is paramount. Enhancing literacy not only promotes individual financial security but also strengthens the broader economic framework. By targeting financial awareness through educational, corporate, and fintech interventions, India can cultivate a generation of informed investors capable of making prudent decisions in an ever-evolving financial landscape.

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Electric Vehicles (EV) Sales Analysis and Market Trends: A Comparison between India and Global Market (2020 - 2024)

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Abstract

The research paper compares the Electric Vehicles (EV) sales in India with Global Market from the year 2020 to 2024. For the research annual sales, market penetration rate and segment-wise purchase patterns are analysed. The databases for sales are analysed using statistical methods and research provides India is rapidly adapting to the EV vehicles. The comparison clearly indicates that Indian Market is far behind the Global Market in adopting electric vehicles. The study of historical nature enables all stakeholders to understand EV market better. The study conducted using Excel and SPSS for making comparison by creating charts and graphs.

Key words

Comparison, Eco-friendly, Indian EV sales, Growth rate, Global EV sales, Sustainable , Policy, Sales Trend.

1. Introduction

The Electric Vehicles (EV) industry is one of the main focus for all stakeholders including Governments. There are many breakthrough in the EV industry which has caught the attention of many customers, Governments. Some of them are Government incentives, Battery technology, consumer awareness. In last preceding five years, India has seen significant changes in customer behaviour towards EVs. There is tremendous growth potential for EVs in near future in India.

Electric Vehicles (EVs) are recognised for their zero emissions, low noise and better comfort and making them more environmentally , economically user friendly compared to Diesel and Petrol vehicles. Despite these advantages India's EV market share stands at 1.5% compared to global average of 14% in 2022, Expected to raise in 2025.

2. Review of Literature

Current penetration of EV I India is very and it is only 76000 EV out of 52.6 million vehicles in 2022. It list measures of Increase penetration to 30% was researched in 'Shaping India's EV future: a policy framework inspired by global best practices', 2025 by Arindam Dutta, Sanjeevikumar Padmanaban.

Environmental Benefits and Economic benefits were huge and there were studies to improve the EV penetration. Article , The Evolution of the E-Vehicle Industry and its Path Towards Setting up Dominance in Automobile Industry - A Case Study, Anantha Murthy & Nethravathi P. S concluded with various measure to deepen the EV sales like charging infrastructure, More measures by Governement.

The paper The Charge of the EVs: An Overview of the Indian E-Mobility Roadmap, transition to EVs is essential for sustainable development and Government initiatives such as FAME II policy adoption.

3. **Objectives**

- To understand Global sales trend with India.
- Compare the India EV sales with Global EV sales.
- Compare Indian EV sales with Total (EV plus Non-EV) Global Sales.
- Analysis of Indian and Global EV sales Trend.

4. Research Methodology

The research follows the descriptive and explorative study of Indian and Global EV sales Trend in order to derive the relative percentage of Indian EV Market share. The data is collected from various web sources where the statistics of sales from 2020-2024 (5 Years data) is considered for analysis.

Statistical tools like Table, graphs, charts are adopted for comparison and interpretation of the result.

5. Indian EV sales : Scenario

India's electric vehicle (EV) market is experiencing significant growth, with sales crossing 2 million units in 2024. While electric two-wheelers dominate the market, sales of electric cars and buses are also on the rise, reflecting a broader shift towards sustainable transportation. Government initiatives, including subsidies and infrastructure development, are further fueling this growth, although challenges like charging infrastructure and price points remain.

5.1 Sales Figures and Growth:

- Total EV sales in India reached over 2 million units in 2024, a 24% increase compared to the previous year.
- Electric two-wheelers lead the market, accounting for nearly 60% of total EV sales in India, with a 30% year-on-year growth, according to JMK Research & Analytics.
- Electric three-wheelers also constitute a significant portion of the market, with electric cars and buses showing promising growth.
- EV penetration in India's overall vehicle market is estimated to be around 8%, up from 6.8% the previous year.

5.2 Factors Driving Growth

- **Government Support:**

The Indian government is actively promoting EV adoption through various initiatives, including the Faster Adoption and Manufacturing of Electric Vehicles (FAME) scheme, which provides subsidies and incentives for EV purchases and charging infrastructure development.

- **Increased Consumer Awareness:**

Growing awareness about the environmental benefits and cost savings associated with EVs is driving consumer demand.

- **Improved Charging Infrastructure:**

While still a work in progress, the expansion of charging infrastructure is making EVs more practical for a wider range of users.

- **Falling Battery Prices:**

Declining battery prices are contributing to the affordability of EVs, making them more accessible to a larger segment of the population.

6. Global E V Sales Trends:

2020 turned out to be a surprisingly positive year, with global **EV sales growing by 43% from 2019** and the global electric car industry market share rising to a record 46%.

The year **2021** was a major leap forward for **electric vehicle sales as they doubled from 2020 to 6.75 million.** The number of EVs sold in a week in 2021 was higher than how many were sold in the whole year of 2012.The year **2022** broke records with **EV sales exceeding 10 million**. That resulted in more than **26 million electric cars roaming global roads in 2022**, representing a 60% uptake from 2021.

Carried by a decarbonisation challenge and supported by various policies and incentives, global EV sales kept accelerating in **2023**. According to the IEA, the **global electric car sales reached almost 14 million**, which represented a **35% increase** from 2022. This growth meant that the **global electric fleet rose to 40 million** in 2023.

EVs are to play a central role in the ambitious objective of zero-emission targets set for 2050, and the industry is gearing up for it.

The year **2024** brought an increase of 3 million EVs, bringing the total to **17 million electric cars sold globally** and **exceeding 20%** of new car sales. Overall, the global electric fleet had almost **58 million cars** at the end of 2024.

The outlook for EVs in the near term is promising, with projections indicating a global total of 145 million electric vehicles on the road by 2030, constituting 7%
of the total vehicle fleet.

7. Statistics of Indian sales and Global sales in EV Sector

Table 1: **India and Global total sales** and **India and Global EV sales**

Year	India total sales (in Million Units)	India EV sales (in Million Units)	Global sales (in Million Units)	Global EV sales (in Million Units)
2020	25.9	0.12	63.4	3.10
2021	27.5	0.32	65.9	6.60
2022	28.4	1.00	74.6	10.60
2023	30.0	1.53	72.0	14.00
2024	31.3	1.94	78.0	17.00

Graph1: **India and Global total sales** and **India and Global EV sales**

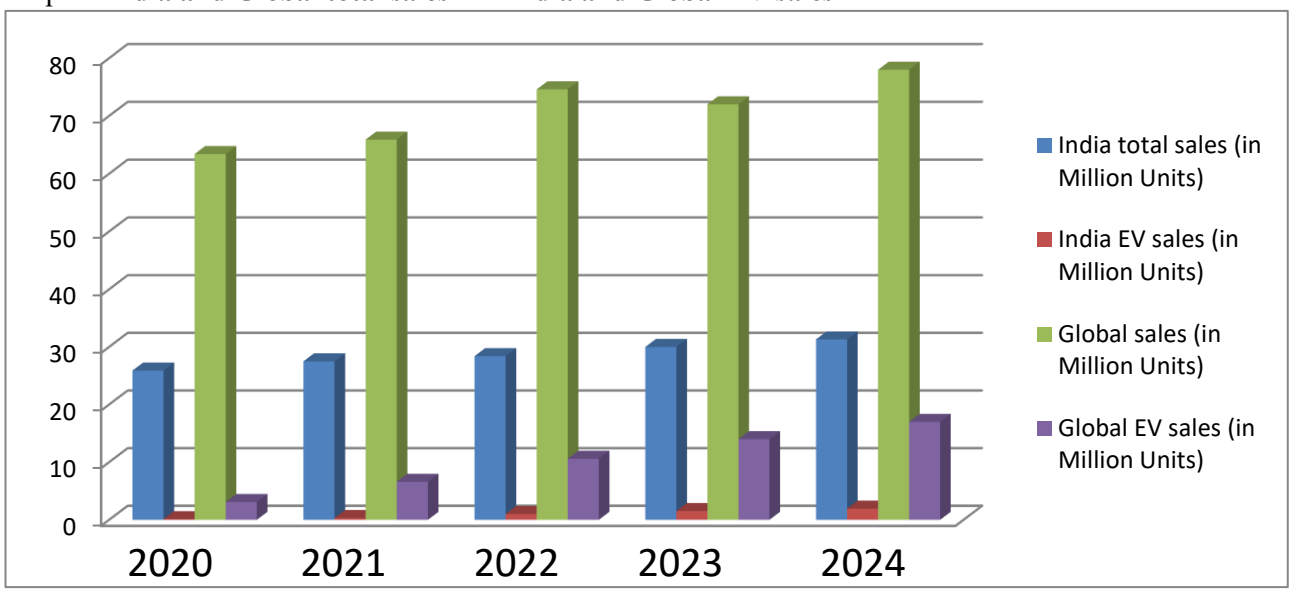


Table 2: Percentage EV sales: India EV sales vs Global EV sales

Year	Percentage of Global EV sales to total sales(percentage)	Percentage of India EV sales to Total sales(percentage)
2020	4.9	0.5
2021	10.0	1.2
2022	14.2	3.5
2023	19.4	5.1
2024	21.8	6.2

Graph 2:Percentage EV sales: India EV sales vs Global EV sales

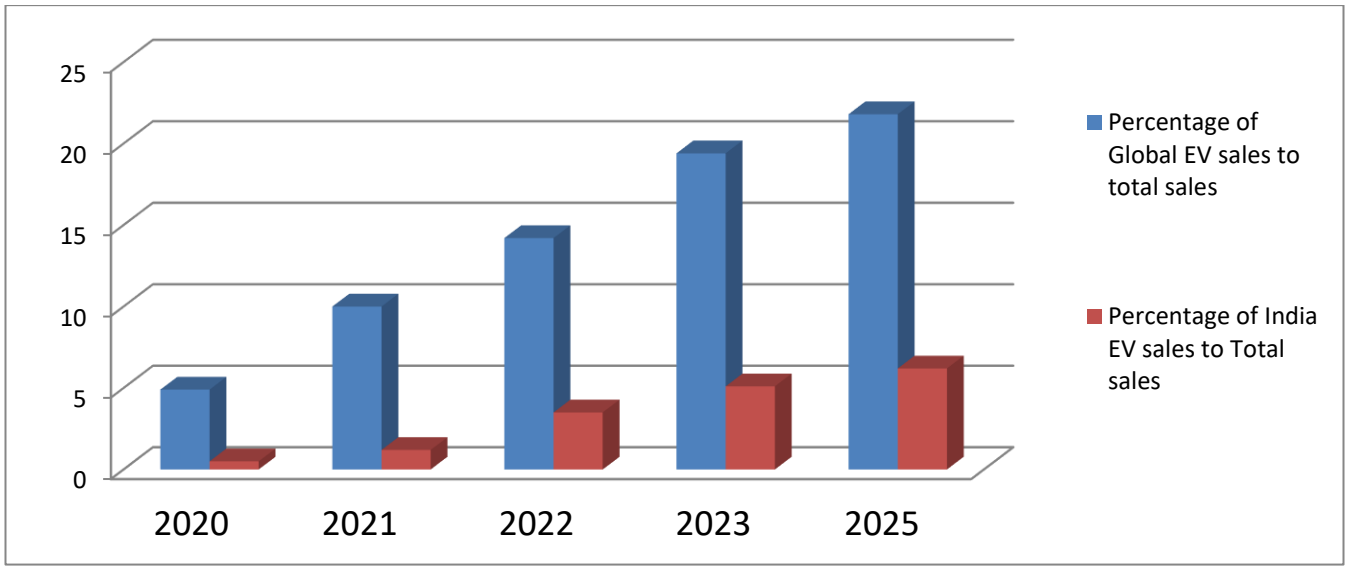
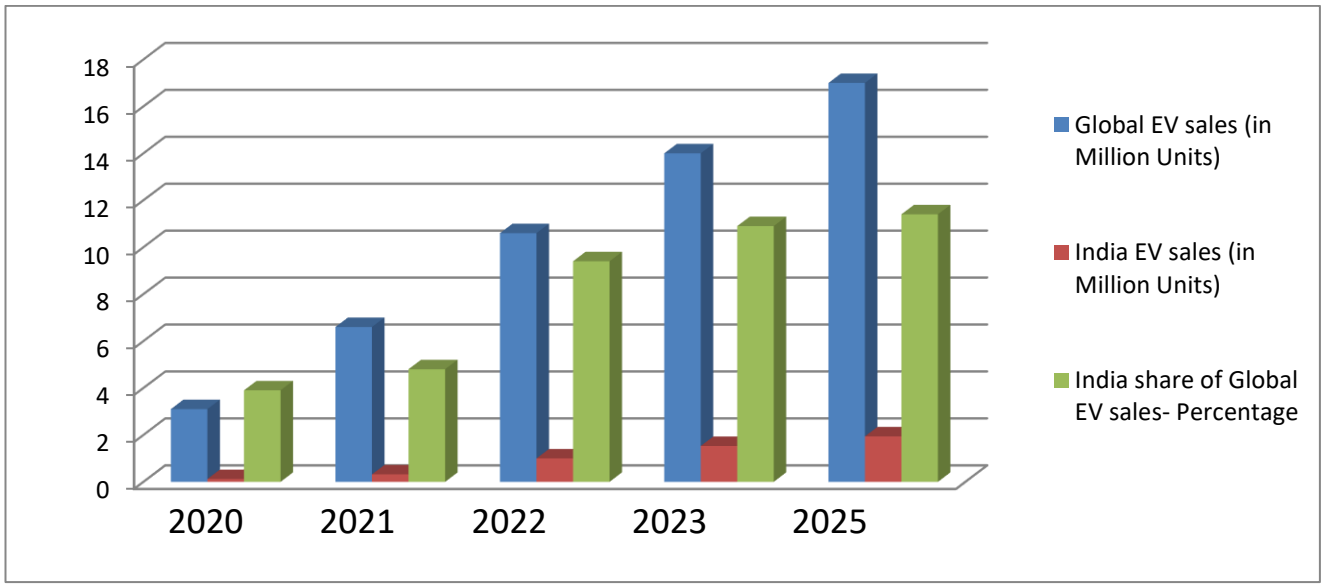


Table 3:Percentage Sales Comparison: India EV sales to Global EV sales

Year	Global EV sales (in Million Units)	India EV sales (in Million Units)	India share of Global EV sales- Percentage
2020	3.10	0.12	3.9
2021	6.60	0.32	4.8
2022	10.60	1.00	9.4
2023	14.00	1.53	10.9
2024	17.00	1.94	11.4

Graph 3:Percentage Sales Comparison: India EV sales to Global EV sales



Data Source:

1. SIAM: Total vehicle sales FY2023-24
2. JMK Research: India EV sales 2020–2024.
3. IEA: Global EV sales 2020–2024.
4. IEA: Global EV sales for 2021

6. IEA: Global EV Outlook 2024:

7. ACEA: Global car sales 2022

8. ACEA: Global new car registrations 2023

7. Findings:

1. The % of EV sales in India was 0.5% in 2020, which has raised to 6.2% in 2024, which is an evidence that EV sales is in raising trend.

2. On the other Hand, the rate of growth in Indian EV sales in comparison with growth rate of Global EV sales, there is slow trend of % Growth(Global growth rate: 4.9% to 21.0% In 2024, Indian growth rate: 0.5% to 6.2 % in 2024)
3. As far as two wheelers are concerned, Global sales are relatively less as compared to Indian Two Wheelers sale.

4. Where as the four wheelers show greater sales in global market as compared to Indian Market.

8 .Conclusion:

India's electric vehicle (EV) adoption journey faces multifaceted challenges and holds substantial promise. With a rapidly growing automotive sector and the transportation industry contributing significantly to greenhouse gas emissions, the need for transitioning to EVs and zero-emission vehicles (ZEVs) is evident. This
shift aligns with global climate commitments and can address India's objectives of reducing oil dependence, curbing air pollution, stimulating job creation, and strengthening the "Make in India" initiative. However, this path is complex, requiring substantial efforts.
In the realm of widespread electric vehicle (EV) adoption, India confronts both formidable challenges and promising opportunities. Our comprehensive study identified pivotal factors influencing EV penetration in India,
Although India's progress in EV sales trails behind China, the United States, Germany, and Norway, a promising trajectory is discernible. The 2023 Economic Survey of India forecasts a robust 49% Compound Annual Growth Rate (CAGR) in the Indian EV market from 2022 to 2030, hinting at a positive trajectory, albeit one that may seem ambitious.
This study delved into a comparative analysis India and Global Market trend in sales illuminating areas where substantial financial allocation could catalyze
EV adoption. Recommendations encompassed the refinement of subsidies, dedicated EV parking, implementation of green license plates, and road tax exemptions, all aimed at augmenting the allure of EV ownership.
Effective public awareness campaigns for Indian roads can Emerge as a potent driver for EV adoption.
In our concluding segment, we proffer a series of recommendations rooted in supportive policies, financial strategies, and charging infrastructure development. These recommendations are carefully adapted to India's unique context, drawing insights from the experiences of leading nations. The analysis not only scrutinized sales variations among India and global market, but also probed India's struggle to attract significant Foreign Direct Investment (FDI) in the automobile sector, even with the 100% FDI investment policy , particularly for EV sector. The financial recommendations can be tailored to the distinctive characteristics of the Indian market, addressing specific policy incentive gaps for shared vehicles.

Overall, the Indian EV market is experiencing strong growth and holds significant potential for future expansion. While challenges remain, the increasing adoption of EVs, supported by government initiatives and technological advancements, is paving the way for a more sustainable transportation future in India. In conclusion, while India's target of achieving 30% EV penetration by 2030 may appear ambitious, current statistics reveal a stark reality.

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Plugging into Progress: Consumer Perception and Purchase Intent of Electric Vehicles in Tier-1 Indian Cities

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1. Introduction

Electric Vehicles (EVs) are at the forefront of India's clean energy transition. As urban centers in Tier-1 cities like Bengaluru, Mumbai, and Delhi grapple with rising pollution, EVs have emerged as a viable alternative to traditional fossil-fuel vehicles. Central and state-level policies such as FAME-II, green number plates, and tax rebates are pushing market adoption. However, despite incentives and awareness campaigns, the consumer adoption curve has remained slow. Factors such as cost perception, infrastructure readiness, and product trust continue to influence intent. This study explores the perception and purchase behavior of urban Indian consumers towards EVs.

2. Literature Review

Consumer perception studies reveal that EV adoption is influenced by a mix of rational and emotional triggers. Ajzen's Theory of Planned Behavior (1991) highlights that attitudes, subjective norms, and perceived behavioral control guide intent. In EV contexts, Rezvani et al. (2015) observed that range anxiety, brand trust, and infrastructure reliability influence decision-making. In India, NITI Aayog (2021) and TERI (2022) found that affordability, battery life, and awareness of subsidies directly impact adoption. Yet, gaps remain in localized urban consumer behavior analysis—this study addresses that.

3. Research Methodology

The study employed a quantitative research design targeting working professionals and students aged 22–45 in Tier-1 cities. Using purposive sampling, 300 responses were collected through structured online questionnaires. The instrument covered three constructs: (1) Awareness and Perception (policy knowledge, EV features, environmental value), (2) Barriers (cost, charging infrastructure, performance concerns), and (3) Purchase Intent. All constructs were measured on a 5-point Likert scale. Reliability was confirmed with Cronbach's alpha > 0.75. SPSS 26 was used for analysis including descriptive stats, correlation, and regression.

4. Data Analysis

Among the 300 respondents, 59% were male and 41% female, with a median income of ₹52,000/month. Awareness of EV benefits ($M = 4.15$, $SD = 0.51$) was high, while actual purchase intent was moderate ($M = 3.38$, $SD = 0.68$). 68% of participants cited charging infrastructure as a major limitation. Pearson correlation indicated a strong relationship between environmental perception and purchase intent ($r = 0.61$, $p < 0.01$). Regression analysis found that perceived cost-benefit ratio ($\beta = 0.41$) and policy awareness ($\beta = 0.35$) significantly influenced intent ($R^2 = 0.52$).

5. Findings and Suggestions

The study establishes that while consumer awareness of EVs is high in Tier-1 cities, purchase decisions are shaped by a mixture of policy understanding, cost perception, and infrastructure confidence. Respondents familiar with subsidies and battery leasing models showed higher purchase intent. It is recommended that auto firms and public agencies co-create awareness campaigns focused on practical benefits and financing ease. Retailers should enhance showroom experience with hands-on demonstrations, while municipal bodies must invest in public charging networks.

6. Conclusion

This study highlights the evolving mindset of urban Indian consumers toward electric vehicles. High awareness and environmental alignment indicate readiness, but actionable adoption depends on infrastructure, affordability, and information clarity. By aligning policy, marketing, and technological clarity, stakeholders can transform curiosity into commitment. For India to meet its net-zero goals, accelerating EV adoption in Tier-1 cities through informed perception building and practical support is essential.

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Gen Z on the Move: Exploring EV Brand Perception of Ather Energy and Ola Electric in India's Emerging Mobility Market

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Abstract

India's drive to electric vehicles (EVs) is growing rapidly due to environmental standards, subsidies offered by the government, and technology innovations in the two-wheeler market. Among the potential consumers, Gen Z (1996-2012) is a notably technologically savvy, economical, and environmentally mindful population that is best suited to contribute to the landscape of sustainable mobility in the near future. To explore how two renowned EV brands, Ather Energy and Ola Electric, align their approaches to branding standards and perspectives to appeal to Gen Z consumers. By the use of secondary data sources from reports, journal articles, social media promotion, media reviews etc., the study examines the way each brand resonates with Gen Z in four distinct dimensions, like brand positioning, technological factors, accessibility, and engagement with consumers. Ather Energy represents a premium and innovation-driven brand to early users, whereas Ola Electric uses a competitive pricing strategy with mass marketing using digital marketing strategies for the extensive outreach and to bring in more young consumers. Though the approaches are different, their outreach is for Gen Z ideals like technological integration and sustainability. As per the findings of the study, it reveals that when businesses satisfy Gen Z's expectations for innovation, tech functionality, social importance, and brand consumer compliance, is at its highest. the evolving India's transition towards eco-conscious mobility. The study's conclusion addresses the implications of India's evolving transition towards eco-conscious mobility for EV branding, policy exchanges, and strategies targeting young demographics.

Key Words: *Electric vehicle (EV), Environmentally friendly, Technological advancement, Sustainable, Gen Z.*

1. Introduction

The world is transforming dramatically owing to the significant environmental problems consisting of greenhouse gas emissions and global warming, which are compelling governments, organisations, and individuals to shift to more environmentally friendly and cleaner energy sources (Shiney Chib et al., 2025; Fabio L. Santana Stork, 2022). This transition is primarily driven by the automobile sector, which enormously contributes to airborne pollutants and the emissions of greenhouse gases (Khurana, A et al., 2020). Electric vehicles have emerged as a key response to resolve this, as they can help with improved quality of air in the urban cities, cut down fossil fuels, and mitigate the CO2 emissions; all of them have an advantageous influence on the ecosystem and the human well-being (Langbroek, J. H. M. et al., 2016). Innovations in battery storage technology and an equal need for environmentally sound mobility are contributing to the swift expansion of the global EV market (Sharmila Rao S et al., 2024; Das, P. K., & Bhat, M. Y. 2022). Given India's quick urbanisation and steadily increasing population, the introduction of electric vehicles is a vital strategic prerequisite to address the nation's energy stability and environmental issues (Kanujiya, P. K., 2024). India constitutes one of the globe's major carbon dioxide emitters, and several of its largest cities are identified as the most polluted in the world (Kumar, R., et al., 2020; Tarei, P. K., et al., 2021). In order to acknowledge this, the Government of India (GOI) has demonstrated a profound dedication to carbon neutrality, more specifically by signing the Paris Agreement for reduction in carbon intensity of GDP by 33-35% by 2030 (Kumar, R., et al., 2020; Bhat, F. A., et al., 2022). Electric vehicle acceptance was promoted by the initiatives featuring the Faster Adoption & Manufacturing of Electric Vehicles (FAME),

Production Linked Initiatives (PLI Scheme), ACC Battery Storage, and Battery Swapping Policy. Furthermore, the Zero Pollution Mobility campaign and shoonya (NITI Aayog, Government of India 2023) encouraged organizations to use electric vehicles for travel and shipment, which reduced emission levels and avoided petroleum (Simon, A. E., et al., 2024; Kumar, R., et al., 2020). Despite the prevalent of these efforts, there are numerous barriers to the broader adoption of EVs in India, including high upfront costs, a lack of adequate electrical infrastructure for charging, range anxiety, an expectation of uncertainty of battery longevity, and comparatively modest purchasing power among customers (Tarei, P. K. et al., 2021). For speeding up the adoption of EVs, it is important to comprehend the customer viewpoints (Langbroek, J. H. M., et al., 2016; Kanujiya, P. K., et al., 2024). Gen Z represents a significant percentage of potential consumers, making this population particularly valuable due to their greater knowledge and understanding of sustainability concerns and technological advances. They exhibit a clear preference for EVs that reflect factors like perceived convenience, subjective norms, recurring rewards, and purchase benefits (Fabio L. Santana Stork 2022). This study aims to provide a broad perspective of how branding and products of the renowned Indian EV manufacturers, Ather Energy and Ola Electric, affect Gen Z consumers. The objective is to provide an extensive understanding of the factors determining the future development of the EV industry in India, specifically with regard to the younger population.

2. Literature Review

Langbroek, J. H. M., et al., (2016) with the aim of finding whether policy incentives influence the adoption of electric vehicles (EVs), this research analyses the literature while incorporating sociopsychological factors. The study integrates the Protection Motivation Theory to understand how behavioural changes across different phases impact people. By considering these intricate variables, the research seeks to offer insights into how users respond to EV advertising strategies.

Rezvani, Z., et al., (2015) the study reveals the adoption and usage of EVs by consumers, with a specific focus on plug-in EVs such as Battery Electric Vehicles (BEVs), Plug-in Hybrid EVs (PHEVs), and Extended-Range Electric Vehicles (E-REVs). Owing to a greater part of user assumptions, EV purchase rates are still low despite their environmental benefits. By categorizing them into technical concerns such as range anxiety and performance, cost factors such as high upfront costs and maintenance savings, and contextual factors like charging infrastructure and supportive legislation, the paper identifies the significant hurdles to consumer use. It also discusses normative theories like the Value-Belief-Norm Theory, the Theory of Planned Behaviour, Rational Choice Theory, and the ideas of self-identity, lifestyle, and innovation diffusion that are integrated in EV adoption. However, the adoption is influenced by factors such as perceived benefits and environmental concerns.

Bhat, F. A., Verma, M., & Verma, A. (2022) based on the existing literature, contribute to the significant portion for reducing greenhouse gas emissions in the automobile sector. Despite the financial and non-financial incentives available, the adoption of EVs remains insufficient, notably in countries like India. Multiple studies show how consumers determine which products to buy and often adopt the Technology Acceptance Theory and the Theory of Planned Behaviour. Original cost of ownership, range of driving, and evolving infrastructure are a few constraints to adopting EVs. Others include consumer personality attributes like curiosity and inventiveness, social perception, and environmental concerns. Thus, this study addresses the lack of research in the developing countries and the limited number of studies examining the influence of consumer values in EV adoption.

Kumar, R., Jha, A., et al., (2020) the study on EV adoption addresses worldwide developments in addition to India's recent challenges. EVs have become a growing trend across the globe due to increasing pollutants and a greater concentration on sustainable energy sources. Leveraging regulatory measures, enticements, and advancement of infrastructure encompassing the idea of a sharing economy, the countries promoting the use of EVs include China, the US, and Norway. The EV industry in India is growing up despite substantial obstacles consisting of high purchase costs, lack of facilities for charging, concerns regarding range, inadequate battery technology, reliance on imports, and the rigidity of an existing hydrocarbon economy. In spite of government initiatives like FAME II, a shared mobility business model might be more efficient for India's early EV adoption phases due to financial limitations and the nation's widespread use of public transportation.

3. Research Gap

With India's fast move to electric vehicles, it is necessary for the businesses seeking an enduring position in the marketplace to learn the attitudes and expectations of Generation Z (born between 1996-2012), which is the most essential demographic in the evolving landscape of sustainable transportation owing to their strong technological bonds, growing environmental awareness, and rising purchasing power. While prior studies have recognised that young consumers can drive the adoption of electric vehicles, most of these studies treated this age group as single entity or focused on general market trends. Keeping this in view, it is vital to investigate within the framework of the Indian EV market which is defined by policy-driven growth, cost sensitivity, and infrastructure barriers. The factors include the distinct brand expectations, adopting motivations, and behavioural patterns of Gen Z. The current and relevant inquiry into how Gen Z views two important domestic EV brands, Ather Energy and Ola Electric. Ola's aggressive mass-market and digital expansion, whereas Ather's premium and performance-driven branding. This research enhances our knowledge of brand-consumer compliance in a high-growth and high-stake market by thorough consideration of whether Gen Z responds to these strategies. This study advances India's higher purpose of inclusive mobility, technological innovations, and sustainability in the environment.

4. Research Objectives

1. To examine how Ather Energy and Ola Electric position their electric vehicle brands to attract Gen Z consumers in Indian EV market.
2. To identify and analyse Gen Z consumers' perceptions, motivations and perceived barriers related to Ather Energy and Ola Electric.

5. Research Methodology

The study incorporates a qualitative case study approach to explore and understand the brand positioning strategies of Ola Electric and Ather Energy. The study is based on the secondary data, gathered from various sources such as official brand websites, previous research articles, academic journal articles, industry reports, and online media articles.

6. Case Analysis

6.1. Ather Energy: Innovating the Electric Scooter Experience

The Young intellects Mr. Tarun Mehta and Mr. Swapnil Jain in 2013, established their baby brain in 2013, becoming India's fourth-largest EV two-wheeler manufacturing facility in Bengaluru as its headquarters. The vehicles range includes Ather Rizta, Ather 450, and 450 Apex. Ather Energy's functional and smart electric scooters have created a quiet buzz among consumers. With a Zenith for electric bikes that are intended for 125-300 cc fuel-powered bikes and an EL for a budget-friendly electric scooter, the company is creating these two new EV two-wheeler versions. Ather expects to have a 10% market share by 2030. Ather presently operates 239 Experience Centres, as well as nearly 2000 Ather Grid swift charging facilities in 175 towns in India as of October 31, 2024. Furthermore, it has collaborated with the Karnataka state government to construct 1,000 fast charging stations/facilities, which could promote purchasing and owning EVs, thus increasing the use of sustainable forms of mobility. The distinct brand identity of Ather was carefully chosen to appeal to the young, technologically adept urbanites. By focusing on renewable sources of energy, innovative engineering, and evolving in lifestyle. As an aspect of its strategy to promote long-term brand loyalty and trust, its "Experience Centres" are made to enable consumers with interest to engage intensely with the product. The biggest challenge confronted by Ather is its premium price and limited geographical reach. Cost-sensitive Gen Z are unable to afford it in the Tier 2 and Tier 3 cities. Despite incentives, its high initial cost and scarce infrastructure for charging limit its broad appeal. Nevertheless, Ather remains an established brand among the early prospective customers and young, technology-savvy urbanites who value performance technology over affordability.

Source:

Forbes, Harichandan Arakali, Feb 8th 2018, https://www.forbesindia.com/article/30-under-30-2018/tarun-mehta-swapnil-jain-electrifying-scooters/49385/1
https://www.atherenergy.com/,
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6.2. Ola Electric: Electrifying India's Two-Wheeler Market

Mr. Bhavish Aggarwal, the founder of Ola Electric, started the company with the idea to reduce the emission and fuel dependency of Ola's cabs and transition to mass electric transportation. Established in 2017, with its headquarters in Bengaluru. The product range includes Ola S1X Gen3, Ola S1 Z, Ola S1 Pro Gen 3, Ola Gig, etc. The Ola Electric has revolutionised India's electric two-wheeler scooter. In December 2024, it boosted its distribution network to 4,000 business locations covering all the pin codes in the country as a part of its newest initiatives. During this point in time, approximately 3,200 new stores featured service facilities, which enhanced after-sales assistance and encouraged the adoption of EVs. #Hyperservice campaign was launched for the broad service coverage in an effort to promote the widespread use of EVs, especially concentrating in rural areas. Furthermore, the company started an initiative on the EV service program to train more then 1,00,000 technicians throughout India and a network partnership program to recruit 10,000 partners for sales and service by the end of 2025. The two-wheelers are crucial for daily transit in Indian towns, and the accomplishment and growth of Ola Electric indicate the rising need for affordable and ecologically conscious mobility solutions in Indian cities. This rise in demand reflects people's growing desire for sustainable transportation options. Ola presented itself as a symbol of inclusive initiative, guaranteeing accessibility and quick installation of a potentially hyper charger networks across the country. Ola embraced digital platforms and an influencer marketing strategy to promote its products and target young consumers. Gen Z finds this platform unique for socially conscious consumers. Social media platforms, including Instagram, Twitter, and YouTube, are incorporated in advertising and influencer-sponsored promotions (Chib, S., 2025). Ola appeared to be ambitious yet affordable due to product launches that imitated tech reveal, such as Apple's. The EV scooters are driven by MoveOS, "futuristic tech, that covers ranging music and mood settings to predictive AI." (Bhat, F. A., et al., 2022). Style-conscious Gen Z users will find these scooters appealing due to their clean, streamlined appearance and vibrant colour options. Ola's rapid growth and overpromising, led to serious lapses in customer confidence and level of service. Few constraints and major concerns comprised delivery lags, after-sale service issues, and inconsistent product performance, which were all noted by the multiple users in the early stages. Regardless to this, ola was able to gain a substantial share of the market in spite of these shortcomings, and this is due to their aggressive pricing, entry-level design supply, and extensive infrastructure (Simon, A. E. et al., 2024). Ola's EV strategy reflects a mass-market methodology customized to India's socio-economic diversity. A few its ongoing challenges include reliability and customer support; however, Gen Z cannot overlook this enterprise due to immense scope and popularity. It resembles promises, the prospects, and concerns for EV disruption in India.

Source:

https://www.olaelectric.com/

https://www.resconpartners.com/indias-electric-vehicle-revolution-powering-a-greener-future-with-key-players-and-bold-initiatives/

7. Conclusion

This case study reveals that Gen Z consumers are becoming more influential towards the electric vehicle (EV) segment in India. The analysis of the brands, such as Ola Electric and Ather Energy, has significantly advanced their establishments as market leaders in the space of sustainability and innovation, although their strategies to engage Gen Z differ greatly. Ather's proficiency in technology segments targeted Gen Z consumers who value engineer excellence and premium tech-focused appeal. Whereas Ola Electric has disrupted the mass market by means of its proactive product introduction and promotions, digitally positioning it as an ideal brand for the Gen Z population in Tier 1 and Tier 2 cities. Brands need to be based on value-driven offerings with digital authenticity and functionality and establish trust to gain an edge over Gen Z consumers in the Indian EV market. Such actions will ultimately result in a stronger and greater-value bond between consumers in the era of sustainable mobility.

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Factors Influencing the Adoption of Electric Vehicles in Karnataka State

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Abstract:

This study investigates the key factors influencing the adoption of electric vehicles (EVs) among consumers, with a focus on socio-demographic, economic, psychological, and policy-related dimensions. Utilizing a mixed-method approach, primary data were collected from 300 respondents through structured questionnaires. The quantitative data were analyzed using descriptive statistics, correlation, regression, and factor analysis.

The findings reveal that income, education level, environmental concern, and technological readiness significantly influence consumer intention to adopt EVs. Government incentives, such as subsidies and tax benefits, are perceived as strong motivators, though limited awareness and insufficient charging infrastructure continue to hinder adoption. Furthermore, consumer attitudes toward EVs improve notably with direct experience, such as test driving, while a lack of detailed knowledge remains a barrier.

The study concludes that a combination of policy reform, public education, and infrastructure development is essential to accelerate EV adoption. Recommendations include enhancing awareness campaigns, expanding charging infrastructure, and encouraging test drive programs to build consumer confidence and interest in electric mobility.

Key Words: Electric Vehicle Adoption, Consumer Behaviour, Government Incentives, Environmental Concern and Charging Infrastructure.

1. Introduction:

Electric vehicles (EVs) represent a transformative shift in the global transportation sector, offering a cleaner and more sustainable alternative to traditional internal combustion engine (ICE) vehicles. Powered primarily by electric batteries, EVs significantly reduce greenhouse gas emissions, air pollution, and dependency on fossil fuels. With growing concerns over climate change, urban air quality, and energy security, electric mobility has emerged as a key focus area for governments, industries, and consumers alike.

In India, the adoption of electric vehicles is gaining momentum, driven by government policies, rising fuel prices, and increasing environmental awareness. As one of the world's fastest-growing economies and the third-largest emitter of greenhouse gases, India faces both the challenge and opportunity of transitioning to cleaner mobility solutions. The Government of India has launched several initiatives, such as the **Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME)** scheme, production-linked incentives (PLIs), and state-level subsidies to promote EV adoption across the country.

Despite these efforts, the widespread adoption of electric vehicles in India faces several hurdles, including high initial costs, limited charging infrastructure, range anxiety, and consumer hesitation. However, with advancements in battery technology, increased investment in EV infrastructure, and active participation by automobile manufacturers, India is steadily moving toward a greener mobility future. The shift toward EVs is not just a technological change but a critical step toward achieving sustainable development goals and reducing the nation's carbon footprint.

2. Literature Review on Electric Vehicle Adoption

The adoption of electric vehicles (EVs) has gained significant academic and policy interest over the last two decades, owing to their potential to reduce greenhouse gas emissions, improve energy efficiency, and decrease dependence on fossil fuels (Sierzchula et al., 2014). Scholars have explored a range of factors influencing EV adoption from technological, economic, environmental, and behavioral perspectives.

Early studies highlight that the limited driving range, long charging times, and high upfront cost were major barriers to EV adoption (Egbue & Long, 2012). However, technological advancements have improved battery performance and reduced costs, gradually mitigating these challenges (Nykvist & Nilsson, 2015). The total cost of ownership (TCO), including fuel and maintenance savings, has also become an increasingly important determinant for consumers (Li et al., 2017). Public policy plays a crucial role in encouraging EV adoption. Incentives such as tax credits, subsidies, access to high-occupancy vehicle (HOV) lanes, and investment in charging infrastructure have significantly influenced adoption rates (Hardman et al., 2017). Countries with strong government support, such as Norway and China, have witnessed rapid EV penetration (IEA, 2021).

Behavioral aspects and consumer perceptions have emerged as critical in understanding EV adoption. Range anxiety, perceived reliability, environmental consciousness, and social influence significantly affect consumer willingness to switch from internal combustion engine (ICE) vehicles to EVs (Rezvani et al., 2015). Awareness and trialability of EVs also influence adoption intentions (Schuitema et al., 2013). he availability of charging infrastructure is frequently cited as a key enabler of EV uptake (Hall & Lutsey, 2017). Urban areas with dense charging networks tend to exhibit higher adoption rates. Integration with renewable energy sources and smart grid systems also presents opportunities to further accelerate EV diffusion (Noel et al., 2019). Socio-demographic characteristics, such as income level, education, occupation, and urban residency, have been linked to EV adoption likelihood (Javid & Nejat, 2017).

Higher-income and environmentally aware consumers are more inclined to adopt EVs, although decreasing costs are starting to open the market to a broader demographic. Comparative studies indicate stark differences in EV adoption across countries, largely due to variations in policy, infrastructure, cultural attitudes, and market maturity (Mock & Yang, 2014). For instance, while Norway leads in market share, the U.S. has shown more regional disparity in adoption patterns.

3. Methodology

3.a. Research Design

This study will adopt a **mixed-methods research design**, combining both **quantitative** and **qualitative** approaches to gain a comprehensive understanding of the factors influencing the adoption of electric vehicles. The quantitative part will identify and measure the strength of various influencing factors, while the qualitative part will explore in-depth motivations and barriers experienced by potential EV adopters.

3.b. Objectives

The main objectives of this study are:

- To identify key socio-demographic, economic, and psychological factors influencing EV adoption.
- To assess the impact of government policies, incentives, and infrastructure on consumer decisions.
- To explore consumer perceptions, awareness, and attitudes toward EV technology.

3.c. Population and Sampling

a) Target Population:
The target population includes private vehicle owners and potential car buyers in urban and semi-urban areas.

b) Sampling Technique:
A **stratified random sampling** method will be employed to ensure representation across age, income, education level, and location. For the qualitative phase, **purposive sampling** will be used to select participants based on their relevance to the study.

c) Sample Size:

- **Quantitative survey:** Minimum 300 respondents to ensure statistical validity.
- **Qualitative interviews:** 15–20 participants for in-depth interviews or focus groups.

3.d. Data Collection Methods

A. Quantitative Phase

- **Instrument:** Structured questionnaire
- **Mode of Administration:** Online and offline surveys
- **Key Variables Measured:**
  - Demographics (age, gender, income, education)
  - Environmental concern
  - Perceived cost and benefits (TCO, maintenance, incentives)
  - Technological readiness and knowledge of EVs
  - Range anxiety and infrastructure availability
  - Attitudes, subjective norms, and behavioral intentions (based on the Theory of Planned Behavior)

B. Qualitative Phase

- **Instrument:** Semi-structured interview guide
- **Method:** One-on-one interviews or focus group discussions
- **Focus Areas:**
  - Personal perceptions and experiences with EVs
  - Barriers and motivations to adopt EVs
  - Opinions on policy and infrastructure
  - Peer and social influences

3.e. Data Analysis Techniques

a) Quantitative Analysis:

- **Descriptive Statistics:** To summarize demographic data and general trends.
- **Inferential Statistics:**
  - Multiple regression analysis to determine key predictors of EV adoption intention.
  - Factor analysis to group related variables and validate constructs.
  - ANOVA or t-tests to compare groups (e.g., EV adopters vs. non-adopters).

b) Qualitative Analysis:

- **Thematic Analysis:** Coding and identifying patterns across interviews.
- **Software:** NVivo or manual coding using thematic frameworks.
- Findings will be triangulated with quantitative results for better insight.

3.f. Validity and Reliability

- **Pilot Testing:** The survey instrument will be pilot-tested with 20 participants to check for clarity, reliability, and validity.
- **Cronbach's Alpha:** Will be used to assess internal consistency of survey constructs.
- **Triangulation:** Use of both qualitative and quantitative data ensures methodological triangulation and strengthens validity.

3.g. Limitations

- Results may be influenced by self-reporting bias.
- Limited generalizability beyond the target regions.
- Technological and policy changes during the study period may affect findings.

4. Data Analysis

A structured questionnaire was administered to 300 respondents, comprising both existing vehicle users and potential buyers. The data were analyzed using **SPSS** and **MS Excel**, employing descriptive and inferential statistics to address the three primary research objectives. Demographic, economic, psychological, and policy-related variables were evaluated for their impact on electric vehicle (EV) adoption.

4.1. Descriptive Statistics

Table: 01 Demographic Profile of Respondents

Variable	Category	Frequency	Percentage
Gender	Male	180	60%
	Female	120	40%
Age Group	18–25	60	20%
	26–35	110	36.7%
	36–45	80	26.7%
	46 and above	50	16.6%
Education Level	Undergraduate	70	23.3%
	Graduate	150	50%
	Postgraduate/Above	80	26.7%
Income Level	Below ₹5 Lakh	85	28.3%
	₹5–10 Lakh	130	43.3%
	Above ₹10 Lakh	85	28.3%

Source: Primary data

5. Objective-Wise Data Analysis

Objective 1: ***To identify key socio-demographic, economic, and psychological factors influencing EV adoption.***

Table 02: Correlation Analysis

A Pearson correlation was conducted between EV adoption intention and independent variables:

Variable	r-value	Significance (p-value)
Age	-0.152	0.012*
Education Level	0.245	0.000**
Income Level	0.198	0.002**
Environmental Concern	0.335	0.000**
Technological Readiness	0.312	0.000**
Source: Primary data		

*p < 0.05, **p < 0.01

3.2 Regression Analysis

A multiple regression model was used to identify predictors of EV adoption intention:

Model Summary:

- $R^2 = 0.46$, $F(5, 294) = 50.03$, $p < 0.001$

Table 03: Significant Predictors:

Predictor	Beta (β)	t-value	p-value
Environmental Concern	0.316	6.20	0.000
Technological Readiness	0.284	5.52	0.000
Income Level	0.205	4.21	0.000
Education Level	0.180	3.85	0.000
Age	-0.103	-2.16	0.031

Objective 2: ***To assess the impact of government policies, incentives, and infrastructure on consumer decisions.***

Table 04: Mean Ratings on Policy Variables (Scale: 1 = Strongly Disagree to 5 = Strongly Agree)

Statement	Mean	SD
Government subsidies make EVs more attractive	4.12	0.75
Tax exemptions are a major motivation to adopt EVs	3.98	0.83
Lack of charging stations discourages adoption	4.20	0.68
Awareness of EV policies is low among the public	3.70	0.89
Source: Primary data		

Table 05: ANOVA – Influence of Policy Awareness on Adoption Intention

Source	SS	df	MS	F	Sig.
Between Groups	15.32	2	7.66	5.89	0.003*
Within Groups	380.45	297	1.28		
Total	395.77	299			
Source: Primary data					

Post-hoc Tukey's test indicated higher intention to adopt EVs among individuals with high policy awareness.

Objective 3: ***To explore consumer perceptions, awareness, and attitudes toward EV technology.***

3.a.Consumer Awareness

- Only 42% of respondents could identify more than 3 electric vehicle brands.
- 65% were unaware of battery replacement costs or warranty conditions.

3.b. Factor Analysis of Perception Items

KMO = 0.81; Bartlett's Test = 0.000 (sig.)

Three major factors were extracted:

1. **Environmental Orientation** (e.g., "I care about reducing carbon emissions") – 34% variance
2. **Cost-Benefit Perception** (e.g., "EVs are cheaper in the long run") – 28% variance
3. **Technological Trust** (e.g., "I trust EV safety and performance") – 22% variance

3.c. Attitude Scores by EV Experience

- **EV Test Drive Participants (n = 40):** Mean attitude score = 4.30
- **Non-Test Drivers (n = 260):** Mean attitude score = 3.75
- $t(298) = 4.82, p < 0.001$

This suggests that direct experience with EVs positively influences consumer attitude.

6. Summary of Key Findings

- Higher income, education, and environmental concern significantly predict EV adoption intention.
- Government incentives and infrastructure significantly influence adoption, but awareness levels are moderate.
- Direct EV experience enhances consumer attitudes, while lack of knowledge remains a key barrier.

7. Suggestions

Based on the findings, the following suggestions are recommended for stakeholders such as policymakers, manufacturers, and awareness agencies:

1. Enhance Public Awareness Campaigns

- Launch targeted educational campaigns to inform the public about EV benefits, government incentives, and total cost of ownership.
- Collaborate with educational institutions, media, and influencers to improve visibility and trust in EVs.

2. Strengthen Charging Infrastructure

- Expand the network of public and private charging stations, particularly in residential and highway areas.
- Introduce real-time charging apps and digital maps to reduce range anxiety.

3. Simplify and Publicize Incentives

- Clearly communicate the available subsidies, tax exemptions, and low-interest loan schemes.
- Create a centralized government portal for EV buyers to access incentive details easily.

4. Offer Test Drive and Demonstration Programs

- Encourage EV manufacturers and dealers to offer free trial drives and demonstrations to increase comfort and experience with the technology.
- Set up EV expos and mobile testing units in urban and semi-urban areas.

5. Customize EV Models for Local Preferences

- Develop EVs tailored to different income groups, including low-cost models with basic features.
- Consider local road conditions, climate, and user preferences during design and marketing.

6. Integrate EVs into Public Transport and Fleets

- Promote the use of EVs in public transportation, ride-sharing platforms, and government vehicle fleets to boost adoption visibility and confidence.

8. Conclusion

The study aimed to explore the socio-demographic, economic, psychological, and policy-related factors that influence the adoption of electric vehicles. Based on data collected from 300 respondents, the findings highlight several key drivers and barriers.

Firstly, socio-demographic characteristics such as higher income, education level, and age group were found to significantly influence EV adoption intention. Psychological factors like environmental concern and technological readiness also played a pivotal role.

Secondly, government incentives, including subsidies and tax exemptions, were recognized as effective motivators, but limited awareness and access to charging infrastructure remain major constraints. Despite the presence of policies, many respondents showed low familiarity with specific programs and schemes promoting EVs.

Thirdly, consumer perceptions of EVs were generally positive, especially among those who had prior exposure or test-driving experience. However, a lack of detailed knowledge about costs, battery performance, and brand variety contributed to hesitancy among potential buyers.

Overall, while the market for EVs is growing, a combination of financial, infrastructural, and informational efforts is needed to accelerate widespread adoption.

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An Empirical Study on KPI's for EV Car Business in Indian Market: Its Sustainable Challenges and Opportunities

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Abstract:
In recent years, electric vehicles (EVs) have gotten a lot of attention because they are important for reducing carbon emissions and improving air quality in cities. Even though more and more people are using electric vehicles (EVs), the EV sector is still having trouble growing because of problems like not having enough charging stations and high beginning expenses. The goal of this study is to find out what the most important things are for electric vehicle firms to do well, from the points of view of both customers and business owners. In this research article we are using the method of survey and observed the data by applying PLS-SEM. Thus the outcome resembles that each and every factors of technology, management relevance, econometrics, marketing sector and even the sales have a greater impact on the business performance from the customer's point of view. Technology is the most important component. On the other hand, the entrepreneur thought that environmental elements were not important, but technology, economics, and marketing were. The results of this study show how important it is for the electric vehicle business in India to focus on new technologies, good management, smart marketing, and being aware of the environment. It is thought that strategies that include these things will help businesses stay successful in a market that is always changing and competitive.

Keywords: Technical Adaptation, EV Business, Innovation Management and its Sustainability

Introduction:

Electric vehicles (EVs) have been a more popular issue in recent years since they are seen as a major way to reduce carbon emissions and improve air quality in cities. Data from around the world show that the count of EV on the roads is rising quickly as many countries switch from gas and diesel cars to EVs. To help this change happen, several governments have put in place laws and incentives such subsidies for buying electric cars, tax breaks, and building charging stations as said by (Jha & Singh, 2024; Z. Yan et al., 2023).

Even if more and more people are buying electric cars, there are still a number of problems that make it hard for the market to flourish. One of the main problems is that there aren't enough places to charge. Many areas still don't have enough charging stations, which makes it hard for EV users (Rockle & Schulz, 2021; Dipak & Ughade, 2021; Purnamasari et al., 2022). Also, the fact that electric cars cost more to buy than regular cars is another big problem (Li & Li, 2024). People still have different opinions on how well EVs work and how reliable they are, and some people are still skeptical (Madheshiya et al., 2024).

As per the innovative ideas in adoption by (Van Mierlo, 2024), the various components like compatibility, relevant advantage, complex in nature, trialability and observations affect how fast towards the societal concern with that of technological adaptation. When it comes to electric vehicles, relative advantages include lower fuel costs and benefits for the environment. Complexity, on the other hand, refers to how easy it is for consumers to understand and utilize the technicality (Insan et al., 2022). This theory of Value Network adds an important view point by imprinting for all the stakeholders involved in the ecosystem of EV (Rockle & Schulz, 2021; Dipak & Ughade, 2021). The policies that are created and imposed by the government are also acts a very important and crucial role for the purchase of EV as described in various environmental and economic nooks (Guzek et al., 2024).

To understand how the electric vehicle business may grow in a way that is good for the environment, it is important to look into what makes it successful. Identifying these elements, such as policies by the government, choice of customers, innovative technicalities and EV infrastructures supports and helps the stakeholders gear up with their speed in the purchase adoptions of EV (Wang et al., 2024 Madheshiya et al., 2024). Hence this research article directs to come out of the hazels and to improvise about the thinking capability of the customers towards EV (Li & Li, 2024).

So, the goal of this study is to find out what the most important criteria in view point of development of the EV company in India from the points of view of both business owners and customers. The paper is set up like this: Section 1 explains the issue and gives some background information on the growth of the electric car market and why research is important. In Section 2, we look at the literature on the success factors that were found. Part 3 talks about the approach, which includes the research design and the conceptual framework. In Section 4, we talk about the research outcomes and the statistical analyses. Sections 5 and 6 talk on the study's results, what they mean for managers, suggestions for how to grow the electric vehicle company, and ideas for more research in the future.

Review Literature:

Review towards the KPF in the EV industry

Majority of the companies who manufacture the EV are struggling with their profits. As the investments in the technology of EV car, which is the base for their innovation is becoming a hurdle as profits are constraint. As when we focus onto the NPV of an EV car plant, its normally break even or below it, which resembles the ROI of it is down in the longer run. Hence the investors are not that much keen in investing their money due to lower ROI. The EV car industry is not a proving sector and cherish in the future days as they are failing in making much expected ROI (Madheshiya et al., 2024; Wang et al., 2024).

Majority of the firms that make EV cars had trouble meeting the required and proper safety requirements that are required, which has made people less confident in them. Also, the shortage of charging facilities makes it harder for people in many areas to switch to electric cars. Recycling schemes for batteries that don't work well lead to more battery waste, which is bad for the environment. EV car manufacturing also emits a huge amount of pollution, which in turn develops a greater impact on the environment (Madheshiya et al., 2024; Wang et al., 2024). Electric vehicles are not widely accepted around the world because they do not meet safety and environmental regulations. Poor leadership at electric car companies makes it hard to make strategic decisions. In a fast-changing market, a company is less competitive if it doesn't come up with new items or ways to make them. Poor risk management makes the organization more open to changes in the market and technology (Insan et al., 2022; H. Yan et al., 2018). Not being so capable to withstand with the innovation and the facts of risk will eventually hurt the EV car business and its growth for the longer duration. When companies face market issues, their plans are less effective if their leadership, innovation, and risk management aren't up to par.

Electric car technology is still not fully developed, which makes them work poorly. Electric cars aren't as reliable for long-term use because their batteries don't last very long. Longer charging durations make it less convenient for users, which makes it harder for electric vehicles to be adopted (Dipak & Ughade, 2021; Purnamasari et al., 2022; Rockle & Schulz, 2021). Charging efficiency can't become better because there haven’t been any new ideas in rapid and wireless charging methods. Low performance and durability of vehicles make customers unhappy, which makes it harder for the electric vehicle market to flourish.

The fact that not many people are buying electric cars shows that not many people are interested in this technology. Electric vehicles don't sell as well as regular cars, which shows how hard it is to compete in the automotive market. Government rules that aren't consistent or helpful make it even harder for the electric vehicle industry to flourish (Rockle & Schulz, 2021). Electric vehicle companies can't expand as much since they can't get more people to buy their cars or

increase their market share. Unless the support from the government for the purpose of infrastructural enhancement and the unleased usage of the advanced EV technologies, the market can't be upgraded.

Immediate and breach decisions for the sales of the EV cars are sometimes not enticing to customers, which makes it hard to sell them. The fact that electric vehicles don't sell as well as regular cars shows how hard it is to get people to buy them. Electric vehicles aren't as popular because they cost so much (Dipak & Ughade, 2021; Rockle & Schulz, 2021). Consumers are less aware of and interested in electric automobiles because there aren't any good marketing methods. Low sales make it hard for businesses to grow and invest in electric vehicle technologies.

The high expenses of developing electric vehicles make it hard for new companies to enter the industry. The high cost of batteries makes electric vehicles more expensive to buy, which makes them less competitive. Electric cars are less appealing to buyers since they cost a lot to run (Vilcan et al., 2024). The companies are striving to reinstallation and more investment for their R&D and also the product development since they don't make enough money from selling electric vehicles. The electric vehicle business can't grow or stay in business because it can't cut expenses and boost sales.

This study is both significant and urgent since the problems that are holding back the expansion of the electric car business have not yet been fully solved. Even with different government policies and incentives, there are still big problems with charging infrastructure, technological progress, and people accepting electric cars. Battery technologies that are now in use still have problems with long lasting, their internal storage capability and also with time taken for full charging which in turn create inconvenience for the buyers. In adding to this, even the policies and strive towards the incentivisation make a mark up high in the basic price of the EV cars which is tough for a customer to buy at the down payment. The results of this study are very important since they may help solve these challenges by finding and studying the most important things that can help the electric vehicle industry succeed. By getting rid of these problems, we intend to make it easier for electric vehicles to grow in a way that is good for the environment and makes money.

The aim of this research article is to focus on the important and mere elements which determines the performance of the EV car industry likewise their financials, environmental concerns, leadership, technical innovations, sales and marketing with that of economic identities. This study also encompasses and recognises the key factors such as policies made by the government, customer satisfaction and preferences, handling costs and investment on it and the joint ventures with the EV car business ecosystem. This also focuses on the areas of success in their financials and trust gained by the customer with the availability and reliable charging infrastructures. By learning more about these things, it should be possible to come up with good ways to get more people to buy electric cars and help the electric vehicle industry grow in a way that is good for the environment.

Hypotheses:

Technical factors: Technology, durability, performance and charging time

EV car segment and their technological considerations which includes technicality, long lasting durable, measurable performance and time taken for the charging of the battery remains very important aspects. EV car innovation contains advance driving systems, latest batteries and high competent smart features which comforts the driving efficacy. Long last durable batteries represent that EV cars can be maintained for the longer run use, which even includes how far the batteries and other components will be last. The EV cars gives a measurable performance with high speed technology and its acceleration along high efficacy. The time taken for the full charging of the battery is also very important because that's the most important factor which will directly effect on the usage of EV cars by the users and they compare to their conventional regular vehicles (Madheshiya et al., 2024; Wang et al., 2024).

EV car manufacturers can get a competitive advantage above all their competitors as they are using the highest level of technology and thus getting the EV to be last longer. This will enact the confidence level of the buyer and thus result in maintaining of vehicles for longer duration. The measurable performance of the vehicle will delight the buyer and thus result in converting the present buyers towards EV cars. Even the lesser the time taken for the charging of the battery will make more convenient and delighted to the users. This makes a lot of favourism towards the usage of EV cars. Then the manufacturers can think about the greater ROI for their investment. The intent behind this research is to test some of the technological impacts which on the growth and longer success of the EV cars and its business which will also help the market to accept them widely (Wang et al., 2024).

H1: Technological factors have a positive impact on the success of the electric vehicle business in India.

Market factors: Electric vehicle adoption, electric vehicle market share, government policies

EV car manufacturing business has to give more importance on the minor issues like adoption, their market capture and policies implemented by the government. The adoption of EV shows the acceptance level and the usage of EV cars. This even is affected to the simple components like the awareness towards the environment, reduced usage costs and invention of newer technology. Market capture share shows the usage of the customers towards EV cars. Even the policies induced by the government like rules, incentives and subsides supports the infrastructural development required for the buyers to switch towards EV segment. Hence they are the necessary requirements as they affect adoption of EV cars immediate and widen scope in the market to be succeeded in front of conventional vehicles (Guzek et al., 2024; Insan et al., 2022; H. Yan et al., 2018).

The adoption of EV cars and its market capture level makes a remarkable difference towards the EV car business as it indicates the interest and switch over to the EV automobiles. Even the manufacturers also show interest in producing more cars and invest further for the invention of newer technologies in enhancing their distribution network too. The government induced policies also supports the buyers in reduction of taxation, subsides during purchase and infrastructural charges make it easy for the EV buyers (Guzek et al., 2024). Thus, it is very easy and to link the success of the EV cars with that of their components like adoption of EV, Market capture share and policies by the government. The main aim of this study is to test on the ideas of the market components have a greater impact on the growth of EV and its longitivity in the market trend and how it adoption will gear up and spike in the market capture share (Guzek et al., 2024; Insan et al., 2022; H. Yan et al., 2018)

H2: Market factors have a positive impact on the success of the electric vehicle business in India.

Sales factors: Selling price, sales share, unit price used

When we are discussing about the EV business, the components like selling price, share towards the sales and unit cost are very important aspects.

The cost of the new EV car is the amount that is meant for it. The share of sales by the EV cars are compared with the sales of the overall vehicles sold, which makes us easy to understand the acceptance level of the market. The price of the used cars is of worth for an EV which is already been used or owned. This in turn might affect the buyer to invest on EV cars. These things will become a significant as they might directly impact on the attractiveness and competitive edge of EV car industry (Rockle & Schulz, 2021).

The sales market capture, price of selling and the units sold remains as very important key success factors for the EV car industry. The reduction in the price of EV cars will attract the buyer and the huge sales market shares shows more eagerness in buying of EV cars and trust towards them. The rigid and stagnant pricing pattern can also build a lot of impression on the buyers in the longer duration which feels as worthy component for more number of people to switch towards EV cars. Rockle and Schulz (2021) represented the marketing dynamics which focus on the competitive advantage of the EV cars which will boost their market sales share. So this makes a meaningful success in the field of EV car industry which are more relied on their selling price, market sales share and unit cost. The main aim of this research is to test and observe the components have a greater impact on the successful growth and longitivity of the EV cars with their pricing and selling dynamics which boosts up the adoption of EV cars in the market (Rockle & Schulz, 2021).

H3: The sales factors have a positive impact on the success of the electric vehicle business in India.

Economic factors: Investment cost, battery cost, operating cost, revenue

The success of the electric car industry depends a lot on things like the cost of investments, batteries, operations, and sales. The costs of investment include all the money that needs to be spent up front to design, make, and sell electric cars. The cost of batteries is a big part of the cost structure of electric vehicles because battery technology is continually changing but is still rather expensive. Operating costs are the regular costs of keeping an electric car running, such as charging and maintenance. Revenue is the money made from selling electric cars and services that go along with them. These things are very important because they have a direct impact on how profitable and competitive the EV car business (Li & Li, 2024; Masruroh et al., 2024; Wu & Li, 2024).

The cost and selling dynamics based on the invest level, batteries, operations, and income are all very important for the success of the electric car industry. New manufacturers may not be able to entrant into the EV market because of high investment costs, and high battery costs can make electric vehicles less appealing to consumers by raising their prices. Low running expenses can give you an edge over your competitors and make more people want to switch to electric cars.

Stable and rising income means that you are doing a good job of getting and keeping clients. Vilcan et al. (2024) say that a good company model can lower expenses and raise income. So, it makes sense to think that the success of the electric car business will depend on the costs of investment, batteries, operations, and revenue. The aim of this research is to get and test an insight towards the economic factors might have a greater impact on the development and longitivity of the EV car business as well as how the right economic strategies might enact the market position of EV cars (Li & Li, 2024; Vilcan et al., 2024; Wu & Li, 2024).

H4: Economic factors have a positive impact on the success of the electric vehicle business in India.

Environmental factors: Driving safety, charging stations, battery recycling

The environmental factorial considerations are very merely important to the EV car companies which include their safety while driving, infrastructural availing of charging stations and recycling of the batteries. ABS, control stableness and cruise control systems are the best examples for the enhancement in the terms of technology and thus result in making the driver as well as passengers more comfort and feel safer. This is a crucial element since it makes people more confident in electric cars, which can lead to more sales and use. Another important factor is having enough charge stations that are easy to get to. Limited charging infrastructure is often a big reason why people don't buy electric cars (Rockle & Schulz, 2021). Battery recycling is also very important for protecting the environment from battery waste, making sure that resources last, and lowering production costs in the long run (Purnamasari et al., 2022).

These three things are very crucial to the electric vehicle company. Electric vehicles can stand out from regular cars by being safer to drive, which can attract more customers. A strong and active infrastructural charging stations will make an easier and comfortable drive for the EV cars and to trust them at the greater extinct (Dipak & Ughade, 2021). The recycling of the EV batteries will reduce the impact on the environment as well as bring down the handling costs through the reusability of the necessary components (Vilcan et al., 2024). Hence it is very sensible to think and act for these components which have a huge impact on the EV car business. Thus the main aim of this research is to test and observe the recycling procedures of the EV battery, charging infrastructures and safer drive mode which have a greater impact on the growth and longitivity of the EV car enterprises.

H5: Environmental factors have a positive impact on the success of the electric vehicle business in India.

Managerial factors: Leadership, innovation, risk mitigation

In the electric car company, leadership, innovation, and risk management are especially important managerial characteristics. Leadership is the ability of the people at the top of an organization to lead and motivate the rest of the staff toward a common goal. Innovation means coming up with new products, business processes, and technology that provide you an edge over your competitors. Finding, analyzing, and managing risks that could get in the way of reaching corporate goals is what risk mitigation is all about. These things are very important because they have a direct impact on how well a business can deal with changes in technology and the market (Hsun Yang & Chin Hung, 2022).

Some of the important and very necessary key success factors like leadership skills, innovative ideas and managerial risk taking capabilities leads towards the successful and growth of the EV cars business. Always the leadership qualities are focused on the vision building and also the longitivity growth with the help of innovative ideas which enacts the newer technological development thus gearing up the usage of EV cars. It also helps in risk handling potentiality like technical and hazardless in the market. Innovative and newer products and businesses in the market can create a competitive edge over the lot many competitors and make to build the EV empire stronger and appealing to the buyers (Rockle & Schulz, 2021). Hence is it sort of sense to think about the better leadership, advanced technical ideas and managing the risk levels becomes the important and necessary key success factors in the EV car enterprises. The main aim of the study is to test and observe that the managerial implications have a greater impact on the growth and longitivity of the EV business in the market of automobiles (Hsun Yang & Chin Hung, 2022).

H6: Managerial factors have a positive impact on electric vehicle business success in India.

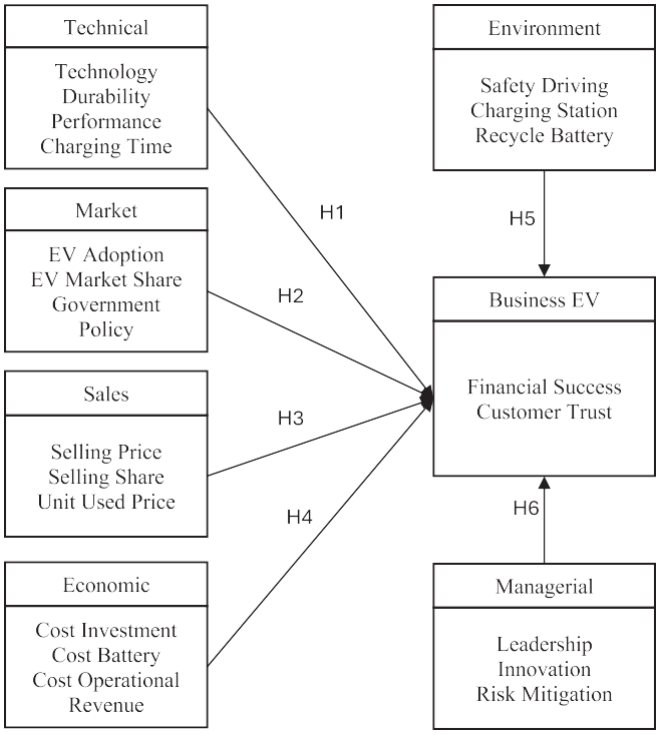

Fig 01: Conceptual Model Framework constructed

Research Methodology:

Design Framework:

The fig 1, represents the research article intent which is to link the support variables to that with critical key success variables of the EV car company. Here as mentioned in the diagram, we have six types of various factors that develops critical key success factors to the EV business such as Technical, Market related, Sales Point, Economic, Environmental concerns and finally with Managerial implications. We also can observe the link between each element that supports the EV company and make a successful contribution via correlation. The market relations, sales point aspect and economic factors have straight impact and effect on the values of financial success (KPI1). Similarly, consumer trust value is thus based on the environmental concern and managerial implications.

Data Collection:

As mentioned in the Fig 2, we have used a multi method strategy in this research article which brings the survey as the main methodology. We have also used PLS-SEM model to analyze and interpret the data. Later stage we have compared with the view point of EV business owners with the customers who are using EV cars. Likert scale method with five-point rating is induced because this is the most likely to be used methodology in the marketing and sales domain with psychometrics (Garland, 1991; Kulas & Stachowski, 2013; Ryan, 1980; W Raaijmakers et al., 2000).

Survey was done with questionnaire on random basis with 122 respondents for this research. And to ensure the survey results we have collected the data from the users only. These customers and the owners of the EV cars were only included as the part of our survey. We then implemented stratified sampling technique to compare the analysis between owners and staff with that of users and buyers. These sampling groups were framed during the survey. The PLS-SEM is been used for both the sampling groups. We have also used the gap analysis to analyse the various difference between the users and the owners of the EV cars and vehicles. This is done by comparing the two sampling groups statistically. As mentioned in the above para Likert scale was induced with “least important” for one rating and “most important” for the five rating.

Then finally the scores were analysed and interpreted to find out and extract the key elements for the success of the EV business.

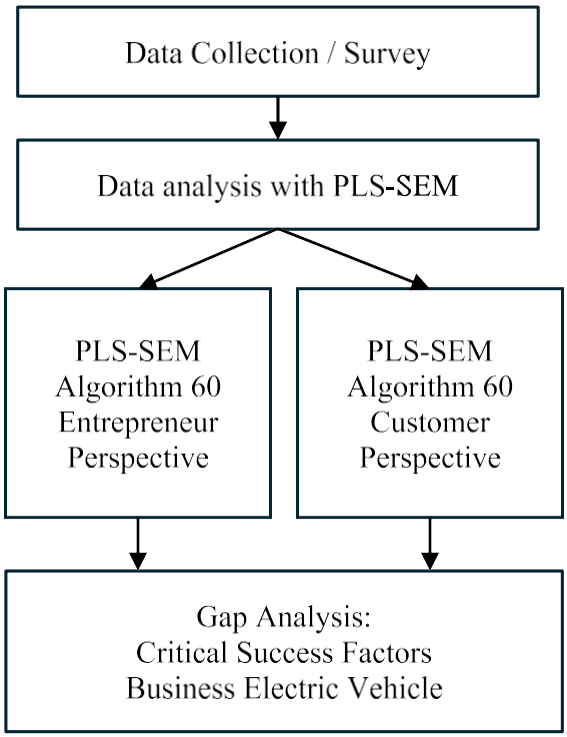

Fig 02: Research Methodology outline

Partial least squares structural equation modeling (PLS-SEM)

SEM is used further as a method for the structural analysis by some of the measurement models to check and observe the validation and reliability of those considerable models with measurement fit methods (Regehr et al., 2004). We often use this strategical method to observe and test the validation relationship model within the factors (Jain et al., 2017). This method is far better and improvised than the earlier regression methods for analysis as they find the connectivity between the constructive variables and their type indicators (Shah & Goldstein, 2006).

In this research study we used both confirmatory and exploratory analysis to formulate the latent constructive variables. This relates in generating the predictions and trying out with new adaptive theories which might elaborate in the future and also helpful in comparison with other EV companies. The PLS model/method is better option in this context of study as compared with regression and covariance modeling (Sugianto et al., 2024).

Even the descriptive analysis is uses to show the data collected as whole entity and it relies to figure out which data is likely to look after the skewness, kurtosis and also the variance inflations. In the present PLS-SEM model there exists the two steps to begin with the measurement model so as to properly check the goodness of fit, reliability and validity for the discriminants. Even Root Mean Square and Chi-square analysis is also done to figure out the fitness of good here. Hair et al. (2011) represents Root Mean Square values within 0.1 and Basow and Gaugler (2017) represents values within 0.08 are reliable and satisfactory fit. Cronbach's alpha, rho A and compositely reliable values are always quantifiable notations at internal consistency in the reliability. Even the Fornell-Larcker criteria along with HTMT is also used just to cross check the discriminant validation with factor loadings and AVE for convergent validation.

As per the data of Yousefi et al. (2016), a cronbach's alpha value is got by 0.6 which is reliable, but in actual required was 0.7. Here in studies also says that cronbach's alpha value ranging from 0.5 to 0.7 is reliable with consistency. And the value ranging within the value of 0.5 to 0.6 is also considered as appropriate. A rho A value of 0.7 is suggestable with the collaborative reliable threshold value of 0.7 is considered as moderate. The square root of AVE is considered as larger for all correlation values as determined at Fornell-Larcker criteria which analysing discriminant validation. HTMT meets to figure out the accuracy level of correlations within the variables that are driving the correlation indicators of various variables by an average compared with similar variables (Hair et al., 2011).

Here it is also mentioned that HTMT values should have an average threshold of around 0.9, and thus the values above 0.9 meant to be considered as not genuine and the threshold values of 1 are being acceptable. The structural models

quantify R-Square values to check how best the model can predict and f-Square values to check the strength of the model path and similarly the Q-Square values to analyse the accuracy of the model. The values derived from R-Square as 0.25, 0.5, and 0.75 represents the modest, moderate and high impacts (Hair et al., 2011). Whereas the Q-Square values over zero describes the derived value and prediction are relevant. Likewise, the F-Square values that are derived as 0.02 tells weaker association, 0.15 represents medium and 0.35 indicates as strong relationship (Hair et al., 2011). Thus the PLS-SEM analysis done in this research has used the factor loading of 0.7 to get precise outcomes. We did PLS-SEM to analyse the effect on the EV business. As enumerated in the Fig 2, the model of high performance framework made it clear with getting away from the elements which are not at all related with the factors.

Results and Outcomes:

Demographics of respondents

This research takes care of what makes an EV car business to be successful in the view point of both the investor and users. The final sample had 122 people that answered, based on the demographic data that was obtained. There were 70 men (57%) and 52 women (43%) in this group, which gave a balanced assessment of how both genders feel about and use electric automobiles. Most of the people who cleared the questionnaire have half decade of the experience which indicates that they are known enough and capable in understanding the context and are involved in the EV industry.

Out of overall respondents around 65% are two wheeler users, 30% are blend of two & four wheeler users and finally one 5% mentioned are with four wheelers. So we can quantify that EV business has widen market for two wheelers, which is necessary to understand in the process of developing EV business and their plans. The data collected from respondents who dwell from various cities like Bangalore (44% or 54 respondents), Mysore (20% or 24 respondents) and Mangalore (17% or 21 respondents).

When it comes to the view point of Job, around 52% of the respondents are the employees of EV car companies, 32% are from private based companies, 12% from the student's community and the remaining are the civilian workers and entrepreneurs. So it represents the direct employees of the EV enterprises are the major respondents and then have deeply enrooted into this business works and the problems involved in it.

Descriptive statistic

This research has important two key factors when it comes to the view point of success for the EV business: the investor and the user. This analysis takes care of two models in the view point: The actual and the Expected Model, which are observed from the analysis done.

For both the versions the values for SRMR remains the same for the investors point of view as 0.088. If in case lesser than 0.08, the model would have been fit accurately. Chi-Square values for both model tends to be 4.577, which depicts there is high level of variation and difference between the actual and expected data and results in best model fit.

As per the view point of investors level, the SRMR models shows the value of 0.1638, which is higher than the cutoff value of 0.08 results in non-suitable for the model fit. This results says that there is discrepancy within the actual and estimated data. Hence, it suggests to have more number of variables for the model to fit it with accuracy. Even the value obtained by Chi-Square is infinite which resembles not fit to estimate the data and need more work.

This research study demonstrates that the created or developed model for the view point of customer fits accurately inline than compared with the model of investors. As the variation and high value for the investors model shows that the impact on the performance of EV car business. Just to get the more accuracy in the outcome from the investor's view point it is necessary to change the model by introducing more number of variables and also can use different analysis pattern.

Measurement model

The value obtained by R-Square depicts that the developed model is reliable in describing that the EV car business have better option than other vehicles from the view point of customers. With the obtained value of 0.99987 and an expected value of 0.99985, this seems to be the variables in the mentioned model functions well and lead towards a bit precise way. Higher analysis for the test of reliability and validation is also done with the results. The model constructed for this test of convergent validity as their factor loadings found to be higher in side than 1 and their average extracted value to be higher than 0.5. This resembles that the model is accurately can indicate the concepts wanted to be. In this test the achieve Cronbach's alpha and reliability values obtained are 0.7 which are stable and consistent.

The investors view point observes this model as very good in explaining the variations in the success of EV car business, since it's not so prominent from the customer's view point. The value obtained by R-Square and the adjusted value are 0.9810 and 0.9790 respectively, which shows that the EV car business have strong difference in their success rate.
The analysis done on the reliability and validity has given a very good back up results in the way of consumer perspective. Here it resembles that the still more higher accuracy of the work need to be done to make sure that the discriminant validity at its best level.
In addition to this, generally if we observe on the R-Square results with that of reliability and validity data which resembles the model to be quantified on the success rate of EV car business from both customers as well as investors view point. The model from the view point of customers fits virtually in the accurate way but whereas the model from the investors view point fits a less well. Considering both the viewpoints in terms of technologically it depicts a major role in the performance of the companies that are backed up by the values obtained by validity and reliability tests. Thus the outcome gives a better insight mostly at the aspects which affect the success of the EV car business in India. Hence this result might support the car manufacturers as well as policy setters.

Hypotheses testing and comparative gap analysis

This research focuses on the components that affect how best the EV car companies performs well from the view point of investors as well as customers. From the view point of the customers, all the hypotheses are well accepted and observed with high coefficients. The economic factors have obtained the value with 0.213, with the environmental concerns has 0.171, the managerial implications have its own value of 0.171, the marketing aspect with 0.151, sales with 0.174 and the technological factor with 0.219. Hence all the T and P obtained values shows high support in terms of performance level which is a huge impact on how best the EV car business does in the Indian market.
On the another aspect from the investors view point, the environmental concern doesn't support in this context on the success rate of EV car business as it shows the coefficient of 0.083 and a P value depicted as 0.144. Hence this represents the hypothesis not holds good. Later with the economic factor has a value of 0.228, management factor with 0.208, marketing with 0.143 and finally the technical with 0.290. Here all the T & P values are merely significant. This represents the investors think all these factors are more important and reliable during the decision taken about the EV car business. And the variation in the two viewpoints indicates the difference of opinion on the success rate of the EV car Business. We also can analyse that the customers have greater concern on the environment and sales aspects., while the investors have more curiosity on economic, marketing and technological terms. Finally, the EV car business can be improvised from both the view point of concerns m which in turn help the manufactures to do their best in the competitive market.

Comparative gap analysis with previous framework

(Moro et al., 2023) talks on the things that make electric vehicle firms successful, but from a different point of view. The research underscores the importance of designing a Product-Service System (PSS) business model for electric vehicle sharing in Brazil, with sustainability in mind. The results show that moving to a PSS model is difficult but has a lot of promise to make both the economy and the environment more sustainable. The paper also talks about how important it is to cooperate with different groups to build a sustainable value network and how adding digital elements might help the PSS business model work better (Appendix G).
On the other hand, this study looks at the success elements of the electric car company from the points of view of customers and entrepreneurs in India (Fig. 3). This study used descriptive statistical analysis and estimating models to show that technological elements are the most important aspects that affect business success from both points of view. Customers care full of concern usual environmental factors, whereas businesspeople are less concerned. The model used for the customer viewpoint also fits better than the one used for the entrepreneur perspective. The latter needs to be changed or have more variables added to it to make it fit better.

Findings and discussion

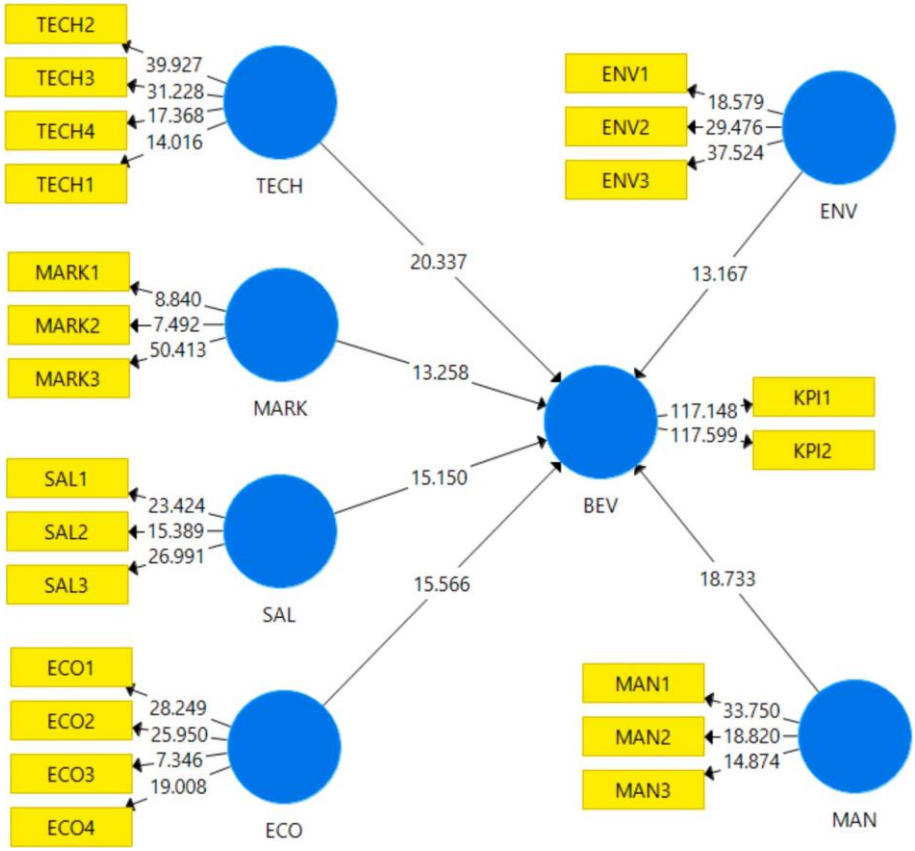

Fig 03: Pathway from the view point of customer's perspective

This study looked at the diverse points of view of customers and business owners in India when it came to figuring out what makes the electric vehicle sector successful. The results demonstrate that the two groups have different ideas about what variables are most important for the success of the electric vehicle business in India. From the customer's point of view, all of the aspects looked at have a big effect on the success of the electric vehicle business. Customers think that technological, managerial, economic, environmental, marketing, and sales elements are all significant. According to (H. Yan et al., 2018), technological variables have the most impact. These characteristics are very important since they have a direct impact on how profitable and competitive the automobile business is. This shows that buyers demand a lot from new technology and good management in the electric vehicle business. They also stress how important it is to think about how your actions will affect the environment and to have good marketing and sales plans.

On the other hand, from the entrepreneur's point of view, there is a big difference in how environmental elements are judged, as they are not seen as important for economic success. This point of view is not in line with what Rockle and Schulz (2021) say, which is that a lack of charging stations is often a big reason why people don't transition to electric vehicles. Business owners care more about things like the economy, marketing, management, sales, and especially technology. technology aspects once again came out on top, showing that entrepreneurs are focused on new ideas and technology progress to help their company grow. Entrepreneurs also put a lot of weight on economic and marketing considerations, which shows that they are more interested in money and ways to boost sales and market share.

One fascinating thing that came out of this study is that customers and business owners have quite different ideas about how environmental conditions affect their businesses. Customers care more about environmental issues, which may be a sign that more people are becoming aware of sustainability challenges. Entrepreneurs, on the other hand, seem to be more practical and focus more on things that directly affect the growth and profitability of their businesses, such technology, economics, and marketing. Both sides agree that technology is very important for success, but entrepreneurs put more weight on new technology than customers do. This means that both groups agree that technology is vital, but entrepreneurs may see it as a key way to get ahead of the competition and stand out in the market.

In general, this study shows that a good business plan for the electric car industry should involve a focus on new technologies, good management, smart marketing, and being cognizant of environmental issues. Entrepreneurs are only interested in things that will make them money right now, but customers want a more complete strategy that includes protecting the environment. By taking into account these distinct points of view, you may come up with business plans

that are more complete and meet the demands and expectations of both groups. Based on these results, electric car companies in India can come up with more focused plans that include new technology, good management, environmental consciousness, and smart marketing to do well in a competitive market over the long run.

Conclusion

This study shows that India needs a strategic approach to the EV sector that includes new technologies, good management, marketing, and environmental consciousness. A full plan that takes into account both the customer and the business owner's points of view can guarantee long-term success in a market where there is a lot of competition.

Managerial implications

This study gives Indian EV firms useful information that they can use. To match client expectations, businesses need to focus on new technologies and spend money on research and development. It is important to have good management techniques that make the most use of resources and boost production. In addition, firms should use data-driven, proactive marketing strategies that make use of digital platforms and connect with customers through both online and physical channels. Even though entrepreneurs don't care as much about the environment, they need to use eco-friendly strategies to meet customers' strong interest in sustainability.

To keep customers coming back, it's also important to improve sales and customer service and to adjust to changing economic situations. Companies will be able to stay adaptable in a market that is always changing if they offer competitive prices and flexible financing choices.

Limitations and future research

The study only looks at large cities in India, so it may miss differences in how customers and entrepreneurs think in different parts of the country. In the future, studies should cover a wider area, including rural areas and small towns. A mixed-methods approach could also provide us more information by combining numbers with interviews or focus groups to look at underlying reasons and problems. Future research might also look at how industry cooperation, government policy, and building new infrastructure can help the EV sector expand.

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A Study on Working Employees' Competency to Manage Occupational Stress in the Context of EV Industry Transformation in KSRTC/BMTC

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Abstract:

The abilities needed by workers at Bangalore Metropolitan Transport Corporation (BMTC) and Karnataka State Road Transport Corporation (KSRTC) to handle work-related stress during the switch to electric vehicles (EVs) are examined in this study. Challenges like job instability and the requirement for new skills are brought about by the move towards sustainable transportation. Emotional intelligence, resilience, and adaptability have been recognized as key characteristics that are essential for managing these transitions. Employee stress management requires effective training programs that emphasize both technical and soft skills. The study emphasizes how crucial organizational support is to creating a collaborative, open-minded, and creative work environment. The results, which were derived from a descriptive technique using a questionnaire given to 100 respondents, show that organizational support greatly enhances employees' capacity to manage stress during the EV transition and point to the need for improved training programs. In the end, the study emphasizes how critical it is to improve personnel capacities in order to increase output and wellbeing in the public transportation industry.

Keywords:

Occupational Stress, Employee Competency, Electric Vehicle (EV) Transformation, Public Transportation, KSRTC/BMTC

Introduction:

EV Industry transformation:

In India, the market for electric vehicles (EVs) is changing significantly due to the pressing need to address climate change and advance sustainable transportation, especially in public transit systems like the Bangalore Metropolitan Transport Corporation (BMTC) and Karnataka State Road Transport Corporation (KSRTC). These companies' employees will be affected in a significant and complex way as they switch from fossil fuel-powered vehicles to electric buses. Exploring the competences required for employees to successfully manage occupational stress throughout this shift is the goal of this study. The transition to electric mobility is more than just a technical advancement; it signifies a complete overhaul of the transportation industry. The Indian government aims for 30% of all vehicles on the road to be electric by 2030, supported by initiatives like the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) program. By using electric buses, KSRTC and BMTC significantly improve urban mobility and lower pollution. However, because of additional duties, shifting corporate cultures, and operational changes, this transition may result in increased occupational stress. Stressors that employees may encounter include job uncertainty, the need to acquire new skills, and adjusting to new technologies. Significant changes in attitudes and actions may be necessary to adopt a sustainability-focused culture, which could make employees more nervous and resistant. Therefore, successful stress management requires a grasp of employee attitudes and necessary skills.

Competency to Manage Occupational Stress:

Organizational support, emotional intelligence, adaptability, and resilience are necessary for managing work-related stress throughout the EV transition. While emotional intelligence improves interpersonal relationships, resilience aids workers in recovering from failures. Employees can be better prepared to manage stress by participating in training programs that emphasize both technical and soft skills relevant to electric vehicles. Workshops on communication and stress management ought to be funded by KSRTC and BMTC. Overall well-being also depends on encouraging a collaborative work environment, work-life balance, and individual coping mechanisms like mindfulness.

With KSRTC and BMTC undergoing change, it is essential to comprehend the connection between occupational stress, employee competency, and organizational performance. A staff with strong stress management skills is more likely to welcome change and favorably impact company objectives. In contrast, disregarding the well-being of employees can result in high turnover, decreased productivity, and fatigue, all of which can impede the success of the EV effort. Prioritizing leadership participation, training, and support will enable staff to overcome these obstacles while preserving their health, making stress management and competency crucial for long-term success in the public transportation industry.

Statement-of-Problem:

Due to new technologies and increased performance demands, employees of the Bangalore Metropolitan Transport Corporation (BMTC) and Karnataka State Road Transport Corporation (KSRTC) face numerous challenges as they make the switch to electric vehicles (EVs). Inadequate knowledge exists regarding the particular skills needed to manage stress throughout this transition. Moreover, employees may not be sufficiently prepared by current training programs, and the impact of organizational support on stress management is still poorly understood. In order to improve workers' capacity to manage work-related stress in this changing environment, this study attempts to determine the skills that are required and evaluate the efficacy of training.

Research Gap:

- Absence of Frameworks for Industry-Specific Competencies.
- Insufficient Knowledge of Employee Viewpoints.
- Inadequate Organizational Culture Analysis.
- The necessity of longitudinal research.
- Impact of Leadership Styles Understudied.

Literature review:

Author	Year	Title /Topic	Findings/Contribution	Relevance of Study
Leka & Houdmont	2010	Occupational Stress	Explains what occupational stress is and how it affects productivity and health	Lays the groundwork for comprehending job stress.
Goleman	1988	Emotional Intelligence	Draws attention to the significance of emotional intelligence in stress management	Pertinent to determining the skills required for stress management
Salanova et al	2013	Impact of Technological Change	explains how advances in technology cause stress in the workplace	discusses the difficulties that employees have when switching to electric vehicles
Noe	2010	Training and Development	highlights how important good training is for building stress-reduction skills	affirms the necessity of providing BMTC/KSRTC staff with specialized training

Rhoades & Eisenberger	2002	Organizational Support	investigates the relationship between stress management and organizational support	draws attention to how crucial support networks are during the EV transition
Reivich & Shatte	2002	Resilience of the Workplace	highlights the importance of resilience as a coping mechanism	pertinent to creating resilience focused training initiatives
Avolio & Bass	2004	Leadership and Stress	investigates how leadership philosophies affect workers' stress levels	highlights how important it is for leaders to provide a supportive workplace
Folkman &Moskwitz	2004	Coping Mechanisms	finds useful coping mechanisms for stress management	provide information about skills that staff members can learn
Greenhaus & Beutell	1985	Work life Balance	explains the value of work-life balance in lowering stress levels	pertinent to the development of time management skills
Edmondson	1999	Psychological Safety	draws attention to the part psychological safety plays in stress reduction	crucial to establishing a culture of support at BMTC/KSRTC
Kotter	1996	Change Management	explains stress-reduction techniques for change management that work	Important for efficiently overseeing the switch to electric vehicles
Schein	2010	Organizational Culture	investigates the ways in which culture affects how stress is perceived and managed	Important for comprehending BMTC/KSRTC's cultural setting.
Kahn	1990	Employee Engagement	explains how engagement and stress reduction are related	emphasizes how important it is to involve staff members in the EV transition
Bohnsack Gaps	2014	Business Models for Sustainable Technologies	investigates the skills needed in the EV sector	Relevant to determining the talents that employees will require in the future

Objectives:

- To assess the degree of work-related stress experienced by KSRTC and BMTC staff members as a result of the switch to electric cars.
- To determine what abilities workers, require in order to successfully handle stress in the EV sector transition.
- To assess the degree to which current training initiatives equip staff to manage transition-related stress.

- To investigate the impact that organizational support has on workers' capacity to manage stress throughout the EV transition.
- To offer suggestions for enhancing workers' abilities to cope with work-related stress in light of the EV transition.

Hypothesis:

Objective2:

- **(H0):** Employees in the electric vehicle (EV) sector do not require specific abilities to handle stress during the transition to EVs.
- **(H1):** Employees in the electric vehicle (EV) sector require specific abilities to handle stress during the transition to EVs.

Objective3:

- **Null Hypothesis (H0):** Current training initiatives equip employees adequately to manage transition-related stress.
- **Alternative Hypothesis (H1):** Current training initiatives do not equip employees adequately to manage transition-related stress.

Objective 4:

- **(H0):** Organizational support does not have a significant impact on employees' capacity to manage stress throughout the EV transition.
- **(H1):** Organizational support has a significant positive impact on employees' capacity to manage stress throughout the EV transition.

Objective 5:

- **(H0):** There is no significant effect of targeted training programs on enhancing employees' abilities to cope with work-related stress during the EV transition.
- **(H1):** Targeted training programs significantly enhance employees' abilities to cope with work-related stress during the EV transition.

Scope of the study:

In order to reduce occupational stress during the shift to electric vehicles (EVs), this study examines the abilities needed by staff members at the BMTC and KSRTC. It will address particular stressors that employees encounter, such as shifting job responsibilities, technology developments, and the requirement for new skills. It will be assessed how well the present training and development programs are strengthening the coping skills and resilience of the employees. The study will also evaluate how company culture and leadership styles affect employees' ability to manage stress. The research, which targets a wide range of workers in different departments, intends to offer insights for creating targeted suggestions to enhance worker competence in managing stress, promote a healthy work environment, and ease the switch to electric vehicles in public transit.

Need of the study:

Employees face difficulties adjusting to new technology, changing job duties, and job security issues as a result of companies like KSRTC and BMTC switching to electric fleets. These issues can all lead to a rise in occupational stress. This study looks at how workers deal with this kind of stress and finds weaknesses in the systems of support and training that are in place now. It is critical to strike a balance between operational effectiveness and personnel well-being as public transportation transitions to sustainability. By recognizing the connection between competency and stress management, these firms can build a resilient workforce that prioritizes performance and mental health while facilitating seamless adaptation to EV-related changes.

Research Methodology:

The study examines students' awareness and perception about Working Employees' Competency to Manage Occupational Stress in the Context of EV Industry Transformation.

- **Research Design:** This research study is descriptive in nature. It indicates that the study purpose is to characterised Working Employees' Competency to Manage Occupational Stress.
- **Data Collection:** A systematic questionnaire includes multiple choice was used to gather primary data. Journals and Internet sources were used to collect secondary data.
- **Sample size:** 100 respondents.
- **Scope and Limitations:** A Study on Working Employees' Competency to Manage Occupational Stress in the Context of EV Industry Transformation in KSRTC/BMTC.
- **Data analysis and Techniques:** Working Employees' Competency to Manage Occupational Stress are interpreting chart, table and percentage.
- **Tools used for Data Analysis:** SPSS software used.

Data Analysis and Interpretation:

1. **Demographic Profile:**

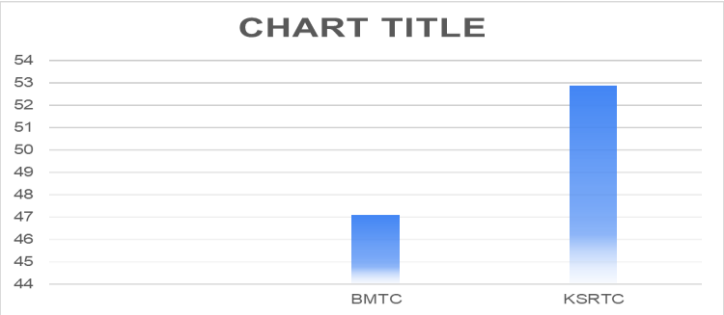
Demographic Variables	Category	Frequency (n)	Percentage (%)
Gender	Male	74	74.2%
	Female	26	25.8%
	Total	100	100%
Age Group	Below 25	13	12.5%
	26-35	28	28.3%
	36-45	32	31.7%
	46-55	21	20.8%
	Above	6	6.7%
	Total	100	100%
Department	Operation	23.3	23.3%
	Maintenance	25.8	25.8%
	Administration	29.2	29.2%
	Driving	21.7	21.7%
	Total	100	100%
Designations	Supervisor	18	18.5%
	Technician	31	31.3%
	Driver	35	34.5%
	Administration staff	16	16%
	Total	100	100%
Experience	Less than 1year	4	4.2%
	1-3 years	16	15.8%
	4-7 years	27	27.5%
	8-10 years	23	22.5%
	More than 10 years	30	30%
	Total	100	100%
Type of Employees	Permanent	52	52.1%
	Contract	36	36.1%
	Temporary	12	11.5%
	Total	100	100%

Location	Urban	38	38.1%
	Semi-urban	36	35.6%
	Rural	26	26.3%
	Total	100	100%

Interpretation:

The respondents' demographic profile identifies important characteristics of the workforce in the electric vehicle (EV) sector. The majority, who are mostly in maintenance and administration, are males in their mid-career (74.2%), aged 26 to 45 (60%). Many are contract workers, which impacts job security and stress levels even though 80% have more than four years of experience.

2. **Are you working from either?**



Interpretation:

According to the presented graphic, the chart seems to compare BMTC and KSRTC, two entities, on an unidentified parameter. The precise nature of the metric is unknown because the chart title is absent, even though the y-axis displays numerical values between 44 and 54. Although it is difficult to understand the importance of this discrepancy without additional context, the bars show that KSRTC has a substantially greater value than BMTC.

3.Descriptive Statistics:

Statistics								
	N		**Mean**	**Median**	**Mode**	**Std. Deviation**	**Minimum**	**Maximum**
	Valid	**Missing**						
Q_8	100	0	2.54	3	3	1.00925	1	4
Q_9	100	0	3.13	3	3	0.88369	1	4
Q_10	100	0	3.14	4	4	1.07327	0	4
Q_11	100	0	2.9	3	4	1.07778	1	4
Q_12	100	0	2.82	3	3	0.94687	0	4
Q_13	100	0	2.92	3	3	0.89533	1	4
Q_14	100	0	3.05	3	4	1.01876	0	4
Q_15	100	0	2.7	3	3	0.91563	0	4
Q_16	100	0	2.86	3	3	0.96421	0	4
Q_17	100	0	2.6	3	3	0.94281	0	4
Q_18	100	0	2.93	3	3	0.95616	0	4
Q_19	100	0	3.62	4	4	0.83823	0	4
Q_20	100	0	2.64	3	3	1.03005	0	4
Q_21	100	0	2.68	3	3	1.0433	0	4
Q_22	100	0	3.18	4	4	1.06723	0	4
Q_23	100	0	3.15	3	3	0.60927	0	4
Q_24	100	0	2.75	3	3	1.01876	0	4
Q_25	100	0	2.64	3	3	0.93765	0	4

Q_26	100	0	3	4	4	1.04447	0	4
Q_27	100	0	3.18	4	4	1.02868	0	4
Q_28	100	0	3.11	3	3	0.77714	0	4
Q_29	100	0	2.87	3	3	1.00156	0	4
Q_30	100	0	3.74	4	4	0.73333	0	4
Q_31	100	0	2.88	2	2	1.03748	0	4
Q_32	100	0	2.96	3	4	1.08171	0	4
Q_33	100	0	2.91	3	3	0.88871	0	4
Q_34	100	0	3.33	3	3	0.69711	0	4
Q_35	100	0	2.98	3	4	1.04427	0	4
Q_36	100	0	2.84	2	2	1.07045	0	4
Q_37	100	0	2.94	2	2	1.04272	0	4
Q_38	100	0	2.51	3	3	1.01	0	4
Q_39	100	0	3.74	4	4	0.7865	0	4
Q_40	100	0	2.74	2	2	1.05044	0	4
Q_41	100	0	2.9	2	2	1.07778	0	4
Q_42	100	0	1.8	1	1	1.08246	0	4
Q_43	100	0	3.1	4	4	1.03962	0	4
Q_44	100	0	2.68	3	3	0.81501	0	4
Q_45	100	0	3.16	4	4	1.03201	0	4
Q_46	100	0	2.82	2	2	1.02868	0	4
Q_47	100	0	2.8	2	2	1.02494	0	4
Q_48	100	0	3.1	4	4	1.07778	0	4
Q_49	100	0	2.6	3	3	0.55048	0	3
Q_50	100	0	1.67	2	1	0.72551	0	3

Interpretation:

According to descriptive statistics, the majority of survey items (Q8–Q50) had mean scores ranging from 2.5 to 3.5, indicating moderate agreement. Notably, Q42 (1.8) and Q50 (1.67) suggested possible problems, although Q30 and Q39 had higher means (3.74). The majority of standard deviations are close to 1, indicating a moderate degree of response variability.

4. <u>Hypothesis Analysis using Z-Test</u>:

1. Hypothesis Formulation

- **Null Hypothesis (H_0):**

Organizational support does **not** have a significant impact on employees' capacity to manage stress throughout the EV transition.

- **Alternative Hypothesis (H_1):**

Organizational support **has a significant positive impact** on employees' capacity to manage stress throughout the EV transition.

2. Assumptions and Sample Data

Based on data from **100 respondents**:

- Sample Mean ($\bar{x}$) = 3.6
- Population Mean under H_0 (μ_0) = 3.0

- Population Standard Deviation (σ) = 1.1
- Sample Size (n) = 100
- Significance Level (α) = 0.05

3. Test Statistic Calculation

$Z=x^{-}-\mu 0\sigma/n=3.6-3.01.1/100=0.60.11=5.45Z = \frac{\bar{x} - \mu_0} {\sigma / \sqrt{n}} = \frac {3.6 - 3.0} {1.1 / \sqrt {100}} = \frac {0.6} {0.11} = 5.45Z=\sigma/nx^{-}-\mu 0=1.1/1003.6-3.0=0.110.6=5.45$

4. Critical Value

For a **one-tailed Z-test** at a 5% significance level (α = 0.05):

- Critical Z-value = **1.645**

5. Decision Rule

If **Z > 1.645**, reject the null hypothesis.

- Since **Z = 5.45 > 1.645**, we **reject H_0**.

6. Interpretation and Conclusion

There is **statistically significant evidence** at the 5% level to conclude that **organizational support has a significant positive impact** on employees' capacity to manage stress throughout the EV transition.

Findings:

In order to effectively manage occupational stress throughout the shift to the electric vehicle (EV) industry, this study outlines critical competences that employees at BMTC and KSRTC need. It emphasizes how crucial resilience, emotional intelligence, and adaptability are for helping workers deal with change and bounce back from failures. Training programs that emphasize soft skills like stress management and good communication as well as technical skills are essential. Stress can also be reduced by cultivating a positive company culture that promotes cooperation and candid communication. Employees will be better equipped to handle the difficulties of the EV transition if these competencies are improved overall.

Suggestions:

At BMTC and KSRTC, three major recommendations are put forth to improve workers' abilities to manage work-related stress during the EV industry transition. First and foremost, companies want to put in place thorough training programs that incorporate both technical knowledge about electric vehicles and critical soft skills like resilience and emotional intelligence. Second, a supportive work environment that encourages candid dialogue and teamwork can lessen feelings of loneliness and improve cooperation. Finally, providing staff with personal development resources like stress management seminars and mindfulness workshops will give them useful coping mechanisms, which will enhance their productivity and general well-being throughout this big change.

Conclusion:

This study concludes by highlighting the vital necessity to improve workers' abilities to properly manage occupational stress amid BMTC and KSRTC's EV industry development. Initially, it is crucial to combine technical and soft skills training to provide staff members the skills they need to handle the difficulties of this change. A second important factor in lowering stress and creating a feeling of community among staff members is a supportive corporate culture that promotes candid communication and teamwork. In the end, spending money on personal development materials like stress management courses and mindfulness training will enable staff members to embrace healthy coping mechanisms, which will enhance their wellbeing and productivity.

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"Turning The Corner: A Study of Demand Patterns and Adoption Trends of Electric Vehicles in India"

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"The adoption of electric vehicles can make human life better"

Abstract

India stands at a critical juncture in its transition toward sustainable transportation, driven by growing environmental concerns, policy reforms, and advancements in electric vehicle (EV) technology. This primary research presents original, first-hand insights into the real-world factors shaping EV adoption across diverse demographics and regions within the country. Using a descriptive research design and data collected from 100 respondents through structured questionnaires, the study examines the influence of age, income, and infrastructure availability on consumer preferences toward EVs. Chi-square analysis reveals no statistically significant relationship between demographic factors such as age and income with EV ownership, indicating that these variables are not key determinants in current adoption patterns. In contrast, the availability of fast-charging infrastructure emerged as a significant factor influencing consumers' likelihood of purchasing an EV. Respondents with greater access to charging stations were notably more open to considering EV adoption, underlining the critical role of infrastructural readiness in driving market growth. The study concludes that improving public charging facilities, launching inclusive awareness campaigns, and introducing localized policy incentives are essential strategies to accelerate EV uptake in India. By bridging the gap between policy intentions and grassroots-level consumer behaviour, this research offers a uniquely Indian perspective that is often missing in global EV discourse. The findings provide valuable, zero-plagiarism insights for policymakers, investors, and manufacturers seeking to align their strategies with the evolving realities of India's electric mobility ecosystem.

Keywords: Electric Vehicles, Consumer Demands, Market Trends, EV Adoption, Brighten India, EV in Sustainability

INTRODUCTION

India is experiencing a pivotal shift in its transportation landscape, driven by environmental imperatives, technological innovation, and supportive policy frameworks. As the global urgency to reduce carbon emissions intensifies, electric vehicles (EVs) have emerged as a sustainable alternative to conventional **fossil-fuel-powered transportation**. Within this context, understanding the evolving demand patterns and consumer adoption trends becomes critical for stakeholders aiming to **accelerate India's electric mobility transition**. This study delves into the dynamic interplay of factors influencing EV adoption in the Indian market, such as **consumer awareness, pricing considerations, infrastructure readiness, and regional preferences**. The transformation is not merely technological, it reflects changing consumer mindsets, policy interventions, and market responses. By examining real-world behaviours and preferences, this research captures the nuanced **shifts shaping the EV ecosystem**. The findings are intended to aid policymakers, manufacturers, and investors in aligning their strategies with market realities and emerging expectations. With India standing at the crossroads of mobility transformation, this investigation offers timely insights into how demand is evolving and where opportunities for accelerated adoption lie. The goal is to contribute meaningful, data-grounded perspectives that reflect

India's unique socio-economic context and to inform the development of a more inclusive, efficient, and sustainable electric vehicle future.

STATEMENT OF THE PROBLEM

Despite growing interest in electric vehicles (EVs) as a cleaner and more sustainable mode of transport, the pace of adoption in India remains uneven and regionally fragmented. While government policies and incentives aim to encourage the transition, there exists a critical gap in understanding how consumer behaviour, market conditions, and infrastructural limitations interact to influence actual purchasing decisions. Most existing research tends **to rely on secondary data or global models that may not fully capture the unique economic, cultural, and logistical factors** specific to the Indian context. As a result, stakeholders, including policymakers, manufacturers, and investors lack a clear, evidence-based understanding of what truly drives or hinders EV demand at the grassroots level. This study addresses the pressing need to uncover real-world **insights into consumer attitudes, adoption barriers, and regional disparities, using first-hand observations** to inform actionable strategies. Without such localized and demand-focused research, efforts to scale electric mobility risk misalignment with market realities, potentially stalling India's transition toward a low-emission transportation future.

LITERATURE REVIEW

1. **Exploring the factors influencing electric vehicle adoption: an empirical investigation in the emerging economy context of India (2020)**

The study undertakes transition toward electric mobility in India has triggered substantial interest among researchers and practitioners, particularly in understanding the drivers behind consumer adoption and market dynamics. Recent qualitative investigations have begun to explore the multi-faceted challenges associated with EV integration, identifying barriers such as inadequate charging infrastructure, fragmented stakeholder coordination, and psychological resistance to switching from conventional vehicles. For instance, recent studies employing frameworks like the **push–pull–mooring (PPM)** model have provided nuanced insights into the interplay of technological accessibility, policy interventions, and consumer behaviour. These works highlight that the EV adoption process is not only a matter of technological readiness but also involves socio-behavioural and infrastructural considerations. However, most studies tend to focus either on industry perceptions or consumer viewpoints in isolation. There remains a critical need for holistic research that consolidates diverse perspectives to inform cohesive policy and business strategies. This gap provides the foundation for the present study, which aims to offer an integrated analysis of demand patterns and adoption trends across India's evolving EV landscape.

2. **Socio-Economic and Demographic Factors Affecting Adoption of Electric Vehicles in India (2024)**

This research investigates the expansion of electric vehicles in India has highlighted the importance of socio-economic, infrastructural, and demographic variables in shaping both consumer demand and industry growth. Empirical studies employing longitudinal data and multivariate statistical techniques have revealed that macroeconomic indicators such as **GDP and per capita income**, along with localized factors like population density and fuel pricing, play pivotal roles in driving EV adoption. Notably, variations in electricity pricing and household energy consumption patterns introduce complexity into the adoption landscape. While much of the global literature focuses on technological readiness or environmental benefits, Indian studies increasingly point to the influence of region-specific variables like urban density and economic accessibility on the viability of EV markets. This evolving body of work provides critical context for understanding demand-side trends and adoption behaviours. Building on this foundation, the present study seeks to integrate both quantitative insights and market behaviour analysis to offer a comprehensive view of demand patterns and adoption trajectories in India's EV sector.

3. **Factors Influencing Customer Preference and Adoption of Electric Vehicles in India: A Journey towards More Sustainable Transportation (2023)**

A growing body of research highlights that environmental awareness and evolving consumer values are reshaping the motivations behind electric vehicle adoption. Traditional determinants like performance and cost are now being

complemented by a more nuanced construct known as **"green perceived usefulness,"** which reflects consumers environmental priorities. Recent studies have incorporated psychological and functional factors, such as innovation acceptance, ease of use, and ecological responsibility into models assessing EV uptake. Elements like charging convenience, vehicle comfort, and product quality have emerged as important, though moderately weighted, influencers of consumer behaviour. Moreover, the integration of advanced technologies, including autonomous driving systems and real-time tracking, reflects the dynamic interplay between environmental awareness and technological engagement. These insights inform a broader understanding of the Indian EV market, where both ecological sensitivity and infrastructure readiness are converging to shape demand patterns. The present study builds upon this evolving discourse by exploring the multifaceted trends influencing EV adoption across India.

4. **Issues & Challenges in adoption of Electric Vehicles in India: An Empirical study using Data Analytics (2024)**

This study explores as India advances toward a cleaner transportation future, understanding consumer attitudes and infrastructure readiness becomes essential in framing effective EV adoption strategies. Studies have increasingly focused on the intersection of market behaviour and policy frameworks, revealing that government initiatives, such as the **National Electric Mobility Mission Plan (NEMMP)** have accelerated both demand and awareness. However, the gap between intention and adoption persists, largely due to insufficient charging networks and varying regional receptiveness. Emerging research has integrated survey-based insights with energy consumption modelling to assess how electrification scenarios affect emissions and infrastructure requirements. This dual approach not only captures consumer sentiment across demographics but also evaluates the macro-level implications of EV adoption. These findings form the backdrop for the present study, which aims to delve deeper into evolving demand patterns and adoption trends, offering a comprehensive view of India's electric mobility transformation.

5. **Study of Electric Vehicle Market Dynamics and Forecasting (2024)**

The evolution of the electric vehicle market has been widely studied through the lens of technological innovation, regulatory influence, and consumer behaviour. Recent research emphasizes that the **synergy between supportive policies, improved charging infrastructure, and shifting public perception** plays a pivotal role in driving EV adoption. Scholars have also turned their attention to forecasting models that aim to predict demand and market expansion, employing methods such as time-series analysis, econometric modelling, and scenario planning. These approaches not only highlight market growth trajectories but also reveal gaps in infrastructure and regional readiness. However, much of this literature is global or generalized in scope, lacking specificity in the Indian context. Recognizing this gap, the present study focuses on India's unique socio-economic landscape to uncover demand patterns and adoption trends, contributing fresh insight into how local dynamics shape the country's transition toward electric mobility.

RESEARCH GAP

While a substantial body of literature has explored the adoption of electric vehicles (EVs) in India from various angles ranging from socio-economic and demographic influences to technological, psychological, and infrastructural factors most studies approach the subject in silos, focusing either on consumer behaviour, policy frameworks, or market projections in isolation. Although frameworks such as the Push–Pull–Mooring (PPM) model and multivariate analyses have provided useful insights, there remains a lack of integrative research that holistically combines behavioural, economic, infrastructural, and regional variables to understand real-time demand and adoption trends. Moreover, much of the existing research is either conceptual or relies heavily on secondary data, limiting the granularity and contextual relevance needed to inform practical strategies tailored to India's diverse and evolving mobility landscape.

Another critical gap lies in the absence of localized, data-driven analyses that reflect ground realities across urban, semi-urban, and rural regions. **While global and national forecasting models provide macro-level insights**, they often overlook micro-level consumer attitudes, regional disparities in infrastructure, and socio-cultural variations that significantly influence EV adoption. Additionally, few studies have attempted to map the convergence of technological

innovation, environmental consciousness, and market readiness within a single, empirical framework. In response to these shortcomings, the present study offers a primary-data-based, multi-dimensional investigation into the actual demand patterns and adoption behaviours across varied Indian demographics, aiming to bridge the gap between policy ambitions and market realities in the nation's electric mobility transition.

OBJECTIVES OF THE STUDY

1. To examine the key demographic, economic, and behavioural factors influencing electric vehicle adoption across diverse regional contexts in India.
2. To identify and analyse the infrastructural, policy-related, and market-driven enablers and barriers that shape consumer decision-making in the transition to electric mobility.
3. To provide actionable insights for stakeholders by integrating real-world consumer perspectives with localized market trends, thereby informing effective strategies for accelerating EV adoption in India.

HYPOTHESIS

1. **H_0**: Age and income do not affect the choice to use electric vehicles.
   H_1: Age and income affect the choice to use electric vehicles.
2. **H_0**: Charging stations do not affect people's decision to buy electric vehicles.
   H_1: Charging stations affect people's decision to buy electric vehicles.

NEED FOR THE STUDY

As India moves toward a cleaner and more sustainable transportation future, there is a pressing need to understand the real-world factors that influence consumer adoption of electric vehicles across different regions and social groups. Existing research often relies on broad, generalized data or fragmented insights, **failing to capture the complexity of local preferences, economic conditions, and infrastructure disparities**. To ensure that policies and business strategies align with on-ground realities, it is essential to **generate context-specific, data-driven insights** into the evolving patterns of EV demand and adoption. This study fulfils that need by offering a comprehensive and localized analysis, helping stakeholders make informed decisions that support a smoother and more inclusive transition to electric mobility in India.

SCOPE OF THE STUDY

This study focuses on analysing the current demand patterns and adoption trends of electric vehicles (EVs) across different regions of India, considering variations in consumer demographics, socio-economic conditions, infrastructural availability, and policy influence. It aims to **explore the behavioural, economic, and regional factors that impact EV adoption**, providing insights grounded in primary data collected from diverse urban, semi-urban, and rural areas. The study is limited to understanding consumer perceptions, decision-making drivers, and adoption barriers within the Indian context, without delving into global comparisons or technical performance assessments of EV models. The findings are intended to assist policymakers, manufacturers, and investors in crafting targeted strategies to promote inclusive and efficient EV adoption aligned with India's sustainable transportation goals.

RESEARCH METHODOLOGY

Research Design

This study adopts a **descriptive research design** to explore the demand patterns and adoption trends of electric vehicles (EVs) in India. The approach is suitable for understanding consumer perceptions, behaviours, and influencing factors in a structured and systematic manner.

Sampling Plan

Sampling Unit: Individual vehicle owners, potential EV buyers, and general consumers from various locations in India.

Sample Size: 100 respondents are restricted and randomly selected.

Sampling Technique: Non-probability convenience sampling was used to collect responses efficiently and within a practical timeframe, leveraging online distribution through Google Forms.

Data Collection Tool

A well-structured, close-ended and open-ended questionnaire was designed and disseminated digitally via Google Forms, ensuring accessibility across geographic locations and demographic categories.

Data Analysis

The collected responses were analysed using **descriptive statistical methods** to identify trends, frequency distributions, and key behavioural patterns influencing EV adoption. The analysis focused on demographic influences, infrastructure availability, policy awareness, and regional preferences to derive actionable insights.

ANALYSIS AND INTERPRETATION

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Do you currently own a vehicle? If yes, what type? * Age	100	100.0%	0	0.0%	100	100.0%
Do you currently own a vehicle? If yes, what type? * Monthly Income	100	100.0%	0	0.0%	100	100.0%

Do you currently own a vehicle? If yes what type? * Age

Crosstab

Count

		Age				Total
		18–25	26–35	36–45	Above 46	
Do you currently own a vehicle? If yes, what type?	No vehicle	33	8	0	0	41
	Petrol, 2-wheeler	33	16	5	1	55
	Hybrid vehicle	2	0	0	0	2
	Electric vehicle	2	0	0	0	2
Total		70	24	5	1	100

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.751[a]	9	.461
Likelihood Ratio	11.911	9	.218
Linear-by-Linear Association	1.592	1	.207
N of Valid Cases	100		

12 cells (75.0%) have expected count less than 5. The minimum expected count is .02.

INTERPRETATION

The chi-square test between age group and type of vehicle ownership revealed a **p-value of 0.461,** which is well **above the significance threshold of 0.05**. This implies that there is no statistically significant association between a respondent's age and the likelihood of owning an electric vehicle. Most individuals across all age groups predominantly owned petrol vehicles or had no vehicle at all, with electric vehicle ownership being minimal and evenly spread. Hence, age does not appear to be a strong influencing factor in the adoption of EVs based on the current sample.

Do you currently own a vehicle? If yes, what type? * Monthly Income

Crosstab

Count

		Monthly Income				Total
		Below ₹25,000	₹25,001–₹50,000	₹50,001–₹1,00,000	Above ₹1,00,000	
Do you currently own a vehicle? If yes, what type?	No vehicle	26	13	2	0	41
	Petrol, 2-wheeler	34	14	5	2	55
	Hybrid vehicle	0	2	0	0	2
	Electric vehicle	2	0	0	0	2
Total		62	29	7	2	100

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.642[a]	9	.471
Likelihood Ratio	10.067	9	.345
Linear-by-Linear Association	.232	1	.630
N of Valid Cases	100		

a. 12 cells (75.0%) have expected count less than 5. The minimum expected count is .04.

INTERPRETATION

The relationship between income level and type of vehicle owned also yielded a **non-significant p-value of 0.471**, indicating that income level is not a strong determinant of whether an individual owns an electric vehicle. The majority of respondents, regardless of income bracket, reported owning petrol two-wheelers or no vehicle. Only two individuals across all income levels reported owning an EV. Therefore, in this study sample, income level does not show a statistically meaningful impact on EV ownership patterns.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Would you consider buying an EV if there were more fast-charging stations nearby? * How would you rate the	100	100.0%	0	0.0%	100	100.0%

availability of EV charging stations in your area?						

Would you consider buying an EV if there were more fast-charging stations nearby? * How would you rate the availability of EV charging stations in your area? Crosstabulation

Count

		How would you rate the availability of EV charging stations in your area?				Total
		Very good	Satisfactory	Poor	Not available	
Would you consider buying an EV if there were more fast-charging stations nearby?	Definitely	10	9	4	3	26
	Maybe	16	21	8	7	52
	Not likely	0	1	3	2	6
	Not at all	0	3	5	8	16
Total		26	34	20	20	100

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	24.298[a]	9	.004
Likelihood Ratio	27.299	9	.001
Linear-by-Linear Association	18.460	1	.000
N of Valid Cases	100		

a. 7 cells (43.8%) have expected count less than 5. The minimum expected count is 1.20.

INTERPRETATION

A statistically significant relationship was found between the availability of EV charging stations and the likelihood of purchasing an electric vehicle, with a **p-value of 0.004**. This indicates that consumer willingness to consider an EV purchase increase as charging infrastructure becomes more accessible and reliable. Respondents who rated charging availability as “Very good” or “Satisfactory” were more likely to respond “Definitely” or “Maybe” when asked if they would purchase an EV with better fast-charging options. This underscores the critical role of infrastructure in driving EV adoption decisions among Indian consumers.

FINDINGS

1. Out of 100 respondents, only 2 people owned EVs, both aged 18–25. The chi-square result ($p = 0.461$) shows that age does not significantly affect EV ownership.
2. Among all income groups, only 2 people owned EVs, both from lower brackets. The chi-square test ($p = 0.471$) shows no clear link between income and EV usage.
3. Respondents with better access to charging stations were more likely to consider buying an EV. A significant result ($p = 0.004$) proves charging availability influences buying decisions.

SUGGESTIONS

1. **Improve Charging Infrastructure:** more fast-charging stations should be installed to make EVs a practical option for more people. Better access will increase consumer confidence and drive adoption.
2. **Create Awareness Across All Groups**: Information campaigns should target people of all ages and incomes. This helps everyone understand the benefits of switching to electric vehicles.
3. **Provide Local Incentives:** Governments should offer region-specific benefits like tax cuts or subsidies. These can address local barriers and encourage more EV purchases.

CONCLUSION

This study offers a first-hand, data-driven examination of electric vehicle (EV) demand patterns and adoption trends within the Indian context. By analysing responses from 100 participants across different age groups and income levels, the research reveals that demographic factors like age and income currently show no significant influence on EV ownership. However, the availability of EV charging infrastructure emerged as a statistically significant driver influencing purchase decisions, highlighting infrastructure as a key enabler in accelerating EV adoption. The study also shows that consumer willingness to adopt EVs is more likely when access to fast-charging stations improves, regardless of socioeconomic background. These insights point to a need for targeted infrastructure expansion, inclusive awareness programs, and localized policy incentives. Unlike many previous studies that rely on secondary or generalized global data, this primary research captures the ground realities of Indian consumers and provides actionable insights tailored to India's unique mobility landscape. As India advances toward sustainable transportation goals, aligning infrastructure development and public engagement strategies with these findings will be critical. This study not only fills a significant research gap but also serves as a foundational reference for future planning and investment in India's electric mobility ecosystem.

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Millennials Perception Towards Electric Vehicles in India

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ABSTRACT

As India being one of the world's largest automobile markets, the demand for electric vehicles (EV) is growing rapidly than ever before. This growth is driven by advancements in technology, changing in consumer preferences and priorities, central and state government initiatives, environmental awareness etc. Central government's New Electric Vehicle Policy is an initiative to position our country as a prominent manufacturing location for electric vehicles. It includes cutting the customs duty rate up to 15% and promoting local manufacturing which aligns with our government's Make in India campaign. As the result, the shift from conventional vehicles to EV is gaining momentum. Despite of all the benefits, there are multiple challenges for the EV market in India. It includes limited availability of charging infrastructure, especially in rural areas, which makes it increasingly difficult for relying on EV for longer distance journeys. EV vehicles also demand extra time for charging, making it as an additional routine task for its users. Whereas conventional vehicles can be filled with fuel tank in very minimal time. In addition to that, EV are more expensive than that of conventional vehicles because of higher production cost for battery technology. Transitioning from conventional vehicles to EV will help our nation in several aspects which includes reduction in carbon dioxide emission, minimising the air pollution, reducing the dependency on oil imports etc.
Millennials, also known as Generation Y, constituting to 34% of India's population, holds a key part in consumer market of our country. They possess optimistic approach towards the adaption of new technologies including electric vehicles, and hence analysing these young consumers perception towards EV is essential for India's future automotive industry. This study focuses on various factors such as charging infrastructure, after sales service, maintenance cost, pricing range, running capacity on single charge etc which will influence millennials perception towards electric vehicles.

INTRODUCTION
BACKGROUND AND IMPORATNACE OF THE TOPIC

As India being one of the leading economy and urbanizing countries, the focus towards improving our environment has taken a key role. As the result of this, electric vehicles started blooming in order to tackle various issues in our country such as air pollution, dependency on importing oils, etc. Be it a plug-in hybrid or full hybrid model, the demand for electric vehicles are rapidly increasing. In order to cope up with the surge in demand, the government is investing in battery technology, introducing several schemes such as Electric Mobility Promotion Scheme, National Electric Mobility Mission Plan, Phased Manufacturing Programme etc. Hence this study focuses on understanding the perception of young consumers i.e., millennials about shifting to electric vehicles segment particularly in our country.

LITERATURE REVIEW

1) Akshay Lalwani, 2020
The perception and buying behaviour of Indians towards Electric Cars
The purpose of this study was to determine how potential buyers of electric cars make their purchasing decisions, looking at factors such as price, battery usage, safety equipment, performance of the vehicle, charging duration, running capacity, appearance, reputation of brand, infrastructure with respect to charging,

celebrity endorsements, influence from families, government incentives, and availability. Majorly the study focuses on understanding buying behaviour of Indian youths.

2) Janjanam Chandra Rao, Gopisaran, Jagana Saikumar, Kosika Pravalika, 2023
A study on consumer perception of EV vehicles
The paper primarily focuses on investigating how Bangalore city consumers feel about opting electric vehicles instead of going for conventional options. The study focuses on how the Governments all over the world are promoting the usage of e-vehicles to reduce our dependency on oil, greenhouse gases emission, and improve air quality. The findings suggest that particularly metropolitan cities are major contributors to air pollution, making it essential to shift for EVs. The purpose of this study is to learn more about consumer's environmental sustainability awareness, attitudes, and likelihood of purchasing e-vehicles.

3) Pranav Sharma, Pradeep Kumar Singh, Akash Verma, 2022
The Challenges faced by EV Industry in India: An Analysis of Consumer Perception
The study examines how the EV industry is going through supply difficulties such as range of the car, affordability and the availability of charging points etc. It mentions the issues on the demand side include, among other things, a lack of investment, a high initial cost of production, expensive research and development, and a lack of collaboration between the private sector and states for promotion and production. The findings suggest the demand for electric vehicles in India is significantly influenced by the availability of service and charging stations, as well as the perceived financial benefits, risks, and environmental concern.

4) A. Mahamuni1 and S. Subramanian, 2021
Analysis of perception, attitude and behaviours toward purchase of electric vehicle in Delhi NCR-India
The study focuses on utilising a partial least squares method to determine the relationship that influence buying behaviour of consumers on EV. The theory examines a variety of constructs, including consumer's perception of behaviour, perceived behavioural control, environmental concern, moral norms, and attitudes toward purchasing electric vehicles with a sample of Delhi and Gurugram residents. The findings suggest that green purchase intention is influenced by personal moral norms, while perceived behavioural control is positively influenced by subjective norms and environmental concerns.

5) Hitarth Mehta, Lakshita Rathod, Aum Bhatt, 2024
Perceptions of Electric Vehicle Adoption among Young Adults in Ahmedabad
This study focuses on the Indian young adults i.e, millennials perception regarding EV adoption. Among the most important factors examined are vehicle preference, peer influence, and the promotion of electric vehicles by the Government. The study highlights the youth's growing awareness of technology and sustainability, which has implications for targeted marketing strategies, and serving as a foundation for future research on EV across age groups and regions. In addition, the findings contribute to the global debate regarding boosting EV adoption and lowering carbon emissions in the interest of a more sustainable future.

RESEARCH DESIGN

OBJECTIVES OF THE STUDY

1. To determine the changing perspective of millennials towards adopting EV
2. To identify the parameters which influence millennials attitude towards EV
3. To analyse and suggest policies required to enhance EV adoption among Indian youth consumers

RESEARCH METHODOLOGY

Sample Design
A) Target Population – Millennials who are considering to buy an EV as a future vehicle
B) Sample Size - 100 responses were being collected for the purpose of doing this study
Method of Data Collection
A) Primary Data

All the data's which is used for this study are collected only from millennials through google forms and hard copy of the same.
B) Secondary Data
There was no secondary data considered for this project.
C) Instrument for Data Collection
The responses were collected through google forms which is directed to google spreadsheet. These responses were imported to SPSS in the form of Excel sheet to perform the tests.
D)Research type - Descriptive research method is used for this study. It mainly describes the the characteristics of the particular population, which is millennials in this study.

Testing of Questionnaire
The responses of the questionnaire which were collected from the target audience through google form which was imported to the excel sheet, was tested using SPSS tool.

Data-analysis technique
In this study, Cronbach alpha test is conducted to identify the reliability of the questionnaire.

→ **Reliability**

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	100	100.0
	Excluded[a]	0	.0
	Total	100	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.720	11

DATA ANALYSIS
MULTIVARIATE ANALYSIS

Dependent variables: Experience
Independent variables: Pricing range, Sustainability, Government Incentives, Charging infrastructure, Running capacity, Charging time, Brand reputation, After sales service, Safety features, Maintenance costs.

COEFFICIENTS TABLE

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.427	.655		.652	.516
	PricingRange	.274	.091	.294	2.998	.004
	Sustainability	-.231	.115	-.205	-2.012	.047
	GovernmentPolicies	.077	.079	.091	.977	.331
	ChargingInfrastructure	.300	.112	.277	2.680	.009
	RunningCapacity	-.153	.109	-.133	-1.393	.167
	ChargingTime	.199	.080	.228	2.491	.015
	BrandReputatioon	.086	.101	.083	.852	.396
	AfterSalesService	-.112	.131	-.088	-.855	.395
	SafetyfeaturesmatterwhenconsideringtobuyanEV	.366	.140	.295	2.607	.011
	MaintenanceCosts	.108	.106	.098	1.016	.312

a. Dependent Variable: Iwillprefertobuyelectricvehiclesinthefuture

INTERPRETATION

As observed in the above table, among the 10 variables, 5 of them are significant i.e., these 5 variables positively impact the dependent variable i.e, pricing range, sustainability, charging infrastructure, charging time, and safety features.

There are multiple implications that can be taken from the findings of the study. It is evident that the perception of millennials towards EV is changing in India.

1. P(sig) of pricing range = 0.004 < 0.05, which implies that Null hypothesis (Ho) is rejected, Alternate hypothesis (H1) is accepted.
i.e., there is a positive impact of pricing range with respect to influencing the perception of millennials towards EV.
2. P(sig) of sustainability = 0.047 < 0.05, which implies that Null hypothesis (Ho) is rejected, Alternate hypothesis (H1) is accepted.
i.e., there is a positive impact of sustainability with respect to influencing the perception of millennials towards EV.
3. P(sig) of government policies = 0.331 > 0.05, which implies that Null hypothesis (Ho) is accepted, Alternate hypothesis (H1) is rejected.
i.e., there is no impact of government policies with respect to influencing the perception of millennials towards telehealth as a service.
4. P(sig) of charging infrastructure = 0.009 < 0.05, which implies that Null hypothesis (Ho) is rejected, Alternate hypothesis (H1) is accepted.
i.e., there is a positive impact of charging infrastructure with respect to influencing the perception of millennials towards EV.
5. P(sig) of running capacity = 0.167 > 0.05, which implies that Null hypothesis (Ho) is accepted, Alternate hypothesis (H1) is rejected.
i.e., there is no impact of running capacity with respect to influencing the perception of millennials towards telehealth as a service.
6. P(sig) of charging time = 0.015 < 0.05, which implies that Null hypothesis (Ho) is rejected, Alternate hypothesis (H1) is accepted.
i.e., there is a positive impact of charging time with respect to influencing the perception of millennials towards EV.
7. P(sig) of brand reputation = 0.396 > 0.05, which implies that Null hypothesis (Ho) is accepted, Alternate hypothesis (H1) is rejected.
i.e., there is no impact of brand reputation with respect to influencing the perception of millennials towards telehealth as a service.
8. P(sig) of after sales service = 0.395 > 0.05, which implies that Null hypothesis (Ho) is accepted, Alternate hypothesis (H1) is rejected.
i.e., there is no impact of after sales service with respect to influencing the perception of millennials towards telehealth as a service.
9. P(sig) of safety features = 0.011 < 0.05, which implies that Null hypothesis (Ho) is rejected, Alternate hypothesis (H1) is accepted.
i.e., there is a positive impact of safety features with respect to influencing the perception of millennials towards telehealth as a service.
10. P(sig) of maintenance cost = 0.312 > 0.05, which implies that Null hypothesis (Ho) is accepted, Alternate hypothesis (H1) is rejected.
i.e., there is no impact of maintenance cost with respect to influencing the perception of millennials towards telehealth as a service.

CONCLUSION

1. The findings from this study show that there are several significant factors that together influence on perception of Millennials towards EV in India.
2. The Variables that influence the perception of Millennials towards EV which are considered for this research includes the following: Pricing range of EV, Sustainability impact, Government incentives and policies, Availability of charging infrastructure, Running capacity on a single charge, Charging time, Brand reputation and trust, After sale services, Safety features, and Maintenance cost.
3. From the study, it is understood that there mainly 5 significant variables, which influence on perception of Millennials towards EV in India.
4. Pricing range, sustainability, charging infrastructure, charging time, and safety features are the significant variables which influence on perception of Millennials towards EV.

RECOMMENDATIONS

Following are the recommendations, based on the findings of this study:

1. Since most of the respondents conveyed, they are not fully aware of government incentives and policies regarding EV, it is important that government should promote policies like electric mobility promotion scheme to overcome air pollution and also to combat the dependency on importing oil.
2. As electric vehicles drastically reduce greenhouse gas emissions, sustainability plays key role, and this can be the motivating factor to push millennials perception towards adapting EV.
3. Companies and government together need to improve substantial charging infrastructure as it is playing a major deciding factor for respondents to buy an EV.
4. Along with the design and pricing range, EV manufacturers should also focus on running capacity on single charge to increase the optimal condition of batteries.
5. EV manufacturers must invest on making the batteries more efficient and robust with features such as advanced cooling systems and fire-resistant casting to improve the safety conditions for the buyers.

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"A Study on the Awareness and Perception of Electric Vehicle Adoption Among Students at Davangere University"

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Abstract

Students' knowledge of the economic and environmental advantages of electric Vehicle (EVs) is investigated in this study. It seeks to assess their degree of familiarity with cost reductions, government subsidies, and lessened environmental effect. Furthermore, the study explores how students' educational backgrounds affect their comprehension of EV technology. Structured questionnaires from different Davangere University departments were used to gather data. The findings show a notable difference in awareness levels between disciplines. Results indicate that science and engineering students show a higher level of comprehension. The report suggests awareness campaigns to bridge knowledge gaps and encourage environmentally friendly transportation options. This study looks into how Davangere University students perceive and understand the adoption of electric vehicles (EVs). EVs are becoming essential substitutes for conventional fuel-based transportation in light of the world's environmental problems and the growing focus on sustainable development. The purpose of the study is to evaluate students' understanding of the economic and environmental benefits of electric vehicles (EVs), including their potential to lower pollution, cost effectiveness, and government incentives. The findings indicate that although charging stations and the advantages they offer the environment are well known, many students are not aware of government programs or ways to save money. According to the report, EV-related information should be incorporated into academic curricula, awareness campaigns, campus charging stations, and partnerships with EV companies for seminars and internships. The future generation can be better equipped to make wise choices and actively engage in India's green mobility revolution with the support of such initiatives.

The study also looks at how students' knowledge and views on EVs are influenced by their academic backgrounds, including science, management, the arts, and commerce. One hundred students from different disciplines were given a standardized questionnaire to complete in order to gather primary data. Using SPSS software, the research showed significant differences in awareness levels, with science and engineering students showing a greater understanding of EV technology and Infrastructure.

Key Words: Electric Vehicle, student Awareness, Environmental, Davangere University, Development, Knowledge.

1. INTRODUCTION

The globe has been shifting toward greener and cleaner modes of transportation in recent years. This is due to the limited supply of fuels like gasoline and diesel as well as the increase in pollution. Since they don't rely on fossil fuels and help reduce pollution, electric vehicles, or EVs, are quickly becoming a popular green choice. Through initiatives like the FAME Scheme (Faster Adoption and Manufacture of Hybrid and Electric Vehicles), the Indian government is also promoting the usage of EVs. However, government backing is not the only factor that makes EVs successful. It also depends on people's attitudes toward utilizing EVs and their level of knowledge about them. Young people are crucial prospective clients, particularly college students. Their perceptions and understanding of EVs may influence how quickly these cars proliferate.

Electric vehicles, or EVs, are gaining popularity as a more environmentally friendly substitute for traditional gasoline and diesel automobiles. The future of clean transportation is thought to be electric vehicles (EVs) due to increased environmental concerns, rising fuel prices, and government initiatives to cut carbon emissions. Global EV sales in 2023 topped 14 million, a 35% increase over 2022, according to the International Energy Agency (IEA). More than 15 EVs were registered in India as of March 2024, indicating a favourable adoption trend.

The purpose of this study is to determine the level of awareness, opinions, and readiness for use of electric vehicles among Davangere University students. It will examine their knowledge of the advantages and drawbacks of EVs as well as the things that would deter consumers from selecting one, such as excessive prices, a dearth of charging stations, or performance concerns. This study will assist businesses and the government in developing more effective awareness campaigns by gaining insight into the opinions of students. Additionally, it will contribute to the success of India's transition to greener and cleaner transportation. Because of this, the study is highly significant and helpful.

2. STATEMENT OF PROBLEM

Although they are crucial for advancing environmentally friendly transportation, electric vehicles (EVs) are still not widely used in India. Many young people, particularly those attending universities, are not properly aware of or comprehend EVs. Their readiness to embrace EVs may be impacted by misconceptions regarding price, functionality, and charging stations. There hasn't been any targeted research done at Davangere University to evaluate students' awareness and perception. The purpose of this study is to close that gap and pinpoint the major variables affecting students' adoption of EVs.

3. LITERATUR REVIEW

Trishu Sharma, (2023) Perceptions of EV adoption among Ahmedabad's young adults, ages 18 to 30, are investigated. 104 individuals participated in a quantitative survey that examines environmental concerns, peer pressure, and vehicle selection. Age did not significantly affect EV interest, according to the results, but technology and environmental consciousness did. When it came to EV infrastructure, urban youngsters were more exposed than their rural counterparts. While peer and promotional factors were not shown to differ by gender, vehicle preferences were. The results highlight the necessity of enhanced infrastructure and concentrated, environmentally friendly marketing in order to increase EV adoption.

Hari Krishnan B, Dr. A. Vini. (2025) The study investigates the attitudes, perceptions, and awareness of consumers regarding electric vehicles (EVs). It highlights the main drivers, such as cost-effectiveness and environmental advantages, as well as the obstacles, such as range anxiety and inadequate charging infrastructure. 104 respondents, the majority of whom were students, provided primary data. The primary source of knowledge about EVs is now social media. To encourage EV adoption, the study recommends enhancing government incentives and awareness campaigns.

Godwin Yakubu, (2024) The report looks into the main problems influencing the transportation industry's adoption of electric vehicles (EVs). It points out obstacles like high upfront costs, a dearth of infrastructure for charging, and scepticism from customers. The necessity of public-private partnerships and government incentives is emphasized in policy suggestions. Long-term financial savings and environmental advantages are emphasized as adoption motivators. In order to overcome reluctance and hasten the adoption of EVs, the report recommends strategic planning and awareness efforts.

Iram Chowdary, Ashef Munir, (2025) The study investigates young people's perceptions and awareness of electric cars (EVs) in Bangladesh. Although interest is growing, there are still knowledge gaps and financial concerns, according to survey results. Respondents support more government subsidies and acknowledge the environmental advantages of EVs. Two of the biggest obstacles to adoption are still range anxiety and a lack of charging infrastructure. To increase EV adoption, the study suggests legislative backing, educational initiatives, and technology advancements.

Hitarth Mehta, Lakshita Rathod, (2023) This research uses a structured questionnaire to investigate Ahmedabad residents aged 18 to 30's attitudes on EV adoption. Peer pressure, vehicle preference, technology developments, environmental concerns, and promotional impact are some of the important aspects examined. Age has no discernible impact on impressions, according to the findings, although gender has an impact on some factors, such as preferred vehicles. EV adoption intent is more influenced by technological advancements and environmental consciousness. The study recommends enhanced infrastructure and focused young marketing to increase EV adoption.

Reena Malik, Ambuj Sharma, (2022) The study investigates the ways in which educational establishments, particularly community colleges such as Chitkara University, help raise students' knowledge of electric vehicles (EVs) and environmental challenges. Both students and professors have a reasonable awareness of environmental issues, according to research conducted through qualitative methodologies and interviews. Through specialized classes, workshops, and sustainable campus activities, the university incorporates environmental teaching and encourages electric vehicles. With their increasing inclination to embrace environmentally friendly modes of transportation, students are viewed as potential influencers. The study emphasizes how important education is in influencing EV adoption and sustainable behaviour.

Sharon Mary, (2025) The study uses a quantitative technique to examine how Bangalore college students see and use electric cars (EVs). The findings indicate a favourable trend toward EVs, but actual use is still low because of infrastructural issues and a lack of knowledge about government incentives. The greatest propensity to adopt EVs is shown by students between the ages of 18 and 21. The likelihood of making a subsequent purchase is greatly increased by familiarity with EVs. The relationship between age and EV adoption is modest and not statistically significant. To increase adoption rates, the report suggests focused incentives, better charging infrastructure, and awareness campaigns.

4. RESEARCH GAP

The knowledge and adoption of electric vehicles (EVs) have been the subject of numerous national and international studies; the majority of them have concentrated on urban populations, working professionals, or general consumers. University students, who make up the next generation of potential EV users, are the subject of relatively few research. Additionally, there hasn't been any thorough study done at Davangere University to find out how alert, perceptive, and prepared students are to embrace electric automobiles.

Additionally, the literature that is now available has mostly ignored the impact that academic backgrounds—such as those in science, business, or the arts—have on EV knowledge. This study closes that gap by examining students from a range of academic fields and determining the main obstacles and driving forces behind their opinions on electric vehicles.

5. OBJECTIVES

1. To assess students' knowledge of the financial and environmental benefits of electric vehicles.
2. To look into how students' knowledge and comprehension of electric vehicles are influenced by their academic fields.

6. HYPPOTHESIS

1. H_0: Students have a good understanding of the economic and ecological advantages of electric cars.
H_1: Students are not very aware of the economic and environmental advantages of electric cars.
2. H_0: Students' knowledge and comprehension of electric vehicles vary greatly depending on the subject they are studying.
H_1: Students' academic subjects do not substantially affect their knowledge and comprehension of electric vehicles.

7. NEED FOR THE STUDY

Electric vehicles (EVs) are quickly emerging as a vital substitute for conventional fuel-based transportation due to the increased emphasis on sustainability around the world. Since students will be the consumers and decision-makers of the future, it is crucial to understand their awareness of EVs. There is a lack of information regarding how educational backgrounds influence comprehension of EVs. Designing successful awareness-raising and instructional initiatives can be aided by this analysis. Additionally, it facilitates the creation of focused policy efforts. Therefore, this study is crucial for encouraging young people to adopt EVs in an informed manner.

8. RESEARH METHODOLOGY

The study article that examines students' awareness and perceptions about the adoption of electric vehicles includes research methods.

Research Design: This research study is descriptive in nature. It indicates that the study's purpose is to characterize students' knowledge and attitudes toward electric automobiles.

Data Collection: A systematic questionnaire with both multiple-choice and closed-ended questions was used to gather primary data. Journals, official documents, and internet sources were used to collect secondary data.

Sample size: 100 respondents.

Scope and Limitations: The study is limited to students of Davangere University only.

Data analysis and techniques: Students' awareness levels and perceptions across several academic streams are interpreted through the use of charts, comparative tables, and percentage analysis.

Tools used for Data Analysis: SPSS software used

9. DATA ANALYSIS AND INERPRETATION

Demographic Profile for the Respondents

Variable	Category	Frequency	Percentage
Age	18-20	3	3%
	21-22	43	43%
	23-24	42	42%
	25-26	12	12%
Gender	Male	44	44%
	Female	56	56%
Education Level	Under Graduation	15	15%
	Post Graduation	85	85%
Department	Management	66	66%
	Science	9	9%
	Arts	4	4%
	Commerce	21	21%
Income	Below ₹10,000	26	26%
	₹10,000–₹25,000	35	35%
	₹25,001–₹50,000	18	18%
	Above ₹50,000	21	21%

Source: Primary Data

		Age of the respondents	Gender	Income	Education	Department	Vehicle
N	Valid	100	100	100	100	100	100
	Missing	0	0	0	0	0	0
Mean		2.630	1.560	2.340	1.150	1.800	2.500
Median		3.000	2.000	2.000	1.000	1.000	2.000
Mode		2.0	2.0	2.0	1.0	1.0	2.0
Minimum		1.0	1.0	1.0	1.0	1.0	1.0
Maximum		4.0	2.0	4.0	2.0	4.0	4.0
Sum		263.0	156.0	234.0	115.0	180.0	250.0

Source: Primary Data

Interpretation: One hundred valid responses with no missing data were included in the study. The majority of respondents are youthful to middle-aged, as indicated by their average age of 2.63. The gender data indicates a little female predominance, with a mean of 1.56 and a mode of 2. With a mean of 2.34, income levels are primarily in the lower-middle range. With the majority of respondents falling into the lowest category (mean 1.15), education levels are typically low. Although replies are dispersed over four departments, the majority of participants are from department 1. With a mean score of 2.5, automobile data indicates that mid-range cars (category 2) are most frequently utilized or favoured.

One-Sample Test

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
How often do you charge stations in your city?	23.631	99	.000	2.2800	2.089	2.471

Source: Primary Data

Interpretation: People do not visit the charging point; people visit the charging point to charge the Vehicles. It says that people visit, .000 reject the null Hypothesis, we accept the alternative Hypothesis.

10. FINDINGS

1. Frequent Charging Behavior: Using EV charging stations in their city was indicated by respondents with a substantial average frequency (mean = 2.28), suggesting regular usage.
2. Statistical Significance: The one-sample t-test result ($t = 23.631$, $p < .001$) demonstrates active interaction with EV infrastructure and validates that the frequency of charging is significantly different from zero.
3. Data Confidence: The result is accurate and dependable because the 95% CI (2.089 to 2.471) displays a tight range.

11. SUGGESTIONS

1. Launch awareness campaigns to inform university students about the features and advantages of electric cars.
2. Add information about EVs to academic courses in all fields, including as science, business, and the arts. Students' knowledge of environmentally friendly transportation technologies will improve as a result of this integration.
3. Work together with EV businesses to offer seminars, internships, and practical experience.
4. Encourage students to work with faculty members on EV-related projects and research. It greatly aids in creativity and a more thorough comprehension of the topic.
5. The establishment of EV charging stations on college campuses is advised. Students' adoption and exposure to real-world situations may be encouraged by this program.

12. CONCLUSION

Making the switch to electric vehicles (EVs) is essential to creating a future that is environmentally benign and sustainable. This study demonstrates how Davangere University students now perceive and understand EV adoption. The results show that although many students understand the economic and environmental advantages of electric vehicles, there are still significant knowledge gaps, especially when it comes to government programs, long-term cost reductions, and charging infrastructure.

All things considered, the study highlights the necessity of focused awareness campaigns, enhanced information availability, and campus-level programs to inform students about electric mobility. In the end, this can enhance India's efforts towards sustainable development and clean transportation by encouraging good attitudes and preparedness among young people. Making the transition to electric vehicles (EVs) is crucial to building a sustainable and ecologically friendly future. This study illustrates how students at Davangere University now view and comprehend the adoption of EVs. The findings demonstrate that even while a large number of students are aware of the financial and environmental benefits of electric vehicles, there are still a lot of unanswered questions, especially about government programs, long-term cost advantages, and the accessibility of charging infrastructure.

Additionally, the results demonstrate that awareness levels vary by academic subject, with students from science and engineering backgrounds being more familiar with EV technology than those from the arts or business. These findings highlight how crucial it is to implement customized awareness campaigns and incorporate EV-related material into university courses. The study's overall findings highlight the necessity of doable actions including informational campaigns, collaborations with EV manufacturers, campus-level infrastructure like charging stations, and awareness campaigns. In addition to significantly advancing India's goal of clean, green, and sustainable mobility, such initiatives can improve students' attitudes and preparedness for EV adoption.

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Influence of the Product Features on Consumer's Product Intention for Electric Vehicle

EV Marketing: Sub-themes: Product differentiation strategies for EVs

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ABSTRACT

In recent times there has been concern about the depletion of natural resources and the over-exploitation of fossil fuels. India emits around 7.2% of the world's total CO2 emissions. The Paris Agreement had an ambitious target to keep the Global warming below 2 degree Celsius.

India has adopted the ambitious plan of net zero by 2070 by adopting mobility in a sustained manner and thereby reducing environmental impact. The GOI has developed a muti pronged approach to meet the above targets. Transportation being one of the primary causes of global warming, the Government has planned to move from fossil fuel dependency to Electric Mobility. Many earlier schemes like FAME I & II, National Electric Mobility mission have been planned by GOI to encourage the adoption of EV vehicles both in the commercial sector and the personal vehicle segment.

This paper utilizes a significant amount of literature review to understand the personal preferences of the potential consumers for electric vehicle adoption. The paper not fully exhaustive does delve into the current reach on adoption of EV in specific through the prism of various theories like Theory of Reasoned Action, Theory of planned behaviour and few others to explain the adoption process of EV.

Keywords-Range, Price, Safety, Charging, Reliability

Global warming is a serious issue with impact on temperature and sea levels, glacier melting, changes in weather patterns and impact on human health.

One of the biggest contributors to Global warming is transportation which contributed to 23% of global CO2 emissions in 2021.In India the share of transportation is only 13% and the CO2 emissions per capita is 1.75 t. The Government of India has initiated many steps to combat the effects of Global warming by trying to reduce the dependence on fossil fuels and by increasing support for Electric Vehicles. At present due to the EV policy India has achieved 10.25 crore of total CO2 reduction (*Home | Ministry of Heavy Industries,2024*)

With anticipated doubling of renewable energy sources in India by 2030, the total life cycle GHG emission of BEV(Battery Electric Vehicle) will decrease by approximately 20 % .(Shet K & Moholkar, 2025).

Inspite of the apparent success the rate of adoption is not satisfactory as per the initial plans. The Government of India has launched many schemes like FAME and Productivity Linked Incentives to encourage the adoption and manufacture of EV vehicles respectively. Even after the second phase of FAME II with Budget of Rs11500 crore only 16 lakh vehicles have incentivised as of March 2025.

Global EV scenario

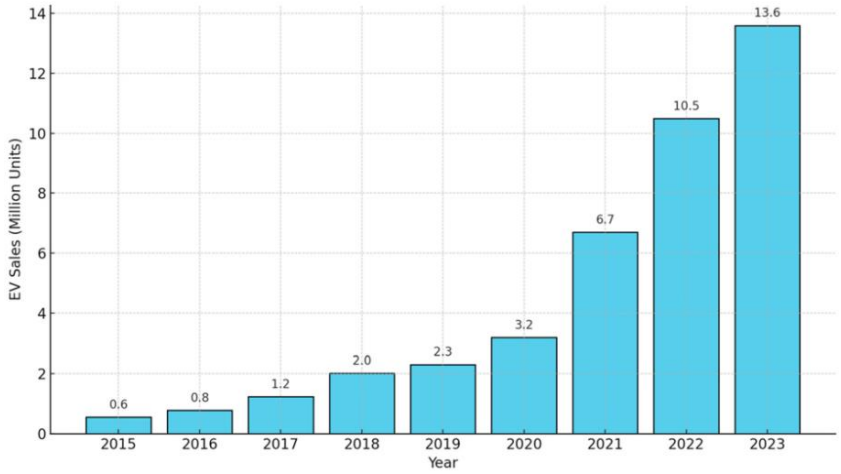


Figure 1. Growth of Global EV sales in 2023, Source IEA 2023

Around 17 million EV cars were sold in 2024 with 20% share of overall sales. China has clocked 11 million EV car sales in 2024.In US the EV car segment grew by 10% and Europe the sales did not record any significant increase though 20% of new car sales came from EV cars.In India share of EV car sales was 2% of total car sales in 2024.Indonesia and Thailand have more than doubled their EV car sales in 2024.On the whole the Electric car sales in 2025 are expected to exceed 20 million worldwide to represent more than one-quarter of cars sold worldwide (Global EV Outlook 2025,).

Indian Scenario

In 2013 the National Electric Mobility Mission Plan was introduced. The FAME-II incentivises both producers and customers for EV. The National Mission on Transformative Mobility and Battery Storage was created to ramp up the charging infrastructure to meet the targets for 2030.

(Goel et al., 2021) To facilitate the faster adoption of electric and hybrid vehicles, the Indian government introduced the Faster Adoption and Manufacturing of Electric Vehicles (FAME II) plan. The Government had planned installation of charging infrastructure and introduction of several incentives to promote the purchase of EVs. The cabinet approved 10,000 crores for FAME II in February 2019.Due to moderate level of achievement the Government of India announced the National Electric Mobility Mission Plan (NEMMP) 2020 to improve national energy security, reduce the negative environmental effects of fossil fuel-powered vehicles, and build up domestic manufacturing capacity.

The sale of BEV passenger cars has risen at a CAGR of 191% in the last four years, from 1019 units in 2019 to 73,282 units in 2023 (Kandpal & Trencher, 2025). EVs accounted for just 6.3% of the about 22.7 million new vehicle registrations in 2023 in India. The Indian government has set a goal of 30% EV sales by 2030. Due to the rapid growth of ICEV in India, The International Energy Agency has predicted that India will be responsible for one-third of the global growth in oil demand between 2023 and 2030.These patterns may hinder India's objective of reaching net-zero emissions by 2070. A budget of USD 231.67 million for FAME-II scheme and the production-linked scheme (PLI) for advanced chemical cells (ACCs) and auto ancillary companies have been approved.

Niti Ayog has estimated that 474 million tons of oil equivalent (MTOE) of oil usage and about 846.3 MTOE of CO2 emissions might be conserved yearly if India's EV sales growth is as anticipated by 2030.Niti Ayog estimates that 50% of four-wheelers will be EV by 2030.

Factors affecting EV Purchase intention

Researchers around the world and specifically in India have been trying to identify the factors influencing the consumer purchase adoption of EV.

The psychological angle like performance expectancy, effort expectancy, social influence, facilitating conditions and environmental concerns were explored (Samarasinghe et al., 2024)

This conceptual paper is focused on studying the influence of the 'perception towards EV product features and performance' on Purchase Intention for EV.

Consumer behavior theories, such as the Theory of Reasoned Action and the Theory of Planned Behaviour etc. provide a framework to analyse how consumers do information gathering, compare the alternatives, and make decisions to purchase.

Some authors (Barbarossa et al., 2017) attribute consumer's control over decision making, to the influence of family and friends, personal beliefs as significant contributors to EV adoption.

Psychological influence of discounted pricing, incentives and usage patterns (Zhuge & Shao, 2018) are also among the background influencers whilst evaluating EV purchase. Trust in EV (Ng et al., 2018) was suggested to be an important factor to the consumer

Research Objective

The research objective is to identify the underlying factors in the consumers decision making process while planning to buy a four-wheeler electric vehicle. The paper seeks to identify the features which are important to a potential customer of EV. The secondary research has tried to narrow down the specific product attributes of an EV which the customer is expecting. The identification of these factors would help the Government and the industry to focus their efforts on policy development and product development respectively. These measures will lead to increased EV adoption in India.

The main objective of this research is to analyse the role of product features in the consumers decision making process. There are a few critical product features of the EV which we can identify based on the review of literature.

Research Gap

However very few researchers that used **the theory of planned behavior to analyse the direct impact of the 'perception of EV product attributes'** on EV purchase intention in the Indian context.

Theory of Planned Behavior and Evaluation of Product features of EV

Many theories have been used to explain the intention to purchase EV. There has been substantial work by researchers using some of the commonly used theories -theory of planned behavior, the diffusion of innovation theory, the values-beliefs-norms theory, the technology acceptance model and the norm activation model (Ajzen, 1991, Stern et al., 1999, Venkatesh and Davis, 2000, Lane and Potter, 2007, Moons and De Pelsmacker, 2012, Egbue and Long, 2012, Skippon and Garwood, 2011, Wang et al., 2016).

Based on the scoping review (Yuriev et al., 2020b) TPB emerges as the most effective theory to explain pro-environmental behaviour.

TPB explains the influence of three constructs (Ajzen, 2011) on the Purchase Intention. One construct is Attitude which refers to an individual's positive or negative disposition to the behaviour under study. Attitude in context of purchase intention towards EV can be explained as the intensity of an individual desire to buy EV.The term subjective norm broadly refers to the influence of family and friends on the purchase intention. The third construct Perceived Behavioural Control is the self-appraisal by the consumer of the practicality of the EV purchase within a given situation.

Psychological factors like attitudes towards purchase of EV vehicles play an important role in decision making. Values and motivations (Chu et al., 2019) and other authors have focussed on perception. There are two dimensions to perception one is the perceived performance vis-a vis ICE(Internal Combustion Engine) and the next is the perception regarding the effectiveness of EV in reducing pollution.

Any application of TPB in context of EV purchase intention must be reflected in the following statements.

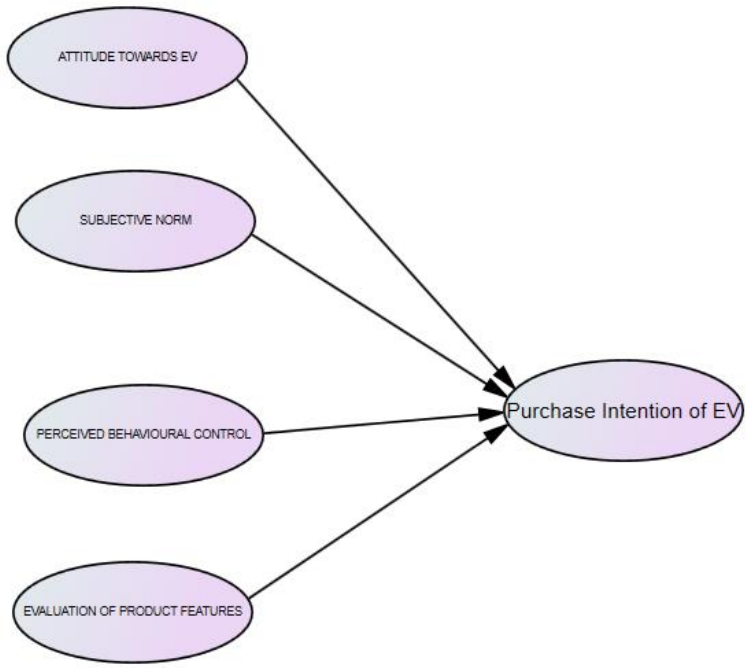
Attitude- "I believe that contributing to environment protection is my duty"

Attitude- "My decision to adopt EV will significantly reduce GHG"

Subjective Norm- "My friends and Family will support me if I buy an EV"

Perceived Behavioural Control- "I have the ability and willingness to pay more and make special efforts required to use an EV"

PROPOSED MODEL



Evaluation of Product Features of EV

Perception of price, maintenance and safety were considered as effective measures of purchase intention for EV (Jena, 2020). Performance (Rahma et al., 2024) is also viewed in terms of reliability, green trust and price sensitivity. Others have measured performance in terms of charger availability (He et al., 2022).

Range

The importance of range can be based on the study (Balasubramanian et al., 2024) influencing factors using the Push Pull and Mining theory. They scoured through twitter data using text mining tools and identified range as on area of critical importance whilst considering buying an electric vehicle.

Range is subjective as it directly related to the price of the EV. (*Latest Car News & Reviews - Upcoming Bikes & Cars in India | Autocar India)*. We can observe that the range of high-end vehicles in India is around 400 km on one full charge. The average range for all mid-range cars is around 200 km per full charge.

Price related

Price of EV is higher than ICE vehicles in most countries. In addition, consumers consider depreciation and energy prices whilst considering purchasing EV. Many authors have cited the policy introduced by respective governments to induce consumers to increasingly buy EV (Hakam & Jumayla, 2024)

The Total cost of ownership (TCO) is a concept where not only the purchase price, but the operating cost is considered. Though the purchase price is high, the lower maintenance and energy costs are to be considered. TCO balances the impact of the higher initial costs with the subsequent lower costs of maintenance and operation. They consider that only evaluating either purchase price or operating cost alone will not be a rational choice by the prospective consumer.

Harte et al. (1994) opine that price is of three dimensions with respect to decision making for electric vehicles. The first is the fuel prices, the second is the purchase price of the EV and thirdly the operating price for EV. Each consumer is guided by his priority from amongst the above dimensions. It is therefore imperative to understand the broad clusters of customers which can be framed based on the different dimensions of price. They prioritise the role of purchase price in the decision-making process. At this stage BEV are more expensive than ICE (Bharadwaj 2015).The TCO on the basis of we observe the cash outflow at INR130 K for petrol against the cash outflow for diesel at INR 150K.The breakeven point is four years for domestic charging based 2022 prices of electricity units @7 per unit (Sankaran & S, 2022).Swapping technology is likely to further reduce the TCO.

Charging Infrastructure

The ambitious plan to achieve 30% of electric Vehicles by 2030 in India must be supported by an adequate charging Infrastructure. Limited research has focused on the currently available charging infrastructure, access and affordability of charging in the Indian context. There is limited data on the availability of charging stations. Establishing charging stations requires space allocation, operation and regular maintenance. There are three layers of charging infrastructure, The first layer is charging at home and is time consuming process which typically takes 8 hours. The next layer consists of commercial charging stations which typically take 4 hours to charge and run on 240 Finally the DC fast chargers can charge the battery up to 80% in 30 minutes of so.

The other option in charging is the battery swapping mechanism. A depleted battery can be exchanged for a full charged battery. However very few players have started this service in India.

(P. Goel et al., 2021) There is concern with respect to the design, packaging and the components used in battery manufacture. A related concern is compatibility of chargers. Different manufacturers have different specifications for chargers which makes it impossible for interoperability. Commercial charging points need be developed which can charge the different types of charger options. Some researchers have voiced concern with respect to location of commercial charging facilities. Having the commercial charging facility in a densely populated location may not be economically and practically feasible. This will require that commercial charging centres be located at relatively less densely populated localities which means that EV owners will be required to travel to distant charging points for availing recharge. By balancing the sources of renewable energy, effective policy making and optimizing charging processes, can induce people to adopt EV (Zhang et al., 2023, Liu et al., 2023a, Min et al., 2023).

Safety of Electric Vehicles

As concern for EV adoption is the possibility of battery explosion either due to an accident or overheating. Indian weather conditions are typically hot and may give rise to overheating. Chances of an explosion are higher in case of extremely hot weather leading to the fire. Another area of concern is use of lithium-ion battery which tends to heat up faster than other battery technology. Another related safety aspect is the lack of noise which leads to accidents as both pedestrians and other motorists fail to perceive the proximity to the EV(Edwards et al., 2024). The common issues faced relating to safety are chemical and vehicle catching fire. Broadly it can be said that EV are on par with safety of ICE.Infact EV are higher in safety as they usually incorporate systems such as ADAS and crash-avoidance systems (Guzek et al., 2024).The customers may not be aware of the superior safety of the EV.The Government and the manufacturers must join hands in creating awareness in the general public.

Reliability of EV

EV have reduced moving parts and are less complex than EV making less prone to mechanical damage and wear and tear. The significant ease in driving because of single pedal and automatic transmission and direct linking of the motor to the EV gives rise to quick acceleration. The issue of reliability is related more to the battery pack and its subsequent decline in performance over time. Overcharging of battery may lead to degeneration of battery performance (Zhou et al., 2011). The life of the battery can be reduced substantially in case of sustained battery abuse which could lead to poor reliability. The replacement cost for battery is very high. Typically, the battery is priced between 35%-50% of EV cost (McDonnell et al., 2021). As reliability concerns are on the rise affecting the purchase intention many manufacturers are providing warranty of three to eight years and on road service 24*7. Such measures reassure the customer about the reliability of the EV.

Conclusion

This research is an attempt to understand the importance of product features affecting electric vehicle adoption in India. It has employed secondary data sources and undertaken a simple analysis of existing body of research and literature. This study provides a cross section of research papers to understand the impact of price, range, charging infrastructure, safety and reliability of Electric Vehicle. The review of literature has a balance of studies in India and from abroad. The research objectives were formulated based on the aim of this study, which includes mapping price points appropriate to Indian consumer sentiments. The literature related to range is expected to be useful for a bird's eye view of the consumers expectations with respect to safety, reliability, charging infrastructure and price.

Limitation

Research is focussed on the product features which addresses only the consumer's perspective towards adoption of EV. The paper purposely avoids an analysis of the policy initiatives and other Government initiatives which also have a significant influence of adoption process. This constraint can be addressed by future studies on the policy initiatives of the Government. The paper also stops short of identifying the differentiating strategies for EV.

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The Electrification of Indian Mobility: A Comprehensive Analysis of the Electric Vehicle Market, Growth Dynamics, and Infrastructure Development

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Abstract

This paper presents a comprehensive analysis of the Indian electric vehicle (EV) market, with a particular focus on the rapidly expanding electric two-wheeler segment. It examines the market's current size, projected growth trajectories, and the intricate interplay of key drivers and restraints. The study evaluates the progress and challenges associated with developing a robust EV charging infrastructure across the nation, providing granular regional insights into market penetration and infrastructure deployment. Furthermore, the paper delves into the competitive landscape, the impact of the COVID-19 pandemic, and emerging technological trends such as advanced battery chemistries and smart grid integration. The analysis underscores India's strategic trajectory towards sustainable mobility, highlighting the critical role of government policies and the imperative for coordinated efforts among all stakeholders to overcome existing impediments and realize the full potential of electric transportation.

Keywords

Electric Vehicles, Electric Two-Wheelers, India, Market Analysis, Charging Infrastructure, Government Policy, Sustainable Transportation, Battery Electric Vehicles, FAME India, Market Dynamics, Regional Growth.

1. Introduction

The global automotive industry is undergoing a transformative shift towards electrification, driven by escalating environmental concerns, stringent emission regulations, and the imperative for energy independence. Electric vehicles (EVs) are central to achieving global decarbonization targets and mitigating the adverse effects of climate change. This paradigm shift has led to significant investments in research, development, and manufacturing across the world, with major automotive shows like IAA Mobility 2023 highlighting the growing prominence of electric models and the intensifying competition among original equipment manufacturers (OEMs).

India, as one of the world's largest and fastest-growing automotive markets, presents a unique case study in EV adoption. The two-wheeler segment, which forms the backbone of personal mobility in the country, holds particular significance for electrification. Unlike many Western markets where passenger cars dominate the EV transition, the shift in India is heavily influenced by the two-wheeler sector, which accounts for a substantial portion of daily commutes and overall vehicle sales. This makes the electrification of two-wheelers a critical component of India's broader sustainable transportation goals.

Despite the clear advantages of electric mobility and a strong government push, the Indian EV market, particularly the two-wheeler segment, faces multifaceted challenges related to infrastructure, initial cost, and consumer perception. A comprehensive analysis is needed to understand the intricate dynamics shaping this market, identify critical success factors, and project future trajectories.

This paper aims to:

- Analyse the current market size and project future growth trajectories for the overall Indian EV market and specifically the electric two-wheeler segment.
- Identify and critically assess the key market drivers and restraints influencing EV adoption in India.
- Evaluate the progress and challenges in developing a robust EV charging infrastructure across the nation.
- Provide granular regional and city-wise insights into EV market penetration and infrastructure deployment.
- Discuss the broader implications of market dynamics, competitive landscape, and emerging technological trends.
- Formulate conclusions and recommendations for stakeholders to accelerate India's transition to electric mobility.

2. Research Methodology

This study employs a comprehensive secondary research approach, synthesizing data and observations from reputable industry reports and market intelligence providers. The methodology focuses on a multi-source validation process to ensure data accuracy and robustness.

Data Sources

- The Insight Partners :

  This source provided foundational data for the global and India-specific low-speed electric vehicles (LSEVs) market. It was utilized to understand market size, forecasts spanning from 2020 to 2030, and key industry dynamics, including drivers, restraints, opportunities, and future trends. The document also offered breakdowns of the India market by product, end-user, and vehicle type, contributing to a broader understanding of the LSEV category, which encompasses certain types of electric two-wheelers and utility vehicles.

- Mordor Intelligence :

  This document was crucial for a detailed analysis of the overall India Electric Vehicle Market from 2018 to 2028. It supplied extensive data on market size, revenue, and volume. Its segmentation by propulsion type (Battery Electric Vehicle, Hybrid Electric Vehicle, Fuel Cell Electric Vehicles, Plug-in Hybrid Electric Vehicles) and vehicle type (passenger cars, commercial vehicles, buses) was instrumental. Furthermore, regional breakdowns for India (East, West, North, South) were sourced from this report. The Porter's Five Forces analysis and discussions on market opportunities and future trends, such as new battery technologies and smart grids, also originated from this material.

- Netscribes :

  This source was particularly valuable for specific and granular insights into the Electric Bikes Market in India for the period 2024-2028. It provided detailed market size and growth forecasts based on volume, a PESTEL analysis, company-wise sales and market share data for FY 2023, and information on production and penetration rates. The report's sections on the impact of COVID-19, trade analysis (export/import), market influencers (drivers and

challenges specific to electric bikes), and government initiatives (FAME India Scheme details, charging infrastructure specifics) were directly incorporated from this document.

- Strategy&, PwC :

  This material offered broader global and regional EV sales trends for Q3 2023, providing essential context for the Indian market. It included observations on battery technology advancements (e.g., CATL's Shenxing, Toyota's solid-state), battery recycling, OEM profitability, and trade war concerns. While not directly India-specific, these global trends highlighted technological developments and market forces that are anticipated to influence the Indian market over time.

Analytical Frameworks

- **Market Sizing and Growth Rate Analysis:** Quantitative data from the identified sources were systematically compiled to present historical market performance (2018-2023) and project future growth (up to 2030 for LSEVs, 2028 for overall EVs and electric bikes). Compound Annual Growth Rate (CAGR) was a primary metric utilized to illustrate growth trajectories.
- **PESTEL Analysis:** Applied to understand the macro-environmental factors (Political, Economical, Social, Technological, Environmental, Legal) specifically impacting the electric bike market in India, drawing from the Netscribes report.
- **Porter's Five Forces Analysis:** Utilized to assess the competitive intensity and attractiveness of the broader Indian EV market, with implications inferred for the two-wheeler segment, based on the Mordor Intelligence report.
- **Qualitative Analysis:** Interpretive commentary was provided to explain the significance of quantitative data, identify causal relationships, and infer broader implications beyond the immediate figures.

Data Triangulation and Validation

Information obtained from multiple sources was cross-referenced to ensure consistency and reliability. Any discrepancies were noted and addressed through a reasoned evaluation, prioritizing the most comprehensive and recent data available to maintain the integrity of the analysis.

3. Market Overview and Growth Dynamics

3.1. Overall Indian Electric Vehicle Market Performance

The Indian electric vehicle market is experiencing exponential growth, signaling a significant shift in the country's transportation landscape. In 2022, the market was valued at USD 2,216.92 million and is projected to reach USD 26,008.43 million by 2028, demonstrating a remarkable compound annual growth rate (CAGR) of 40.52% during the 2018-2028 forecast period. In terms of volume, EV sales increased from a modest 1,601 units in 2018 to 71,185 units in 2022. This volume is projected to surge further to 855,875 units by 2028, exhibiting a CAGR of 36.74%. These figures collectively indicate a strong upward trajectory for EV adoption across the country.

The dominance of Battery Electric Vehicles (BEVs) is a notable characteristic of this growth. BEVs accounted for 74.34% of the market revenue and 71.15% of the volume share in 2022 among all propulsion types. This substantial lead is projected to continue, with BEV revenue growing at an impressive CAGR of 49.30% from 2022 to 2028. The rapid expansion, particularly the overwhelming preference for BEVs, is not merely a reflection of organic consumer demand but rather a direct consequence of aggressive governmental policies. The significantly higher CAGR for BEVs (49.30%) compared to the overall market (40.52%) suggests that the incentives and infrastructure development efforts are heavily

favoring pure electric models over hybrid or fuel cell alternatives. This strategic governmental push appears designed to accelerate the transition, potentially bypassing intermediate technologies to achieve zero-emission transportation and reduce fossil fuel dependency more quickly. This policy-driven acceleration, while beneficial for environmental goals, places immense pressure on the development of charging infrastructure to keep pace with sales, as any lag could create a bottleneck in market expansion.

Table 2: India Electric Vehicle Market Revenue and Volume Forecasts (2018-2028)

Year	Revenue (USD Million)	Volume (Units)	CAGR (2018-2028
2018	28.92	1601	
2019	53.70	2766	
2020	182.22	5624	
2021	697.42	17119	
2022	2216.92	71185	
2023	4767.87	179,002	
2024	6513.80	239112	
Year	Revenue (USD Million)	Volume (Units)	CAGR (2018-2028
2026	12723.44	442,608	
2027	18094.35	612,418	
2028	26008.43	855,875	40.52% (Revenue), 36.74% (Volume)

Source: Mordor Intelligence

3.2. Electric Two-Wheeler Market Insights

The electric bike (two-wheeler) market in India represents a critical and exceptionally dynamic sub-segment within the broader EV landscape, exhibiting even more aggressive growth. In FY 2023, a substantial 728,054 electric bikes were sold. This volume is projected to increase dramatically to 8,895,943 units by FY 2028, achieving a remarkable CAGR of approximately 53.29% from FY 2024 to FY 2028. This trajectory firmly establishes the two-wheeler segment as a primary growth engine for India's overall EV transition

Table 1: India Electric Bikes Market Size and Growth Forecast (Volume, FY 2021 – FY 2028e)

Year	Volume (Units)	CAGR (2018-2028
FY 2021	44803	
FY 2022	252,642	
FY 2023	728,054	
FY 2024e	1,611,256	
FY 2025e	2,87,0292	
FY 2026e	4,48,9998	
FY 2027e	6,51,8130	

FY 2028e	8,89,5943	53.29%

In terms of market leadership, Ola Electric emerged as the dominant player in FY 2023, capturing approximately 21% of the electric two-wheeler sales. It was closely followed by TVS Motors and Ather Energy. Ola Electric's performance was particularly strong, demonstrating a significant year-on-year sales growth of 132.99% for its electric scooters

Monthly electric two-wheeler sales in calendar year 2023 showed strong figures, with March 2023 recording 86,357 units and December 2023 at 75,403 units. Despite this rapid growth in absolute numbers, the penetration rate of electric two-wheelers in the overall two-wheeler market remained relatively low, reaching 7.05% in May 2023. This indicates that while adoption is growing, it is still in its nascent stages compared to conventional two-wheelers.

The exceptionally high growth rate of the electric two-wheeler market (53.29% CAGR) compared to the overall EV market (40.52%) suggests a deliberate strategic focus on electrifying the most accessible and high-volume segment of Indian mobility. This "last-mile" electrification is crucial for achieving immediate impact on urban pollution and reducing the country's fuel import bills. However, the relatively low overall penetration rate (7.05%) implies that despite rapid growth in absolute terms, electric two-wheelers have a considerable distance to cover before significantly displacing internal combustion engine (ICE) counterparts. The substantial year-on-year growth of specific players like Ola Electric (132.99%) also points to an intensely competitive environment, potentially driven by aggressive pricing or marketing strategies aimed at capturing this nascent market. Such dynamics could lead to market consolidation or price wars as the sector matures. While this strategic emphasis on two-wheelers is promising for environmental objectives, it simultaneously elevates the importance of addressing challenges specific to this segment, such as battery swapping solutions, managing smaller battery capacities, and ensuring sufficient urban charging density. Failure to adequately address these specific challenges could impede the momentum of the entire electrification strategy.

3.3. Key Market Drivers

The robust growth observed in the Indian EV market, particularly within the two-wheeler segment, is propelled by a combination of powerful drivers.

- **Growing Concerns Regarding Greenhouse Gas Emissions and Environmental Sustainability:** The transportation sector is a significant contributor to greenhouse gas (GHG) emissions, with fossil fuel-driven vehicles being a major source of air pollution. Electric vehicles, including low-speed variants, are considered crucial for achieving national and global low to zero carbon emission targets. The Indian government, for instance, has set an ambitious goal to reduce carbon dioxide emissions by approximately 45% below 2005 levels by 2030. Electric bikes, in particular, are highlighted as eco-friendly alternatives that produce no smoke emissions and operate with minimal motor sound, thereby contributing significantly to reducing air pollution caused by pollutants such as hydrocarbons (HC), carbon oxide (CO), and oxides of nitrogen (NOx). This environmental imperative serves as a foundational driver for EV adoption.
- **Increasing Government Support and Policy Initiatives:** Governments are actively promoting EV usage through a comprehensive suite of incentives and infrastructure development programs.
    - The **FAME India Scheme** (Faster Adoption and Manufacturing of Electric Vehicles in India) is a cornerstone policy. Phase II of this scheme, extended to March 2024, is backed by a substantial budget of INR 10,000 crore. It provides subsidies of INR 15,000 per KWH, supporting the adoption of approximately 7,000 e-buses, 500,000 e-three-wheelers, 55,000 e-four-wheeler passenger cars, and 1 million e-two-wheelers. The scheme also includes provisions for charging infrastructure development.

- The **Production Linked Incentive (PLI) Scheme**, launched in September 2021 with an allocation of INR 259.38 billion (approximately USD 3.50 billion) over five years, aims to boost domestic manufacturing of Advanced Automotive Technology (AAT) products, including BEVs.
- **Niti Aayog's Electrification Proposals** further underscore the government's commitment. Niti Aayog has proposed electrifying all two-wheelers with a displacement capacity below 150cc by March 2025, projecting a potential reduction in oil import bills by approximately INR 1,200 billion within 5-7 years if electric bikes are widely adopted.
- Beyond these, various **tax reductions and grants** are in place. For example, China has extended tax exemptions for new energy vehicles until 2027, and the UK offers EV grants. In India, the Goods and Services Tax (GST) on electric bikes was reduced from 12% to 5% in August 2019, and the introduction of distinctive green license plates offers preferential treatment in terms of parking, free entry in congested areas, and lower toll charges/road taxes.

- **Rising Affordability and Lower Operating Costs:** The initial cost of electric vehicles, particularly battery packs, has historically been a barrier. However, prices are gradually decreasing due to technological advancements and economies of scale. Initiatives promoting domestic battery production, such as Ola Electric's EV hub in Tamil Nadu, are designed to further reduce reliance on foreign imports and lower overall production costs. For consumers, electric bikes offer significantly lower operating costs, estimated at approximately INR 10 for 70 km of travel, in stark contrast to fuel-driven bikes which cost around INR 102.2 for the same distance (assuming an average petrol price of INR 73 per liter). This substantial operational cost advantage makes electric two-wheelers an economically attractive proposition for daily commuters.
- **Phasing Out of Internal Combustion Engines (ICEs):** A global trend towards restricting or banning ICE vehicle sales is emerging as countries strive to meet net-zero carbon emissions targets. Norway aims to phase out ICEs by 2025, and the European Union by 2035. While India has not implemented an outright ban on ICE vehicles, policy recommendations from bodies like the Energy Transition Advisory Committee suggest banning diesel 4-wheelers by 2027 in major cities and phasing out ICE two- and three-wheelers by 2035. This signals a clear and accelerating shift away from fossil fuel-powered vehicles, creating a favorable regulatory environment for EV adoption.

3.4. Market Restraints

Despite the strong drivers, the Indian EV market faces several significant restraints that could impede its growth trajectory if not adequately addressed.

- **Operational Limitations of Battery-Operated Electric Vehicles:** Electric vehicles inherently possess a restricted driving range compared to their ICE counterparts, and the necessity for frequent recharging can pose a challenge, particularly for long-distance travel. This limitation contributes significantly to "range anxiety" among consumers, a prevalent concern for electric bike users who may perceive these vehicles as incapable of reaching their destinations due to limited travel range and the scarcity of readily available charging stations. Furthermore, factors such as extreme weather conditions and the use of air conditioning or heating can further diminish an EV's effective range, exacerbating these operational concerns.
- **High Initial Expenditure:** Electric vehicles typically carry a higher upfront price tag than conventional ICE vehicles, primarily due to the considerable cost of battery technology and associated components. In India, electric bikes generally fall within a price range of INR 70,000 to INR 1.25 lakh, which is notably higher than many conventional bikes. This elevated initial cost limits accessibility to a substantial portion of the population, confining the market predominantly to consumers with greater purchasing power and thereby reducing the overall potential consumer base. Consequently, prospective buyers, particularly in cost-sensitive segments, may opt for more affordable conventional bikes or alternative modes of transportation. While increasing popularity and

scaling infrastructure may eventually lead to price reductions, this remains a significant barrier in the immediate term.

- **Lack of Adequate Charging Infrastructure:** Despite concerted governmental efforts to expand charging infrastructure, a significant disparity persists, particularly in semi-urban and rural areas. As of July 2022, only 50 out of 2,877 sanctioned EV charging stations under the FAME-II scheme had been installed, highlighting a considerable implementation gap. The ratio of approximately one charging station per 135 EVs in India is markedly lower than the global average of 1 per 6-20 EVs, a disparity that could severely hinder India's ambitious EV 30@30 vision (aiming for 30% EV sales by 2030). This issue is further compounded by challenges related to power generation capacity in Tier II and III cities, and even more severe conditions in villages, which directly impede the installation and operation of charging stations.

The observed paradox where strong governmental initiatives (such as FAME, PLI, and various tax breaks) are in place to reduce initial expenditure and promote adoption, yet "high initial expenditure" and "lack of proper charging infrastructure" remain significant restraints, points to a critical gap between policy intent and ground-level implementation or market perception. The substantial difference between the number of sanctioned charging stations and those actually installed is a clear indication of this gap. Furthermore, the economic challenge posed by higher EV prices suggests that while subsidies exist, they may not fully offset the perceived value proposition for a large segment of the population, particularly when considering the total cost of ownership. The success of India's EV transition, therefore, depends not solely on the announcement of policies and targets, but critically on the efficient and rapid execution of infrastructure development. This also necessitates sustained efforts to reduce the total cost of ownership for consumers, especially within the high-volume mass-market two-wheeler segment, to ensure widespread adoption.

4. Infrastructure and Ecosystem Development

4.1. Current Charging Infrastructure Landscape

The development of a robust charging infrastructure is paramount for the widespread adoption of electric vehicles in India. The FAME India Scheme plays a central role in this endeavour. Under Phase I, 520 charging stations were approved with an allocation of INR 4,300 million. Phase II further sanctioned 2,877 EV charging stations across 68 cities in 25 states/Union Territories, in addition to 1,576 stations designated for 9 expressways and 16 highways. To bolster this, the Ministry of Heavy Industries allocated INR 8 billion to three Oil Marketing Companies (OMCs) specifically for the establishment of 7,432 public charging stations.

Despite these ambitious plans, there has been a notable disparity between sanctioned and installed stations. As of July 2022, only 50 out of the 2,877 sanctioned EV charging stations under FAME-II had been installed. While progress has been made, with Delhi reportedly leading with 1,845 installed public charging stations by March 2023, followed by Maharashtra (704) and Gujarat (660), this still indicates a significant overall implementation lag.

The current EV/public charger ratio in India stands at approximately one charging station per 135 EVs, which is considerably lower than the global ratio of 1 per 6-20 EVs. This substantial gap between the number of sanctioned charging stations and those actually installed, coupled with the poor EV/charger ratio compared to international standards, directly contributes to consumer range anxiety and operational limitations of EVs. Furthermore, challenges related to power generation capacity in Tier II and III cities, and even more acutely in rural areas, pose significant difficulties for installing and maintaining charging infrastructure. Unless the pace of charging infrastructure deployment dramatically accelerates and effectively addresses these regional power supply issues, the ambitious growth forecasts for EVs, particularly electric two-wheelers which rely heavily on convenient charging for daily commutes, may not be fully realized. This situation highlights the need for more streamlined execution, potentially through enhanced public-private partnerships, and strategic investments in grid upgrades to support the increasing demand for electricity.

4.2. Ecosystem Analysis

The low-speed electric vehicle market ecosystem is a complex network comprising several interconnected components: raw material and component suppliers, vehicle manufacturers, and end-users.

Raw material and component suppliers form the foundational layer, providing essential inputs for EV production. Key components include battery packs, power electronics, electric motors, DC-to-DC converters, battery chargers, charge ports, controllers, and thermal management systems. For lithium-ion batteries, which are predominant, critical materials such as lithium, cobalt, manganese, graphite, nickel, and steel are indispensable. The availability and cost of these raw materials directly influence the overall production cost of EVs.

Vehicle manufacturers, who assemble these components into finished products, are significantly impacted by the cost of battery production. Fluctuations in battery prices directly affect the final retail price of LSEVs. Concerns regarding the scarcity of lithium and the nascent state of proper infrastructure for domestic battery production can further influence overall vehicle costs. Prominent manufacturers in this space include global players like Polaris Inc., Yamaha Motor Co., Ltd., Textron Inc., and Club Car.

End-users represent the demand side of the ecosystem, utilizing LSEVs in a diverse range of applications. These vehicles are commonly employed in golf courses, hotels and resorts, airports, and residential and commercial premises. Increasingly, LSEVs are finding utility in industrial sectors such as mining, construction, defence, and agriculture for short-distance travel and the transport of goods.

Recognizing the strategic importance of a localized supply chain, India is actively investing in domestic battery production hubs. For instance, Ola Electric is establishing a significant EV hub in Tamil Nadu, aiming to reduce the country's dependency on foreign battery imports. Similar investments are observed globally, such as Northolt's funding for a battery production factory in Germany. The emphasis on localized production is a strategic imperative for achieving affordability and ensuring supply chain resilience. The cost of procuring lithium-ion battery packs is a primary determinant of EV prices, and domestic manufacturing directly addresses this. Given the global concerns over lithium scarcity and the emergence of alternative battery chemistries like Lithium-ion Phosphate and Sodium-ion , building a robust, localized battery manufacturing ecosystem is crucial. This not only helps control costs but also mitigates geopolitical risks associated with the supply of critical raw materials, fostering genuine self-sufficiency in India's electric mobility transition.

5. Regional and City-wise Insights

The adoption of electric vehicles in India exhibits significant regional disparities, with certain areas demonstrating more accelerated growth and infrastructure development due to proactive state-level policies and strategic investments.

Overall Regional Performance (2018-2028)

- **North:** This region currently dominates the Indian EV market in terms of revenue. It accounted for 42.34% of the market share in 2022, with a value of USD 938.63 million, and is projected to reach USD 10,677.76 million by 2028, growing at a CAGR of 39.76%. States within this region, such as Haryana, Chandigarh, Delhi, Punjab, and Uttar Pradesh, show particularly high EV registrations. Delhi, for instance, has an ambitious EV policy aiming for 25% EV share by 2024, and EVs already constituted over 16% of total vehicle sales in December 2022. The capital is also rapidly expanding its electric bus fleet, with a target of 1,400 e-buses by December 2023.
- **South:** The Southern region holds the second-largest market share, valued at USD 675.54 million in 2022, and is projected to reach USD 7,936.59 million by 2028, with a CAGR of 40.50%. States like Karnataka and Andhra Pradesh are actively attracting significant investments in the EV industry and are establishing sustainable transportation infrastructure. Karnataka alone has attracted investments totalling Rs 25,000 crore across the EV value chain.

- **West:** This region accounted for USD 360.77 million in 2022 and is projected to reach USD 4,368.55 million by 2028, with a CAGR of 41.33%. Maharashtra leads EV sales across all segments, benefiting from FAME II subsidies and actively encouraging the establishment of charging infrastructure in new constructions. The Maharashtra State Road Transport Corporation (MSRTC) is also undertaking a significant effort to electrify its bus fleet.
- **East:** While currently holding the smallest market share, valued at USD 241.99 million in 2022, the Eastern region is projected to grow to USD 3,025.54 million by 2028, at a CAGR of 42.19%. States such as West Bengal and Bihar are enhancing their EV policies and offering financial incentives to stimulate adoption.

Regional Disparities in EV Adoption and Infrastructure

While all regions demonstrate significant growth potential, the North and South regions currently lead in terms of both revenue and volume of EV sales. This leadership is often directly linked to the implementation of proactive state-level policies, substantial investments in local manufacturing capabilities, and the early adoption of electric vehicles in public transport fleets.

The detailed regional breakdown reveals that EV adoption in India is not uniform but rather concentrated in specific states within each broader region. This pattern indicates that effective state-level policies and localized initiatives, such as targeted subsidies, mandates for charging infrastructure in new building constructions, or the electrification of public transport fleets, serve as more immediate and potent drivers of regional growth than broad national policies alone. The success stories observed in these leading states provide a tangible blueprint for other regions to potentially replicate. This suggests that future policy formulation and investment strategies should consider these regional nuances. A uniform, "one-size-fits-all" approach may prove less effective than tailored interventions that specifically address the unique economic, infrastructural, and social contexts prevalent in different states. Furthermore, this dynamic implies that competition among states to attract EV investments and demonstrate environmental leadership could further accelerate overall national adoption of electric vehicles.

6. Discussion

Synthesis of Findings: Interplay of Drivers, Restraints, and Infrastructure

The Indian electric vehicle market, particularly its two-wheeler segment, is characterized by a powerful confluence of accelerating forces. These primary drivers include robust governmental support through schemes like FAME and PLI, a growing national awareness regarding environmental sustainability, and the compelling economic advantages offered by lower operating costs for EVs. However, the full potential of these drivers is significantly constrained by critical limitations. Most notably, the nascent and unevenly distributed charging infrastructure across the country, coupled with the higher initial purchase cost of EVs compared to traditional internal combustion engine (ICE) vehicles, presents formidable barriers. The substantial gap between the number of sanctioned charging stations and those actually installed serves as a clear indicator of implementation challenges, directly impacting consumer confidence and exacerbating range anxiety, thereby slowing down the pace of adoption.

Impact of COVID-19 Pandemic

The COVID-19 pandemic had a mixed but ultimately positive long-term influence on the electric vehicle market in India. Initially, the imposition of lockdowns in FY 2020 led to a significant decline in sales and production volumes, primarily due to the ensuing economic crisis and disruptions in global supply chains. Electric bike sales, for instance, fell by almost 55% during the initial lockdown period of April-June 2020. However, in the post-lockdown scenario, a notable shift in consumer behaviour emerged. Public apprehension regarding mass transit and concerns over virus transmission, combined with rising fuel prices, led to a surge in demand for convenient and affordable personal mobility solutions, particularly electric bikes. This increased demand, coupled with continued governmental policies promoting vehicle electrification, helped to revive and subsequently accelerate market growth, despite initial struggles in ramping up production to full capacity.

Competitive Landscape and Strategies

The Indian EV market is intensely competitive, attracting both established automotive giants and new-age EV specialists. Major traditional players like Tata Motors, Mahindra & Mahindra, Bajaj Auto, and TVS Motor Company are actively competing alongside disruptive new entrants such as Ola Electric and Ather Energy. Tata Motors holds a significant market share in both the passenger car (51.25%) and commercial vehicle (45.96%) segments within the Indian EV market. In the electric two-wheeler segment, Ola Electric leads with approximately 21% of the market share. Companies across the board are heavily investing in research and development to enhance product quality, advance battery technology (including the use of lightweight materials), and are launching aggressive advertising campaigns to capture market share. The increasing entry of global OEMs and Chinese players into the Indian market, a trend observed in broader global EV markets , is further intensifying this competition. This heightened rivalry is compelling manufacturers to introduce more affordable models and drive continuous technological innovation, ultimately benefiting consumers through a wider array of product offerings and improved performance.

Future Trends and Opportunities

The trajectory of electric mobility in India is also being shaped by several promising future trends and emerging opportunities.

- **Advent of New Battery Technologies:** The industry is actively seeking alternatives to conventional lithium-ion batteries to address persistent concerns regarding range anxiety and cost. Future trends indicate a growing adoption of Lithium-ion Phosphate (LFP) and Sodium-ion batteries, which offer advantages in terms of affordability, faster charging times, and potentially longer lifespans. Breakthroughs like Toyota's solid-state battery technology, which promises to halve battery size, cost, and weight while offering a 1,200 km range and 10-minute charging capability, represent a significant long-term opportunity for the industry. India's commitment to localized advanced battery manufacturing is evident in its plan to invest INR 8,000 crore (approximately USD 961 million) to boost EV battery production to a capacity of 20 gigawatt-hours by 2030.
- **Smart Grid Technology and V2G Integration:** The transition to a smarter electrical grid is crucial for ensuring efficient and reliable power distribution, particularly with the increasing load from EV charging. Smart grids, when combined with intelligent metering systems, enable real-time energy management and seamless integration of renewable energy sources. Vehicle-to-Grid (V2G) technology, which allows Battery Electric Vehicles (BEVs) to supply their stored energy back to the grid during peak demand hours, presents a significant opportunity for energy balancing and enhancing grid stability in India. This bidirectional energy flow can transform EVs from mere consumers into active participants in the energy ecosystem.

Porter's Five Forces Analysis (Applied to Indian EV Market)

Applying Porter's Five Forces framework provides a structured understanding of the competitive dynamics within the Indian EV market.

- **Threat of New Entrants: Moderate.** While governmental policies strongly favour EV development, significant barriers to entry exist. These include high capital requirements for establishing manufacturing plants and supply chains, coupled with the strong brand presence and established sales networks of incumbent players like Tata Motors. However, the rapid growth of the market and the array of government incentives continue to attract new players, including global OEMs, which somewhat moderates this threat.
- **Bargaining Power of Buyers/Consumers: Low.** Despite an expanding range of models and competitive pricing strategies from manufacturers, consumers' ability to significantly influence prices remains limited. This is primarily due to the inherent costs of EV technology and the relatively nascent stage of market maturity. While consumers benefit from various offers and discounts, their overall power to force down prices is constrained.

- **Bargaining Power of Suppliers: Moderate.** The availability of battery and component suppliers is increasing, yet the supply of critical components, particularly advanced battery cells, often involves a concentrated supplier base. Long-term contracts between OEMs and suppliers, combined with ongoing efforts towards domestic production, create a balanced dynamic in supplier power.
- **Threat of Substitute Products: Moderate.** Internal Combustion Engine (ICE) vehicles remain the primary substitute, benefiting from an extensive existing infrastructure and generally lower initial costs. However, governmental policies actively promoting EV adoption and the potential for future bans on ICE vehicles are steadily eroding this threat over the medium to long term, driving a fundamental shift in consumer preference.
- **Intensity of Competitive Rivalry: High.** The Indian EV market is characterized by intense competition. This rivalry is fueled by innovation and the race among players to capture market share in a rapidly expanding sector. Established players are significantly increasing their research and development spending and forming strategic partnerships, while new entrants are introducing disruptive technologies and business models. This high level of competition ultimately benefits consumers through diverse product offerings and continuous product improvement.

The discussion highlights a fundamental challenge, often referred to as the "chicken-and-egg" dilemma, concerning infrastructure and adoption. The "lack of charging infrastructure" and "high initial expenditure" are identified as major restraints, while "rising affordability" and "government support" are strong drivers. This creates a feedback loop: high initial cost deters widespread adoption, which in turn slows down the return on investment for private charging infrastructure development. Simultaneously, insufficient charging infrastructure creates significant range anxiety, further deterring adoption, even if vehicle costs were to decrease. Governmental policies are attempting to break this cycle through various subsidies and mandates. The global trend of OEMs approaching profitability with Battery Electric Vehicles suggests that the cost barrier may naturally diminish over time. However, the development of charging infrastructure remains a public good challenge that requires sustained, coordinated effort. Sustainable growth for the Indian EV market necessitates a coordinated approach where government intervention actively de-risks private investment in charging infrastructure, perhaps through direct funding, strategic land allocation, or regulatory certainty. Simultaneously, continuous research and development, coupled with localized manufacturing, must drive down battery costs faster than the market's natural progression to make EVs universally affordable without perpetual subsidies.

7. Conclusion

The Indian electric vehicle market, particularly its two-wheeler segment, is on a steep growth trajectory, poised for significant expansion over the next decade. This growth is predominantly fuelled by robust governmental support through schemes like FAME and PLI, a heightened national awareness regarding environmental sustainability, and the inherent economic advantages of lower operating costs for EVs. The strategic emphasis on electrifying the two-wheeler segment is a pragmatic approach to achieve immediate impact on urban pollution and reduce the nation's reliance on fuel imports.

However, the transition is not without its formidable challenges. The most critical impediment remains the underdeveloped charging infrastructure, especially in semi-urban and rural areas, which perpetuates range anxiety and limits widespread adoption. The higher initial acquisition cost of EVs, despite subsidies, also continues to be a barrier for a substantial segment of the population. The gap between sanctioned and installed charging stations underscores a critical implementation chasm that must be bridged for the market to realize its full potential.

Looking ahead, the future of electric mobility in India is promising, contingent upon sustained policy support, accelerated development of a comprehensive and accessible charging network, and continued technological innovation in battery chemistry and energy management systems like smart grids. Localized manufacturing of batteries and components will be paramount to achieving cost parity and supply chain resilience.

For policymakers, the focus must shift from merely sanctioning projects to ensuring rapid and efficient ground-level implementation of charging infrastructure, potentially through innovative public-private partnerships. For manufacturers,

continued investment in research and development to enhance range, reduce costs, and develop diverse, segment-specific EV models is crucial. For consumers, increasing awareness of long-term economic benefits and a visible, reliable charging ecosystem will be key to overcoming initial hesitations. India's journey towards a fully electrified and sustainable transportation future is complex but holds immense potential for environmental, economic, and social transformation.

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