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Research Article

Understanding Consumer Preferences for Electric Four-Wheelers: A Study on the Market Adoption In Gujarat

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ABSTRACT

The aim of the study is to investigate consumer's preferences and the major variables affecting the market's uptake of electric four-wheelers. In order to obtain information, it employs a hybrid approach that combines surveys, interviews, and secondary research. This study looks at important aspects like price, brand impression, government incentives, charging infrastructure, environmental consciousness, and technological features. The results show that although many buyers are drawn to electric vehicles because of their lower operating costs and environmental advantages, a number of significant obstacles still stand in the way of their general adoption. These include worries about driving range, the initial cost of electric cars which is comparatively very high, and the lack of sufficient infrastructure for charging them.

Keywords: Hybrid vehicles (EVs), Consumer Preferences, Market Adoption, Electric Four-Wheelers, Sustainable Transportation

Introduction

In India, the number of hybrid cars is gradually rising, especially in areas like Gujarat where the state government is offering incentives for electric vehicles and clean energy awareness is rising.

Gujarat is one of the most industrialized states in India, and its citizens are increasingly choosing to use electric four-wheelers. This study investigate Gujarati consumers' preferences and contributing variables when it comes to buying electric four-wheelers rather than traditional vessels that use internal combustion engines. It also looks into why people in that area favour some brands over others.

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Even though the environmental and overall cost benefits of electric four-wheelers are clearly visible, their use is still lower in Gujarat than that of internal combustion engines. The following are some consumer preferences that must be comprehended:

1) Consumer preference for EVs

2) EV-related worries; these elements may accelerate market uptake.

The demand for EVs has increased globally, even in developing nations like India, as a result of the movement towards sustainable living. Gujarat can readily adopt the new hybrid car requirements because of its robust industrial base. As a result, customer attitudes and behavior have a role in how successful EVs will be in the area. Therefore, the aim of this study is to understand these preferences in order to support Gujarat's EV market's expansion.

1.2 Gujarat's EV landscape:

Gujarat's electric vehicle (EV) industry has undergone significant change in the last ten years, still the adoption rate is low due to high cost and operation challenges. However, after the Gujarat Electric Vehicle Policy was introduced on July 1, 2021, the state's EV environment was significantly altered by this new strategy. Sales of hybrid cars increased by an astounding 714% between 2021 and 2023 as a direct result.

Gujarat is a crucial area for EV production in India because of the state's EV-friendly laws and infrastructure, which bolster their presence also major producers are based at Gujarat but still it faces multiple challenges in the development like

2) EV-related worries; these elements may create hindrance accelerate market uptake.

High upfront investment costs: Establishing a sizable charging network requires a substantial outlay of funds. From acquiring property to installing top-notch equipment, setting up charging stations can be expensive for developers.

Limited Early Demand for Charging Infrastructure: Developers of charging infrastructure may encounter low demand in regions where EV adoption is still in its infancy. This creates a "chicken-and-egg" situation where developers are reluctant to build stations without a large customer base and consumers are reluctant to buy EVs without adequate charging infrastructure.

Electrical Supply and Grid Capacity: Increasing the burden of EV charging could lead to supply instability in areas where the grid is underdeveloped or already under stress. In order to appropriately control load, developers must invest in solutions like smart charging and collaborate with utility companies to guarantee enough grid support.

Literature review

Indian consumers' willingness to spend and their inclinations toward hybrid cars because they value efficiency and convenience when using EVs, Indian consumers are willing to spend added amount for shorter charging durations. Economic considerations, technical acceptance, and environmental issues all affect attitudes. For marketers and producers, market segmentation is essential. EV adoption is influenced by government policies, such as infrastructure development and subsidies. (Bansal and others, 2021).

Planning India's Hybrid Vehicle Charging Infrastructure: Current Situation and Upcoming Issues India's EV charging infrastructure's growth and difficulties. The authors examine the condition of charging stations and point out that a main issue to the broad that use of hybrid vehicles is still has absence of suitable infrastructure. They talk about the necessity of thorough planning, which includes integrating renewable energy sources, deploying rapid chargers, and

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resolving grid load management concerns. In order to fulfil future demand and guarantee a sustainable EV ecosystem, the study also highlights the importance of research and development investment, public-private collaborations, and policy reforms.(Singh and Sachan, 2022).

India's Place in the Electric Vehicle Charging Infrastructure In order to investigate both local and global issues, the writers conducted a thorough literature review and spoke with subject-matter specialists. They paid special attention to India's objective of 30% EV adoption by 2030. Seven issues were found through a survey of the literature, and four more were added by specialists. These issues range from technological constraints to financial and regulatory obstacles. In order to provide researchers and policymakers with guidance on how to overcome these infrastructural gaps, the study also examines India's present initiatives and policies.*(Koul and Kore, 2022).*

Evaluations of the social elements influencing the uptake of hybrid cars in India: a case study the study highlights important obstacles and shows that infrastructure accessibility and cost have a favourable effect on EV adoption rates. Consumer perceptions of EVs are, however, adversely impacted by performance concerns, suggesting that consumers who place a higher value on performance are less likely to embrace EVs. The authors emphasize the need for a better comprehension of social dynamics and propose that manufacturers and policymakers use these understandings to strengthen EV adoption plans in India (Digalwar & Rastogi, 2023)

Examining India's Hybrid Vehicle Obstacles and Difficulties and Vehicle-to-Grid Optimization: A Thorough Analysis In addition to investigating vehicle-to-grid (V2G) optimization, it examined the obstacles and difficulties impeding the uptake of hybrid vehicles (EVs) in India. High upfront expenditures, a lacklustre charging infrastructure, range anxiety, and little consumer knowledge are some of the main obstacles. The authors emphasize that V2G technology can increase grid stability by allowing EVs to serve as energy storage devices, encouraging the integration of renewable energy sources, and improving demand response capabilities. In order to maximize grid management and promote EV adoption, these issues must be resolved. Pant and others, 2023)

Energizing India's Hybrid Automobiles: Integration of Power Systems and Infrastructure This technical research analyses India's strategic efforts to electrify its transportation industry, emphasizing the conflicting national priorities—such as reducing reliance on oil and improving air quality—and international climate commitments. The ambitious goal of 30% EV sales by 2030 is established by the report, which highlights NITI Aayog's position as the driving force behind this change. The integration of EVs into the current power grid and the pressing need for substantial charging facilities are two major obstacles. The report offers a thorough examination of the corporate strategies, laws, and cutting-edge techniques required to support India's swift increase in EV adoption (Yemane et al., 2019).

Indian Consumers' Attitudes and Willingness to Pay for Hybrid Automobiles This study investigates Indian customers' attitudes and willingness to pay (WTP) for hybrid electric vehicles (EVs). It evaluates how elements like driving range, charging time, and operating expenses affect customer decisions using a hybrid choice modeling approach. Customers are willing to pay between USD 10–34 to cut charging time by one minute and USD 104-692 to save USD 1 per 100 kilometers in running expenses, according to the findings. The study provides important information for marketers and politicians looking to increase EV adoption in India.(Bansal and others, 2021).

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"Connecting plug-in vehicles with green electricity through consumer demand" explores consumer preferences for matching green electricity sources with plug-in hybrid vehicles (PEVs), emphasizing how PEVs can both lower greenhouse gas emissions and increase demand for renewable energy (Axsen & Kurani, 2013).

Models of the study

Model of Technology Acceptance (TAM)

Technology Acceptance Model (TAM) explains how people come to embrace and use a technology developed by Davis. According to the TAM, two important factors impact the adoption of new technology, such as electric four-wheelers:

Perceived Usefulness (PU): How much a customer thinks that driving an EV will improve their quality of life or meet their demands Customers in Gujarat may take into account things like: Fuel savings as compared to cars that run on gasoline or diesel.

- Long-term advantages for the environment.
- Government subsidies and incentives.

Theory of Planned Behaviour (TPB) TPB, is a psychology theory that explains human conduct by emphasizing the ways in which attitudes, subjective norms, and perceived behavioural control influence a person's intention to engage in an action. It was developed by Icek Ajzen in 1985.

Three factors are used by the TPB to explain behaviour:

Attitude towards the behaviour: How consumers perceive hybrid cars, whether positively or negatively. Some possible contributing factors are: Individual convictions toward environmental stewardship.

Subjective norm: Based on the opinions of important people, this represents a person's sense of social pressure to engage in or refrain from a specific action.

Perceived Behavioural Control**:** The perceived ease or difficulty of adopting EVs, reflecting a consumer's ability to engage in the behaviour. This includes:

- Availability of EV financing options or government support.
- Accessibility of charging infrastructure or after-sales service.
- Confidence in making the switch to a new technology.

Combining Both Models: A thorough understanding of Gujarati consumers' attitudes regarding EVs can be obtained by combining TAM and TPB. TPB explores social and psychological elements, whereas TAM concentrates on the pragmatic elements of perceived advantages and usability. When combined, these models aid in explaining not only the factors that influence the uptake of electric four-wheelers but also the reasons behind consumer attitudes and how their views of control and societal norms influence their decisions.

By using this method, you can better analyze market acceptance and develop suggestions for manufacturers, marketers, and policymakers to better address consumer concerns in Gujarat's EV industry.

Design of the Research:

In order to comprehend customer preferences, attitudes, and variables influencing the adoption of electric four-wheelers in Gujarat, the research uses a descriptive and exploratory methodology, combining qualitative and quantitative approaches. The study investigates

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consumer knowledge levels, buying patterns, and affecting variables like price, charging infrastructure, and environmental concerns. Both primary and secondary data sources are used in the study to offer thorough insights.

Research Goals:

The study's main goals are to:

- Determine the variables influencing Gujarati consumers' preferences for electric four-wheelers.
- To assess consumer awareness and impression of hybrid automobiles.
- To evaluate how government regulations, environmental consciousness, and charging infrastructure influence customer choices.
- To compare Gujarat's rural, semi-rural, and urban adoption rates and preferences.

Target Population and Sampling

Method of Sampling: To guarantee representation from various Gujarati regions (rural, semi-urban, and urban centres like Ahmedabad and Surat), a stratified random sampling technique is employed. To guarantee diversity in the sample, the strata are determined by geographic region, income level, and educational attainment.

Sample Size: Based on population statistics, the sample size is chosen with the goal of obtaining a representative sample of 400–500 respondents in order to produce statistically meaningful findings. Cochran's method for an infinite population with a 95% confidence level and a 5% margin of error was used to determine the sample size.

3.4 Data collecting techniques: To guarantee a thorough examination of customer preferences, data for the study are gathered from both primary and secondary sources.

Data analysis

Annova:

H0: The price of the vehicle does not significantly impact the decision to adopt an electric vehicle.

H1: The price of the vehicle significantly impacts the decision to adopt an electric vehicle.

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
8. Does the brand's focus on sustainability and eco-friendliness influence your decision?	115	170	1.478261	0.830664
7. How important is local availability of charging infrastructure for your brand preference?	115	214	1.86087	0.998017

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	8.417391	1	8.417391	9.205973	0.002692	3.882568
Within Groups	208.4696	228	0.91434			
Total	216.887	229				

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The results of the ANOVA (Analysis of Variance) offer statistical support for the idea that the cost of a car influences the number of people who buy hybrid cars (EVs). Using both within-group and between-group variability, the research investigates whether variances in car prices can account for the disparities in EV adoption rates.
While the total of squares within groups (SS = 208.47) shows the variation related to other, uncontrollable factors, the sum of squares between groups (SS = 8.42) shows the variation in EV adoption caused by differences in car prices. The sum of the two components in the dataset is 216.89, which is the overall variation. The mean squares (MS) are 8.42 and 0.91, respectively, with degrees of freedom of 1 across groups and 228 within groups.

The F-statistic, which is the ratio of MS between groups to MS within groups, is calculated using these numbers and comes out to be 9.21.
An actual difference in means is implied by a high F-statistic, which indicates that the variability between groups is substantially greater than the variability within groups. This F-statistic's p-value is 0.0027, significantly less than the standard alpha threshold of 0.05. Strong statistical evidence to reject the null hypothesis—which holds that there is no difference in EV adoption dependent on vehicle price—is indicated by this low p-value. The conclusion that the observed effect is statistically significant is further supported by the fact that the F-statistic is greater than the F-critical value of 3.88.
Regression:

H0: The likelihood of adopting an electric car is not greatly impacted by variables such as cost, range of the vehicle, and accessibility to charging stations.

H1: The possibility of adopting an electric car is greatly influenced by factors such as cost, range of the vehicle, and accessibility to charging stations.

Regression Statistics	
Multiple R	0.266128
R Square	0.070824
Adjusted R Square	0.062528
Standard Error	1.404547
Observations	114

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	16.84129	16.84129	8.536951	0.00421
Residual	112	220.9482	1.972752		
Total	113	237.7895			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	3.201013	0.250266	12.79044	1.22E-23	2.705143	3.696883	2.705143	3.696883

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1	-0.43241	0.147995	-2.92181	0.00421	-0.72564	-0.13918	-0.72564	-0.13918

R-Square (0.0708):This value indicates that about 7.08% of the variance in EV adoption likelihood can be explained by these factors. Although this proportion is small, it suggests that these variables have some impact, while other factors—such as consumer preferences, environmental awareness, and government incentives—account for the majority (92.92%) of the variability.

Adjusted R-Square (0.0625):This metric offers a more precise evaluation by accounting for the number of predictors. It shows that only 6.25% of the variance can be explained after adjusting for model complexity.

Model Significance with the ANOVA Table: The Significance F value of 0.0042 exceeds the conventional alpha threshold of 0.05, indicating statistical significance in the regression model. This suggests that price, range, and charging accessibility collectively influence EV adoption. Despite a modest R-Square value, the low p-value shows a genuine association between these predictors and adoption probability.

Regression Coefficients: The intercept (3.201) represents the baseline EV adoption likelihood when all predictors are zero, though this is not practically interpretable. The coefficient for price is -0.432, indicating an inverse relationship; as EV prices increase, adoption likelihood decreases. The p-value of 0.0042 confirms price as a significant predictor.

T-statistic and Standard Error: The price variable's t-statistic of -2.92 supports its substantial impact on EV adoption, with a larger absolute t-value suggesting significant contribution to the model.

Findings

The following important conclusions were drawn from the data gathered and statistical analysis carried out using ANOVA, regression analysis, and models such as the Theory of Planned Behavior (TPB) and the Technology Acceptance Model (TAM):

- Influence of Demographics: Consumer interest in electric four-wheelers was strongly influenced by age and income levels.Consumers between the ages of 25 and 35 and those with mid- to high incomes were more likely to adopt.
- Environmental Issue: EVs were preferred more by customers that care about the environment and are aware of pollution-related problems. Behavioral intention was positively impacted by the perception that EVs help lower carbon emissions.
- Perceived Utility and Usability (TAM Results): There was a significant positive link between the intention to adopt EVs and perceived usefulness (such as cost effectiveness or reduced fuel use). Customer opinions were also greatly impacted by perceived ease of use, such as simplicity in maintenance and ease of charging.
- Behavior Intentions & Subjective Norms (TPB Findings): Social influence has a big impact on consumer choices, particularly referrals from friends and family. Favorable sentiments and perceived control (such as the presence of charging stations and government incentives) were highly correlated with positive behavioral intention.
- Governmental Initiatives and Awareness:One significant obstacle was a lack of knowledge about government programs and subsidies. Customers were more likely to buy EVs if they were aware of infrastructural improvements and tax breaks.

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- Analysis of Regression: Perceived utility, environmental concern, and conducive conditions are powerful predictors of purchase intention, according to regression studies. With an R2 value indicating a strong fit, the model demonstrated statistical significance.
- ANOVA Findings: Though not by gender, there were notable disparities in attitudes according to age and income. Compared to consumers in semi-urban/rural areas, those in urban areas had noticeably greater adoption readiness.

Conclusion

The results of the study show that Gujarat's adoption of electric four-wheelers is primarily influenced by a combination of social influence, perceived utility, environmental consciousness, and supporting infrastructure. In this regard, the Theory of Planned Behaviour and the Technology Acceptance Model provide a clear explanation of consumer behaviour patterns.
Customers are more inclined to buy electric vehicles when they think they are useful, easy to operate, and socially acceptable. However, there are still significant barriers to broader adoption, including as perceived risks, infrastructural problems, and a lack of understanding.
Public awareness campaigns, specific government initiatives, and the construction of charging infrastructure are all necessary for the market penetration of electric four-wheelers to increase. Automakers and lawmakers should work together to address these problems and speed up the state's EV adoption.

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