Identifying and Ranking Barriers to Electric Vehicle Adoption among First-Time and Second-Time Potential Buyers in India: A Delphi-AHP Approach

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Abstract
India's push toward electric mobility is critical for addressing urban pollution, reducing carbon emissions, and achieving sustainable transportation goals. However, the transition to electric vehicles (EVs) faces substantial resistance due to multidimensional barriers varying across consumer segments. This study identifies and prioritizes these barriers by examining two groups: first-time and second-time potential EV buyers, providing actionable insights for differentiated policy and market interventions.
A three-phase research design was employed. First, a comprehensive literature analysis identified 25 obstacles across five dimensions: technological, infrastructural, financial, social, and policy-related. Using the Delphi approach, expert evaluations from 30 participants—15 from each consumer segment—identified the top ten essential problems for each group. These were evaluated using the Analytic Hierarchy Process (AHP) to determine relative importance.
Findings reveal that while range anxiety and inadequate charging infrastructure are universally critical, first-time buyers prioritize performance concerns and social influence, whereas second-time buyers are more influenced by economic factors, technological skepticism, and policy clarity.
The study offers segment-specific recommendations—ranging from infrastructure enhancement and performance assurance to financial incentives and transparent policies—to accelerate India's EV transition. It also provides implications for entrepreneurs and SMEs developing EV-related solutions. By identifying barriers across segments, the study supports innovation in sustainable business models—such as localized charging networks, battery leasing, and digital mobility platforms—strengthening Asia's green entrepreneurial ecosystem and contributing to literature by integrating comparative consumer perspectives into a structured prioritization framework.

Keywords: Electric Vehicle Adoption, Delphi Method, Analytic Hierarchy Process, EV Barriers, Sustainable Entrepreneurship, Indian EV Market

1. Introduction

The rising popularity of electric cars (EVs) is driving a substantial revolution in India's automotive industry. This move to electric mobility is more than just a technological progression; it is a critical component of India's larger strategic objectives to reduce carbon emissions, reduce urban air pollution, and support long-term economic growth. As the world's fifth-largest automobile market, India's transition to electric vehicles has significant promise for environmental sustainability and economic resilience, closely aligning with global climate change goals. (Gupta, 2024). This transition also unlocks new entrepreneurial opportunities in the EV value chain—ranging from charging infrastructure and renewable energy integration to software-based fleet management and component manufacturing. SMEs and start-ups play a pivotal role in translating sustainability goals into scalable business innovations, aligning directly with Asia's sustainable development agenda.

Despite the bright outlook, various obstacles continue to prevent mainstream EV adoption in India. Among these, the high initial cost of electric vehicles—primarily driven by pricey battery technologies—presents significant financial barriers that hinder potential purchasers (Adhikari et al., 2020; Shetty et al., 2020). Furthermore, technological problems such as limited driving range and the insufficiency of public charging infrastructure greatly contribute to customer hesitancy and restricted market adoption (Yadav et al., 2024). Although the Indian government has introduced initiatives like the Faster Adoption and

Manufacturing of Hybrid and Electric Vehicles (FAME) scheme, aimed at providing financial incentives and infrastructure development, these efforts have yet to generate widespread market traction. Furthermore, consumer perceptions vary markedly between first-time EV buyers, who typically exhibit skepticism regarding reliability and convenience, and second-time EV buyers, whose decisions are informed by prior experiences. This distinction underscores the need for differentiated strategies tailored to the specific concerns of each segment(Dixit & Singh, 2022).

Previous research has emphasized the importance of technology advancements—particularly in battery efficiency and smart charging solutions—in overcoming customer opposition. Equally important is the role of awareness efforts that highlight the practical benefits and operational viability of electric vehicles (Bhat & Verma, 2023; Digalwar & Rastogi, 2023). Additionally, robust governmental support mechanisms, including financial subsidies and coherent policy initiatives, significantly influence public perception and adoption intent (Ali & Naushad, 2022). Understanding the behavioral and social factors related to electric mobility is also required for building effective marketing strategies that inspire consumer trust (Anastasiadou & Gavanas, 2022).

Ultimately, India's transition toward large-scale electric mobility hinges on successfully addressing both technological and behavioural challenges. Advancing this transition—by expanding charging infrastructure, reducing battery costs, and executing targeted consumer education—can meaningfully accelerate progress towards a sustainable, low-emission transport system (Kurien & Srivastava, 2020).

In consumer decision-making, individuals vary in perceptions and readiness based on prior exposure to electric vehicles. First-time potential buyers often exhibit uncertainty, limited product familiarity, and greater reliance on social influence and infrastructure cues. In contrast, second-time buyers—those who have previously explored EV options—demonstrate informed attitudes, realistic expectations, and specific concerns about technological maturity and long-term cost. Recognizing these distinctions enhances understanding of adoption barriers and supports the development of tailored policy and marketing strategies. Moreover, such segmentation enables entrepreneurs, SMEs, and policymakers to co-create innovative, market-driven solutions that foster sustainable business growth, consumer confidence, and inclusive progress within Asia's evolving EV ecosystem.

To bridge existing knowledge gaps, this study systematically identifies and prioritizes the key barriers affecting EV adoption among two distinct consumer segments in India: first-time and second-time potential EV buyers. A structured multi-phase approach was adopted, combining expert-based evaluations with multi-criteria decision-making techniques. A detailed explanation of the research design, including the Delphi method and the Analytic Hierarchy Process (AHP), is provided in the Methodology section that follows.

To guide this investigation, the following research questions were formulated:

2. What are the primary barriers influencing electric vehicle adoption among first-time and second-time potential EV buyers in India?

2. How do these barriers differ in significance between first-time and second-time potential EV buyers?

By clearly distinguishing between the concerns of first-time and second-time EV buyers, this study provides actionable insights that can inform policy formulation, strategic infrastructure investments, and consumer engagement initiatives, thereby advancing India's transition toward sustainable electric mobility.

2. Literature Review

Electric vehicles (EVs) offer a promising pathway toward sustainable mobility and reduced environmental degradation, addressing India's mounting environmental challenges and dependence on fossil fuels (Saxena & Yadav, 2024; Dhillon et al., 2023). Despite clear advantages—lower operating costs, reduced emissions, and improved energy efficiency—EV adoption in India remains modest due to intertwined technological, financial, infrastructural, policy, and behavioral barriers.

Technological apprehensions dominate consumer perceptions. Persistent range anxiety—the fear of battery depletion mid-journey—continues to deter buyers (Padmavathy et al., 2023; Wang et al., 2017). Although battery technology has improved, concerns about battery life, durability, and performance persist, especially under India's high temperatures and varied geography (Gorlin et al., 2015). The lack of technology standardization, such as inconsistent charging connectors and differing battery systems among manufacturers, further complicates user confidence and convenience (Li et al., 2019).

Financial barriers remain equally critical. The high upfront cost of EVs—mainly driven by expensive batteries (Whittle et al., 2022; Cordeiro & Losekann, 2021)—poses a significant hurdle in a price-sensitive market. Additional financial burdens include costly battery replacements, limited financing mechanisms, and insufficient, unevenly applied government incentives (Dhillon et al., 2023). Scholars emphasize that targeted fiscal support—subsidies, tax relief, and innovative leasing or pay-per-use schemes—is essential for scaling EV adoption (Aungkulanon et al., 2023).

Infrastructure deficiencies further limit diffusion. The scarcity and uneven distribution of charging stations, especially fast chargers, amplify range anxiety and undermine reliability (Shalalfeh et al., 2021; Vidhi & Shrivastava, 2018). Rural and semi-urban areas remain largely excluded from EV infrastructure networks, perpetuating regional disparities (Berkeley et al., 2018). A shortage of skilled maintenance and repair facilities adds to concerns about service availability (Rezvani et al., 2015). Expanding nationwide charging infrastructure and investing in specialized EV service centers are vital to building consumer confidence (Morrissey et al., 2016; Aungkulanon et al., 2023).

India's policy and regulatory frameworks, though improving, remain fragmented and unpredictable. Inconsistent emission standards, incentive criteria, taxation, and long-term planning erode trust among both consumers and manufacturers (Peters & Dütschke, 2014; Padmavathy et al., 2023). A coherent, stable policy environment is indispensable for encouraging investment, fostering innovation, and reinforcing consumer confidence (Wang et al., 2017; Dhillon et al., 2023).

Finally, social and behavioral factors strongly shape EV acceptance. Cultural preferences for internal combustion vehicles, skepticism toward new technologies, and inertia in consumer habits hinder willingness to switch (Kongklaew et al., 2021; Peters & Dütschke, 2014). Peer influence, media representation, dealership behavior, and awareness campaigns all affect perceptions (Cellina et al., 2013; Whittle et al., 2022). Targeted outreach, consumer education, and strategic marketing that emphasize practical benefits and long-term value can help normalize EV ownership and accelerate adoption (Padmavathy et al., 2023).

In summary, the current scenario of EV adoption in India reflects a complex interplay of technological, financial, infrastructural, policy-related, and social factors. Achieving widespread EV adoption requires holistic, integrative strategies involving coordinated policy efforts, infrastructure development, consumer education, financial incentives, and technological advancement. Comprehensive approaches addressing these interconnected challenges are essential to realizing India's EV ambitions sustainably and equitably.

The entrepreneurial dimension of these challenges is equally significant. Recent studies suggest that SMEs and start-ups act as catalysts in overcoming adoption barriers by introducing cost-effective charging solutions, circular battery reuse systems, and inclusive mobility services. Integrating entrepreneurial innovation into EV adoption frameworks ensures that sustainability transitions also generate employment, local value creation, and long-term economic resilience.

Table 1: List of barriers influencing EV adoption

Barriers	**Reference**	
Social Barriers		
Dealers' reluctance to push EVs	(Carley et al., 2019)	(Wang et al., 2018)
Social Influence and Peer Adoption	(Manca et al., 2020)	(Singh et al., 2020)
Consumer skepticism towards new technology	(Gandoman et al., 2019)	(Rezvanizaniani et al., 2014)
Lack of consumer awareness	(Chidambaram et al., 2023)	(Khandakar et al., 2020)
Preference to conventional vehicles	(Barter et al., 2015)	
Policy Barriers		
Lack of long-term Govt planning	(Knezović et al., 2017)	(Goulianou et al., 2024)
Poor coordination between government agencies	(Steinhilber et al., 2013)	(Azadnia et al., 2021)
Unclear or inadequate emission standards	(Hao et al., 2021)	(Qian & Yin, 2017)
Unsatisfactory regulatory structure	(Gonzalez Venegas et al., 2021)	(Yeung & Liu, 2023)
Infrastructural barriers		
Integration with renewable energy sources	(Gonzalez Venegas et al., 2021)	(Abo-Khalil et al., 2022)
Standardization of charging technology	(Das et al., 2020)	(Chamberlain & Al-Majeed, 2021)
Lack of Charging Infrastructure	(Ding, 2023)	(Cao et al., 2021)
Lack of fast chargers	(Jin et al., 2013)	(Azadfar et al., 2015)
Lack of repair and maintenance workshops	(Bonges & Lusk, 2016)	(Kester et al., 2018)
Technological barriers		
Range anxiety	(Noel et al., 2019)	(Rainieri et al., 2023)

Battery technology	(Barter et al., 2015)	(Mahmoudzadeh Andwari et al., 2017)
Performance efficiency	(Castillo et al., 2020)	(Patyal et al., 2021)
Grid capacity and stability	(Richardson, 2013)	
Technological standardization	(Gonzalez Venegas et al., 2021)	(Mahdavian et al., 2021)
Limited battery life	(Carley et al., 2013)	(Haddadian et al., 2015)
Fewer EV models	(Quak et al., 2016)	
Financial barriers		
High initial cost	(Giansoldati et al., 2020)	(Hardman et al., 2017)
Battery replacement cost	(Hsieh et al., 2019)	(Kara et al., 2017)
Limited government subsidies	(Steinhilber et al., 2013)	(Zhu et al., 2020)
Lack of credit access for EVs	(Adhikari et al., 2020)	(Ruoso & Ribeiro, 2022)

3. Methodology

This study used a three-phased analytical approach to identify and rank barriers to the adoption of electric cars (EVs) among two unique customer segments: first-time and second-time potential EV buyers in India. The methodological framework includes: (1) the identification and categorization of barriers through a comprehensive literature review; (2) the refinement of these barriers using the Delphi technique, based on expert inputs collected via a 10-point Likert scale; and (3) the prioritization of the final set of barriers through the Analytical Hierarchy Process (AHP), employing Saaty's 9-point pairwise comparison scale. Figure 1 provides a visual representation of this structured research methodology. This structured methodology not only identifies adoption barriers but also generates actionable intelligence for entrepreneurs and SMEs seeking to align their business models with sustainable mobility trends in Asia.

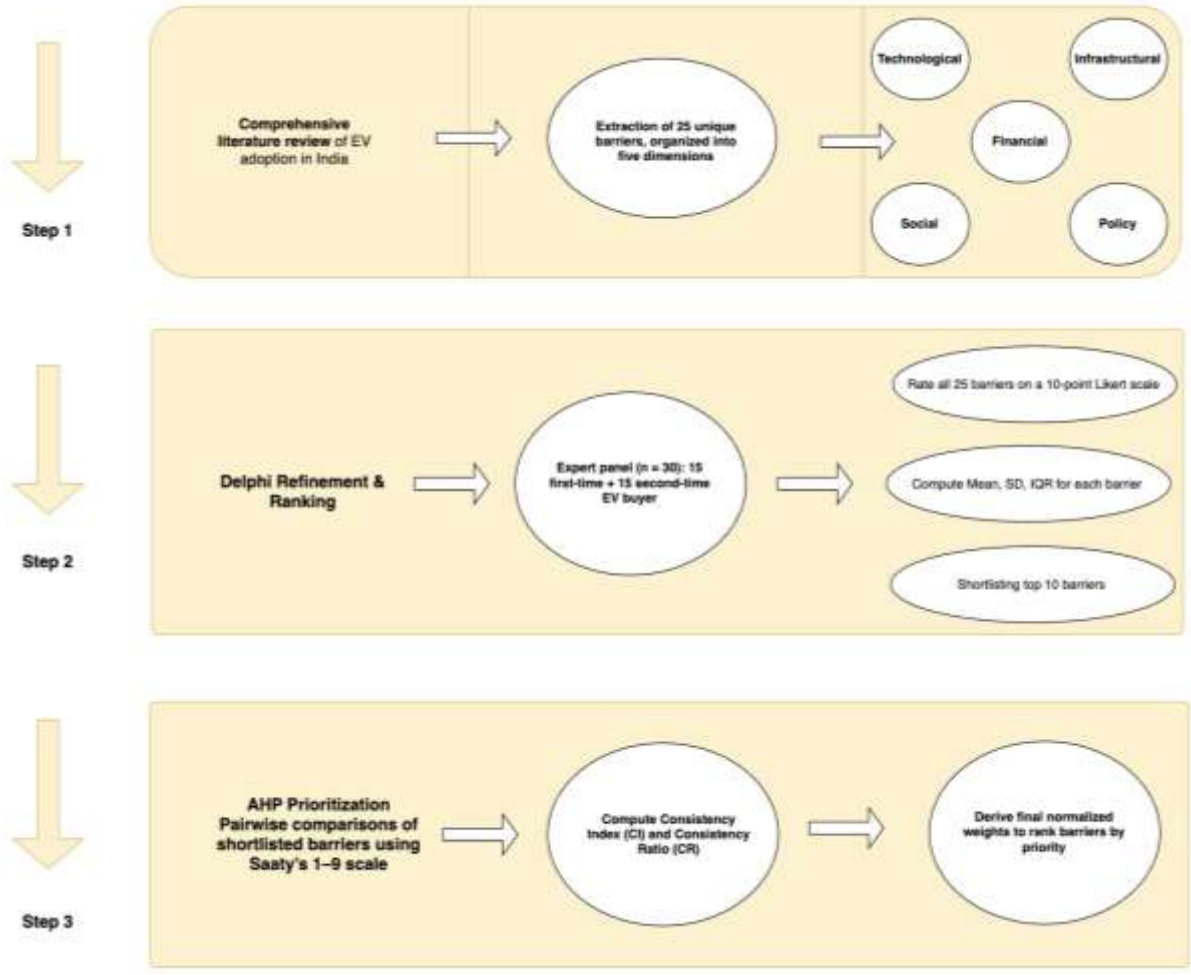


Figure 1. Structured Research Methodology

3.1 Phase 1: Barrier Identification through Comprehensive Literature Review

In the initial phase an extensive literature review was conducted to identify the barriers which are affecting the adoption. It resulted with 25 barriers categorised into five dimensions:

1. Technological Barriers (TCB)
2. Financial Barriers (FIB)
3. Infrastructural Barriers (INB)
4. Social Barriers (SOB)
5. Policy Barriers (POB)

3.2 Phase 2: Barrier Refinement and Ranking Using the Delphi Technique

To refine the list of barriers identified in Phase 1, a two-round modified Delphi technique was conducted. The Delphi method is a structured, consensus-driven expert consultation process, widely used in empirical social science research to prioritize factors involving multi-stakeholder perspectives (Linstone & Turoff, 2011)

A panel of 30 domain experts was created, comprising individuals with extensive experience in personal car usage, electric vehicle (EV) interest, and technological adoption. This composition ensured that the panel reflected a realistic consumer-level understanding and insights into EV-related concerns.

Step 1: Questionnaire Design and Compilation of Barriers

A total of 25 barriers were compiled through literature review, covering five dimensions: technological, infrastructural, financial, social, and policy-related barriers. Each expert was asked to rate the severity of each barrier using a 10-point Likert scale, where:

- 1 = Minimal impact on EV adoption
- 10 = Critically impedes EV adoption

Step 2: First Round of Expert Rating

Experts provided individual assessments for each barrier. Their responses were recorded and subjected to statistical analysis to evaluate the central tendency, dispersion, and consensus of expert judgments.

Step 3: Statistical Aggregation and Analysis

To determine the significance and consensus around each barrier, the following metrics were calculated:

- Mean (μ): Average importance rating across all experts

$$\mu = \frac{1}{n}\sum_{i=1}^{n} x_i \quad (1)$$

where x_i is the score given by the i^{th} expert, and n is the total number of experts.

- Standard Deviation (SD): Measures variability in expert ratings

$$\sigma = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n} (x_i - \mu)^2} \quad (2)$$

- Interquartile Range (IQR): Indicates consensus; computed as the difference between the third quartile (Q3) and the first quartile (Q1):

$$IQR = Q3 - Q1 \quad (3)$$

Step 4: Segmentation and Shortlisting Based on Buyer Type

To further enhance relevance, the expert responses were segmented into two consumer groups:

- First-time potential EV buyers
- Second-time potential EV buyers

This segmentation captured differences in exposure, decision logic, and risk perception. First-time buyers generally emphasized practical, usability-related concerns, while second-time buyers highlighted technological maturity, cost, and regulatory considerations.

The top 10 barriers for each group were selected based on descending mean scores and IQR thresholds.

Step 5: Consensus Validation and Output Confirmation

To assess the level of agreement among expert responses, the Interquartile Range (IQR) and Standard Deviation (SD) values for each barrier were examined. According to established Delphi evaluation standards, barriers were considered to reflect sufficient expert consensus if they met the criteria of IQR ≤ 2 and SD ≤ 1.2. These thresholds balance both statistical dispersion and practical convergence in judgment.

The analysis revealed that over 80% of the barriers selected for the final shortlisting met both criteria, confirming the reliability and internal coherence of expert evaluations. Furthermore, the consistent identification of several critical barriers across both first-time and second-time buyer segments reinforced the empirical validity and contextual robustness of the Delphi technique implemented in this study.

3.3 Phase 3: Prioritization of Barriers through Analytical Hierarchy Process (AHP)

The final phase involved employing the Analytic Hierarchy Process (AHP), a widely recognized multi-criteria decision-making tool, to prioritize and quantitatively rank the top 10 barriers identified in Phase 2. Developed by Thomas L. Saaty in the 1970s, AHP systematically enables experts to evaluate and prioritize multiple decision criteria by quantifying their intuitive judgments through structured pairwise comparisons (Saaty, 1977; Saaty, 1990). This method employs a 1–9 scale to express the relative importance of elements, ranging from equal to extreme importance. A significant advantage of AHP lies in its ability to verify the internal consistency of expert judgments using the consistency ratio (CR), thereby enhancing methodological reliability. The 1–9 Saaty scale used in this study is presented in Table 2.

To ensure methodological transparency and replicability, the AHP was implemented in the following detailed step-by-step process:

Step 1: Establishment of Hierarchical Structure

A structured hierarchical model was formulated, clearly defining the overall goal—"Prioritization of barriers affecting EV adoption"—as the top hierarchical level. Subsequently, the second hierarchical level consisted of the ten barriers identified in Phase 2 for each consumer segment (first-time and second-time EV buyers), treated independently.

Step 2: Pairwise Comparison Matrix Formation

Expert judgments were elicited from two separate panels, each comprising 15 domain experts representing first-time and second-time potential EV buyers. These experts were carefully chosen based on their experience in automotive usage, technological evaluation, or policy engagement related to electric mobility in India.

Experts rated the relative importance of each pair of barriers using Saaty's 1–9 scale, detailed in Table 2:

Table 2. Saaty's 1–9 Scale for Pairwise Comparisons in AHP

Number	Linguistic scale
1	Equal value
3	Moderate value
5	Strong value
7	Very strong value
9	Extreme value
2,4,6,8	Intermediate values

These comparisons resulted in two separate 10×10 matrices, reflecting the collective expert judgment on barrier importance for each buyer segment.

Step 3: Normalization and Derivation of Priority Weights (Eigenvector Calculation)

The pairwise comparison matrices were normalized by dividing each matrix element by its respective column total. Subsequently, the priority vector (weights for each barrier) was calculated by averaging each row of the normalized matrix. Mathematically, the calculation of each barrier's weight w_i is given as:

$$w_i = \frac{1}{n}\sum_{j=1}^{n} \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \quad (4)$$

Where:

- w_i = Priority weight of barrier i
- a_{ij} = Value from the pairwise comparison matrix
- n = Total number of barriers (in this case, 10)

Step 4: Computation of Consistency Index (CI)

To check the consistency of the judgments provided by experts, the Consistency Index (CI) was computed using the following formula:

$$CI=(\lambda\text{max}-n)/(n-1) \quad (5)$$

In this Equation, λmax indicates the eigenvalue, and n represents the no. of major criteria

Step 5: Computation of Consistency Ratio (CR)

The Consistency Ratio (CR) evaluates whether expert judgments were logically coherent. It is computed as:

$$CR=CI/RI \quad (6)$$

Where:

- RI = Average random consistency index (values in Table 3) (Saaty, 1990).
- A CR value less than or equal to 0.1 indicates acceptable consistency.

In this study, the computed CR values were 0.038 (first-time buyers) and 0.060 (second-time buyers), both within the acceptable limit, confirming strong judgmental coherence and methodological reliability.

Table 3. Random index (RI)

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.058	0.9	1.12	1.24	1.32	1.41	1.45	1.49

An essential obstacle in the application of AHP is the possibility of an inconsistent matrix of pairwise comparisons. This arises because, even for a relatively small number of criteria, the total number of comparisons can become large. This increase may challenge experts in providing logically consistent evaluations. Consequently, inconsistencies may emerge, leading to matrices that lack the mathematical properties assumed by AHP (Jarek, 2016).

Step 6: Final Ranking of Barriers
Using the calculated priority weights, barriers were quantitatively ranked, clearly indicating their relative significance. These rankings provided robust guidance for targeted policy-making and strategic intervention for both first-time and second-time potential EV buyers. This detailed, systematic application of AHP ensured rigorous, transparent prioritization of barriers and significantly improved the validity and applicability of the research findings.

4. Analysis and results

4.1 Selection of Top 10 Barriers Using Likert Scale

To identify and prioritize barriers, an extensive review of relevant literature was initially conducted. This resulted in the identification of various barriers, which were subsequently subjected to empirical evaluation using a structured survey. Specifically, a 10-point Likert scale (ranging from 1 indicating "least important" to 10 indicating "extremely important") was utilized to gauge experts' perceptions regarding the significance of these identified barriers.
Two distinct respondent groups were considered for this study to capture diverse perspectives: first-time potential EV buyers, who have not previously evaluated or owned an EV, and second-time potential EV buyers, who have prior experience in evaluating EVs and thus possess informed insights.

Table 4. Descriptive Statistics and Ranking of 25 Barriers to Electric Vehicle Adoption Based on Likert Scale Responses from First-Time Potential EV Buyers

Name	Mean	SD	IQR	Ranking
Range anxiety	9.87	0.34	0	1
Battery technology	7.07	1.12	1	12
Performance efficiency	9.13	0.72	1	5
Grid capacity and stability	5.93	0.68	0.5	15
Technological standardization	7.27	0.85	1	8
Limited battery life	7.27	1.00	0.5	8
Fewer EV models	7.20	1.05	1.5	10
High initial cost	6.60	0.71	0.5	13
Battery replacement cost	6.33	1.01	1	14
Limited government subsidies	5.40	0.80	1	16
Lack of credit access for EVs	4.40	0.49	1	19
Integration with renewable energy sources	4.33	0.47	1	20
Lack of Charging Infrastructure	9.80	0.40	0	2
Standardization of charging technology	7.13	0.81	1	11
Lack of fast chargers	9.60	0.49	1	4
Lack of repair and maintenance workshops	9.73	0.44	0.5	3
Social Influence and Peer Adoption	7.67	0.79	1	6
Consumer skepticism towards new technology	5.20	0.98	2	17
Lack of consumer awareness	5.20	0.98	1.5	17
Preference to conventional vehicles	7.33	1.07	1	7
Dealers' reluctance to push EVs	3.60	0.71	1	25
Lack of long-term government planning	4.13	0.72	1	22
Poor coordination between government agencies	4.33	1.19	1.5	20
Unclear or inadequate emission standards	3.80	0.83	0.5	24
Unsatisfactory regulatory structure	4.07	1.06	0	23

Upon collecting responses, the mean scores for each barrier were calculated, enabling a clear comparative ranking. The analysis facilitated the selection of the top ten barriers, individually identified for each respondent group. The barriers were rated separately by first-time and second-time potential EV buyers. Tables 4 and 5 present the detailed statistical analysis of 25 barriers for each group. Subsequently, the top 10 barriers for both groups were extracted and are shown in Table 6.

Table 5. Descriptive Statistics and Ranking of 25 Barriers to Electric Vehicle Adoption Based on Likert Scale Responses from Second-Time Potential EV Buyers

Name	Mean	SD	IQR	Ranking
Range anxiety	9.67	0.47	1	1
Battery technology	6.73	0.77	1	11
Performance efficiency	5.40	0.61	1	15

Grid capacity and stability	5.13	0.50	0	20
Technological standardization	7.80	0.40	0	6
Limited battery life	5.07	0.44	0	21
Fewer EV models	4.80	0.40	0	24
High initial cost	9.00	0.00	0	4
Battery replacement cost	7.53	0.50	1	8
Limited government subsidies	5.33	0.47	1	16
Lack of credit access for EVs	5.87	0.81	1.5	12
Integration with renewable energy sources	5.60	0.71	1	13
Lack of Charging Infrastructure	9.20	0.40	0	2
Standardization of charging technology	5.27	0.44	0.5	17
Lack of fast chargers	4.93	0.25	0	22
Lack of repair and maintenance workshops	7.67	0.47	1	7
Social Influence and Peer Adoption	5.20	0.40	0	18
Consumer skepticism towards new technology	9.13	0.34	0	3
Lack of consumer awareness	5.53	0.72	1	14
Preference to conventional vehicles	7.47	0.50	1	9
Dealers' reluctance to push EVs	4.73	0.44	0.5	25
Lack of long-term government planning	8.20	0.40	0	5
Poor coordination between government agencies	4.87	0.34	0	23
Unclear or inadequate emission standards	6.93	0.68	0.5	10
Unsatisfactory regulatory structure	5.20	0.40	0	18

The top-ranked barriers clearly reflect a strong emphasis on infrastructural and technological concerns among respondents in both groups, notably highlighting issues such as range anxiety, lack of charging infrastructure, and maintenance support availability. Furthermore, distinct differences emerged between groups: first-time potential buyers placed greater emphasis on barriers related to immediate EV usability and variety, whereas second-time potential buyers exhibited heightened concerns around economic factors and informed skepticism about technology reliability.

These initial insights provided through the Likert-scale analysis form a solid foundation for deeper investigation and prioritization using the Analytic Hierarchy Process (AHP), discussed in subsequent sections. Table 6 summarizes the top 10 barriers identified separately for the two buyer groups, which were then subjected to further evaluation using AHP.

Table 6. Likert Scale-based Ranking of Top 10 Barriers

1st Time Potential Buyers				**2nd Time Potential Buyers**		
Rank	**BC**	**Barriers (FB)**	**Average**	**BC**	**Barriers (SB)**	**Average**
1	FB1	Range anxiety	9.87	SB1	Range anxiety	9.67
2	FB2	Lack of Charging Infrastructure	9.80	SB2	Lack of Charging Infrastructure	9.20
3	FB3	Lack of repair and maintenance workshops	9.73	SB3	Consumer skepticism towards new technology	9.13
4	FB4	Lack of fast chargers	9.60	SB4	High initial cost	9.00
5	FB5	Performance efficiency	9.13	SB5	Lack of long-term government planning	8.20
6	FB6	Social Influence and Peer Adoption	7.67	SB6	Technological standardization	7.80
7	FB7	Preference to conventional vehicles	7.33	SB7	Lack of repair and maintenance workshops	7.67
8	FB8	Limited battery life	7.27	SB8	Battery replacement cost	7.53
9	FB9	Technological standardization	7.27	SB9	Preference to conventional vehicles	7.47
10	FB10	Fewer EV models	7.20	SB10	Unclear or inadequate emission standards	6.93

4.2 Prioritization of Barrier Categories

4.2.1 First-Time Potential EV Buyers

To identify the most influential barrier categories from the perspective of first-time potential buyers, the Analytic Hierarchy Process (AHP) was employed using structured pairwise comparisons from domain experts. The five broad barrier categories analyzed were: technological, infrastructural, social, financial, and policy barriers.

The analysis revealed that infrastructural barriers were assigned the highest weight (0.492), establishing them as the most significant impediment. This underscore concerns such as limited availability of public charging stations, insufficient repair networks, and inadequate fast-charging infrastructure as primary constraints for first-time buyers unfamiliar with EV ecosystem limitations.

Technological barriers were ranked second (weight = 0.255), reflecting user anxieties regarding battery performance, driving range reliability, and compatibility across models. These concerns are particularly heightened for first-time buyers who lack prior exposure to EVs and are more sensitive to technological uncertainties.

Social barriers held the third position (0.126), signifying moderate influence from social perception, peer influence, and prevailing norms favouring internal combustion engine (ICE) vehicles. Financial barriers (0.077) and policy barriers (0.051) were ranked lower, suggesting that while cost considerations and government policy play a role, they are comparatively less critical for this group at the initial adoption stage.

The consistency ratio (CR = 0.039) confirms the internal reliability of expert judgments, validating the robustness of the priority weights obtained.

The detailed results of this comprehensive analysis are presented in Table 7.

Table 7: Barrier Category Prioritization (AHP Results – 1st Time Buyers)

	TCB	FIB	INB	SOB	POB	Weight	Ranking
TCB	0.223	0.302	0.199	0.279	0.270	0.255	**2nd**
FIB	0.056	0.076	0.094	0.054	0.102	0.077	**4th**
INB	0.585	0.424	0.523	0.517	0.410	0.492	**1st**
SOB	0.088	0.156	0.112	0.110	0.162	0.126	**3rd**
POB	0.047	0.042	0.072	0.039	0.057	0.051	**5th**

consistency ratio **=** 0.039

4.2.2 Second-Time Potential EV Buyers

For second-time potential EV buyers, individuals who have previously considered or evaluated EVs but have not yet adopted them, a similar AHP process was conducted to evaluate their specific barrier concerns.

Infrastructural barriers once again emerged as the top-ranked concern (weight = 0.494), reaffirming the central role of charging access, service availability, and network reliability in delaying adoption, even among more informed consumers.

Technological barriers were consistently ranked second (weight = 0.253), indicating that apprehensions about technical reliability and long-term performance persist, albeit slightly reduced compared to first-time buyers due to greater familiarity.

Social barriers (weight = 0.125) retained third position, reflecting continued social hesitancy, although likely moderated by prior exposure.

Financial barriers (0.075) and policy barriers (0.053) remained the lowest-ranked categories. For second-time buyers, these may be perceived as less immediate constraints, possibly due to a deeper understanding of available subsidies or future cost advantages of EV ownership.

The calculated consistency ratio (CR = 0.037) affirms the validity of expert input and ensures that the prioritization structure is methodologically sound.

The detailed results of this comprehensive analysis are presented in Table 8.

Table 8: Barrier Category Prioritization (AHP Results – 2nd Time Buyers)

	TCB	FIB	INB	SOB	POB	Weight	Ranking
TCB	0.233	0.272	0.215	0.270	0.276	0.253	**2nd**
FIB	0.064	0.074	0.087	0.048	0.100	0.075	**4th**
INB	0.563	0.447	0.520	0.537	0.405	0.494	**1st**
SOB	0.092	0.164	0.103	0.107	0.161	0.125	**3rd**
POB	0.049	0.043	0.075	0.038	0.058	0.053	**5th**

consistency ratio **=** 0.037

These findings provide strategic recommendations for policymakers and stakeholders, indicating urgent and high-impact areas that require targeted intervention and budget allocation to effectively promote EV adoption.

4.3 Barrier Analysis for First-Time Potential EV Buyers

To gain deeper insights into specific barriers influencing initial adoption decisions, a detailed AHP analysis was conducted among first-time potential buyers. These purchasers have no past experience evaluating or owning electric vehicles, and thus provide critical insights into the key factors driving initial acceptance. The hierarchical decision structure employed in this Analytic Hierarchy Process (AHP) analysis, detailing the prioritized barriers, is presented in Figure 2.

The AHP analysis identified Range anxiety (FB1) as the most critical barrier with the highest priority weight (0.264). These finding highlights consumer's significant apprehension regarding the reliability of EV batteries and their adequacy for daily commuting and long-distance travel.

The second-ranked barrier was Lack of charging infrastructure (FB2), with a weight of 0.221. This result underscores critical concerns about inadequate charging facilities, directly impacting practical usability and confidence in EV adoption.

Lack of repair and maintenance workshops (FB3) ranked third (weight = 0.138), emphasizing significant consumer concerns related to after-sales support and availability of specialized service centers. This infrastructure-related barrier reflects anxieties regarding long-term vehicle maintenance and ownership experiences.

The barrier, Lack of fast chargers (FB4), was fourth (weight = 0.135), highlighting the essential need for rapid charging options to support daily EV practicality, convenience, and user satisfaction.

The fifth-ranked barrier, Performance efficiency (FB5), had a weight of 0.073, illustrating buyers' concerns regarding comparative vehicle performance, including acceleration, speed, and overall efficiency compared to conventional internal combustion vehicles.

Ranked sixth, the barrier social influence and peer adoption (FB6) carried a weight of 0.046, reflecting moderate yet meaningful concerns regarding peer perceptions, social validation, and collective user experiences influencing new technology adoption decisions.

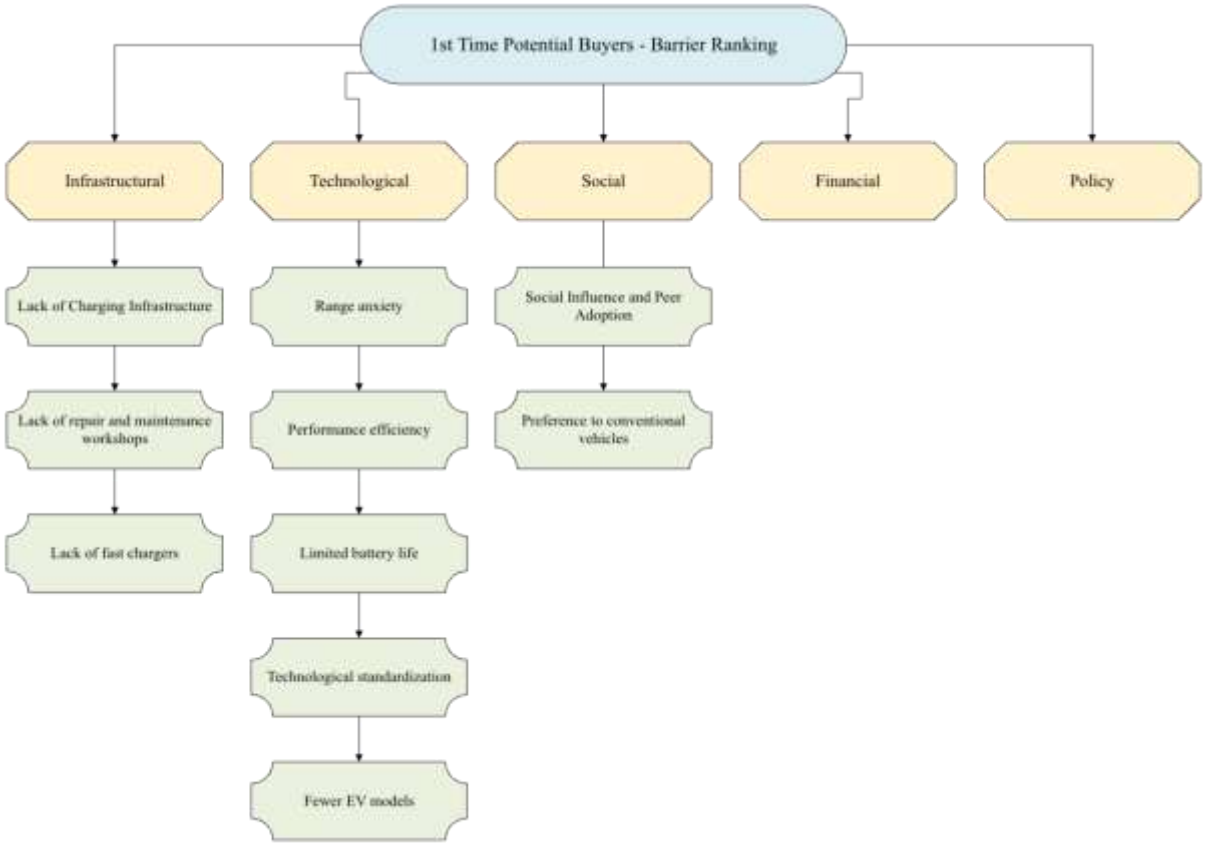


Figure 2. Hierarchical Structure for AHP-based Barrier Prioritization (First-Time Potential EV Buyers)

The remaining barriers, although lower in priority, include Limited battery life (FB8) (weight = 0.040), signifying apprehensions about battery durability and lifespan; Preference for conventional vehicles (FB7) (weight = 0.032), highlighting a natural inertia favouring familiar automotive technologies; Technological standardization (FB9) (weight = 0.031), underscoring consumer concerns about interoperability and universal compatibility across different EV models and manufacturers; and Fewer EV models (FB10) (weight = 0.020), reflecting limited vehicle choices as a barrier to adoption.

The calculated consistency ratio for this group's responses was 0.038, signifying strong internal

coherence and methodological reliability of the expert judgments obtained. The summarized results are presented comprehensively in Table 9 and Figure 3.

These insights into first-time buyers' concerns highlight critical areas where targeted interventions—particularly improvements in infrastructure (charging stations, repair services) and technology (battery range, performance efficiency)—are necessary to facilitate initial EV adoption and transition away from conventional vehicle preferences.

Table 9: AHP Barrier Prioritization for First-Time Potential EV Buyers

	FB1	FB2	FB3	FB4	FB5	FB6	FB7	FB8	FB9	FB10	Weight
FB1	0.290	0.304	0.317	0.331	0.283	0.263	0.221	0.218	0.220	0.190	**0.264**
FB2	0.218	0.229	0.240	0.245	0.255	0.223	0.203	0.199	0.208	0.189	**0.221**
FB3	0.109	0.113	0.119	0.095	0.166	0.161	0.148	0.158	0.160	0.149	**0.138**
FB4	0.108	0.115	0.154	0.123	0.130	0.146	0.153	0.134	0.145	0.141	**0.135**
FB5	0.060	0.052	0.042	0.055	0.058	0.078	0.099	0.102	0.081	0.106	**0.073**
FB6	0.044	0.040	0.029	0.033	0.029	0.039	0.056	0.045	0.064	0.083	**0.046**
FB7	0.042	0.036	0.026	0.025	0.019	0.022	0.032	0.027	0.042	0.049	**0.032**
FB8	0.057	0.049	0.032	0.039	0.024	0.037	0.050	0.043	0.027	0.038	**0.040**
FB9	0.042	0.035	0.024	0.027	0.023	0.020	0.024	0.051	0.032	0.034	**0.031**
FB10	0.033	0.026	0.017	0.025	0.012	0.010	0.014	0.024	0.020	0.021	**0.020**

CR = 0.038

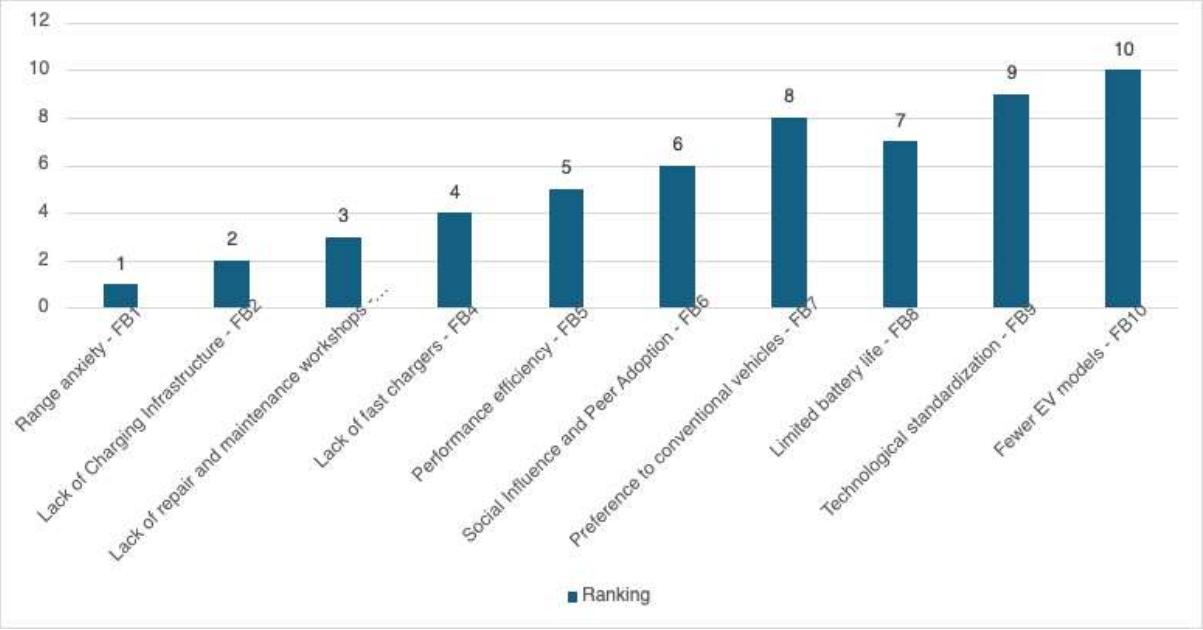


Figure 3. Barrier Ranking for First-Time Potential EV Buyers

4.4 Barrier Analysis for Second-Time Potential EV Buyers

A detailed Analytic Hierarchy Process (AHP) analysis was conducted among second-time potential EV buyers—individuals who have previously evaluated electric vehicles but have not yet proceeded with adoption. This analysis offered critical insights into persistent and evolving barriers informed by prior exposure to EV technology. Figure 4 illustrates the hierarchical decision structure employed in prioritizing these barriers.

Consistent with first-time buyers, the primary barrier identified by second-time potential buyers was Range anxiety (SB1), assigned the highest weight (0.274). This finding reinforces persistent concerns related to EV driving range adequacy, battery reliability, and practical usability in daily commuting and long-distance travel.

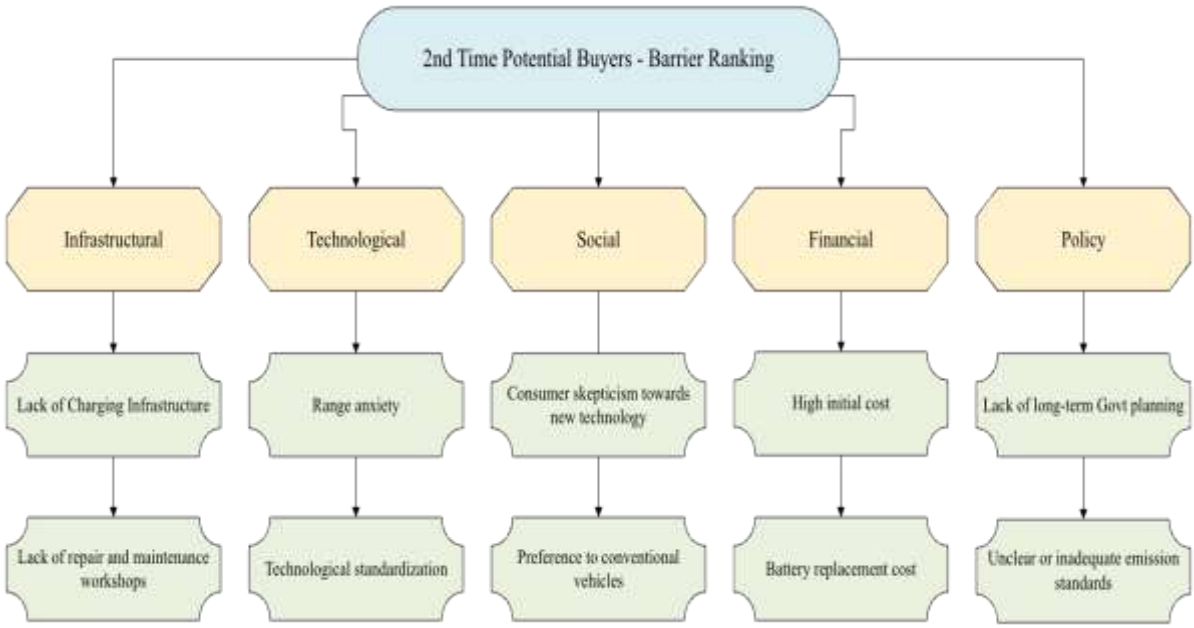


Figure 4. Hierarchical Structure for AHP-based Barrier Prioritization (Second-Time Potential EV Buyers)

Closely following was the Lack of charging infrastructure (SB2), with a weight of 0.271, further emphasizing sustained infrastructural barriers. Despite previous exposure, these buyers continue to perceive insufficient charging networks and limited accessibility as major impediments, underscoring the critical importance of infrastructural advancements to facilitate broader adoption.

The third-ranked barrier was Consumer skepticism towards new technology (SB3), with a weight of 0.098. This barrier reflects deeper cognitive concerns among experienced buyers about the reliability, technological maturity, and long-term performance consistency of EVs, indicative of their heightened awareness of technological uncertainties and associated risks.

The fourth-ranked barrier, Lack of repair and maintenance workshops (SB7) (weight = 0.083), highlights ongoing apprehensions related to after-sales service infrastructure. This persistent concern indicates a continued need for expanding specialized EV maintenance networks to enhance consumer confidence.

Following closely, in fifth place, was Technological standardization (SB6) (weight = 0.081), underscoring the importance of universally compatible technological standards and interoperability across charging systems. This barrier signifies continued informed demand for clearly defined, uniform technical standards.

The subsequent barrier, Preference for conventional vehicles (SB9), with a weight of 0.065, demonstrates an enduring inertia towards conventional automotive technologies, highlighting the lingering influence of established driving habits and traditional vehicle preferences among this informed buyer group.

High initial cost (SB4), ranked seventh (weight = 0.044), reflects second-time buyers increased economic awareness and sensitivity toward upfront investment requirements associated with EVs relative to traditional vehicles.

Further identified barriers include Battery replacement cost (SB8) (weight = 0.037), emphasizing concerns regarding long-term financial obligations and total ownership expenses; Lack of long-term government planning (SB5) (weight = 0.027), highlighting skepticism towards the continuity and reliability of supportive EV adoption policies; and finally, Unclear or inadequate emission standards (SB10) (weight = 0.021), reflecting concerns about policy ambiguities and regulatory uncertainties that potentially impact consumer confidence in the viability of EV ownership.

The calculated consistency ratio for this group's responses was 0.060, signifying strong internal coherence and methodological reliability of the expert judgments obtained.

The comprehensive summary of second-time potential EV buyers' barrier rankings is presented in Table 10 and Figure 5:

Table 10: AHP Barrier Prioritization for Second-Time Potential EV Buyers

	SB1	SB2	SB3	SB4	SB5	SB6	SB7	SB8	SB9	SB10	Weight
SB1	0.295	0.301	0.352	0.238	0.192	0.307	0.311	0.239	0.310	0.199	**0.274**
SB2	0.282	0.287	0.341	0.235	0.196	0.317	0.316	0.237	0.303	0.197	**0.271**

SB3	0.061	0.061	0.073	0.126	0.126	0.080	0.111	0.137	0.082	0.119	**0.098**
SB4	0.050	0.049	0.023	0.040	0.070	0.028	0.026	0.043	0.031	0.078	**0.044**
SB5	0.046	0.044	0.017	0.017	0.030	0.017	0.018	0.024	0.020	0.035	**0.027**
SB6	0.066	0.062	0.063	0.100	0.118	0.069	0.057	0.104	0.067	0.108	**0.081**
SB7	0.065	0.062	0.045	0.108	0.113	0.083	0.069	0.099	0.077	0.104	**0.083**
SB8	0.045	0.044	0.019	0.034	0.045	0.024	0.025	0.037	0.033	0.058	**0.037**
SB9	0.056	0.056	0.053	0.077	0.090	0.061	0.053	0.065	0.059	0.079	**0.065**
SB10	0.033	0.032	0.014	0.025	0.019	0.014	0.015	0.014	0.017	0.022	**0.021**

CR = 0.060

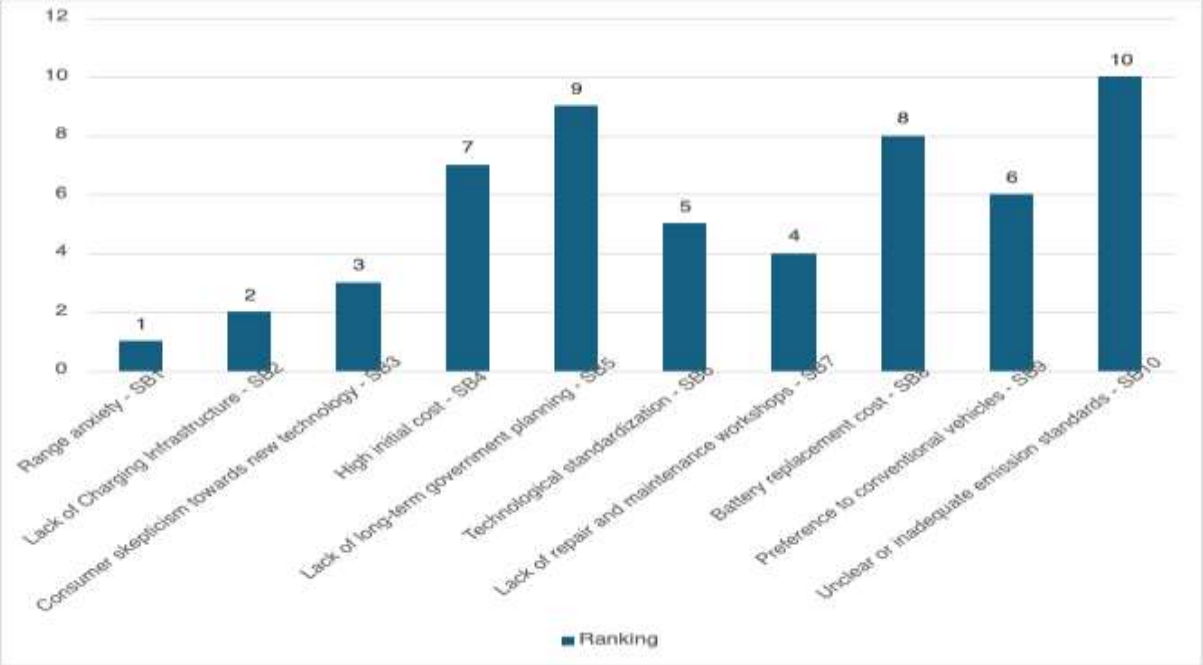
Overall, this detailed analysis clearly reveals that second-time potential EV buyers—equipped with prior knowledge and evaluation experience—place greater emphasis on informed, nuanced considerations including technological reliability, long-term economic implications, and policy clarity. These insights underscore the necessity for targeted interventions addressing deeper cognitive barriers, financial affordability, and clear policy frameworks to sustain consumer interest and facilitate continued engagement and eventual adoption.

4.5 Comparative Analysis Between First-Time and Second-Time Potential Buyers

A comparative analysis between first-time and second-time potential electric vehicle (EV) buyers was conducted to identify both shared and unique barriers affecting their adoption intentions, as illustrated in Figure 6. The Venn diagram visually summarizes the critical barriers identified through the Delphi-AHP methodology, clearly distinguishing between universally significant and segment-specific impediments.

Both consumer segments—first-time and second-time potential electric vehicle (EV) buyers—consistently identified five critical barriers that universally hinder EV adoption, regardless of prior experience or familiarity. These include range anxiety, reflecting enduring consumer concerns about battery capacity and the reliability of driving range; lack of charging infrastructure, underscoring the persistent infrastructural deficits that compromise the practicality of EV usage; lack of repair and maintenance workshops, highlighting apprehensions related to post-sales service accessibility; preference for conventional vehicles, which reveals entrenched consumer habits and a psychological reliance on internal combustion engine (ICE) vehicles; and technological standardization, which captures unease regarding interoperability and the absence of unified technology standards across different EV manufacturers and models. These shared barriers point to systemic challenges within the Indian EV ecosystem that demand coordinated and long-term strategic interventions.

Figure 5. Barrier Ranking for Second-Time Potential EV Buyers



In addition to these critical concerns, first-time potential EV buyers emphasized five unique barriers that reflect their limited familiarity with EV technologies, practical apprehensions, and susceptibility to social influences. These include the *lack of fast chargers*, highlighting the need for immediate convenience and accessibility; *performance efficiency*, representing concerns about whether EVs can match the dynamic capabilities of ICE vehicles; *social influence and peer adoption*, demonstrating the role of social validation and collective behavioural patterns in shaping adoption decisions; *limited battery life*, indicating skepticism around battery durability and longevity; and *fewer EV models*, which restricts consumer choice and diminishes the appeal of EV ownership. These insights underscore the importance of interventions that enhance product availability, improve technological familiarity, and expand visible charging infrastructure to reduce initial resistance among first-time buyers.

Conversely, second-time potential EV buyers—characterized by greater exposure to EV technologies and more informed decision-making—identified a different set of distinctive barriers. These include consumer skepticism towards new technology, reflecting ongoing doubts about the long-term viability and reliability of EVs; high initial cost, denoting heightened price sensitivity and economic evaluation of value; battery replacement cost, pointing to concerns over long-term maintenance and lifecycle expenses; lack of long-term government planning, which reveals uncertainties about the continuity and adequacy of supportive policy frameworks; and unclear or inadequate emission standards, suggesting the need for more coherent regulatory guidance and environmental policy alignment. These findings indicate that targeted strategies for this segment must prioritize economic incentives, reinforce technological credibility, and ensure transparent, future-oriented regulatory mechanisms to support sustained EV adoption.

These comparative insights significantly underscore the need for differentiated, targeted interventions to effectively facilitate electric vehicle adoption. For first-time buyers, strategies must primarily address infrastructural accessibility and practical technological enhancements to mitigate initial adoption apprehensions. Meanwhile, for second-time buyers, policies and market interventions should focus on building technological trust, clearly communicating economic advantages, and establishing robust, transparent, and supportive policy environments. Overall, this nuanced understanding provided by the comparative analysis is instrumental in guiding policymakers, industry stakeholders, and market strategists to implement more focused and consumer-specific initiatives aimed at increasing electric vehicle penetration in India.

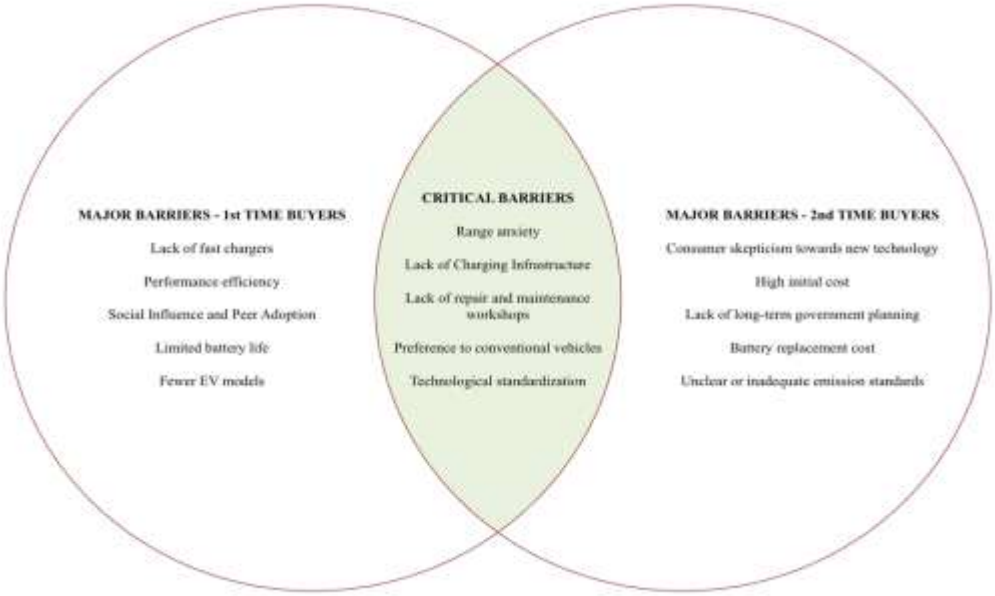


Figure 6. Major and Critical EV adoption barriers by buyer type.

4.6 Analysis of expert opinion

All experts provided detailed and constructive feedback on the full set of criteria and factors included in the survey instrument. None of the experts recommended the elimination of any criterion or factor, nor were there suggestions to add additional items. This reflects a high level of consensus regarding the completeness and relevance of the selected variables for assessing barriers to electric vehicle (EV) adoption.

The composition of the expert panels reflected broad and relevant domain representation across both respondent categories. For the first-time potential EV buyer group, there was a predominant representation from academic researchers, supported by industry professionals, automobile enthusiasts, and government authorities. In contrast, the second-time potential buyer group exhibited a well-balanced distribution across academic experts (professors), automotive industry professionals, and government and policy advisors. This distribution reflects the more evaluative and experienced orientation of the second-time buyer segment. The detailed distribution of expert groups is presented in Table 11 and Table 12.

Table 11: Expert Groups – First-Time Potential EV Buyers

Expert Group	Area of Expertise in Context	No. of Experts
Academic Researchers	EV adoption research, consumer behaviour, technology acceptance models	7
Automotive Industry Professionals	Product strategy, dealership outreach, EV marketing	4
Automobile Enthusiasts & Early Adopters	Real-world usage expectations, peer influence on first-time buyers	2
Govt. Authorities	Awareness schemes, financial incentives for new EV users	2

Table 12: Expert Groups – Second-Time Potential EV Buyers

Expert Group	Area of Expertise in Context	No. of Experts
Professors	Automobile usage behaviour, satisfaction metrics, consumer psychology	2
Automotive Industry Professionals	Vehicle performance, post-sales service feedback, repeat buyer trends	8
Government and Policy Advisors	EV policy formulation, infrastructure readiness, regulatory insight	5

5. Discussion

This study systematically explored and prioritized barrier affecting electric vehicle (EV) adoption among two distinct consumer segments: first time and second-time potential EV buyers in India. By integrating the Delphi method with the Analytic Hierarchy Process (AHP), the research identified critical differences and similarities in consumer concerns, providing nuanced insights for tailored policy and market interventions.

The findings clearly indicated infrastructural barriers as the most significant obstacle to widespread EV adoption, underscoring persistent issues such as insufficient charging infrastructure, limited availability of maintenance workshops, and lack of fast-charging options. The consistently high ranking of infrastructural concerns across both first-time and second-time buyers highlights that substantial investments in infrastructure remain paramount to improving EV adoption rates. Consequently, policy measures should prioritize rapid expansion and equitable distribution of public charging stations and maintenance facilities nationwide, potentially mitigating consumers' infrastructural anxieties and promoting greater acceptance.

The prioritized barriers present tangible opportunities for entrepreneurs and SMEs to innovate. Small enterprises can bridge infrastructural gaps by establishing local charging hubs, mobile battery-swapping units, and low-cost maintenance services. Financial-technology start-ups can design leasing or subscription models that reduce upfront costs, while social enterprises can focus on consumer education and trust-building campaigns. These initiatives contribute to sustainable entrepreneurship and job creation, linking innovation, enterprise, and sustainability across Asia.

Technological barriers emerged as another dominant category, driven primarily by persistent concerns around battery technology, vehicle performance efficiency, range anxiety, and standardization issues. Notably, range anxiety remained a significant apprehension for both buyer groups, reflecting deeply ingrained perceptions regarding EV reliability and usability. To address these issues, continuous advancements in battery technology and performance standards, combined with transparent communication and consumer education, could significantly enhance consumer confidence and adoption willingness.

An intriguing distinction surfaced between the two consumer segments regarding their prioritization of specific barriers. First-time potential buyers emphasized immediate operational and usability concerns such as performance efficiency, battery durability, social influences, and limited EV model options. This indicates that initial adoption decisions are heavily influenced by immediate practicality and experiential aspects. Addressing these concerns requires targeted consumer education, practical demonstrations, and direct engagement strategies that showcase EV reliability and convenience in daily use.

Conversely, second-time potential buyers, possessing prior EV evaluation experience, showed greater sensitivity towards financial considerations, technology skepticism, and the clarity of policy frameworks. Issues such as high initial costs, battery replacement expenses, long-term government planning, and clear emission standards ranked

significantly higher among this segment. These informed concerns necessitate comprehensive and transparent policy measures, clear regulatory communication, economic incentives, and structured long-term planning to bolster sustained confidence and reduce uncertainties.

The comparative analysis between both buyer groups provides critical strategic insights for stakeholders. While infrastructural and technological issues form the common foundation of consumer hesitation, differentiated strategies tailored to consumer familiarity and exposure levels are essential. Specifically, first-time buyer interventions should concentrate on reducing practical and immediate barriers through enhanced accessibility and consumer-centric information dissemination. For second-time buyers, long-term trust-building through policy transparency, economic incentives, and improved technological reliability is crucial.

The methodological integration of Delphi and AHP employed in this research provided robust, valid, and reliable prioritizations, offering policymakers and industry stakeholders actionable insights for targeted interventions. Future research might extend these findings through longitudinal studies to observe shifting barrier perceptions over time, or by exploring more detailed demographic segments to further enrich strategies aimed at promoting sustainable electric mobility in India.

6. Conclusion and Limitations

This study systematically identified, prioritized, and compared critical barriers influencing electric vehicle (EV) adoption among two distinct consumer segments in India: first-time potential EV buyers and second-time potential EV buyers. Using a structured Delphi-AHP methodology, the research revealed essential insights that inform targeted strategies for policymakers and industry stakeholders.

The findings underscore the predominant role of infrastructural barriers, highlighting the urgent need to enhance charging infrastructure, fast-charging facilities, and maintenance support networks across India. Technological barriers, particularly concerns such as range anxiety, technological reliability, and standardization, also significantly impact consumer decision-making. Moreover, distinct variations between first-time and second-time buyers indicate nuanced differences that must be strategically addressed. First-time buyers exhibited concerns about immediate practical usability and model availability, while second-time buyers emphasized long-term financial implications, technological reliability, and clarity in policy frameworks.

These nuanced insights imply that tailored strategies are essential. For first-time buyers, immediate infrastructural improvements, comprehensive consumer education, and practical demonstrations could alleviate initial barriers. For second-time buyers, enhancing trust through technological reliability, clear economic incentives, and robust long-term policy frameworks is critical for sustained adoption.

The results of this study offer actionable interventions tailored to each consumer segment. For first-time EV buyers, interventions should prioritize visible infrastructural upgrades, such as expanding fast-charging stations and ensuring reliable maintenance services. Simultaneously, awareness campaigns, product demonstrations, and peer-led testimonials can reduce skepticism and build trust. For second-time buyers, interventions must focus on long-term reliability and cost-efficiency by subsidizing battery technologies, providing detailed total cost of ownership data, and delivering transparent, consistent policy roadmaps. Collectively, these targeted strategies can effectively mitigate segment-specific adoption barriers and accelerate the transition to electric mobility in India.

Despite the rigorous methodological approach and valuable insights, this study acknowledges certain limitations. First, the research primarily focused on personal car users and enthusiasts, potentially limiting the generalizability of findings across broader demographic groups, such as commercial fleet operators or rural populations. Second, the Delphi and AHP methodologies, although robust, are inherently reliant on expert judgments, introducing potential subjective biases despite consistency checks. Third, barriers may evolve over time due to rapid technological advancements and shifting policy landscapes, highlighting the necessity for ongoing research to maintain relevance and accuracy.

Future research directions could include longitudinal studies to monitor evolving barrier perceptions, broader demographic inclusions to enhance generalizability, and comparative analyses across different geographical regions or international contexts. Addressing these research gaps would further enrich strategic frameworks, fostering a comprehensive and sustainable approach to promoting electric mobility in India. In conclusion, electric vehicle adoption is not merely a technological or policy challenge but also an entrepreneurial opportunity. By engaging SMEs, innovators, and start-ups in resolving the identified barriers, India can create a vibrant ecosystem of sustainable entrepreneurship that aligns with the United Nations' Sustainable Development Goals (SDGs 7, 9, 11, and 13) and advances Asia's green economic transformation. Promoting ethical and socially responsible entrepreneurship within the EV ecosystem will enhance sustainability outcomes and community trust, ensuring India's transition serves as an inclusive model of green growth across Asia.

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