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Driving Sustainability: Electric Vehicle Adoption for Viksit Bharat 2047

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Abstract

Global warming has emerged as one of the most pressing challenges worldwide, necessitating urgent measures to mitigate the escalating emissions of greenhouse gases. The transportation sector, a significant contributor to these emissions, is at the forefront of this environmental crisis. In response, automobile manufacturers are increasingly focusing on developing innovative solutions to decrease reliance on non-renewable energy sources. Electric vehicles (EVs) have gained prominence as a pivotal innovation, offering a sustainable alternative that aligns with global climate goals such as the Sustainable Development Goals (SDG) 2030.

The transition to electric mobility, however, is not without its challenges. Despite advancements in technology and substantial investments in research and development, the adoption of electric vehicles remains uneven across different regions and demographics. While several factors, such as environmental awareness, governmental incentives and advancements in battery technology, drive consumer interest in EVs, numerous obstacles hinder widespread adoption. High initial costs, limited charging infrastructure, range anxiety, and a lack of consumer awareness about the benefits of EVs continue to be significant barriers.

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This study aims to identify and analyse the key drivers and obstacles influencing consumer adoption of electric vehicles. By examining these factors, the research seeks to provide insights into strategies that can accelerate EV adoption, contributing to a reduction in greenhouse gas emissions and fostering sustainable transportation networks. The findings of the study hold particular relevance for India, where the vision of Viksit Bharat 2047 emphasizes technological innovation and sustainability to achieve national progress. Understanding consumer behaviour and addressing the barriers to EV adoption will be crucial for achieving this vision and ensuring a greener, more sustainable future.

Keywords: Electric Vehicle Adoption, Sustainable Transportation, Greenhouse Gas Emissions, Consumer Behaviour, Climate Change Mitigation, Viksit Bharat 2047

Introduction

Background and Context of the Research Problem

India has the second-largest road network in the world, and road transportation is a crucial part of daily life for its citizens. Over 60% of the population relies on personal or shared vehicles for commuting (Ministry of Road Transport and Highways, 2020). However, the rising cost of petrol and diesel has placed a heavy financial burden on individuals and families, leading to increased prices for goods and services. This has created economic difficulties for many people, especially those in lower-income groups (Kumar & Gupta, 2022).

In addition to these economic challenges, vehicles that run on petrol and diesel are a major source of pollution. When these fuels are burned, they release harmful gases and particles into the air, which contribute to poor air quality and health problems (World Health Organization, 2020). This environmental damage has highlighted the need for cleaner and more eco-friendly transportation alternatives. Electric vehicles (EVs) are seen as a viable alternative to these issues. Unlike traditional vehicles, EVs do not produce harmful emissions, making them a cleaner option for the environment (International Energy Agency, 2021). They also have the potential to reduce long-term costs for vehicle owners, as they rely on electricity instead of expensive fuels (Indian Ministry of Heavy Industries, 2021). By encouraging the use of EVs,

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India can address both economic and environmental concerns, paving the way for a healthier and more sustainable future.

This study aims to identify the factors that influence customers to adopt electric vehicles and explore the barriers that prevent them from doing so. Comprehending these elements factors will offer perspectives on customer perceptions and help inform strategies to promote electric vehicle adoption in India.

Literature Review

Electric vehicles (EVs) are gaining attention globally as a sustainable alternative to traditional internal combustion engine (ICE) vehicles. Several studies have explored consumer perceptions, challenges, and future prospects of EV adoption in India and globally.

Kalra (2022) highlighted the challenges faced by EV adoption in India, primarily due to high capital costs and insufficient charging infrastructure. The study emphasized that government incentives, technological advancements, and a supportive financing environment could significantly drive the EV market's growth over the next decade. Similarly, Pareek (2022) observed that manufacturers need to focus on research and development to improve pricing, design, and branding to create a positive consumer perception of EVs in India.

Rane (2021) conducted a multinational study across 17 countries with 13,500 respondents, finding that current EVs often fail to meet consumer expectations. However, the promotion of innovative products, such as retrofit kits, could enhance consumer interest, particularly through effective marketing. Kumar and Jain (2021) identified limited range and insufficient charging facilities as significant barriers to EV adoption in India. They suggested increasing the availability of charging stations to address these concerns.

In Tamil Nadu, Selva and Arunmozhi (2020) found that most consumers prefer EVs for their driving range and eco-friendliness. Similarly, Tupe (2020) revealed that environmental concerns are a significant factor influencing EV purchase intentions among Indian consumers. Kumar and Padmanabhan (2019) emphasized the importance of transitioning to EVs to reduce carbon emissions, particularly in the transportation sector.

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Kesari, Sharma, and Goel (2019) argued that public procurement and investments from fleet operators like Ola and Uber could drive initial EV adoption in India, though private EV adoption might take five to six years. Tu and Yang (2019) noted that consumer attitudes towards EVs are cautious due to limited knowledge and suggested that manufacturers should take proactive initiatives to address consumer needs.

Aggarwal, Gedda, and Parikh (2019) explored the challenges faced by two-wheeler EV users, particularly in terms of range and battery weight. On the other hand, Agarwal (2019) examined the future potential of EVs in India, highlighting their advantages over traditional vehicles and the challenges faced by consumers and the market. Masurali and Surya (2018) emphasized the role of consumer education and government efforts in creating awareness and influencing positive perceptions of EVs.

Mohamed, Arasan, and Sivakumar (2018) discussed the opportunities and challenges of implementing EVs in India, including cost and efficiency issues. They highlighted the potential for EVs to reduce greenhouse gas emissions and oil dependency. Gujarathi, Shah, and Lokhande (2018) analyzed the Indian EV market and identified the need for sustainable alternatives to reduce greenhouse gas emissions and address the country's heavy reliance on imported oil. Lastly, Nazneen, Ali, and Bhalla (2018) identified consumer awareness of EVs' environmental benefits but stressed the importance of improving infrastructure and shaping consumer perceptions through government and manufacturer investments.

These studies collectively underscore the need for collaborative efforts from governments, manufacturers, and stakeholders to overcome challenges and accelerate EV adoption in India and beyond. The existing literature highlights various obstacles and prospects for EV adoption in India, such as cost barriers, limited charging infrastructure, and consumer perceptions. However, a significant research gap exists in aligning EV adoption with India's long-term vision of *Viksit Bharat 2047*, which aims for sustainable and inclusive development. Current studies lack a focus on rural and semi-urban regions, region-specific strategies, and the integration of emerging technologies like AI and smart grids. Moreover, there is limited examination of the socio-economic effects of the EV transition, the scalability of current

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initiatives, and the contribution of public-private partnerships in driving nationwide adoption. Addressing these gaps through a holistic and futuristic approach can provide actionable insights for achieving sustainable mobility and carbon neutrality in India by 2047.

Methodology

The study adopts a descriptive research design to explore the research problem. Using the snowball sampling technique, 120 samples were selected. Primary data were collected through questionnaires and secondary data were sourced from journals. The data analysis employed the percentage method for distributional insights and the weighted average method to evaluate the relative importance of different factors. The Shapiro-Wilk and Kolmogorov-Smirnov tests revealed significant deviations from normality ($p < 0.05$) for all encouraging and discouraging factors, suggesting the need for non-parametric tests, viz. the Mann-Whitney U test, for further analysis.

Results

Table 1: Socio-Demographic Profile of Respondents

Variable	Category	No. of Respondents	Percent
Gender	Male	78	65%
	Female	42	35%
Age Group	18-25	31	26%
	26-30	22	18%
	31-40	29	24%
	41-50	26	22%
	Above 50	12	10%
Activity Status	Self-employed	26	22%
	Regular employee	32	27%
	Casual employee	29	24%
	Student	21	18%

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	Unemployed	12	10%
Monthly Household Income	Rs. 10,000-25,000	22	18%
	Rs. 25,000-50,000	53	44%
	Rs. 50,000-75,000	33	28%
	Rs. 75,000-1,00,000	4	3%
	Above Rs. 1,00,000	8	7%
Type of Vehicle Owned	Electric Vehicle	60	50%
	Petrol and Diesel Vehicle	60	50%

Source: Primary Data

The socio-demographic profile of the respondents reveals a balanced gender distribution, with 65% male and 35% female participants. Age-wise, the majority of respondents (26%) belong to the 18-25 age group, followed by 24% in the 31-40 age group, while only 10% are above 50 years. Regarding activity status, 27% are regular employees, 24% are casual employees, 22% are self-employed, 18% are students, and 10% are unemployed. With regard to monthly household income, 44% of respondents lie within the Rs. 25,000-50,000 range, with only 3% earning between Rs. 75,000-1,00,000 and 7% earning above Rs. 1,00,000. Finally, vehicle ownership is evenly split, with 50% owning electric vehicles and the remaining 50% using petrol or diesel vehicles. This diverse sample provides valuable insights into various socio-demographic factors influencing the study.

Table 2: Factors that encouraged for buying an electric vehicle

Factors	Mean	Standard deviation
Environment friendly	2.58	1.527
Low maintenance cost	2.41	1.000
No fuel required	2.41	1.226
Better performance	3.62	1.117
Government benefits	3.99	1.319

Source: Primary Data

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Descriptive statistics were calculated to examine consumer's perceptions of encouraging factors for adoption, rated on a Likert scale from 5 as strongly agree to 1 as strongly disagree. Consumers reported the strongest agreement with government benefits (M=3.99, SD=1.32) and better performance (M=3.62, SD=1.12), suggesting these factors were the most influential. Lower agreement was observed for environmental friendliness (M=2.58, SD=1.53), low maintenance cost (M=2.41, SD=1.00), and no fuel requirement (M=2.41, SD=1.23). It is also to be noted that environmental friendliness exhibited the highest variability (SD=1.53), indicating diverse opinions, while low maintenance cost showed the lowest variability (SD=1.00), suggesting more consistent responses.

H1: There is a significant association between the type of vehicle ownership (electric vehicle vs. petrol & diesel vehicle) and the encouraging factors influencing ownership decisions.

Table 3: Mann-Whitney U test results for encouraging factors by vehicle type

Encouraging factor	Mann-Whitney U	Wilcoxon W	Z	P value
Environment friendly	1513.500	3343.500	-1.559	.119
Low maintenance cost	1635.500	3465.500	-0.919	.358
No fuel required	1497.000	3465.500	-1.663	.096
Better performance	1435.000	3265.000	-2.027	.043*
Government benefits	1597.500	3327.000	-1.154	.249

Source: Primary data

* indicate statistical significance at p < .05.

A Mann-Whitney U test revealed a significant difference in the perception of better performance between Electric Vehicle (EV) and Petrol/Diesel (P&D) users, U = 1435.00, Z = -2.03, p = 0.043. However, no significant differences were found for environmental friendliness, low maintenance cost, no fuel required, and government benefits (p > 0.05).

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Table 4: Factors that discouraged for buying an electric vehicle

Factors	Mean	Standard deviation
Higher purchase cost	2.20	1.447
Lack of charging facilities	2.46	1.052
Battery expensive	2.71	1.007
People negative attitude	3.66	1.192
Long recharge time	3.98	1.423

Source: Primary Data

Descriptive statistics revealed varying levels of agreement on barriers to adoption. Participants reported the highest agreement with recharge time (M=3.98, SD=1.423) and negative attitudes (M=3.66, SD=1.192). In contrast, high purchase cost (M=2.20, SD=1.447) and lack of charging facility (M=2.46, SD=1.052) were perceived as less significant barriers. Battery expense received moderate agreement (M=2.71, SD=1.007).

Table 5: Mann-Whitney U test results for discouraging factors by vehicle type

Discouraging factor	Mann-Whitney U	Wilcoxon W	Z	P value
Higher purchase cost	1609.500	3439.500	-1.066	.287
Lack of charging facilities	1626.500	3456.500	-.978	.328
Battery expensive	1523.000	3353.000	-1.608	.108
People negative attitude	1482.500	3312.500	-1.780	.075
Long recharge time	1537.000	3367.000	-1.520	.128

Source: Primary data

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The Mann-Whitney U test results indicated that there were no significant differences between electric vehicle and petrol/diesel vehicle users for the variables of high purchase cost, lack of charging facility, battery expense, negative attitude, and recharge time, as all the p-values were greater than 0.05 ($p > 0.05$).
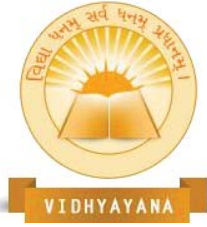
Discussion

The significant difference in Better Performance between Electric Vehicle (EV) and Petrol/Diesel (P&D) users suggests that EV owners value performance more than P&D owners. This could mean that manufacturers might focus on promoting the performance benefits of EVs. Since no significant differences were found for factors like Environment Friendly, Low Maintenance Cost, No Fuel Required, and Government Benefits, it indicates that both groups see these features similarly. For EV manufacturers and policymakers, this suggests that highlighting performance could be a key strategy to attract more customers.

The lack of significant differences between electric vehicle and petrol/diesel vehicle users on factors like purchase cost, charging facility, battery expense, negative attitude, and recharge time suggests that both groups share similar perceptions and concerns regarding these factors, indicating that these variables may not significantly influence the choice between vehicle types. This could imply that other factors, such as government incentives or environmental considerations, might play a more crucial role in shaping users' preferences.

Conclusion

The analysis highlights that while the performance of electric vehicles stands out as a key factor driving their adoption, several challenges hinder their widespread acceptance. These include high purchase costs, limited availability of charging infrastructure, the expensive nature of batteries, negative public perceptions, and the lengthy time required for recharging. Although these factors may not significantly deter all consumers, they represent critical areas of concern that could slow the transition to electric vehicles. Addressing these barriers through targeted interventions such as offering financial subsidies, expanding charging networks, reducing battery costs through technological advancements, and conducting public awareness

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campaigns to shift perceptions will be essential. A comprehensive strategy that promotes the benefits of electric vehicles while systematically reducing these obstacles is crucial to fostering adoption and achieving the ambitious vision of Driving Sustainability: Electric Vehicle Adoption for Viksit Bharat 2047.

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