

The EV Equation: What's Accelerating Electric Car Adoption in India

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Abstract—The adoption of Electric cars has become essential to mitigate environmental challenges and align with sustainability goals, particularly in rapidly developing nations like India. This study examines the key factors influencing consumer purchase intentions for four-wheeler Electric cars in the Indian market. The research aims to explore economic, environmental, technological, infrastructure, Govt subsidies and brand image affecting electric car adoption.

Findings indicate that financial concerns, including the high upfront cost and high maintenance costs of Electric cars, lack of repair and maintenance facilities, and limited government subsidies are significant deterrents. Technological challenges, limited battery range, slow charging infrastructure, long charging times, and doubts about battery performance, further inhibit adoption. On the other hand, heightened environmental awareness, reduced fuel costs, long term savings positively influence purchase intentions. Further, though customers are willing to purchase the electric cars, yet owning electric car does not enhance social status in the eyes of the peers. This study aims to provide actionable insights for policymakers, automotive manufacturers, and marketers to drive sustainable growth in India's electric car market. The findings contribute to the broader discourse on sustainable mobility, offering practical strategies to accelerate the transition to cleaner transportation systems while supporting India's commitments to the Paris Agreement and the United Nations Sustainable Development Goals (SDGs).

Index Terms—Electric vehicles, India, financial factors, Environmental factors, Economic factors, Technological factors, Govt subsidies, Brand image

I. INTRODUCTION

Electric vehicles are increasingly recognized as a solution to mitigate environmental challenges worldwide such as global warming, pollution and greenhouse gas emission. Governments worldwide including India are introducing incentives such as subsidies and tax benefits to promote the adoption of

electric vehicle in consumers and manufacturers. Despite these incentives India's EV market growth has been slower and less advanced than previously thought, with only 2000 EV cars sold in 2016 compared to the rapid growth of traditional vehicles. Factors like high upfront costs, limited charging infrastructure and concerns about battery life continue to deter away potential buyers.

India's transportation sector contributes significantly to its carbon emissions accounting for more than 75% of the total greenhouse gas emissions of the nation. A transition of the population towards the greener and cleaner alternative of transportation - electric vehicles - will allow the government to address these concerns while promoting sustainability and urban mobility. This research will aim to delve deeper into the drivers and barriers of EV purchases in India helping identify strategies to accelerate the market's expansion.

This research paper is divided into various sections. Each section provides insights about electric car adoption in India. The first section is an introduction followed by a review of relevant literature by researchers in the electric vehicle industry. The next is about the research questions, research methodology followed and a statistical analysis of the findings and their implications. The concluding section of the research focuses on the limitations of the study and future research directions that researchers can follow.

II. LITERATURE REVIEW

Electric vehicles first came into existence in the middle of 19th century (Rogers, 1962), when electric power was the most preferred mode for motor vehicle propulsion providing a level of ease and comfort unmatched by those of its fuel driven competitors. Electric cars have to completely rely on the energy stored in their battery packs thus their driving range is directly influenced by the batteries' capacity. The

ranges of the battery are dependent on factors such as the vehicle's configuration, driving style, driving condition, climate, age of car, road conditions and age of the vehicle (Tornatzky & Fleischer, 1990). Once finished the battery life takes a long time to recharge in comparison to internal combustion engines (ICE) driven by fuel. There are several factors that also affect the battery charging life such as the charging infrastructure, charger configuration and operating power levels (Zhang et al., 2017). Electric cars have several advantages over fuel driven vehicles due to their simple operation, convenience, no noise, no greenhouse gas emissions and being heavily beneficial to the environment. (Tu & Yang, 2019).

The potentials of electric vehicles have been studied by many researchers from various angles, technical, economic, environmental, consumer attitude and purchase intentions. Various studies indicate that there is a struggle for electric vehicles to create appropriate markets at least in the areas of public perception and public perception around electric vehicles in India. (Varghese et al., 2021).

The year 2017 began with the rise in demand of Electric Vehicles with the concept of making EV's for longer distance drives and to improve their vehicle maintenance. Technology perception and adoptions have two features: first is the attribute of technology and the second is the adopter. In management outlook, it can be explained through "innovation diffusion theory (IDT)" (Rogers, 1962) and following extensions such as the TOE (technology organization environmental) framework (Tornatzky & Fleischer, 1990). These are associated with the adoption of new technology based on usefulness (performance expectancy), ease of use (effort expectancy), social influence and facilitating conditions. These parameters also play a very crucial role in the adoption of Electric Vehicles (Thananusak et al., 2019).

The commercial vehicle segment is expected to be the fastest-growing industry sector in the EV industry. India and China are major contributors to the growth of the electric commercial segment. (Tu & Yang, 2019). Currently the electric vehicle market is controlled by globally established players such as Tesla (US), BYD (China), BMW (Germany), Volkswagen (Germany), and Nissan (Japan). These companies are mainly focused on developing new products and technologies to adopt expansion strategies and undertake collaborations, partnerships

and acquisitions to gain traction in this high growth electric vehicle market (Zhang et al., 2017). The Asia Pacific market is expected to spot the fastest growth followed by Europe and North America. Countries like China, Japan and South Korea are inclined toward technological innovations and development of advanced electric vehicles (Varghese et al., 2021).

As a relatively new technology that has only begun to become a mainstream product it is important to understand the level of awareness that Indian consumers have towards Electric cars especially Hybrid electric vehicles (HElectric cars) and Plug-in electric vehicles (PElectric cars) and how consumer awareness affects purchase intentions of the consumer (Thananusak et al., 2019).

Consumer knowledge is essential so that purchasers may make the right choices and make a choice at the right moment. The study of Zhang et al (2017) explored factors that affect consumers choices alongside consumer awareness towards Electric cars in China. The study used survey data from correspondents residing in Nanjing China. They utilized 3 regression models to determine the factors that influence the acceptance of Electric cars, purchasing time frame and purchase price. The study also concluded that additional factors affecting purchasing behaviour include academic degree, age, annual income, maintenance cost and opinion of peers. The findings of this study set a separate criterion for Chinese consumers and what motivates their purchasing decisions with regards to Electric cars. Many studies also suggest that a high level of environmental awareness about issues like climate change and global warming has a positive impact on the adoption of environmentally friendly transportation models (Tu & Yang, 2019). Education is vital in creating consumer awareness while purchasing a new product. How one gains knowledge on EV management and infrastructure should be known to all. Governments should enforce policies to educate populations about the benefits and then we can expect more acceptance for electric cars (Varghese et al., 2021).

Social and psychological influences significantly shape consumer behavior toward adopting four-wheeler electric vehicles (Electric cars). Peer recommendations and societal norms often guide individuals' perceptions of Electric cars, as these factors establish a sense of trust and legitimacy in the

market. Tu & Yang (2019) highlight that individuals are more likely to consider Electric cars if they perceive them as endorsed or positively reviewed by their social circles, reflecting the importance of social proof in adoption. Additionally, societal attitudes toward sustainability and innovation play a critical role, as consumers align their purchasing decisions with broader cultural or community values. For instance, in markets where sustainability is a prioritized norm, individuals are more inclined to perceive Electric cars as desirable due to their alignment with environmental consciousness. (Varghese et al., 2021)

However, the influence of social norms and peer behaviours can vary. Thananusak et al. (2019) note that while positive reinforcement from social groups can promote adoption, the lack of visible users or ambassadors for Electric cars in certain demographics may serve as a barrier. This duality suggests that the impact of social influences is mediated by awareness campaigns and exposure to EV benefits. Furthermore, Varghese et al. (2021) argue that attitudes toward innovation, including perceptions of Electric cars as futuristic and technologically advanced, can offset initial apprehensions, making individuals more open to adoption. Thus, fostering a socially supportive and innovation-positive environment is essential for boosting EV adoption rates.

Consumer attitudes toward purchasing electric vehicles (Electric cars) in India are influenced by various factors. A study by Neupane and Sharma (2023) indicates that affordability, charging infrastructure, and environmental consciousness are primary factors influencing Indian consumers' decisions to purchase Electric cars. The research suggests that while there is a growing awareness of environmental issues, practical concerns such as the high upfront vehicle costs and low charging/battery infrastructure availability, limited model ability significantly impacts the consumers' purchase intentions and serve as significant barriers to adoption.

Consumer acceptance of EV technology in India is shaped by perceptions of ease of use, technological reliability, and alignment with personal values. A study by Bansal et al. (2021) found that Indian consumers are willing to pay a premium for Electric cars with improved positive attributes such as reduction in battery charging time, extended drivable range, and

lower operating costs. The research emphasizes the importance of enhancing EV attributes to meet consumer expectations and drive adoption in the Indian subcontinent. Additionally, a study by Wagh (2024) discusses the role of indigenous manufacturers and government policies in shaping consumer perceptions and acceptance of Electric cars in India. The research showcases the importance of policies to protect manufacturers and in building a community that consumers can trust where EV adoption is encouraged.

Vehicle costs, operating and maintaining expenses alongside government subsidies play a vital role in the adoption of electric vehicles. A study by Bansal et al. (2021) reveals that the Indian consumer market is willing to pay additional amounts to extend the drivable range of the EV, reduce charging time and save on operating costs, showcasing that financial incentives play a significant role in the consumer's decision-making process. This claim is further supported by the McKinsey report (McKinsey & Company, 2023) suggesting that while there is a willingness to consider Electric cars as a viable mode of transportation the actual adoption may be influenced by the availability of financial incentives and the development of necessary infrastructure to support usage. Despite lower operating costs compared to ICE vehicles, the high upfront investment cost that Electric cars bare often deters potential Indian consumers. The report also emphasizes that financial strategies such as subsidies, reduced registration fees, tax benefits can help ease and offset the financial burden of adoption on the consumer. Moreover, partnerships between the government and manufacturers can take place to provide consumers with more accessible pathways to EV ownership.

Enhancing consumer education on the long-term cost savings and environmental benefits of Electric cars is a crucial step towards increasing vehicle adoption in the Indian consumer market. Research has shown that a lack of awareness regarding the total cost of ownership (TCO) of Electric cars, which is often lower than that of internal combustion engine (ICE) vehicles, is a significant barrier (Varghese et al., 2021). Thus educating consumers about the financial benefits, such as reduced maintenance costs, government incentives like tax benefits and subsidies can shift consumer perceptions toward adoption. Governments can introduce awareness campaigns highlighting

environmental benefits, including reduced greenhouse gas emissions and improved air quality, could also appeal to socially and environmentally conscious buyers (Tu & Yang, 2019).

Another effective strategy involves the development and improvement of charging infrastructure. The availability of charging stations is a critical determinant of EV adoption, as potential buyers often cite "range anxiety" as a primary concern (Thananusak et al., 2019). A robust charging network ensures that users can travel long distances without fear of depleting battery life.

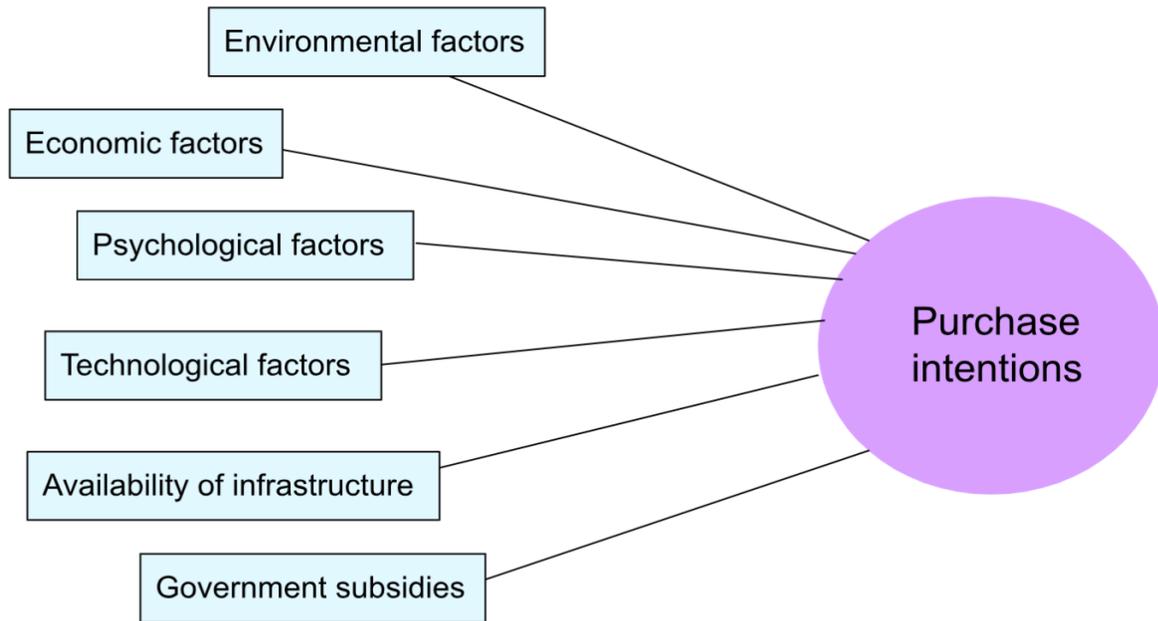
Research gap and objectives:

Literature review indicates that there are a multiplicity of factors affecting the adoption of EVs around the globe. Despite govt incentives, India's EV market growth has been slower and less advanced than

previously thought, with only 2000 EV cars sold in 2016 compared to the rapid growth of traditional vehicles. Accordingly, the researcher's main aim is to investigate the which out of the economic, environmental, technological, infrastructure availability, govt subsidies and brand image is the most import factor that shape the decision process of an Indian consumer while purchasing and adopting towards the EV lifestyle. In addition, research also throws light on as to how can the government leverage these factors to promote widespread adoption of four-wheeler Electric cars in India. Hence, the study aims to provide in-depth insights for governments, policy makers, marketers and manufacturers to enhance four wheeler EV adoption in India.

Given below is the research structure as proposed by the researcher:

Fig 1: Research Structure



Source: Self-created by Researcher

III. RESEARCH METHODOLOGY

Study uses primary as well as secondary data. Literature review, based on which research questions, and objectives were formed, is the secondary data, whereas for primary data, a Google form was circulated to the Indian consumers using convenience sampling, having questions related to demographic

details and questions related to the Environmental, Economic, Technological, Availability of infrastructure, Govt subsidies, and Brand image factors, styled on a five-point Likert scale.

Statistical analysis, discussion and implications:

Total responses 283, out of which 97.2% participants owned a 4-wheeler vehicle while 2.8 did not. 84.8% respondents did not own a electric car while 15.2%

did. 64% participants were 36–50-year-old age range, 25.8% were above 50 years old, 4.6% were 18-25 years old and 5.7% were between 26-35 years old. 60.4% were females, 39.2% were males and 0.4% did not reveal their gender. 67.5% has more than rupees 20,00,000 annual household income, 19.1% had between ₹10,00,000–₹20,00,000, 10.6% had between ₹5,00,000–₹10,00,000 and 2.8% had Less than ₹5,00,000. 60.1% participants had a master's degree, 30.4% has a bachelor's degree, 3.2% had high school degree, 2.8% had other, and 3.5% had a doctorate.

66.7 % (Strongly agree and agree responses) agreed that electric cars are better for the environment than traditional cars and 69.6 % agreed that electric cars create less environmental pollution than traditional cars. Hence, majority of people are aware of the environmental benefits of the electric cars in India. However, more efforts are required to make remaining almost 30-33% to understand the environmental benefits of electric cars.

56.8% agreed that owning an Electric car would save money in the long run and 78.7 % agreed that electric cars reduce fuel costs. However, majority (75.2%) found the initial cost of electric vehicle as well as maintenance costs (52.7%) to be higher. Hence, it is evident that initial costs and maintenance costs are acting as deterrents to electric cars adoption and reduced fuel costs and long run money savings are the propellers. Thus, manufacturers should look into it and try to reduce the initial cost by improving manufacturing processes and provide better after sale services to the customers. Govt can also play a role here and can provide subsidies and reduced taxes to reduce the initial cost.

56.2 % respondents do not find electric car technology to be reliable and trustworthy and 50.5 % believe that electric car requires regular software updates and maintenance. Hence, technology is a deterring factor in electric car adoption and this needs to be dispelled both by the manufacturers and government. In addition to technology, respondents indicated infrastructure bottlenecks as well with 79.1% agreeing to that there is limited Electric car charging infrastructure in India, 60% finding that electric cars have long charging times, 61.1% found that battery life of an Electric car is often uncertain and 67.1% responses favoured that India lacks repair and maintenance facilities for Electric cars. Hence, there is an urgent need to expand the charging infrastructure

and repair and maintenance facilities. There is a need to focus on technological advancements so that charging times can be reduced and battery life can be predicted.

As indicated above as well, majority of respondents (66.07%) expressed inclination for purchase of electric cars if government gives subsidies and provides roadside assistance (68.5%). In addition, though brand of electric car matters for respondents (70.6%), yet owning electric car does not enhance social status in the eyes of the peers (28.2 %). Despite all the deterrents, 57.9 % intend (most likely and likely responses) to purchase an electric car in near future and another 25.4 % neutral. Hence, it can be said that respondents are positive for electric car purchase in near future.

On the basis of the analysis above, researcher recommends that the Indian government can work in collaboration with manufacturers and private institutions to launch campaigns in both the rural and urban districts of India to disseminate this information. Key digital media platforms such as social media apps can also play a key role in the spread of information to the younger youth consumer market. The Indian government could invest in public-private partnerships (PPPs) to establish widespread charging infrastructure, particularly in tier-2 and tier-3 cities where adoption rates are currently low. Policies encouraging the installation of home and workplace chargers could further enhance the convenience and accessibility of Electric cars (Zhang et al., 2017). Moreover, the government can come up with policies to integrate renewable energy sources into charging stations to increase the environmental benefits of EV adoption. Inspiration can also be drawn from countries like China and Norway, where government initiatives and policies have significantly increased the number of charging points per capita, leading to higher EV adoption rates. Lastly, creating an ecosystem where consumers feel supported via helplines, user manuals and guides could improve the overall adoption rates.

Limitations, Future research directions and Conclusion:

The study's findings could have been more robust with a larger sample size and the application of advanced analytical techniques. Future research may explore regional variations in electric car adoption across India. Additionally, further investigations could

examine how buyer behavior differs based on demographic factors such as gender, education level, and age.

This study highlights the multiple factors influencing the adoption of electric cars in India, revealing that while environmental consciousness and long-term economic benefits positively shape consumer intentions, significant barriers persist. High initial costs, limited maintenance infrastructure, and technological constraints—particularly around battery performance and charging—remain critical deterrents. Additionally, the absence of perceived social prestige linked to EV ownership further tempers enthusiasm. To foster broader adoption, policymakers must enhance financial incentives, expand charging infrastructure, and promote public awareness. Automotive manufacturers and marketers should align strategies with consumer expectations and sustainability narratives.

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