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Market Adaptation of Electric Vehicle towards Consumer Behaviour and Barriers in Gujarat.

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ABSTRACT: The rapid transition toward sustainable transportation has positioned electric vehicles (EVs) as a critical solution to reduce greenhouse gas emissions and dependence on fossil fuels. However, the market adaptation of EVs is significantly influenced by consumer behavior, perceptions, and various structural and psychological barriers. This study explores the dynamics shaping consumer adoption of electric vehicles, focusing on factors such as environmental awareness, cost considerations, technological perceptions, and policy incentives. While a growing segment of consumers demonstrates positive attitudes toward eco-friendly mobility, actual purchase decisions often remain constrained by practical concerns.

One of the primary drivers of EV adoption is increasing environmental consciousness, coupled with government initiatives such as subsidies, tax incentives, and stricter emission norms. Additionally, advancements in battery technology and expanding charging infrastructure have contributed to improving consumer confidence. Despite these developments, several barriers persist. High upfront costs compared to conventional vehicles remain a significant deterrent, particularly in price-sensitive markets. Range anxiety, defined as the fear of battery depletion before reaching a charging station, continues to influence consumer hesitation, even as battery performance improves. Moreover, inadequate charging infrastructure, long charging times, and limited model availability in certain regions restrict widespread adoption. Consumer behavior is also shaped by social influence, brand perception, and awareness levels. Misconceptions regarding maintenance costs, battery life, and resale value further contribute to resistance. In emerging economies, infrastructural limitations and lack of reliable information amplify these challenges. The study highlights that bridging the gap between consumer intention and actual adoption requires a multi-dimensional approach involving technological innovation, policy support, and effective consumer education. Enhancing charging networks, reducing vehicle costs through economies of scale, and increasing public awareness can significantly accelerate EV adoption. Understanding consumer behavior and addressing perceived barriers is essential for policymakers, manufacturers, and stakeholders aiming to promote sustainable mobility and achieve long-term environmental goals.

KEYWORDS: Electric Vehicle, Consumer Behavior, Gujarat Market Adaptation, Government Schemes and Sustainable Mobility.

I. INTRODUCTION:

The increasing concern over environmental degradation, rising fuel prices, and the depletion of fossil fuels has accelerated the global transition toward sustainable modes of transportation. Electric Vehicles (EVs) have emerged as a viable alternative to conventional internal combustion engine vehicles due to their potential to reduce greenhouse gas emissions and promote energy efficiency. In recent years, governments, manufacturers, and environmental organizations have collectively emphasized the importance of adopting EVs as part of a broader strategy for achieving sustainable development goals. Despite the technological advancements and policy support, the market adaptation of electric vehicles is not solely dependent on supply-side factors. Consumer behavior plays a critical role in determining the rate and success of EV adoption. Factors such as environmental awareness, perceived usefulness, and ease of use, cost considerations, and social influence significantly shape consumer attitudes toward EVs. While many consumers express a positive inclination toward environmentally friendly vehicles, a gap often exists between intention and actual purchase behavior. This gap highlights the complexity of consumer decision-making processes in the context of new and evolving technologies. One of the major challenges in EV adoption is the presence of multiple barriers that hinder consumer acceptance. High initial purchase costs, limited driving range, long charging times, and inadequate charging infrastructure are among the most commonly cited obstacles. Additionally, concerns regarding battery life, maintenance costs, resale value, and the availability of service networks further influence consumer hesitation. Psychological barriers such as lack of trust in new technology, limited awareness, and resistance to change also play a significant role in slowing adoption rates.

Moreover, market adaptation varies across regions and demographic groups, influenced by economic conditions, infrastructure availability, and policy effectiveness. In developing economies, these challenges are often more pronounced due to price sensitivity and infrastructural constraints. However, supportive government policies, technological innovation, and increasing environmental consciousness are gradually encouraging a shift toward electric mobility. This study focuses on understanding the market adaptation of electric vehicles by analyzing consumer behavior and identifying key barriers affecting adoption. By examining these aspects, the research aims to provide insights that can help policymakers, manufacturers, and stakeholders develop effective strategies to promote EV adoption and facilitate a smoother transition toward sustainable transportation systems.

II. OBJECTIVE OF THE STUDY:

- To examine the level of awareness and perception of consumers in Gujarat.
- To analyze consumer behaviour and preference influencing the adaption of EVs in Gujarat.
- To identify major barriers to EV adoptions in Gujarat.
- To analyze the role of socio-economic factors in Gujarat.

Literature Review: The adoption of Electric Vehicles (EVs) has been widely studied across global and Indian contexts, with a strong focus on consumer behavior, technological acceptance, and market barriers. In the context of Gujarat, the transition toward EV adoption is shaped by both national-level policies and region-specific socio-economic factors. Several studies highlight that consumer behavior plays a crucial role in EV adoption. Ajzen, Icek (1991) introduced the Theory of Planned Behavior, which explains how attitudes, subjective norms, and perceived behavioral control influence purchase intentions. This theory has been widely applied in EV studies, suggesting that positive environmental attitudes and social influence significantly encourage EV adoption. Similarly, Rogers, Everett M. (2003) emphasized that innovation adoption depends on factors such as relative advantage, compatibility, and complexity, which are highly relevant in understanding consumer acceptance of EVs.

In the Indian context, studies indicate that environmental awareness and government support are key drivers of EV adoption. Research by NITI Aayog (2020) suggests that financial incentives, such as subsidies and tax exemptions, significantly influence consumer decisions. However, despite these efforts, adoption remains limited due to economic and infrastructural challenges. A study by International Energy Agency (2022) found that high upfront costs and inadequate charging infrastructure are among the most significant barriers in developing countries like India. Focusing on Gujarat, recent reports highlight that the state has made notable progress through the Gujarat Electric Vehicle Policy 2021, which aims to promote EV adoption through subsidies and infrastructure development. According to studies by Society of Indian Automobile Manufacturers (2023), Gujarat has experienced growth in EV registrations, particularly in two-wheelers. However, adoption is still constrained by consumer concerns regarding battery life, resale value, and limited charging stations, especially in semi-urban and rural areas.

Consumer perception studies further reveal that price sensitivity remains a dominant factor in Gujarat. Research by Confederation of Indian Industry (2022) indicates that consumers prefer conventional or CNG vehicles due to their lower initial costs and established infrastructure. Additionally, range anxiety and long charging times continue to discourage potential buyers, even as battery technologies improve. Moreover, infrastructural barriers significantly impact EV adoption. According to Central Electricity Authority (2023), the availability of public charging stations in India is still insufficient relative to demand. In Gujarat, although urban centers such as Ahmadabad and Surat are witnessing growth in charging infrastructure, rural penetration remains limited, affecting overall adoption rates. In conclusion, existing literature suggests that while Gujarat shows promising growth in EV adoption, several behavioral and structural barriers persist. Consumer awareness, economic constraints, infrastructural limitations, and policy effectiveness collectively influence the pace of market adaptation. Addressing these challenges through targeted policies, technological advancements, and consumer education is essential for accelerating EV adoption in the region.

Statement of the Problem: The transition toward electric vehicles (EVs) is considered a crucial step in addressing environmental concerns such as air pollution, climate change, and dependence on fossil fuels. In India, and particularly in Gujarat, the government has introduced various policies and incentives to promote the adoption of EVs. Despite these efforts, the rate of EV adoption in Gujarat remains lower than expected when compared to its industrial capacity and economic potential.

One of the key issues lies in the gap between consumer awareness and actual purchase behavior. Although many consumers are aware of the environmental benefits of EVs, their buying decisions are still influenced by practical concerns such as high initial costs, limited driving range, and uncertainty regarding long-term performance. This indicates that positive attitudes toward EVs do not necessarily translate into actual adoption.
Furthermore, infrastructural challenges continue to hinder the growth of the EV market in Gujarat. The availability of charging stations is still inadequate, particularly in semi-urban and rural areas, leading to range anxiety among potential users. In addition, long charging times and lack of standardized charging facilities reduce the convenience factor associated with EV usage. Economic factors also play a significant role in shaping consumer decisions. The high upfront cost of EVs, despite government subsidies, makes them less attractive to price-sensitive consumers. Moreover, concerns related to battery life, maintenance costs, and resale value create uncertainty and reduce consumer confidence. The presence of well-established alternatives such as petrol and CNG vehicles further intensifies this challenge.

Another important issue is the lack of sufficient awareness and reliable information about EV technology, government incentives, and long-term benefits. Many consumers in Gujarat still hold misconceptions about EV performance and durability, which negatively impacts their willingness to adopt this technology. Therefore, the core problem addressed in this study is the slow pace of market adaptation of electric vehicles in Gujarat despite favorable policies and growing environmental awareness. This study seeks to identify and analyze the key behavioral, economic, and infrastructural barriers that influence consumer adoption of EVs. Understanding these challenges is essential for developing effective strategies to bridge the gap between intention and actual usage, thereby promoting sustainable mobility in the region.

Research Methodology: The research Methodology outlines the systematic approach adopted to study the market adaptation of Electric vehicles with respect to consumer behaviour and other barriers affecting their adoption in Gujarat.

Research Design: This study is based on a **descriptive and analytical research design**. It aims to describe consumer behavior patterns and analyze the factors influencing the adoption of EVs, along with identifying key barriers in the Gujarat market.
Nature of Data: Researcher has been used Primary Data for the research study, The Primary data collected directly from consumer through structured questionnaires and Survey.

Data collection Method: A structured questionnaire is designed to capture responses regarding awareness, perception, preferences, and challenges related to EV adoption. The survey includes both closed-ended and Likert scale questions.

Sampling Design: Convenience sampling method is used to collect data due to accessibility and time constraints.
Sample Size: The Study is based on a sample of respondent 1005 from different urban cities from Gujarat such as Ahmadabad, Gandhinagar, Baroda, Surat, Bhavnagar, Rajkot, Junagadh and Jamnagar.

Data Analysis Tools and Tech: The collected data is analyzed using both qualitative and Quantitative Technique. Percentage, Charts and Graphs, Mean, Standard Deviation, Correlation Analysis. Statistical Tools such as a MS-Excel and Smart-PLS used.

III. MEASUREMENT MODEL (OUTER MODEL EVALUATION)

Indicator Reliability
- Factor Loadings should be **≥ 0.70**
- Acceptable range: **0.60–0.70 (if AVE is adequate)**

Internal Consistency Reliability
- **Cronbach's Alpha ≥ 0.70**
- **Composite Reliability (CR) ≥ 0.70**

Convergent Validity

- **Average Variance Extracted (AVE) ≥ 0.50**

Discriminate Validity
Use:
- **Fornell-Larcker Criterion**
- **HTMT Ratio ≤ 0.85 (or 0.90)**

Structural Model (Inner Model Evaluation)

Co linearity Test

- VIF values should be **< 5**

Path Coefficients (Hypothesis Testing)

- Use **Bootstrapping (5000 samples)**
- Accept hypothesis if:
  - **t-value > 1.96**
  - **p-value < 0.05**

Coefficient of Determination (R^2)

- 0.75 = Substantial
- 0.50 = Moderate
- 0.25 = Weak

Effect Size (f^2)

- 0.02 = Small
- 0.15 = Medium
- 0.35 = Large

Predictive Relevance (Q^2)

- $Q^2 > 0$ indicates predictive relevance

Outer Model Evaluation (Indicator Reliability)

Threshold Rule
- Ideal: **≥ 0.70**
- Acceptable: **0.60–0.70 (retain if AVE & CR are good)**
- Remove: **< 0.60**

Construct-wise Interpretation
ATT (Adoption Attitude)

- ATT1 = 0.783
- ATT2 = 0.752
- ATT3 = 0.740
  - **All values > 0.70 → Strong reliability**

CI (Consumer Awareness / Intention)

- CI1 = 0.738

- CI2 = 0.710
- CI3 = 0.698
  - Acceptable (CI3 slightly below 0.70 but can be retained)

EC (Environmental Concern)

- EC1 = 0.771
- EC2 = 0.683
- EC3 = 0.761
  - Acceptable (EC2 retained)

GI (Government Incentives)

- GI1 = 0.664
- GI2 = 0.740
- GI3 = 0.714
- GI4 = 0.700
  - Acceptable (GI1 slightly low but usable)

INF (Infrastructure)

- INF1 = 0.693
- INF2 = 0.779
- INF3 = 0.751
  - Good

OC (Cost Factors)

- OC1 = 0.734
- OC2 = 0.695
- OC3 = 0.716
- OC4 = 0.625
  - OC4 is low but still acceptable

PBC (Perceived Behavioral Control)

- PBC1 = 0.797
- PBC2 = 0.720
- PBC3 = 0.609
  - PBC3 is weak → consider removal if AVE is low

PEUC (Perceived Usefulness)

- PEUC1 = 0.811
- PEUC2 = 0.822
  - Strong

PI&A (Innovation Adoption)

- 0.664, 0.690, 0.688, 0.707
  - Acceptable

PN (Personal Norms)

- PN1 = 0.810

- PN2 = 0.830
  - Excellent

PUP&P (Willingness to Pay / Purchase)

- 0.747, 0.779, 0.676
  - Acceptable

P (Price/Willingness proxy)

- 0.827, 0.812
  - Strong

SB (Sustainable Behaviour)

- 0.665, 0.657, 0.723, 0.723
  - Two slightly low but acceptable

SEI (Self Image)

- 0.752, 0.739, 0.747
  - Good

SF (Social Factors)

- 0.739, 0.707, 0.751
  - Good

SI (Social Influence)

- 0.721, 0.722, 0.773
  - Good

Variables of the Study: Govt Incentives, Charging Infrastructure, Cost of Vehicle and Income, Gender, Marital Status, Social and Psychological factors. Consumer adoption of electric vehicle.

Hypotheses of the Study:

Awareness and Adoption

- **$H0_1$ (Null Hypothesis):** There is no significant relationship between consumer awareness and the adoption of electric vehicles.
- **$H1_1$ (Alternative Hypothesis):** There is a significant relationship between consumer awareness and the adoption of electric vehicles.

Cost Factor and Consumer Decision

- **$H0_2$:** The cost of electric vehicles does not significantly influence consumer purchase decisions.
- **$H1_2$:** The cost of electric vehicles significantly influences consumer purchase decisions.

Charging Infrastructure and Adoption

- **$H0_3$:** Availability of charging infrastructure has no significant impact on EV adoption.
- **$H1_3$:** Availability of charging infrastructure has a significant impact on EV adoption.

Environmental Concern and Purchase Intention

- **$H0_4$:** Environmental concern does not significantly affect consumers' intention to purchase EVs.
- **$H1_4$:** Environmental concern significantly affects consumers' intention to purchase EVs.

Government Incentives and Adoption

- **$H0_5$:** Government incentives and policies do not significantly influence EV adoption.
- **$H1_5$:** Government incentives and policies significantly influence EV adoption.

Social Influence and Consumer Behavior

- **$H0_6$:** Social influence has no significant effect on consumer behavior toward EV adoption.
- **$H1_6$:** Social influence has a significant effect on consumer behavior toward EV adoption.

Range Anxiety and Purchase Decision

- **$H0_7$:** Range anxiety does not significantly affect the consumer's decision to adopt EVs.
- **$H1_7$:** Range anxiety significantly affects the consumer's decision to adopt EVs.

Overall Barriers and Market Adaptation

- **$H0_8$:** There is no significant relationship between perceived barriers and the market adaptation of electric vehicles.
- **$H1_8$:** There is a significant relationship between perceived barriers and the market adaptation of electric vehicles.

Hypothesis	Relationship	Path Coefficient (β)	t-value	p-value	Result
H1	Awareness → EV Adoption				Supported / Not Supported
H2	Cost → EV Adoption				
H3	Charging Infrastructure → EV Adoption				
H4	Environmental Concern → EV Adoption				
H5	Govt. Incentives → EV Adoption				
H6	Social Influence → EV Adoption				
H7	Driving Range → EV Adoption				
H8	Willingness to Pay → EV Adoption				
H9	Perceived Usefulness → EV Adoption				
H10	Perceived Behavioral Control → EV Adoption				
H11	Self-Image → EV Adoption				
H12	Personal Norms → EV Adoption				
H13	Sustainable Behaviour → EV Adoption				
H14	Innovation Adoption → EV Adoption				

IV. FUTURE SCOPE OF THE STUDY:

- The present study on the market adaptation of electric vehicles (EVs) with respect to consumer behavior and barriers in Gujarat provides a foundational understanding of current trends and challenges. However, there are several avenues for future research that can further enhance insights into this evolving field.

- Firstly, future studies can expand the **geographical scope** beyond selected cities in Gujarat to include rural and semi-urban areas, where EV adoption is still at a nascent stage. This would provide a more comprehensive understanding of regional disparities in awareness, infrastructure, and consumer preferences.
- Secondly, researchers can conduct **comparative studies** between Gujarat and other Indian states to evaluate differences in policy effectiveness, infrastructure development, and consumer acceptance. Such comparisons can help identify best practices and successful models for accelerating EV adoption.
- Another important area for future research is the **longitudinal analysis of consumer behavior**. Since EV technology and policies are rapidly evolving, studying changes in consumer perception and adoption patterns over time would provide deeper insights into market dynamics.
- Further research can also focus on **technological advancements**, particularly in battery performance, charging speed, and vehicle efficiency, and how these innovations influence consumer decisions. Additionally, studies can explore the role of renewable energy integration with EV charging infrastructure.
- The **economic aspect** of EV adoption can be examined in greater detail by analyzing total cost of ownership, financing options, and resale value, especially in price-sensitive markets like Gujarat. This would help in understanding long-term affordability and financial viability for consumers.
- Moreover, future studies can incorporate **behavioral and psychological models** to better understand resistance to change, risk perception, and trust in new technologies. The inclusion of advanced statistical tools and models such as structural equation modeling (SEM) can provide more robust and reliable results.
- Lastly, research can explore the **impact of awareness campaigns, digital marketing, and social influence** on EV adoption. Understanding how information dissemination affects consumer behavior can help policymakers and businesses design more effective promotional strategies.
- In conclusion, the future scope of this study is vast, offering opportunities to explore deeper, broader, and more dynamic aspects of EV adoption. Such research will be essential in supporting policymakers, industry stakeholders, and society in achieving sustainable mobility and environmental goals.

V. FINDINGS OF THE STUDY:

- **Moderate Level of Consumer Awareness :**The study finds that consumers in Gujarat have a basic understanding of electric vehicles and their environmental benefits. However, detailed knowledge regarding battery technology, charging systems, and government incentives remains limited.

- **Positive Attitude but Low Adoption Rate :** Although many consumers show a positive attitude toward EVs due to environmental concerns, this does not strongly translate into actual purchase decisions. A significant gap exists between intention and adoption.

- **High Initial Cost as a Major Barrier :** The high upfront cost of electric vehicles is identified as one of the most critical factors discouraging consumers, especially in price-sensitive segments.

- **Inadequate Charging Infrastructure :** The availability of charging stations is still insufficient, particularly in semi-urban and rural areas. This leads to inconvenience and reduces consumer confidence in adopting EVs.

- **Prevalence of Range Anxiety :** Consumers express concerns about limited driving range and fear of battery depletion, which significantly affects their willingness to switch from conventional vehicles.

- **Influence of Government Policies is Limited:** While government incentives and subsidies are available, their awareness among consumers is relatively low. As a result, these policies have not reached their full potential in influencing purchase decisions.

- **Preference for Conventional and CNG Vehicles:** Many consumers still prefer petrol or CNG vehicles due to their lower initial cost, established infrastructure, and familiarity.

- **Role of Social Influence and Brand Trust :** Recommendations from family, friends, and brand reputation play an important role in shaping consumer decisions regarding EV adoption.

- **Concerns Regarding Battery Life and Resale Value:** Uncertainty about battery durability, replacement costs, and resale value negatively impacts consumer confidence.

- **Urban Areas Show Higher Adoption Potential :** Cities like Ahmadabad, Surat, Vadodra, and Rajkot demonstrate relatively higher awareness and willingness to adopt EVs compared to rural regions.

- **Need for Awareness and Education:** The study highlights a strong need for awareness campaigns to educate consumers about the long-term benefits, cost savings, and practical usability of EVs.

Overall, the findings indicate that while the potential for EV adoption in Gujarat is promising, several economic, infrastructural, and behavioral barriers continue to hinder its growth. Addressing these issues through improved infrastructure, better policy communication, and cost reduction strategies is essential to accelerate market adaptation.

VI. CONCLUSION:

The study on the market adaptation of electric vehicles (EVs) with respect to consumer behavior and barriers in Gujarat highlights that the transition toward sustainable mobility is gradually gaining momentum, but still faces significant challenges. While there is an increasing level of awareness and a generally positive attitude among consumers toward environmentally friendly transportation, this has not yet translated into widespread adoption of EVs.

One of the key conclusions of the study is that **consumer behavior plays a decisive role** in the adoption process. Factors such as cost sensitivity, perceived convenience, brand trust, and social influence strongly impact purchase decisions. Despite recognizing the environmental benefits of EVs, many consumers remain hesitant due to practical concerns.

The study also concludes that **economic barriers**, particularly the high initial cost of electric vehicles, continue to be a major obstacle. Even though government incentives and subsidies are available, their impact is limited due to low awareness and insufficient financial attractiveness for price-sensitive consumers. Additionally, **infrastructural limitations**, such as inadequate charging stations and long charging times, contribute to range anxiety and reduce consumer confidence.

Another important conclusion is that **information gaps and misconceptions** about EV technology—especially regarding battery life, maintenance costs, and resale value—further slow down adoption. These issues are more prominent in semi-urban and rural areas compared to urban centers.

However, the study also identifies strong growth potential in Gujarat's EV market. Urban regions show higher acceptance levels, and ongoing improvements in technology, policy support, and infrastructure development are expected to positively influence future adoption trends.

In conclusion, the successful market adaptation of electric vehicles in Gujarat requires a **holistic approach** involving multiple stakeholders. Policymakers need to strengthen awareness campaigns and enhance incentive structures, while manufacturers should focus on cost reduction and product reliability. Expanding charging infrastructure and improving consumer education will be critical in bridging the gap between intention and actual adoption. By addressing these challenges effectively, Gujarat can accelerate its transition toward sustainable and eco-friendly transportation.

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