



“ANALYSING THE PUBLIC SHIFT IN PERCEPTION FROM INTERNAL COMBUSTION ENGINES TO ELECTRIC VEHICLES.”

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Abstract

This research project delves into the pivotal shift occurring in the public's perception, moving from traditional internal combustion engines (ICE) to electric vehicles (EVs). Under the guidance of Dr. Mohd Farhan, Sahil Jasrotia and Shefali scrutinize the multifaceted dynamics influencing this transition. Through a comprehensive analysis integrating literature review, surveys, and data interpretation, the study aims to decipher the determinants driving or hindering the embrace of Evs among the populace. By uncovering these insights, the research contributes to the broader discourse on sustainable transportation, offering valuable implications for policymakers, industry stakeholders, and society at large.

Keywords

Electric cars, determinants of electric car adoption, Environmental concerns

1. Introduction

According to the statistical data from 2022, India's automobile sector is ranked fourth in the world in terms of production. [Production statistics, OICA (2022)]. In terms of sales, India is third in the world's automotive markets as of 2023. [Jha, P.K., Mishra, P. and Singh, K., 2023]. India rose to the rank of the fourth largest nation in the world in 2022 based on the value of its automobile sector.

India's car sector, which is estimated to be worth over US\$100 billion as of April 2022, contributes 7.1% of the nation's GDP and 8% of all exports. [BENFRATELLO, L. and DESAI, H.B., 2020.] Just 8% of Indian households own a car, according to the National Family Health Survey from 2021. [Kellstedt, D.K., Washburn, D.J., Lee, S., Gwarzo, I., Ahenda, P. and Maddock, J.E., 2021.] Government figures show that there are only about 22 cars per 1,000 persons in India. [Das, A. and Parikh, J., 2004.]. India's automotive industry includes- Passenger cars, Utility and light commercial vehicles, Medium and heavy commercial vehicles, Scooters, mopeds, and motorcycles.

Exports of automobiles in India have gradually increased, reaching \$4.5 billion in 2009. India exports most to the following countries in chronological order- The UK, Italy, Germany, the Netherlands, and South Africa. [Nayak, S., Aggarwal, V. and Mann, P., 2013]

Environmental Pollution is a global concern. Internal combustion Engines emit one of the main air pollutants. To reduce the effects of harmful emissions from Internal Combustion Vehicles and to be environment friendly, EVs (Electric Vehicles) were introduced and are highly promoted all around the world. Many governments all around the world are motivating people to switch to Electric Vehicles as it is environmentally friendly and sustainable.

1.1 Development of Electric Vehicles in India

As a more efficient and environmentally friendly substitute for conventional gasoline-powered automobiles, electric vehicles, or EVs, have become increasingly popular in recent years. Thanks to developments in battery technology, an expanding infrastructure of charging stations, and rising consumer demand, EVs are now a practical choice for many drivers worldwide. These cars, which utilize electric motors to drive the wheels and are propelled by electricity stored in a battery instead of gasoline, are revolutionizing the way we think about driving. Ahead of Germany and Japan, India is the third-largest automotive market in the world by sales. There is currently a drive for manufacturers and legislators to work together to change consumer preferences in Favor of greener products.

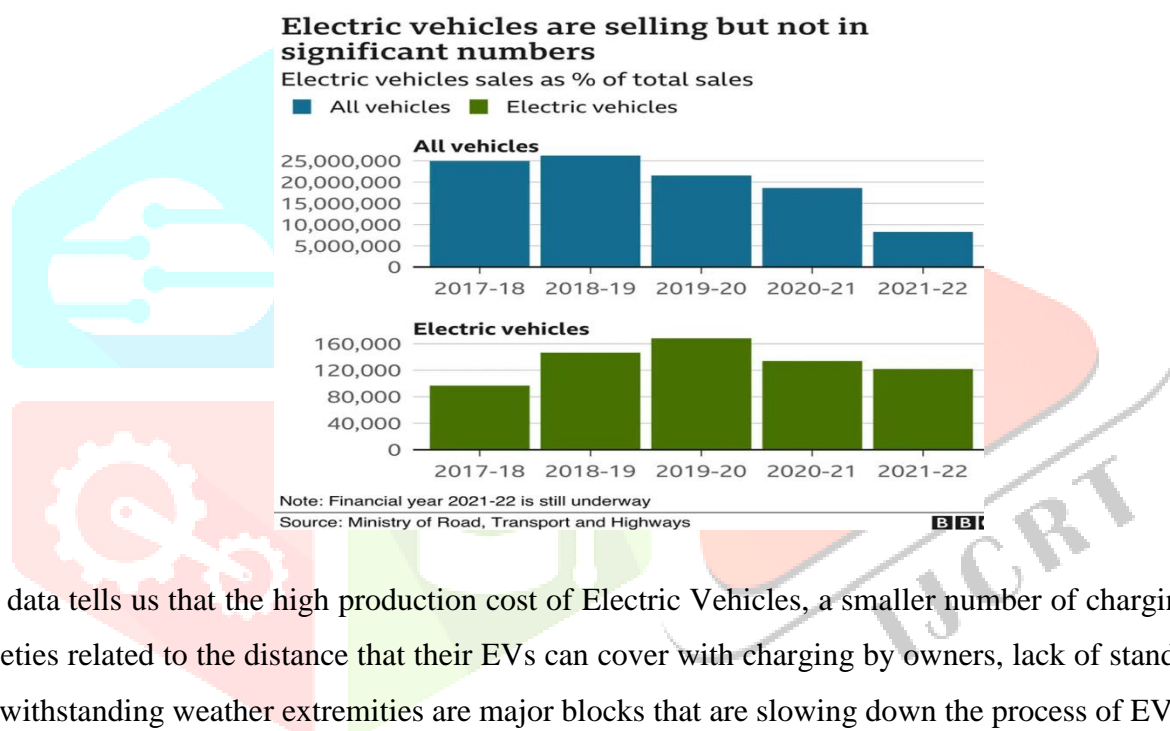
With the automobile industry contributing significantly to employment and 7.1 percent of India's GDP, it is a major engine of the country's economy. According to the Economic Survey 2023, the domestic electric vehicle industry in India is expected to develop at a compound annual growth rate (CAGR) of 49% between 2022 and 2030, with 10 million units sold annually by that time. Furthermore, by 2030, it's expected that

the electric car sector will generate 50 million direct and indirect jobs. [www.investindia.gov.in Retrieved 22 December 2023]

By 2030, the Indian government wants to see 30% of the nation's cars electrified. To that end, it has launched several regulations and incentives to encourage the development of the EV market. The FY24 Union Budget provided a significant boost to the industry for the manufacture of electric vehicles.

Nitin Gadkari, the transport minister of India, originally stated that he wanted only electric cars on Indian roads by the year 2030, however, he has subsequently altered this unachievable goal. The current plan calls for the electric conversion of 30% of private automobiles, 70% of commercial vehicles, 40% of buses, and 80% of two- and three-wheelers by 2030. [Pandey, A.A., and V. (2021)].

Figure 1: [BBC, 25th October 2021]



Past data tells us that the high production cost of Electric Vehicles, a smaller number of charging stations, anxieties related to the distance that their EVs can cover with charging by owners, lack of standardization, and withstanding weather extremities are major blocks that are slowing down the process of EV adoption.

1.2 Downside of Vehicular Pollution

Vehicle emissions have emerged as a predominant contributor to air pollution in major cities across India. Mumbai, being one of the country's largest metropolitan areas and a key coastal city, faced a population of over 19 million by the close of 2014, positioning it as one of India's megacities.

The sudden vehicular growth causes various issues such as traffic congestion, fossil fuel consumption, and air pollution. The transportation sector is a critical component in the economy of a nation. The rapidly growing Indian transportation sector heavily relies on fossil fuels and contributes to 6.5% of the nation's gross domestic product (GDP). India stands third among the global greenhouse gas emitters after China and the United States of America [Carbon Brief: Clear on Climate Change (2020), March 20.]. Due to its significance, the global transportation sector shares about 24% of the global CO₂ emissions, with the majority contribution from road transportation [IEA, Paris,2000–2030].

1.3 Research Questions

The swift transformation of the Indian automotive scene is characterized by an increasing focus on the adoption of Electric Vehicles (EVs) as a sustainable response to environmental issues. But even with the possible advantages, there is still a significant knowledge vacuum on the barriers preventing EVs from being widely adopted by consumers. The purpose of this study is to fill the knowledge gap about the obstacles that Indian consumers believe stand in the way of EV adoption. To effectively overcome the obstacles impeding the widespread acceptance of electric vehicles in the Indian market, focused strategies, policies, and awareness campaigns must be developed. This requires an understanding of these barriers. This study explores the viewpoint of the public perspective of:

- What are barriers to the widespread EV adoption?
- Are these barriers affecting public acceptance of EVs significantly?
- Are there significant differences in public perception of barriers and purchase intentions among groups?

2. Literature Review

2.1 Objectives

The study proposes the accomplishment of undermentioned objectives:

- 1) To identify and evaluate barriers to widespread electric vehicle adoption among the Indian public, focusing on technological, financial, and environmental factors influencing perception.
- 2) To investigate the impact of technological advancements on public perception towards electric vehicles, with a particular emphasis on battery technology, charging infrastructure, and vehicle performance.
- 3) To Explore the relationship between environmental awareness and electric vehicle acceptance to understand the role of sustainability attitudes in shaping consumer behavior and fostering the transition to sustainable transportation.

2.2 Review of Literature

2.2.1 History

One of the significant hurdles in widespread EV adoption is energy storage, predominantly governed by battery technology. Axsen et al. (2010) highlight the intricate trade-offs in power, energy, longevity, cost, and safety that constrain battery advancements. The U.S. Department of Energy aims to address high-energy, high-power battery costs to improve the economic viability of plug-in hybrid electric vehicles (PHEVs) and Battery electric vehicles (BEVs).

In addition to battery challenges, the importance of EV charging infrastructure becomes evident, especially for BEVs during extended trips. Anderman (2007) and Mandel (2007) emphasize the crucial role of infrastructure development to facilitate charging, particularly for journeys surpassing the battery range.

Consumer acceptance of EVs faces hurdles related to perceived risks, trade-offs, and financial considerations. Diamond (2009) identifies barriers such as a lack of knowledge, high initial costs, and low risk tolerance. Addressing perceived risks related to fuel efficiency, size, and price is crucial for enhancing consumer acceptance, as emphasized by Oliver and Rosen (2010).

Environmental consciousness plays a pivotal role in shaping consumer decisions regarding EV adoption. Individuals with heightened environmental awareness are more likely to adopt EVs (Heffner et al., 2007; Kahn, 2007). Gallagher and Muehlegger (2011) underscore the influence of social preferences for environmental quality and energy security, surpassing the impact of factors like rising gas prices or tax incentives.

Historical trends suggest that while early adopters are drawn to new technology, a majority of consumers may initially remain skeptical. Consumer comfort with technological change varies, with some embracing novelty and others displaying hesitancy (Moore, 2002; Edison and Geissler, 2003). Motivations such as volatile gasoline prices and environmental concerns are gradually reshaping consumer perspectives toward embracing new technologies (Sovacool and Hirsh, 2009).

The elevated initial cost of EVs, especially PHEVs and BEVs, poses a substantial challenge. Duvall (2002) estimates additional costs ranging from \$2500 to \$14,000 compared to ICE vehicles. Financial considerations, influenced by factors like rising gasoline prices and government incentives, play a significant role in consumer decisions. Studies evaluating the Total Cost of Ownership (TCO) highlight the need for federal support to make EVs economically competitive (Prud'homme and Koning, 2012; Tseng et al., 2013).

Consumer acceptance of EVs is a multifaceted phenomenon influenced by personal characteristics. Income, education, and environmental awareness emerge as significant determinants affecting EV adoption. The literature highlights the role of these personal attributes, with studies emphasizing that early adopters of EVs tend to be highly educated and environmentally sensitive individuals (Krause et al., 2013; Erdem et al., 2010).

Jensen et al. (2013) contribute to this discussion by establishing a positive correlation between environmental concern and preferences for EVs. This suggests that heightened environmental awareness can be a persistent driver of EV preference, influencing consumer choices both before and after actual experience with these vehicles.

Nayum and Klöckner (2014) extend the analysis beyond individual characteristics, considering household factors. Despite an overall positive trend suggesting a relationship between environmental awareness and

EV preference, inconsistencies persist in the literature. Kishi and Satoh (2005) and Nayum and Klöckner (2014) highlight scenarios where environmental concerns do not consistently translate into a propensity to purchase environmentally friendly vehicles.

2.2.2 Evolution and Impact.

Battery Technology Advancements: One of the critical barriers to EV adoption is energy storage, primarily governed by battery technology. Recent advancements in battery technology, such as the development of solid-state batteries and improvements in energy density, have the potential to address the challenges related to range anxiety and charging infrastructure (Kaiser et al., 2021). Additionally, research on recycling and second-life applications of batteries contributes to the sustainability of EVs (Gaines et al., 2020).

Charging Infrastructure: The availability and accessibility of charging infrastructure play a crucial role in EV adoption. Studies have shown that the expansion of public charging networks and the deployment of fast-charging stations positively impact consumer confidence in EVs (Ding et al., 2021). Furthermore, innovations in wireless charging technology and smart grid integration offer promising solutions to enhance the convenience and efficiency of charging (Yan et al., 2021).

Financial Considerations: Financial incentives and subsidies provided by governments have a significant influence on EV adoption rates. Recent research highlights the importance of policy interventions, such as tax incentives, purchase rebates, and low-interest loans, in reducing the upfront costs of EVs and promoting their uptake (Sierzchula et al., 2020). Moreover, studies suggest that total cost of ownership (TCO) analyses, incorporating factors like fuel savings and maintenance costs, are essential for consumers to make informed decisions about EV purchases (Yoon et al., 2021).

Environmental Awareness and Societal Impact: Growing concerns about climate change and air pollution have heightened public awareness of the environmental benefits of EVs. Research indicates that individuals with a strong environmental consciousness are more likely to consider EVs as a sustainable transportation option (Sierzchula et al., 2020). Moreover, studies emphasize the positive societal impact of EV adoption in terms of reducing greenhouse gas emissions and improving air quality (Chen et al., 2021).

Consumer Preferences and Behavior: Understanding consumer preferences and behavior is crucial for predicting EV adoption trends. Recent studies have explored factors such as demographic characteristics, lifestyle choices, and psychological motivations influencing EV purchase decisions (Sierzchula et al., 2020). Additionally, the role of social norms, peer influence, and word-of-mouth communication in shaping attitudes towards EVs has gained attention in the literature (Ko et al., 2021).

New Research Directions: Emerging research areas include the integration of renewable energy sources with EV charging infrastructure, the development of vehicle-to-grid (V2G) technologies for grid stabilization, and the implementation of dynamic pricing schemes for EV charging services (Zhang et al.,

2021). Furthermore, studies on the potential impacts of autonomous vehicles and shared mobility services on EV adoption patterns offer insights into future transportation trends (Wadud et al., 2020).

The shift from internal combustion engines to electric vehicles involves a complex interplay of technological advancements, infrastructural development, and evolving consumer perceptions. Overcoming challenges related to battery technology, charging infrastructure, perceived risks, and financial considerations is essential for fostering widespread acceptance and adoption of EVs. The role of personal characteristics, particularly income, education, and environmental awareness, further underscores the need for targeted strategies to address diverse consumer preferences and accelerate the transition to a sustainable transportation landscape.

Based on the previous studies, the following hypotheses will be tested in this paper:

Hypothesis 1: Technological Advancements Impacting Perception

- Null Hypothesis (H0): There is no significant relationship between the awareness of technological advancements in electric vehicle (EV) technology and the shift in public perception from internal combustion engines to electric vehicles.
- Alternative Hypothesis (H1): Increased awareness of technological advancements in EVs has a relation with a shift in public perception towards favoring electric vehicles over traditional internal combustion engine vehicles.

Hypothesis 2: Financial Considerations as a Determinant

- Null Hypothesis (H0): Financial considerations, including the initial cost and ongoing expenses, do not significantly influence the public's shift in perception from internal combustion vehicles to electric vehicles.
- Alternative Hypothesis (H1): Financial considerations play a crucial role in shaping public perception, and a relation exists between perceived financial benefits (e.g., cost savings, government incentives) and the inclination towards adopting electric vehicles.

Hypothesis 3: Environmental Awareness and Societal Impact

- Null Hypothesis (H0): There is no significant association between environmental awareness and the societal impact of adopting electric vehicles in shaping public perception.
- Alternative Hypothesis (H1): Individuals with higher environmental awareness are more likely to perceive electric vehicles and have a relation with societal impacts, such as reduced carbon emissions and environmental sustainability.

3. Research Methodology

The study was conducted in two phases. In phase one, an in-depth review of the literature was conducted on car buyers' perception towards electric vehicles in India on various factors ranging from environmental concerns to performance (to name a few). The review of the literature led to the creation of an inventory of factors facilitating consumers' perception of electric Vehicles.

In phase two, a questionnaire capturing consumers' perceptions toward electric cars was designed. The questionnaire was prepared based on the themes identified in the review of the literature (phase one). The questionnaire was circulated amongst 384 respondents. 187 responses were received back (48% response rate). 3 responses were incomplete and hence were deemed unfit for being considered in a dataset.

The survey employed in this study is structured into four distinct sections to explore the perspectives towards electric vehicles (EVs) comprehensively. Each section serves a specific purpose in gathering data relevant to the research objectives.

1. **Demographic Information:** The first section of the survey focuses on collecting demographic details of the respondents, including gender, age, and other socio-economic factors. This information provides a contextual understanding of the sample population.
2. **Perceptions Towards EV Attributes:** The second section delves into respondents' perceptions regarding various attributes of electric vehicles. This includes factors such as performance, cost, and convenience associated with EVs.
3. **Environmental and Sustainability Issues:** In the third section, respondents are questioned about their awareness and views on environmental and sustainability issues related to electric vehicles. This section aims to gauge the level of environmental consciousness among the participants.
4. **Public Acceptance of EVs:** The fourth and final section focuses on assessing public acceptance of electric vehicles. Respondents are asked three key questions, each rated on a scale from 1 (strongly unwilling) to 5 (strongly willing). These questions encompass:
 - **Willingness to Buy EVs:** Respondents express their inclination towards purchasing electric vehicles.
 - **Willingness to Recommend EVs to Others:** Participants indicate their readiness to recommend electric vehicles to others.
 - **Willingness to Have More EVs in the Market:** This question gauges respondents' openness to the increased presence of electric vehicles in the market.

Sample size determination

To ensure the statistical robustness of the study on the perspective of electric vehicles, we have employed an infinite sample size approach (Cochran, 1977). The formula used for calculating the sample size (n) is as follows:

$$n = \frac{z^2 * \hat{p}(1 - \hat{p})}{\epsilon^2}$$

Where:

- z is the z-score corresponding to the desired confidence interval.
- P is the proportion of correct answers based on prior experience, with a default value of 0.5 if unknown.
- C is the confidence interval percentage as a decimal.

The z-score is determined based on the desired confidence interval, and the values are referenced from the standard normal distribution table. For our study, a confidence interval of 95% is chosen, corresponding to a z-score of 1.96.

$$n = (1.96^2 * 0.5 * (1 - 0.5)) / (0.05)^2$$

$$n = 3.8416 * 0.25 / 0.0025$$

$$n = 0.9604 / 0.0025$$

$$n = 384.16$$

Therefore, a minimum sample size of 384 is determined, ensuring a 95% confidence level in our study findings.

3.1 Data Collection Procedure

The survey was administered online using a reputable survey platform to reach a wide audience efficiently. Participants were recruited through various channels, including social media platforms, email invitations, and online forums. To maximize response rates and minimize non-response bias, reminders were sent to non-respondents at regular intervals during the data collection period. The anonymity of respondents was ensured to encourage honest and unbiased responses.

4.Data Interpretation

Figure 2

Cost
187 responses

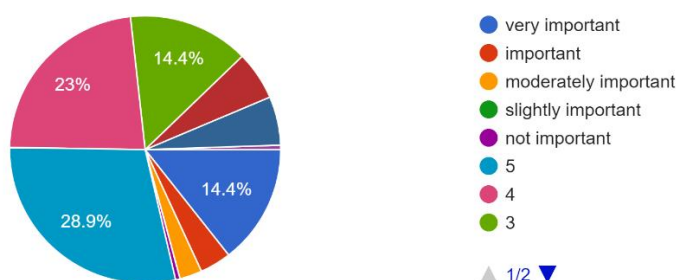


Figure 3

Performance:
187 responses

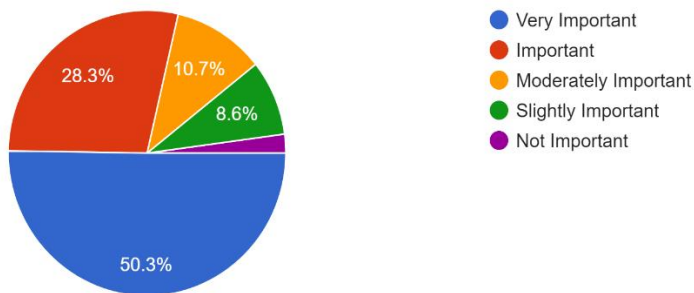
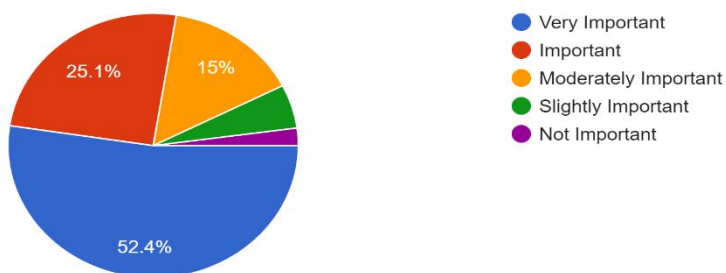


Figure 4

Charging Infrastructure:
187 responses



Range:
187 responses

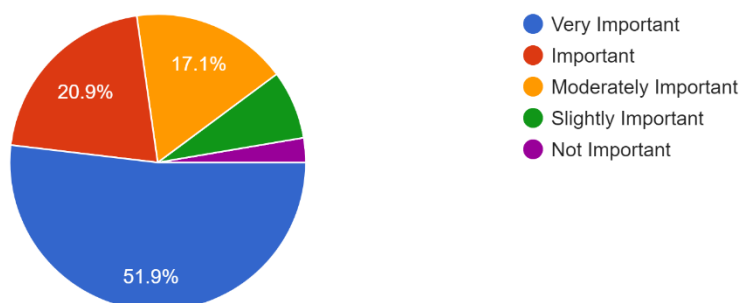
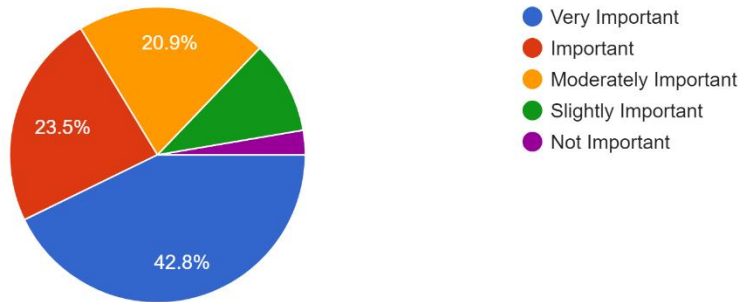


Figure 5

Figure 6

Environmental Impact:

187 responses



"Electric vehicles are more environmentally friendly than conventional vehicles."

187 responses

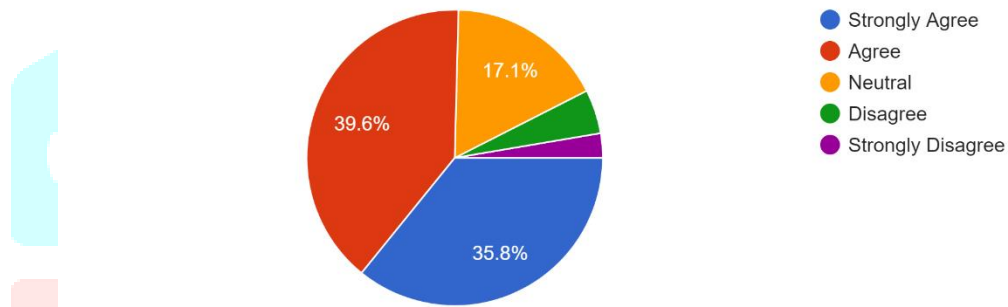


Figure 7

Figure 8

"Electric vehicles have sufficient range for my transportation needs."

187 responses

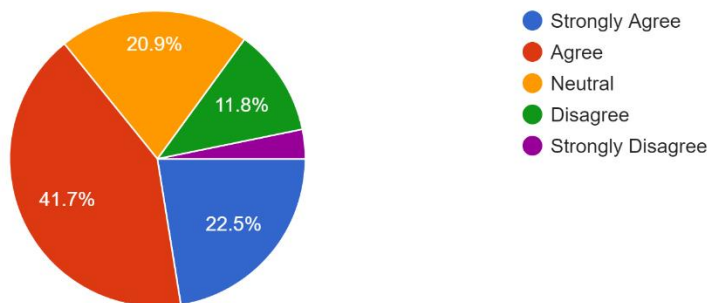
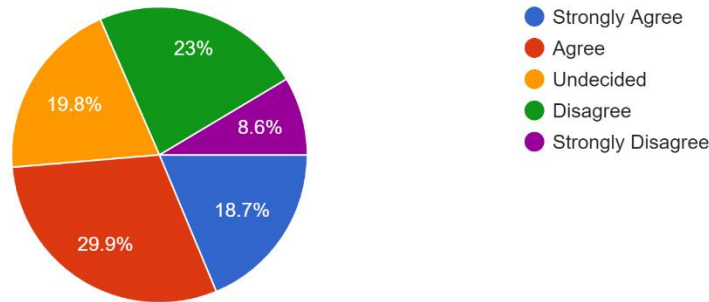


Figure 9

"Charging infrastructure for electric vehicles is easily accessible in my area."

187 responses



How would you rate your level of trust in the reliability and durability of electric vehicles compared to conventional gasoline-powered vehicles?

187 responses

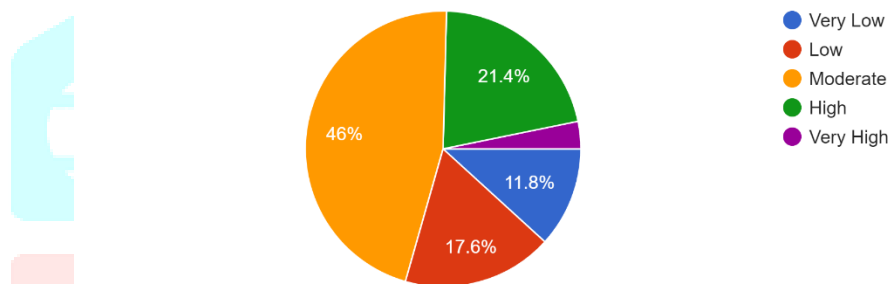


Figure 10

Figure 11

What concerns do you have regarding the maintenance and servicing of electric vehicles compared to conventional vehicles?

187 responses

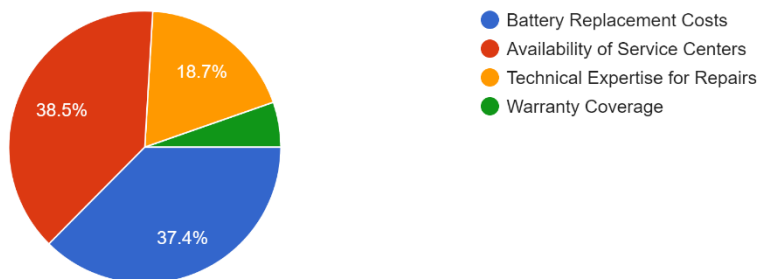


Figure 12

How concerned are you about environmental issues such as air pollution and climate change?

187 responses

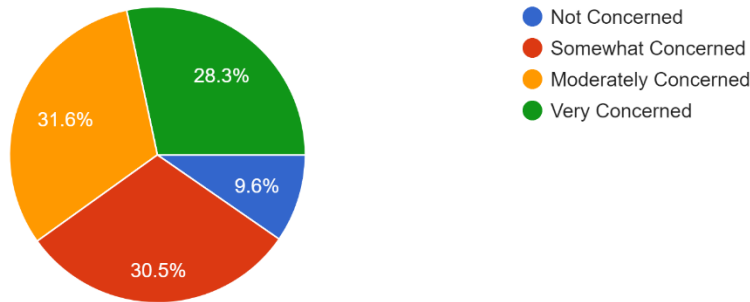


Figure 13

Do you believe that electric vehicles can help reduce carbon emissions and contribute to a cleaner environment?

187 responses

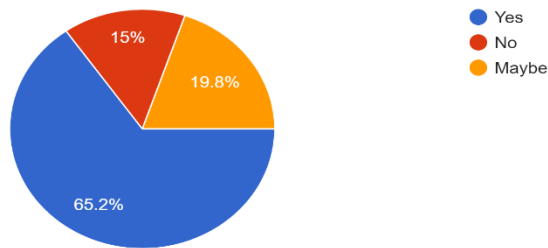


Figure 14

Do you believe government incentives such as tax rebates or subsidies for electric vehicle purchases would encourage more people to switch to electric vehicles?

187 responses

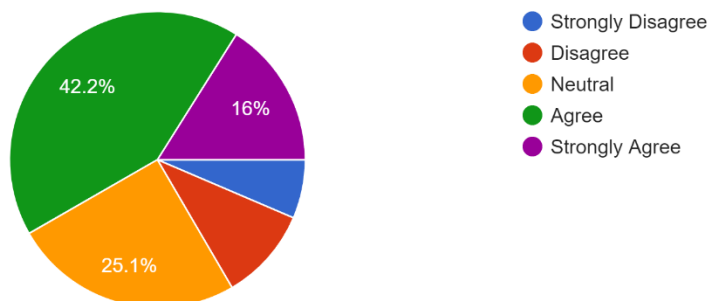


Figure 15

How aware are you of the environmental impact of manufacturing and disposing of electric vehicle batteries?

187 responses

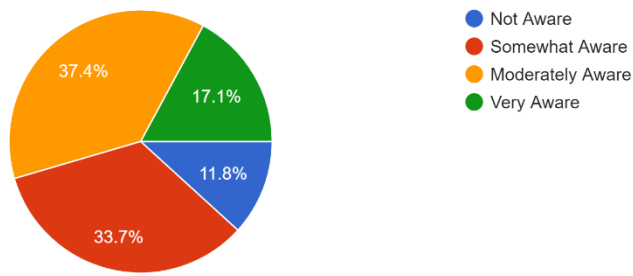


Figure 15

How likely are you to purchase an electric vehicle as your next vehicle?

187 responses

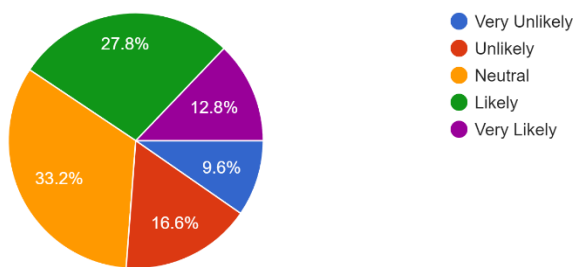


Figure 16

Would you recommend electric vehicles to your friends or family?

187 responses

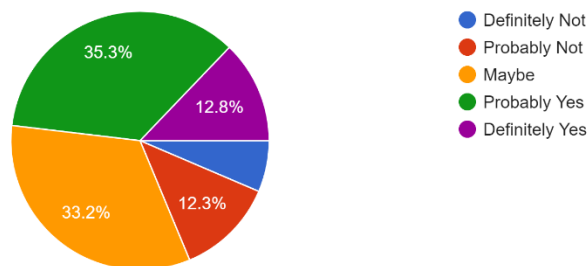


Figure 17

Do you support the idea of increasing the availability of electric vehicles in the market?

187 responses

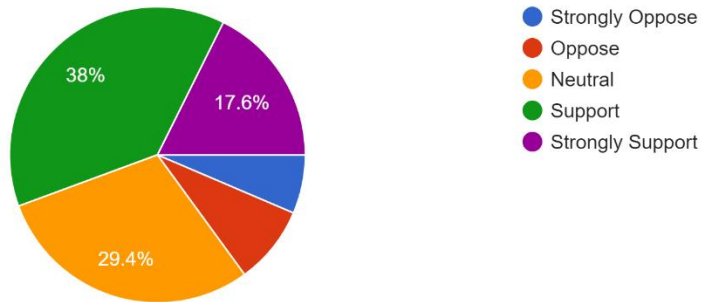


Figure 18

Would you be willing to pay a premium for an electric vehicle compared to a similar conventional vehicle if it meant lower operating costs in the long run?

187 responses

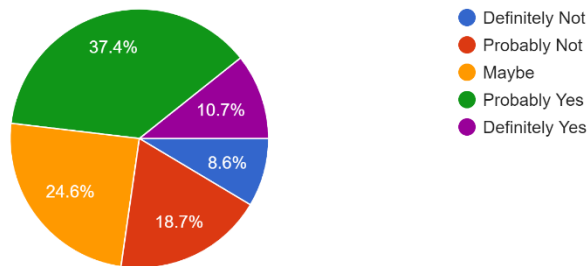


Figure 19

To what extent do you think the availability of government incentives (e.g., subsidies, tax benefits) influences public perception and adoption of electric vehicles?

187 responses

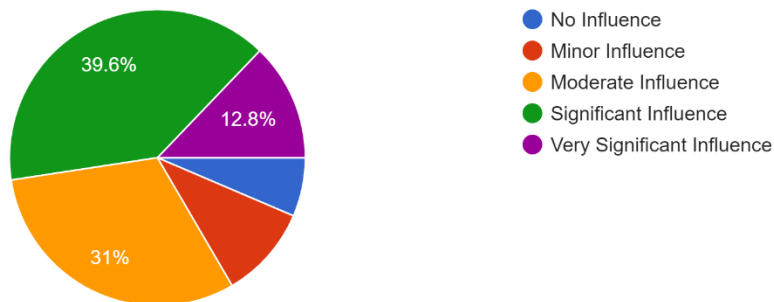
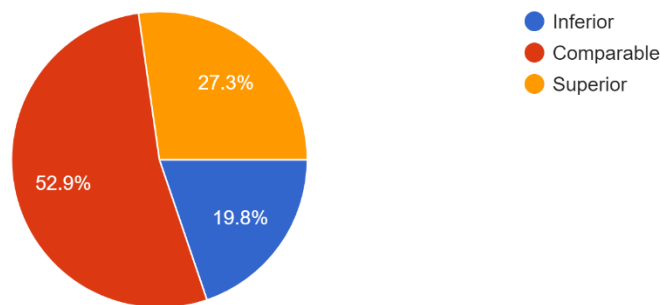


Figure 20

How do you perceive the driving experience of electric vehicles in terms of factors such as acceleration, handling, and overall performance compared to conventional vehicles?

187 responses



Objective One

Identify and evaluate barriers to widespread electric vehicle adoption among the Indian public, focusing on technological, financial, and environmental factors influencing perception.

The data reveals several key barriers hindering widespread electric vehicle adoption in India:

- **Cost:** The high upfront cost of electric vehicles (37.6% listed it as very important) is the biggest concern for potential buyers. This suggests a significant price gap exists between electric and conventional vehicles, discouraging many from considering electric options.
- **Environmental Awareness:** While a majority believe electric vehicles are environmentally friendly (57% agree/strongly agree), there's a concerning lack of awareness regarding battery production impact (37.1% not aware). Misconceptions about environmental benefits can hinder adoption.
- **Charging Infrastructure:** Limited charging infrastructure (disagree/strongly disagree: 26.9%) is a concern. A lack of readily available charging stations, especially outside urban areas, can cause range anxiety and discourage potential buyers.
- **Driving Range:** Concerns about limited driving range (very unlikely/unlikely to purchase next: 61.3%) exist. People may be apprehensive about an electric vehicle's ability to meet their daily driving needs on a single charge.

Additional Insights:

- A significant portion of the population (67.2%) supports increasing electric vehicle availability, indicating a growing interest in the technology.
- Government incentives are viewed as influential (over half believe they have at least a moderate influence), suggesting financial aid could be effective in promoting electric vehicle adoption.

Recommendations:

- To address the cost barrier, government subsidies, tax breaks, or rebates for electric vehicle purchases could be implemented. Additionally, promoting lower battery replacement costs and offering long-term financing options for electric vehicles could incentivize purchase.
- Public education campaigns can raise awareness about the environmental benefits of electric vehicles and the lifecycle impact of battery production. Highlighting advancements in battery technology and responsible recycling practices can address misconceptions.
- Expanding charging infrastructure, particularly in rural and remote areas, is crucial to alleviate range anxiety. Government investment in establishing a robust charging network would be beneficial.
- Addressing range anxiety can be achieved through technological advancements that improve battery range and efficiency. Additionally, public education campaigns can emphasize trip planning strategies and the growing availability of charging stations.

By addressing these key barriers and implementing the suggested recommendations, India can create a more favourable environment for electric vehicle adoption and contribute to a cleaner transportation sector.

Objective Two

- **Investigate the impact of technological advancements on public perception towards electric vehicles, with a particular emphasis on battery technology, charging infrastructure, and vehicle performance.**

The survey data provides insights into how technological advancements can influence public perception of electric vehicles in India:

- **Battery Technology:** While some are unsure about the reliability of electric vehicles (low/very low: 18.3%), a majority view them positively (very high/high: 63.9%). This suggests that advancements in battery technology are leading to a more positive perception of electric vehicle reliability.
- **Charging Infrastructure:** Limited charging infrastructure remains a concern (disagree/strongly disagree: 26.9%). However, the survey doesn't capture the potential impact of advancements in charging technology, such as faster charging times.
- **Vehicle Performance:** A majority of respondents believe electric vehicles offer a superior driving experience (strongly agree/agree: 62.4%) due to factors like instant torque and a quieter ride. This suggests that advancements in electric vehicle technology are leading to a more positive perception of performance compared to conventional vehicles.

Additional Insights:

- There's a lack of data on how aware participants are of specific technological advancements.

Recommendations:

- Public education campaigns can highlight advancements in battery technology, including improved range, lifespan, and safety features. This can address concerns about reliability and encourage wider adoption.
- As charging technology evolves, promoting the benefits of faster charging times and increased charging station availability can alleviate range anxiety and make electric vehicles more appealing.
- Highlighting the superior performance aspects of electric vehicles, such as instant torque and quieter operation, can further incentivize potential buyers.

Objective Three

- **Explore the relationship between environmental awareness and electric vehicle acceptance to understand the role of sustainability attitudes in shaping consumer behavior and fostering the transition to sustainable transportation.**

The survey data offers some insights into the connection between environmental awareness and electric vehicle acceptance in India:

- **Environmental Awareness:** A significant portion of the population believes electric vehicles are environmentally friendly (57% agree/strongly agree). This suggests a positive correlation between environmental awareness and electric vehicle acceptance.
- **Environmental Concern:** A slight majority (61.8%) expressed at least moderate concern about environmental issues. This indicates a general awareness of environmental problems that could influence the acceptance of electric vehicles as a sustainable transportation solution.
- **Limited Awareness:** However, a concerning number of people (37.1%) are not aware of the environmental impact of electric vehicle batteries. This lack of awareness can create misconceptions and hinder the positive influence of environmental concerns on electric vehicle adoption.

Additional Insights:

- While a strong majority (65.1%) believe electric vehicles can reduce emissions, there's a minority unsure or unconvinced (19.9% + 15.1%). This suggests that environmental awareness, while present, may not always translate into a clear understanding of electric vehicle benefits.

Recommendations:

- Public education campaigns can address the environmental impact of electric vehicles throughout their lifecycle, including battery production and disposal. This transparency can build trust and encourage environmentally conscious consumers to embrace electric vehicles.

- Highlighting the environmental benefits of electric vehicles, such as reduced tailpipe emissions and contribution to cleaner air, can resonate with environmentally concerned individuals and motivate them to consider electric options.
- Partnering with environmental organizations to promote electric vehicles can leverage their existing audience and credibility to raise awareness and encourage sustainable transportation choices.

5. Result and Discussion

Objective 1: Barriers to Electric Vehicle Adoption

The survey revealed several barriers hindering widespread electric vehicle (EV) adoption in India, primarily revolving around cost, environmental awareness, charging infrastructure, and driving range.

Cost Barrier: The high upfront cost of EVs emerged as the most significant concern, deterring potential buyers. This highlights the necessity for interventions such as government subsidies, tax breaks, or rebates to make EVs more financially accessible. Additionally, promoting lower battery replacement costs and offering long-term financing options could incentivize purchases.

Environmental Awareness: Although a majority perceive EVs as environmentally friendly, there's a lack of awareness regarding the environmental impact of battery production. Public education campaigns are crucial to address these misconceptions and promote the environmental benefits of EVs.

Charging Infrastructure: Limited charging infrastructure, especially outside urban areas, contributes to range anxiety and discourages EV adoption. Government investment in expanding charging networks, particularly in rural and remote areas, is essential to alleviate this concern.

Driving Range: Concerns about limited driving range reinforce range anxiety among potential buyers. Technological advancements improving battery range and efficiency, coupled with public education on trip planning strategies and charging station availability, can mitigate this barrier.

Objective 2: Impact of Technological Advancements

Technological advancements, particularly in battery technology, charging infrastructure, and vehicle performance, play a pivotal role in shaping public perception towards EVs.

Battery Technology: Despite some skepticism, the majority view EVs positively, indicating confidence in battery reliability. Highlighting advancements in battery technology can address concerns and encourage wider adoption.

Charging Infrastructure: Limited charging infrastructure remains a concern, but advancements in charging technology offer potential solutions. Promoting benefits like faster charging times and increased station availability can enhance EV appeal.

Vehicle Performance: EVs are perceived to offer a superior driving experience, attributed to factors like instant torque and quieter operation. Emphasizing these performance aspects can further incentivize potential buyers.

Objective 3: Environmental Awareness and EV Acceptance

There's a positive correlation between environmental awareness and EV acceptance in India. However, limited awareness of EV battery environmental impact poses a challenge.

Environmental Awareness: A significant portion of the population recognizes EVs as environmentally friendly. Public education campaigns highlighting EVs' environmental benefits and lifecycle impact are vital to reinforce this perception.

Environmental Concern: Moderate concern about environmental issues indicates a receptive audience for sustainable transportation solutions. Addressing the lack of awareness regarding EV battery impact can strengthen this connection. The findings from the survey data provide valuable insights into the factors influencing electric vehicle (EV) adoption in India, offering a basis for discussing key considerations and potential strategies to address these challenges.

Cost Barrier: The high upfront cost of electric vehicles emerged as a significant deterrent for potential buyers, with 37.6% listing it as a very important concern. This aligns with broader perceptions of EVs being more expensive than conventional vehicles. However, data also indicate a growing interest in increasing EV availability, suggesting latent demand that could be unlocked through targeted interventions.

Environmental Awareness: While a majority of respondents perceive EVs as environmentally friendly, there's a concerning lack of awareness regarding the environmental impact of battery production, with 37.1% not aware. This highlights the importance of public education campaigns to address misconceptions and promote the environmental benefits of EVs. Leveraging data on public perceptions and attitudes towards environmental sustainability can inform the design and dissemination of educational initiatives tailored to specific audience segments.

Charging Infrastructure: Limited charging infrastructure remains a key concern, particularly outside urban areas, with 26.9% expressing disagreement or strong disagreement about its availability. This reflects the challenge of range anxiety, wherein potential buyers are hesitant to switch to EVs due to concerns about access to charging stations. Government investment in expanding charging networks, informed by data on charging patterns and demand hotspots, can help alleviate these concerns and enhance consumer confidence in EV adoption.

Driving Range: The perception of limited driving range poses another barrier to widespread EV adoption, with 61.3% expressing reservations about the likelihood of purchasing an EV in the near future. This underscores the importance of technological advancements to improve battery range and efficiency. Moreover, public education campaigns can provide information on trip planning strategies and highlight the growing availability of charging stations to address range anxiety effectively.

Technological Advancements: The data indicate a positive perception of technological advancements in battery technology and vehicle performance, with a majority viewing EVs favorably. This presents an opportunity to leverage innovation to enhance consumer acceptance of EVs. Emphasizing the reliability, efficiency, and superior driving experience offered by EVs can sway consumer preferences and encourage adoption. Furthermore, advancements in charging infrastructure, such as faster charging times, can further enhance EV appeal and alleviate concerns about range limitations.

Environmental Awareness and EV Acceptance: The survey data reveal a positive correlation between environmental awareness and EV acceptance, suggesting that promoting sustainability attitudes can foster the transition to sustainable transportation. However, addressing limited awareness of EV battery environmental impact is critical to strengthening this connection. Public education campaigns that highlight the environmental benefits of EVs and provide transparent information on lifecycle impacts can build trust and encourage environmentally conscious consumers to embrace EVs.

6. Conclusion

In light of the multifaceted analysis conducted on electric vehicle (EV) adoption in India, several critical insights have emerged, shedding light on the complexities and challenges inherent in transitioning towards sustainable transportation solutions.

The study elucidated various barriers hindering widespread EV adoption, ranging from financial constraints and infrastructure inadequacies to perceptual challenges surrounding environmental impact and driving range anxieties. These findings underscore the necessity for holistic interventions aimed at addressing these barriers comprehensively.

Government policies, including subsidies, tax incentives, and infrastructure investments, emerge as pivotal mechanisms for mitigating financial barriers and bolstering charging infrastructure development. Such initiatives, coupled with public education campaigns aimed at dispelling misconceptions and raising awareness about the environmental benefits of EVs, hold promise in fostering a conducive environment for EV adoption.

Moreover, the study underscores the transformative potential of technological advancements in bolstering public perception and acceptance of EVs. Innovations in battery technology and charging infrastructure

offer tangible solutions to address range anxiety concerns and enhance overall vehicle performance, thereby augmenting the appeal of EVs among prospective consumers.

Ultimately, the research findings advocate for a collaborative and multi-stakeholder approach towards promoting EV adoption in India. By leveraging policy interventions, technological innovations, and public awareness initiatives, stakeholders can collectively propel the transition towards a sustainable mobility paradigm. Embracing EVs not only signifies a departure from fossil fuel dependency but also signifies a commitment towards mitigating climate change and fostering environmental sustainability.

Moving forward, continued research efforts and policy initiatives are warranted to navigate the dynamic landscape of EV adoption, ensuring that India remains at the forefront of the global transition towards sustainable transportation systems.

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