

An Analysis of Consumer Challenges in the Adoption of Electric Vehicles in Kannur City

Shimjith Moolayil

*Assistant Professor & Head, PG Department of Commerce National College of Arts and Science,
Puliyavu, Kozhikode*

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Abstract—The movement toward sustainable transportation has generated heightened attention regarding electric vehicles (EVs), yet their broader market penetration remains hindered by financial, technical, structural, and behavioral obstacles. This investigation evaluates the obstacles encountered by consumers in the adoption and utilization of electric vehicles within Kannur City and assesses the impact of specific socio-economic variables on EV adoption. Primary data were obtained from consumers through a structured questionnaire administered via convenience sampling. A total of 100 responses were received, with 95 responses deemed suitable for study. Percentage analysis, Garrett ranking technique, and binary logistic regression were used for data analysis. The Garrett ranking analysis identifies costly battery replacement as the principal obstacle, trailed by substantial upfront purchase costs, limited availability of EV variants, apprehensions regarding battery durability, and difficulties in accessing charging infrastructure. The logistic regression results indicate that age, education, and occupation have a significant influence on EV adoption, while gender, monthly income, and family size are not statistically significant. The study highlights the necessity of mitigating financial and battery-related impediments, enhancing consumer knowledge, and reinforcing the foundational infrastructure to promote increased adoption of electric vehicles in Kannur City.

Index Terms—Electric Vehicles, EV Adoption, Consumer Challenges, Socio-economic Factors, Garrett Ranking, Kannur City

I. INTRODUCTION

The global automotive sector is experiencing a notable transition towards sustainable mobility, primarily influenced by environmental issues, technological advancements, and evolving infrastructure. Electric vehicles (EVs) present a

crucial solution in the worldwide efforts to address climate change, particularly as the transportation industry contributes significantly to greenhouse gas emissions (Vivek et al., 2025). The swift rise in environmental awareness, coupled with escalating fuel costs and the exhaustion of traditional energy sources, has spurred the development and acceptance of electric vehicles (EVs) globally. The appeal of Electric Vehicles (EVs) has surged as a response to environmental challenges, propelled by technological progress and favorable government initiatives. More and more, both consumers and industries are opting for EVs to mitigate carbon emissions, with global sales anticipated to hit 12 million units by 2025 and nearly double to 23 million units by 2030, expanding at an average annual growth rate of approximately 21 percent (IEA, 2023).

Notwithstanding these initiatives, the rate of adoption and utilization of electric vehicles among consumers remains comparatively sluggish when juxtaposed with traditional vehicles. The environmental advantages of electrification can be considerable; however, the adoption of electric vehicles in the United States is hindered by a variety of enduring barriers associated with cost, financing, and charging infrastructure, which have been intensified by the intricacies of the global supply chain within the automotive industry. Furthermore, there are equity issues regarding access to electric vehicles for lower-income demographics, and the complexities of the protracted value chain encompass shortages of raw materials and components, challenges in battery recycling, elevated production costs, fragmentation in production, manufacturer relocation, as well as inefficient and carbon-heavy production methods. The most pressing challenges within the supply chain pertain to the essential minerals required for battery

technology, shortages of semiconductors, and restrictions related to offshore operations (Trost and Dunn, 2023; Woodley et al, 2024).

Consumer perception regarding EV adoption is a complex construct shaped by environmental attitudes, cost-benefit evaluations, technological trust, social norms, and policy frameworks.(Vivek et al. 2025).Itemphasizes the significance of information dissemination, government intervention, and changing market dynamics in shaping consumer attitudes. It is essential to comprehend and tackle these perceptual barriers to enhance the global and Indian adoption of electric vehicles (EVs). Against this study focuses on major challenges faced by consumers in adoption and usage of electric vehicles with special reference to Kannur city

II. REVIEW OF LITERATURE

James et al. (2022) identified technical challenges as the primary barrier to electric mobility in India, particularly issues related to battery technology, charging infrastructure, driving range, and power availability. Using Analytic Hierarchy Process (AHP) and Decision Making Trial and Evaluation Laboratory (DEMATEL) methodologies, it assigns significant weight (48.8%) to technical barriers and shows their influence in causing other barriers. Market, economic, policy, and infrastructure barriers are also identified as distinct challenges to electric vehicle (EV) adoption. Muthulakshmi et.al (2024) revealed that India already has the infrastructure necessary for the general usage of fuel-powered automobiles. The majority of electric vehicles (EVs) use lithium-ion batteries, and India is in a position to buy these batteries from other nations. Infrastructure is the most significant of many challenges to the adoption of EVs in India. India currently has adequate infrastructure, but it is not enough for India's long-term objectives. The barriers that are being mentioned here are primarily focused on the zero-emission future goal. A few suggestions are made in order to help India reach its goal of having no emissions by 2070.Apurva et.al (2024) revealed the influential factors over individuals' desire to adopt an EV were categorized into four main types (contextual, situational, demographic, and psychological); situational factors, which can act as both barriers and motivators, had the most

influencing components. The most cited barriers to adoption of EVs were found to be the lack of charging stations availability and their limited driving range. The most cited motivators to EV adoption were found to be reduction in air pollution and the availability of policy incentives. The findings of this study may guide policymakers in formulating effective transportation and energy policies, as well as provide guidance to those who are responsible for designing EVs that fit the needs and demands of potential consumers.Vidhyasree (2025) points out that the lack of sufficient charging infrastructure continues to be a major obstacle for EV adoption in India. To alleviate supply chain risks, India must ensure access to resources for batteries and encourage domestic mining and recycling capabilities. It is vital to establish a strong battery recycling and disposal infrastructure to address the environmental and health risks associated with end-of-life (EOL) EV batteries.

III. NEED FOR THE STUDY

The escalating apprehension regarding environmental deterioration, climate change, elevated energy expenses, and reliance on traditional energy sources has amplified the significance of electric vehicles as a substitute transportation option. The shift toward electric vehicles from conventional automobiles can play a role in decreasing fossil fuel dependency and advancing sustainable transportation solutions. Despite the rising utilization of electric vehicles, consumer adoption continues to be shaped by multiple economic, technological, infrastructural, and behavioral considerations.Future buyers encounter numerous obstacles when considering electric vehicle adoption, including substantial upfront expenses, costly battery replacements, uncertainties about battery durability, restricted travel distance per charge, prolonged charging periods, sparse charging station networks, minimal vehicle variety, and insufficient technical expertise. The presence and convenience of charging infrastructure alongside reliable after-sales support significantly shape consumer readiness to transition to electric vehicles. Recognizing these impediments is essential for pinpointing barriers that may hinder broader EV market penetration and utilization.

Kannur City represents an ideal location for investigating these concerns, as residents from

varying economic backgrounds are increasingly engaging with electric mobility solutions. Nevertheless, consumer perspectives and assessments of the practical and financial hurdles associated with EV adoption may diverge considerably among different socio-economic segments. Consequently, examining the socio-economic composition of consumers, categorizing and prioritizing their primary obstacles, and evaluating correlations between socio-economic factors and EV adoption intentions becomes imperative. This study initiative aims to deliver empirical insights into the obstacles hindering electric vehicle adoption within Kannur City. The results may offer valuable perspectives on consumer apprehensions and furnish pertinent data for EV manufacturers, service providers, infrastructure developers, and policymakers seeking to overcome impediments concerning expenses, battery technology, charging infrastructure, consumer knowledge, and ancillary support systems.

IV. OBJECTIVES OF THE STUDY

- To study the socio-economic profile of selected electric vehicle consumers.
- To identify the major challenges faced by consumers in adoption and usage of electric vehicles.
- To study the influence of socio-economic factors on consumers' intention to adopt electric vehicles.

V. METHODOLOGY

The research is both descriptive and analytical in its approach. It aims to identify and examine the challenges that consumers face in adopting electric vehicles in Kannur City. As one of the emerging urban centers in Kerala, Kannur City has begun to witness a gradual rise in the use of electric vehicles, driven by increased environmental awareness and favorable government policies. Nevertheless, consumers in Kannur may still face practical challenges concerning charging infrastructure, availability of services, and technical knowledge. This study utilizes both primary and secondary data sources. Primary data will be gathered directly from consumers through a structured questionnaire, while secondary data will be sourced from research journals, books, government publications, and reports from the electric vehicle industry. A convenience sampling method has been employed to select participants. A total of 100 respondents were chosen for the study based on the availability of time and data. However, after verifying the data, five samples were found to be unsuitable, resulting in a final sample size of 95 respondents. The data collected will be analyzed using various statistical methods, including percentage analysis, multiple regression analysis and Garrett ranking techniques

VI. FINDINGS OF THE STUDY

The socio-economic profile of the respondents provides an overview of the characteristics of the respondents participating in the study on the adoption of electric vehicles .

Table 1 Socio-Economic Profile of the Selected Respondents

Particulars		Frequency	Percentage
Gender	Male	77	81.0
	Female	18	19.0
Age	Below 35 years	29	30.5
	35-45 years	47	49.5
	Above 45 years	19	20.0
Education	Under graduate	64	67.4
	Post graduate	31	32.6
Occupation	Business	48	51.0
	Employees	47	49.0

Monthly Income	Below 25000	17	17.9
	25000-50000	45	47.4
	Above 50000	33	34.7
Family size	Less than 3 members	27	28.4
	3-5 members	52	54.7
	Above 5 members	16	16.8
Total		95	100

Source: Field Survey, 2026

The demographic profile of the respondents reveals that a majority of the respondents were male. Out of the total 95 respondents, 77 respondents (81.0 per cent) were male, while only 18 respondents (19.0 per cent) were female. This indicates that male respondents constituted the dominant group in the study. With regard to age, the majority of the respondents belonged to the age group of 35–45 years. A total of 47 respondents (49.5 per cent) were in the 35–45 years category, followed by 29 respondents (30.5 per cent) who were below 35 years, and 19 respondents (20.0 per cent) who were above 45 years. This shows that middle-aged individuals formed the major portion of the sample. In terms of educational qualification, most of the respondents were undergraduates. About 64 respondents (67.4 per cent) possessed undergraduate qualifications, whereas 31 respondents (32.6 per cent) were postgraduates. This indicates that the respondents were reasonably educated and capable of understanding the subject of the study. Regarding

occupation, 48 respondents (51.0 per cent) were engaged in business activities, while 47 respondents (49.0 per cent) were employees. The distribution shows that both business people and employees were almost equally represented in the study.

With respect to monthly income, a large proportion of the respondents belonged to the income group of ₹25,000–₹50,000. Around 45 respondents (47.4 per cent) earned between ₹25,000 and ₹50,000 per month, followed by 33 respondents (34.7 per cent) earning above ₹50,000, and 17 respondents (17.9 per cent) earning below ₹25,000. This indicates that the majority of the respondents belonged to the middle-income category. The preponderance of respondents (54.7 per cent) are members of households comprising 3–5 individuals, establishing this as the dominant family-size classification within the sample. Approximately 28.4 per cent of respondents originate from families with fewer than 3 members, whereas 16.8 per cent are affiliated with families exceeding 5 members

Table-2 Adoption of Electric Vehicles among Respondents

Particulars		Frequency	Percentage
Adoption of Electric Vehicles	Yes	62	65.3
	No	33	34.7
Total		95	100.0

Source: Field Survey, 2026

The above table shows the adoption status of electric vehicles among the respondents. Out of the total 95 respondents, 62 respondents (65.3 per cent) have adopted electric vehicles, while 33 respondents (34.7 per cent) have not adopted electric vehicles. The findings indicate that a majority of the respondents have adopted electric vehicles. However, a

considerable proportion of respondents have not yet adopted electric vehicles, indicating that certain economic, technological, infrastructural, and other challenges may continue to influence consumers' decisions regarding the adoption and usage of electric vehicles.

Table 3 Garrett Ranking of Challenges Faced by Consumers towards Adoption of Electric Vehicles

Challenges	Garrett Score	Rank
Elevated Initial Acquisition Expenditure	50.18	2

Insufficient Charging Station Network	33.50	13
Extended Charging Duration Impedes Electric Vehicle Market Penetration	38.89	9
Restricted Operational Range	45.23	6
Expensive Battery Replacement	53.87	1
Inadequate Charging Infrastructure Development	37.56	10
Limited Public Knowledge Regarding Electric Vehicle Technology	44.41	7
Scarcity of Authorized Service Facilities	27.78	14
Insufficient Availability of Qualified Technical Personnel	37.14	11
Concerns Regarding Battery Longevity	48.04	4
Challenges in Locating Charging Amenities	46.39	5
Restricted Selection of Available Electric Vehicle Models	49.78	3
Battery Safety Apprehensions Present Significant Obstacles	34.67	12
Uncertainty about Government Regulatory Frameworks and Financial Incentive Programs	40.14	8

Source: Field Survey, 2026

The Garrett ranking analysis demonstrates that Expensive Battery Replacement constitutes the most significant challenge as perceived by consumers, achieving the highest Garrett score of 53.87 and attaining Rank 1. This finding suggests that the substantial financial implications of battery replacement represent a critical concern affecting consumers' decisions regarding EV adoption. Elevated Initial Acquisition Expenditure occupies the second position with a Garrett score of 50.18, reflecting that the comparatively substantial upfront investment required for electric vehicle purchase constitutes another substantial impediment. Restricted Selection of Available Electric Vehicle Models occupies the third position with a score of 49.78, demonstrating that constrained model availability may similarly restrict consumers' propensity to embrace electric vehicle adoption. Apprehensions concerning battery longevity attains the 4th position with a score of 48.04, demonstrating consumer apprehensions regarding the durability and anticipated operational lifespan of electric vehicle batteries. Difficulties in identifying charging infrastructure ranks in the 5th position with a score of 46.39, succeeded by constrained operational range at the 6th position with a score of 45.23. These results demonstrate that charging availability and vehicle range constitute essential practical factors. Inadequate public awareness of electric vehicle technology occupies the 7th position, with a Garrett score of 44.41. This indicates that limited awareness and comprehension of electric vehicle technology

may represent an additional substantial impediment. Uncertainty about government regulatory structures and financial incentive mechanisms ranks in the 8th position with a score of 40.14, signifying certain concern pertaining to the transparency and predictability of governmental policies and financial incentives.

Extended charging duration impedes electric vehicle market penetration occupies the 9th position with a Garrett score of 38.89, whereas inadequate charging infrastructure development holds the 10th position with a score of 37.56. insufficient availability of qualified technical personnel ranks 11th, achieving a Garrett score of 37.14. Among the lower-ranked challenges, Battery safety apprehensions present significant obstacles ranks 12th with a score of 34.67, and insufficient charging station network ranks 13th with a score of 33.50. Scarcity of authorized service facilities demonstrates the lowest Garrett score of 27.78 and ranks 14th, indicating that this represents the least significant challenge among the examined factors. The research findings demonstrate that financial and battery-related concerns dominate the highest rankings, specifically battery replacement costs, initial purchase expenditure, battery durability, and EV model availability. Charging-related and operational challenges also maintain several prominent positions. Conversely, authorized service facilities, charging station accessibility, and technical personnel availability demonstrate comparatively lower Garrett scores relative to the predominant cost and battery-related concerns. Meanwhile

Chidambaram et al. (2022) identified high cost and inadequate charging infrastructure as major barriers to EV adoption in developing countries. The study emphasized the importance of government incentives

and policy support in promoting EV adoption, supporting the present study's focus on cost and charging-related challenges faced by consumers.

Table 4 Logistic Regression Results on Socio-Economic Factors Influencing Electric Vehicle Adoption

Variables	B	S.E.	Wald	df	Sig.	Exp(B)
Gender	0.076	0.127	0.358	1	0.550	1.079
Age	0.185	0.076	5.887	1	0.015*	1.203
Education	0.395	0.071	30.647	1	0.000*	1.484
Occupation	-0.344	0.167	4.244	1	0.039*	0.709
Monthly income	0.153	0.149	1.054	1	0.304	1.165
Family size	-1.712E-6	0.000	0.905	1	0.341	1.000
Constant	-1.575	0.470	11.243	1	0.001*	0.207
-2 Log Likelihood	1456.586					
Nagelkerke R ²	0.053					
Hosmer–Lemeshow χ^2	14.346					
Overall Classification Accuracy	69.6%					

Dependent Variable: Adoption Of Electric Vehicles
Source:Primary Data,2026

The binary logistic regression analysis was conducted to examine the influence of selected socio-economic factors on the adoption of electric vehicles. The results indicate that Age, Education, and Occupation have a statistically significant influence on the dependent variable at the 5 per cent level, while Gender, Monthly Income, and Family Size do not have a statistically significant influence. The coefficient for Gender is 0.076 with a significance value of 0.550, which is greater than 0.05. Therefore, gender does not have a statistically significant influence on the dependent variable. The odds ratio of 1.079 indicates that the estimated odds associated with gender are approximately 1.079 times the reference category, although this effect is not statistically significant.

Age has a positive coefficient of 0.185 and a significance value of 0.015, indicating a statistically significant relationship at the 5 per cent level. The odds ratio of 1.203 suggests that a one-unit increase in age is associated with approximately a 20.3 per cent increase in the odds of the outcome, holding the

other variables constant. Education has a positive coefficient of 0.395 and a significance value of 0.000. Since the significance value is below 0.05, education has a statistically significant influence on the dependent variable. The odds ratio of 1.484 indicates that a one-unit increase in the education variable is associated with approximately a 48.4 per cent increase in the odds of the outcome, ceteris paribus. Occupation has a negative coefficient of -0.344 with a significance value of 0.039, indicating a statistically significant relationship at the 5 per cent level. The odds ratio of 0.709 indicates that a one-unit increase in the occupation variable is associated with approximately a 29.1 per cent decrease in the odds of the outcome, holding the other variables constant. Monthly Income has a coefficient of 0.153 and a significance value of 0.304. Since the significance value is greater than 0.05, monthly income does not have a statistically significant influence on the dependent variable. The odds ratio of 1.165 indicates an estimated increase in the odds, but the relationship is not statistically significant. Similarly, Family Size

has a coefficient of $-1.712E-6$ and a significance value of 0.341. Since the significance value exceeds 0.05, family size does not have a statistically significant influence on the dependent variable. The odds ratio of 1.000 indicates a negligible estimated change in the odds.

The model has a $-2 \text{ Log Likelihood}$ value of 1456.586. The Cox & Snell R^2 is 0.038, while the Nagelkerke R^2 is 0.053. Thus, the Nagelkerke R^2 indicates that approximately 5.3 per cent of the variation in the dependent variable is explained by the socio-economic variables included in the model. The Hosmer–Lemeshow test reports a chi-square value of 14.346 with 8 degrees of freedom and a significance value of 0.073. Since the significance value is greater than 0.05, the test is not statistically significant, indicating that there is no statistically significant difference between the observed and predicted values and that the model has an acceptable fit according to this test. The overall classification accuracy is 69.6 per cent, indicating that the model correctly classifies 69.6 per cent of the observations based on the selected predictors. Overall, the results show that Age, Education, and Occupation are statistically significant predictors, whereas Gender, Monthly Income, and Family Size are not statistically significant predictors in the model.

VII. CONCLUSION

The research demonstrates that a substantial majority of respondents have embraced electric vehicle technology. This finding suggests that electric vehicles have achieved meaningful market penetration among the surveyed population; however, a noteworthy segment of non-adopters persists, suggesting that economic constraints, technological limitations, infrastructural gaps, and other factors continue to shape consumer decisions regarding electric vehicle adoption and utilization. The Garrett ranking analysis identifies expensive battery replacement as the predominant obstacle encountered by consumers, trailed by high upfront purchase costs, limited availability of electric vehicle models, apprehensions about battery durability, and difficulty accessing charging infrastructure. These results underscore that acquisition expenses, battery-related apprehensions, model diversity, and charging accessibility represent critical determinants affecting

consumer adoption and usage patterns of electric vehicles.

The binary logistic regression analysis demonstrates that age, education, and occupation significantly predict electric vehicle adoption, while gender, monthly income, and family size do not exhibit statistically significant effects. The model achieved a Nagelkerke R^2 value of 0.053, and the Hosmer–Lemeshow test confirmed adequate model fit. This study reveals that despite relatively strong electric vehicle adoption rates among participants, multiple obstacles continue to impede their widespread adoption and utilization. Key interventions including reducing battery replacement expenses, expanding charging infrastructure, broadening the range of available EV models, enhancing technical and maintenance support services, and raising consumer knowledge and awareness could foster a more favorable ecosystem for accelerated electric vehicle adoption throughout Kannur City.

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