Research Paper

Towards Sustainable Mobility: Unveiling Consumer Preferences for 4-wheeler Electric Vehicle Adoption in India

Bibin Xavier [1]* and Issac Jacob John[2]

[1] Marian College Kuttikkanam Autonomous; bibinxavier54@gmail.com, https://orcid.org/0000-0001-6303-2067
[2] Marian College Kuttikkanam Autonomous; issacjoh1230@gmail.com
* Correspondence: bibinxavier54@gmail.com

Abstract: In an age increasingly prioritizing sustainable transportation, Electric Vehicles (EVs) represent a transformative solution, guiding the automotive industry towards environmental stewardship. However, EV adoption in India faces multifaceted challenges, necessitating a nuanced understanding of consumer preferences. This study addresses this gap by examining factors influencing the adoption of 4-wheeler EVs through a sequential exploratory mixed research approach. Qualitative interviews with 10 participants provided insights into attributes like price, subsidy, range, performance, battery capacity, charging station accessibility, and resale value. Subsequently, a choice-based conjoint analysis involving 420 respondents quantitatively evaluated these attributes. Findings highlight affordability and subsidies as pivotal, alongside preferences for extended range and satisfactory performance. Best profile analyses for each attribute offer actionable insights for manufacturers and policymakers, emphasizing the need for strategic pricing, subsidy optimization, and infrastructure development to enhance EV adoption. These insights are crucial for developing targeted strategies to promote wider EV adoption, thereby contributing to sustainable transportation goals in India and beyond.

Keywords: EV adoption, 4-wheelers, Conjoint analysis, Relative importance analysis, Best profile

1. Introduction

India became the world's most populous nation, overtaking China with a population of over 1.43 billion people in 2023(O'Neill, 2023). This demographic surge has led to a substantial rise in automobile demand. The Road Transport Sector, which handles about 87% of passenger traffic and 60% of freight traffic in India, is vital in addressing this increasing demand. (Ministry of Road Transport & Highways, Government of India, 2023). However, the swift growth of road transportation brings serious environmental sustainability issues, primarily due to the increased carbon dioxide emissions and other pollutants. On a global scale, the transportation sector significantly contributes to environmental pollution, being responsible for 15% of man-made greenhouse gas (GHG) emissions (Fiore et al., 2023). Vehicles with internal combustion engines, particularly those using petrol and diesel, produce substantial pollutants including CO, NOx, HC, and PM (Bhandarkar, 2013). Both light-duty and heavy-duty vehicles significantly contribute to the high levels of CO2, CO, NO2, VOCs, and PM2.5 (Debbarma et al., 2023), underscoring the urgent necessity for sustainable alternatives. The need to decarbonize the rapidly expanding

Received: 123/03/2025
Revised: 25/03/2025
Accepted: 31/03/2025
Published: 31/03/2025

Citation: Xavier, B., & Jacob John, I. (2025). Towards Sustainable Mobility: Unveiling Consumer Preferences for 4-wheeler Electric Vehicle Adoption in India. Sustainability Review, 1(1), 11-27. https://sustainabilityreview.org/index.php/home/article/view/3

travel sector is in line with the Sustainable Development Goals (SDGs) and the net-zero emission targets set forth in the Paris Agreement and reinforced at the COP26 Conference (Fragkos, 2022). The adoption of EVs, characterized by lower emissions and greater energy efficiency, is a crucial step toward achieving these global objectives (Tiseo, 2023). In India, among the registered 4-wheeler vehicles (including passenger and goods vehicles) in 2023, 39.18% operate on petrol, 42% on diesel, with only 1.5% being EVs (VAHAN SEWA, Vehicle Class Wise Vehicle Category Group Data for All State, 2024). Despite the potential of electric vehicles (EVs) to mitigate environmental concerns, their adoption has not met targets (Nimesh et al., 2024) and faces obstacles due to various factors. With the majority of 4-wheeler users preferring traditional crude oil-based engines, it is crucial to understand the barriers preventing these users from transitioning to EVs.

Current research on EV adoption has predominantly focused on identifying influencing factors without delving into their relative significance or optimal combinations for maximizing customer satisfaction. Addressing this gap, this study aims to comprehensively examine the determinants influencing consumer adoption of 4-wheeler EVs in India. Using a sequential exploratory mixed-method approach, the research begins with qualitative interviews to uncover nuanced factors shaping consumer decisions. Subsequently, quantitative conjoint analysis will assess the relative importance of these factors and explore effective feature combinations to enhance satisfaction. This dual-phase methodology seeks to provide a nuanced understanding of 4-wheeler EV adoption dynamics specific to India, identifying key drivers and offering actionable insights to stakeholders for aligning EV development with consumer preferences and regional needs.

2. Literature Review

The main economic barrier preventing the widespread adoption of EVs revolves around high acquisition costs, primarily attributed to expensive battery technology. This issue has been emphasized in multiple studies conducted in Brazil, Ireland, and India (Ali & Naushad, 2022; Munshi et al., 2022; Murugan & Marisamynathan, 2022a, 2022b; Pillai et al., 2022; Ruoso & Ribeiro, 2022). Moeletsi, (2021) highlights the considerable influence of purchase and battery prices on EV adoption. The study suggests that high initial costs can dissuade potential buyers, emphasizing the necessity for more affordable EV options in the market. In regions like China (Cui et al., 2021), the UK (Mandys, 2021), and the Nordic countries (Noel et al., 2020), acquisition costs stand out as pivotal determinants influencing the prospects of EV adoption. Similarly, in Korea, the acquisition cost, especially compared to consumers' previous fossil fuel vehicles, plays a crucial role in shaping their decision-making process (Jang & Choi, 2021). However, divergent views on the significance of acquisition costs for EV adoption in India are apparent in the studies conducted by Krishnan & Koshy, (2021) and Goel et al., (2021). Interestingly, in Taiwan, both acquisition and maintenance costs influence consumers' intentions to adopt EVs (Dutta & Hwang, 2021), while in Virginia, adoption dynamics are shaped by a combination of acquisition and operational costs (Jia & Chen, 2021). This intricate landscape underscores the multifaceted nature of cost considerations in the global EV adoption landscape.

Government incentives and policies also wield significant influence over EV adoption (Khurana et al., 2020; Zhang et al., 2014). Government-driven factors such as subsidies and tax rebates can enhance the appeal of EVs by increasing their financial accessibility. The importance of government financial support for consumers has been underscored as a critical incentive in numerous studies (Chhikara et al., 2021; Higueras-Castillo et al., 2020; Jia & Chen, 2021; Munshi et al., 2022; Xia et al., 2022). This support plays a crucial role in promoting EV adoption across various regions, including Virginia, USA (Jia &

Chen, 2021), Spain (Higueras-Castillo et al., 2020), India (Munshi et al., 2022), and China (Xia et al., 2022). Government subsidies for EV purchases and reductions in electricity-related operational costs are critical factors influencing EV adoption (Mohammadzadeh et al. 2022; Ramesan et al. 2022). Künle & Minke, (2022) highlight its importance in France, Germany, and Norway. Kong et al., (2020) emphasize that purchase subsidies have a significant impact on Chinese consumers' willingness to adopt electric vehicles. On the contrary, Ogunkunbi et al., (2022) argue, based on their study across 15 European countries, that financial subsidies and tax reductions do not positively correlate with battery electric vehicle (BEV) adoption. Alongside environmental awareness (Brinkmann & Bhatiasevi, 2021) the perceived economic value of EVs significantly impacts purchase intent (Asadi et al., 2021). The perceived value, coupled with financial incentives, plays a crucial role in influencing EV adoption (Sierzchula et al., 2014). According to Zhuge et al., (2020), economic factors such as subsidies, petrol prices, and electricity prices play a critical role in EV adoption, influencing both EV and conventional vehicle owners in distinct ways.

Chen et al. (2020) underscored the importance of charging time and vehicle-to-grid capability as influential factors for electric vehicle (EV) adoption in the Nordic region. Interestingly, they found that battery life and the availability of public charging were prioritized by conventional car owners over these factors, revealing differing considerations between conventional and EV owners. Meanwhile, the advancement of technology, particularly the increase in battery capacity, is a pivotal factor driving the growth of electric vehicle (EV) adoption in Korea, as highlighted by Lashari et al. (2021). Additionally, Jang & Choi, (2021) emphasized the critical roles of proximity to charging stations and charging efficiency in shaping EV adoption in Korea. Furthermore, in Hawaii, USA (Wee et al., 2020), and Spain (Higueras-Castillo et al., 2020), crucial factors influencing EV adoption include range anxiety, particularly among long-distance commuters, as well as the availability of public charging infrastructure and charging time. Guerra & Daziano (2020), based on their research in Philadelphia, USA, highlight that consumers are willing to pay for an extended EV driving range, shorter charging times, and reduced operational costs, illustrating the varied preferences driving EV adoption across diverse geographical contexts.

Multiple studies underscore a combination of factors crucial to EV adoption. In India, end-user preferences for EVs are influenced by factors such as vehicle performance (Krishnan & Koshy, 2021; Pradeep et al., 2021), attitude (Khurana et al., 2020), and battery range. Similarly, in the UK, EV performance and battery range have emerged as pivotal considerations (Mandys, 2021). In Taiwan, consumer perspectives are shaped by the synergy between vehicle performance and the availability of charging infrastructure (Dutta & Hwang, 2021). Additionally, Higueras-Castillo et al., (2021) emphasize the vehicle's range as a critical factor in EV adoption. Furthermore, Sun et al., (2022), highlight the importance of technical standards, such as safety, performance, and compatibility, in building consumer trust and confidence in EV technology. Consumers' preference for EVs offering longer ranges underscores concerns about battery life and the frequency of recharging.

Chen et al., (2020), identified charging time and vehicle-to-grid capability as pivotal factors influencing EV adoption in their study of the Nordic region. Interestingly, for conventional car owners, considerations such as battery life and the availability of public charging infrastructure outweigh those for EV owners. Additionally, the study revealed that factors such as driving range, speed, acceleration, design, and style had minimal impact on consumers' intentions to adopt EVs, whereas fuel economy, ease of operation, and technological reliability emerged as critical factors.

A consensus across various global studies highlights that insufficient charging infrastructure remains a primary barrier to widespread consumer adoption of EVs (Jang & Choi, 2021; Li et al., 2020; Munshi et al., 2022; Ramesan et al., 2022; Rodrigues et al., 2021; Ruoso & Ribeiro, 2022; Xue et al., 2021). The availability of charging infrastructure plays a crucial role in EV adoption in China, as highlighted by Li et al. (2020). Similarly, the density of public charging infrastructure is considered a critical factor influencing the adoption of BEVs in Norway (Schulz & Rode, 2022) and China (Ma & Fan, 2020). Interestingly, this factor does not significantly impact the adoption of plug-in hybrid electric vehicles (PHEVs) in China (Ma & Fan, 2020). In Denmark, Haustein et al., (2021) emphasize that fast-charging infrastructure significantly influences EV adoption among consumers, whereas in Sweden, its importance is less pronounced.

Künle & Minke, (2022) highlight the intricate connection between the availability of charging infrastructure and the adoption of plug-in electric vehicles, addressing the dilemma of which comes first. They suggest that while charging infrastructure is crucial for increasing EV adoption rates, technological advancements alone do not determine adoption. Meanwhile, in the United States, White et al. (2022) underscore the importance of public charging station density in influencing consumer decisions to transition to EVs. This perspective is echoed by (Khandakar et al., 2020), who stress the necessity of expanding charging infrastructure to promote wider EV adoption. Accessible and convenient charging facilities play a vital role in alleviating consumer concerns such as range anxiety.

In India, the availability of charging infrastructure has emerged as the primary factor influencing EV adoption (Murugan & Marisamynathan, 2022a, 2022b). Conversely, another Indian study presents a contrasting viewpoint, arguing that charging infrastructure is not a decisive factor for EV adoption (Ali & Naushad, 2022). Simultaneously, these studies suggest that factors such as speed, range, comfort, design, and battery technology significantly influence the decision-making process of Indian consumers regarding EV adoption. Additionally, the perceived and prospective accessibility of public EV chargers is noted to play a crucial role, especially in densely populated urban areas (He et al., 2020). Financial incentives, charging infrastructure, and local production facilities exhibit a positive correlation with EV adoption, with charging infrastructure identified as the most influential factor (Sierzchula et al., 2014). Several factors contribute to the adoption of EVs, encompassing financial barriers, vehicle performance, charging infrastructure availability, environmental conservation efforts, societal influences, and increasing social awareness (Michael et al., 2022). Mathew & Varaprasad, (2020) explored barriers to EV adoption in India, emphasizing limited EV battery range and inadequate charging infrastructure as significant obstacles. This underscores the need to address these practical challenges to facilitate broader EV adoption.

Existing literature extensively documents the factors influencing EV adoption, often relying on either quantitative surveys or qualitative interviews, which may provide an incomplete understanding of EV adoption dynamics. Despite increasing interest in EVs, adoption rates in India have not met anticipated levels. Therefore, deciphering these factors and identifying the optimal combination of features preferred by customers using tools such as conjoint analysis is crucial for developing effective strategies to promote widespread EV adoption.

3. Research Methodology

3.1 Approach

This study employed a sequential exploratory mixed research method (Harrison & Reilly, 2011) strategically integrating qualitative and quantitative research techniques. This approach is particularly effective in comprehensively exploring consumer behavior and preferences in the context of EV adoption (Ramadan & Othman, 2023). By starting with qualitative analysis to deeply understand customer preferences and subsequently using conjoint analysis to measure the optimal combination of these preferences and the best profile that can satisfy the customers, the mixed-method design allows for a thorough investigation of the subject matter.

3.1.1 Qualitative Phase

In conducting a qualitative structured interview to explore the attributes and features guiding customers in their decision to purchase a 4-wheeler EV, a representative sample of 10 participants was carefully selected following the guidelines outlined by Boddy (2016). This group consisted of three current 4-wheeler EV users and seven potential adopters, ensuring a diverse range of perspectives. By including both current EV users and individuals intending to adopt EVs within the next three years, this study aimed to gather comprehensive insights. This strategic approach facilitated the exploration of factors influencing current EV owners' decisions and the motivations and barriers influencing future EV adoption. Through this inclusive methodology, the study aimed to uncover nuanced insights to develop strategies for promoting broader EV adoption. Despite the small group size, it was suitable for the exploratory nature of this phase, allowing for detailed personal insights. The structured interviews yielded a wide range of attributes that customers considered significant when acquiring a 4-wheeler EV. Subsequently, a systematic screening and categorization process using thematic analysis (Kiger & Varpio, 2020), was employed to condense these attributes into a more manageable set. Respondents' statements and key terms were coded for each attribute. To ensure the reliability of the process, an impartial colleague independently undertook identical tasks, and the attributes were compared until a consensus was reached. This process resulted in the identification of a concise list of seven attributes. The attribute levels were determined by researching the current specifications of EVs from leading manufacturers in India (Table 1).

3.1.2 Quantitative Phase

Building on insights from the qualitative phase, a quantitative phase using choice-based conjoint analysis was conducted. Conjoint analysis is a powerful multivariate technique designed to measure consumer preferences for various products and services by analyzing the trade-offs customers make when making purchase decisions (Rao, 2010). In traditional surveys, participants often rate all attributes as important, making it challenging to discern true priorities. Conjoint analysis overcomes this by presenting respondents with trade-off decisions. It aims to determine the relative importance of product attributes and their levels by calculating the utility that consumers assign to each attribute (Hair et al. 2013). This method allows researchers to derive insights into which attributes and their specific levels drive consumer preferences most effectively. This study employed choice-based conjoint analysis (CBC) (Eggers et al., 2022) to identify the key attributes influencing EV purchase decisions. The attributes considered included speed (performance), range, price, subsidy, battery capacity, availability of charging stations, and resale value (after 5 years). CBC was chosen for its ability to quantify customer preferences using utility scores or part-worths, which standardize the measurement of attribute importance and interactions (Orme, 2010). By simulating realistic trade-off scenarios in the EV market, CBC sur-

veys allowed respondents to evaluate various attribute combinations. This approach provided valuable insights into how consumers make decisions when selecting EVs, reflecting real-world decision-making dynamics effectively.

Using Questionpro.com, a sufficient sample size of 420 participants was obtained through purposive sampling from individuals who were expected to buy electric cars (EVs) during the next three years, for the choice-based conjoint analysis (Verma & Chandra, 2018). In order to guarantee that the information acquired was specifically pertinent to the study goals, this selection process was based on the rationale of choosing participants who mirrored the target market for electric vehicles. This study attempted to identify the preferences, priorities, and decision-making elements that might affect potential EV customers' decisions when they were choosing between various EV characteristics and attributes. QuestionPro uses an orthogonal array with a level balance to generate different variations of CBC scenarios in an organized manner. Every participant was presented with three different scenarios that each required them to select a 4-wheeler EV that best matched their actual booking preferences. By selecting one of these profiles, participants assisted us in collecting information about their trade-offs and preferences. The most favored attribute combinations and the relative value of each characteristic were then ascertained by a conjoint analysis.

4. Results and Discussion

4.1 Qualitative Analysis

The transcripts were carefully coded and transcribed. The resultant table (Table 1) summarizes the features or attributes that were found, along with the different levels that correspond to each feature, and is backed up by sample extracts.

Attribute/Feature	**Illustrative excerpts**	**Levels**
Price	'The price of the 4-wheeler EV is too high compared to the petrol and diesel vehicles.' 'The price of 4-wheeler EV's is on the higher side.'	• Less than 6 lakhs • 6 lakhs – 12 lakhs • 12 lakhs – 18 lakhs • 18 lakhs – 24 lakhs • 24 lakhs and above
Subsidy	'The subsidies provided by the government on 4-wheeler EVs are reduced.'	• Less than 5% • 5% - 15% • 15% -25% • 25% and above
Range	'Yes, I personally have a fear of running out of a battery while using a 4-wheeler EV...'	4-wheeler • Less than 250 km • 250 km – 350 km • 350 km – 450 km • 450 km and above
Performance (Speed)	'I can say about the EV that if we are driving with two people in a scooter then in a sloppy area it	4-wheeler • Less than 130 km/h • 130 km/h – 150 km/h • 150 km/h and more

	gets slower and it will not give you that much power as a petrol scooter.'	
Battery	'Charging a 4-wheeler EV is time consuming compared to its alternatives. It will take one hour or 2 hours or maybe sometimes more than 4 hours.' "The government should invest in research and development for better battery life and lower battery prices.'	4-wheeler • Less than 40 kWh • 40 kWh – 60 kWh • 60 kWh – 80 kWh • 80 kWh and above
Charging Station Availability	'The government should try to bring more and more charging stations, most importantly, comfortable charging stations for the public where the driver or the passengers can rest or spend some time as the car or their scooter gets charged up.' 'The charging facilities for 4-wheeler EVs are not available in our area.'	• Within 5 km radius • 5 km radius – 10 km radius • 10 km radius – 15 km radius • 15 km radius and above
Resale Value	'The resale value of 4-wheeler electric vehicles is less compared to petrol or diesel vehicles.'	• Less than 30% • 30% to 50% • 50% to 60% • 60% and above

Table 1. Conjoint attributes, excerpts, and levels

A conjoint analysis was conducted using the attributes and their levels based on the findings of the qualitative study.

4.2 Descriptive analysis

Table 2 provides a demographic summary after 420 valid responses were gathered. In the conjoint study of 4-wheeler EV adoption, the gender distribution of participants was found to be 56.7% male (238 participants) and 43.3% female (182 participants), with no participants identifying as other. Age-wise, the age group of 35–44 accounts for the largest percentage of participants (31.2%), followed by the groups of 18–24 (21.4%), 25–34 (21.2%), and 45–54 (21.2%). Out of all age groups, only 4.5% are 55–64. The smallest percentage (0.5%) are under 18 and none are above 64. In terms of income, the majority of participants

(41.2%) make between 5 lakhs and 10 lakhs annually, followed by 21.4% who make 10 lakhs and more, 21.0% who make between 2 lakhs and 5 lakhs, and 16.4% who make less than 2 lakhs.

		Total	Percentage
Gender	Female	182	43.3
	Male	238	56.7
	Other	0	0.0
	Total	420	100.0
Age	Under 18	2	0.5
	18-24	90	21.4
	25-34	89	21.2
	35-44	131	31.2
	45-54	89	21.2
	55-64	19	4.5
	Above 64	0	0.0
	Total	420	100.0
Income	Less than 2 lakhs/annum	69	16.4
	2 lakhs to 5 lakhs	88	21.0
	5 lakhs to 10 lakhs	173	41.2
	10 lakhs and above	90	21.4
	Total	420	100.0

Table 2. Demographic details

4.3 Conjoint Analysis Results

The conjoint analysis (Table 3) provides detailed insights into the preferences of consumers regarding 4-wheeler EVs, illuminating key factors influencing their adoption in sustainable transportation. Price emerges as the most critical determinant, with a substantial decrease in utility as prices rise, highlighting its paramount importance in consumer decision-making. Subsidies, although impactful, show a relatively lower influence compared to price, yet higher subsidy levels correlate positively with utility scores due to their direct effect on affordability. Range is another significant factor, with consumers favoring EVs capable of longer distances per charge, indicating a strong preference for extended operational capability. Speed exhibits minimal influence on consumer choices for 4-wheeler EVs, suggesting that other factors such as practicality and cost-efficiency are more decisive. Battery size plays a moderate role, with preferences peaking between 40-80 kWh capacities. The availability of charging stations within a closer radius positively impacts utility, emphasizing the critical role of infrastructure accessibility in EV adoption. Furthermore, the resale value after 5 years significantly influences consumer decisions, with varying utility scores based on the percentage of the vehicle's initial value retained, underscoring its importance in long-term ownership considerations. These findings underscore the complex interplay of factors shaping consumer preferences and highlight avenues for enhancing EV adoption strategies in the market.

4-Wheeler				
Feature	**Relative Importance (A)**	**Levels**	**Part-Worth Utility (B)**	**Utility (A*B)**
Price	46.02%	Less than 6 lakhs	1.304	0.600
		6 lakhs – 12 lakhs	0.934	0.430
		12 lakhs – 18 lakhs	0.115	0.053
		18 lakhs – 24 lakhs	-0.513	-0.236
		24 lakhs and above	-1.841	-0.847
Subsidy	5.75%	Less than 5%	-0.139	-0.008
		5% - 15%	-0.161	-0.009
		15% - 25%	0.068	0.004
		25% and above	0.232	0.013
Range	26.13%	Less than 250 km	-1.085	-0.284
		250 km – 350 km	-0.25	-0.065
		350 km – 450 km	0.7	0.183
		450 km and above	0.635	0.166
Performance (Speed)	3.94%	Less than 130	-0.118	-0.005
		130 – 150	0.151	0.006
		150 and more	-0.033	-0.001
Battery	5.50%	Less than 40kWh	-0.206	-0.011
		40kWh – 60kWh	0.065	0.004
		60kWh – 80kWh	0.169	0.009
		80kWh and above	-0.028	-0.002
Availability of Charging Stations (Radius)	5.08%	Within 5km	0.155	0.008
		5 km – 10 km	-0.192	-0.010
		10 km – 15 km	-0.106	-0.005
Resale Value (After 5 Yr.)		15 km and above	0.143	0.007
		Less than 30%	-0.283	-0.021
		30% to 50%	0.046	0.003
		50% to 60%	0.002	0.000
		60% and above	0.235	0.018

Table 3. Part-worth, importance, and utility of 4-wheeler EVs.

4.4 Best and Worst Profiles

Table 4 delineates the best and worst profiles based on attribute preferences for 4-wheeler electric vehicles, offering a nuanced understanding of consumer priorities.

The table provides a clear comparison of attribute preferences for 4-wheeler electric vehicles (EVs), showcasing the best and worst profiles based on consumer choices derived from conjoint analysis. Price emerges as the most influential factor, where consumers

strongly prefer EVs priced below 6 lakhs compared to those priced at 24 lakhs and above. Subsidies play a critical role, with EVs offering 25% or more subsidy receiving higher utility scores than those with 5% to 15% subsidy, indicating that financial incentives significantly enhance attractiveness. Range is another pivotal attribute, with EVs capable of traveling between 350km to 450km per charge preferred over those with less than 250km range, emphasizing the importance of extended operational distances for consumer satisfaction. Performance, measured by speed, shows a preference for EVs capable of speeds between 130 km/h to 150 km/h over those with speeds below 130 km/h. Battery size also influences preferences, with EVs equipped with 60kWh to 80kWh batteries preferred over those with less than 40kWh, highlighting the importance of battery capacity for range and performance. Availability of charging stations within a radius of less than 5km is favored over stations located 5km to 10km away, underscoring the convenience factor in infrastructure access. Lastly, the resale value after 5 years significantly impacts consumer decisions, with EVs retaining 60% or more of their initial value preferred over those retaining less than 30%, reflecting long-term investment considerations. These insights from the conjoint analysis provide a nuanced understanding of consumer preferences and underscore the importance of these attributes in shaping strategies for promoting EV adoption in the market.

Attribute	**4 - wheeler**	
	Best Profile	**Worst Profile**
Price	Less than 6 lakhs	24 lakhs and above
Subsidy	25% and above	5% - 15%
Range	350km – 450 km	Less than 250 km
Performance (Speed - km/h)	130 km/h – 150	Less than 130
Battery	60kWh – 80kWh	Less than 40kWh
Availability of charging stations (radius)	Less than 5km	5km – 10km
Resale value (after 5 yr.)	60% and above	Less than 30%

Table 4. Best and worst profile

5. Findings

This study delved into the determinants influencing the adoption of electric vehicles (EVs) in India, specifically focusing on 4-wheelers. Through a mixed-method approach blending qualitative interviews and choice-based conjoint analysis, several critical insights emerged. Price emerged as the foremost factor shaping consumer decisions, with a strong preference observed for EVs priced below 6 lakhs, contrasting sharply with lower utility scores for vehicles priced at 24 lakhs and above. Subsidies played a pivotal role, with higher subsidy levels significantly enhancing consumer attractiveness towards EVs. Range proved crucial, with consumers favoring vehicles capable of traveling 350-450 km per charge, emphasizing the need for extended operational distances to alleviate range anxiety. Performance, particularly speed, had minimal impact, suggesting practicality and cost-efficiency weigh heavier in consumer decision-making. Battery capacity moderately influenced preferences, with consumers preferring EVs equipped with 60-80 kWh batteries. Accessibility to charging stations within a 5 km radius was preferred, highlighting

convenience in infrastructure availability. The resale value after 5 years also wielded significant influence, with EVs retaining 60% or more of their value preferred, underscoring considerations of long-term ownership costs. These findings provide nuanced insights into consumer preferences, offering strategic pathways for policymakers and industry players to promote EV adoption in India by addressing affordability, infrastructure development, and technological advancements.

6. Implications & Directions for Future Research

Based on the findings of this study on EV adoption in India, several implications and future research directions can be identified. Firstly, policymakers should prioritize initiatives that address the affordability of EVs, particularly by enhancing subsidies and incentives that make them more competitive compared to traditional vehicles. Given the significant preference for EVs priced below 6 lakhs and those with higher subsidy levels, strategies to reduce manufacturing costs or increase financial incentives could accelerate adoption rates.

Secondly, there is a clear need for infrastructure development, especially in expanding the availability of charging stations within a 5 km radius, which was shown to positively influence consumer preferences. Future research should explore innovative solutions for charging infrastructure deployment, such as integrating charging stations into existing urban infrastructure or leveraging renewable energy sources for sustainable charging options.

Thirdly, technological advancements in battery capacity and performance remain critical. Consumers exhibited a preference for EVs with larger battery capacities (60-80 kWh), indicating a demand for extended range capabilities. Research focusing on improving battery efficiency, reducing charging times, and enhancing overall vehicle performance could further enhance the attractiveness of EVs in the market.

Moreover, the study highlighted the importance of long-term ownership costs, with resale value after 5 years influencing consumer decisions. Future research should delve deeper into factors impacting resale values and explore strategies to increase the resale value of EVs through improved battery longevity, maintenance programs, and market awareness.

Lastly, as consumer preferences and adoption barriers evolve, ongoing research should continue to monitor and analyze shifting trends in EV adoption. Studies that incorporate longitudinal data and dynamic modeling techniques can provide valuable insights into evolving consumer behavior, regulatory impacts, and technological advancements that shape the future landscape of sustainable transportation in India and beyond. By addressing these implications and advancing research in these areas, stakeholders can better navigate the complexities of EV adoption and accelerate the transition towards a greener automotive future.

6. Conclusion

This study provides comprehensive insights into the key determinants influencing the adoption of electric vehicles (EVs) in India, specifically focusing on 4-wheelers. The research highlights that price sensitivity is paramount among consumers, emphasizing the critical role of subsidies in enhancing affordability. Factors such as extended range, adequate performance, optimal battery capacity, and accessible charging infrastructure also

significantly influence consumer preferences. Moreover, the study underscores the importance of considering long-term ownership costs, particularly the resale value, in shaping EV purchase decisions. Moving forward, policymakers, manufacturers, and stakeholders should prioritize strategies aimed at reducing costs, expanding infrastructure, and advancing technological capabilities to accelerate EV adoption and support sustainable mobility initiatives in India.

7. References

Ali, I., & Naushad, M. (2022). A Study to Investigate What Tempts Consumers to Adopt Electric Vehicles. World Electric Vehicle Journal, 13(2), 1–15. https://doi.org/10.3390/wevj13020026

Asadi, S., Nilashi, M., Samad, S., Abdullah, R., Mahmoud, M., Alkinani, M. H., & Yadegaridehkordi, E. (2021). Factors impacting consumers' intention toward adoption of electric vehicles in Malaysia. Journal of Cleaner Production, 282, 124474. https://doi.org/10.1016/j.jclepro.2020.124474

Bhandarkar, S. (2013). Vehicular Pollution, Their Effect on Human Heatlh and Mitigation Measures. Vehicle Engineering(VE), 1(2). www.seipub.org/ve33

Boddy, C. R. (2016). Sample size for qualitative research. Qualitative Market Research, 19(4), 426–432. https://doi.org/10.1108/QMR-06-2016-0053/FULL/XML

Brinkmann, D., & Bhatiasevi, V. (2021). Purchase Intention for Electric Vehicles Among Young Adults in Thailand. Vision, 27(1), 110–118. https://doi.org/10.1177/09722629211001981/ASSET/IMAGES/LARGE/10.1177_09722629211001981-FIG2.JPEG

Chen, C. fei, Zarazua de Rubens, G., Noel, L., Kester, J., & Sovacool, B. K. (2020). Assessing the socio-demographic, technical, economic and behavioral factors of Nordic electric vehicle adoption and the influence of vehicle-to-grid preferences. Renewable and Sustainable Energy Reviews, 121, 1–39. https://doi.org/10.1016/j.rser.2019.109692

Chhikara, R., Garg, R., Chhabra, S., Karnatak, U., & Agrawal, G. (2021). Factors affecting adoption of electric vehicles in India: An exploratory study. Transportation Research Part D: Transport and Environment, 100, 103084. https://doi.org/10.1016/J.TRD.2021.103084

Cui, L., Wang, Y., Chen, W., Wen, W., & Han, M. S. (2021). Predicting determinants of consumers' purchase motivation for electric vehicles: An application of Maslow's hierarchy of needs model. Energy Policy, 151, 112167. https://doi.org/10.1016/J.ENPOL.2021.112167

Debbarma, S., Lal, B., & Phuleria, H. C. (2023). Near road urban air pollution due to vehicular traffic: Effect of real-world driving conditions and vehicle composition. EGU23. https://doi.org/10.5194/EGUSPHERE-EGU23-1617

Dutta, B., & Hwang, H. G. (2021). Consumers purchase intentions of green electric vehicles: The influence of consumers technological and environmental considerations. Sustainability (Switzerland), 13(21). https://doi.org/10.3390/su132112025

Eggers, F., Sattler, H., Teichert, T., & Völckner, F. (2022). Choice-Based Conjoint Analysis. Handbook of Market Research, 781–819. https://doi.org/10.1007/978-3-319-57413-4_23

Fiore, S., Zhang, Y., Luiza, A., Ferrer, C., Márcio, A., & Thomé, T. (2023). Carbon Emissions in Transportation: A Synthesis Framework. Sustainability 2023, Vol. 15, Page 8475, 15(11), 8475. https://doi.org/10.3390/SU15118475

Fragkos, P. (2022). Decarbonizing the International Shipping and Aviation Sectors. Energies 2022, Vol. 15, Page 9650, 15(24), 9650. https://doi.org/10.3390/EN15249650

Goel, P., Sharma, N., Mathiyazhagan, K., & Vimal, K. E. K. (2021). Government is trying but consumers are not buying: A barrier analysis for electric vehicle sales in India. Sustainable Production and Consumption, 28, 71–90. https://doi.org/10.1016/J.SPC.2021.03.029

Guerra, E., & Daziano, R. A. (2020). Electric vehicles and residential parking in an urban environment: Results from a stated preference experiment. Transportation Research Part D: Transport and Environment, 79, 102222. https://doi.org/10.1016/J.TRD.2020.102222

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2013). Multivariate Data Analysis. Pearson Education Limited. https://books.google.co.in/books?id=VvXZnQEACAAJ

Harrison, R. L., & Reilly, T. M. (2011). Mixed methods designs in marketing research. Qualitative Market Research: An International Journal, 14(1), 7–26. https://doi.org/10.1108/13522751111099300/FULL/XML

Haustein, S., Jensen, A. F., & Cherchi, E. (2021). Battery electric vehicle adoption in Denmark and Sweden: Recent changes, related factors and policy implications. Energy Policy, 149, 112096. https://doi.org/10.1016/J.ENPOL.2020.112096

He, S. Y., Luo, S., & Sun, K. K. (2020). Factors Affecting the Adoption Intention of Electric Vehicles: The Roles of Objective, Perceived and Prospective Accessibility. SSRN Electronic Journal, 1–24. https://doi.org/10.2139/ssrn.3660754

Higueras-Castillo, E., Guillén, A., Herrera, L. J., & Liébana-Cabanillas, F. (2021). Adoption of electric vehicles: Which factors are really important? International Journal of Sustainable Transportation, 15(10), 799–813. https://doi.org/10.1080/15568318.2020.1818330

Higueras-Castillo, E., Kalinic, Z., Marinkovic, V., & Liébana-Cabanillas, F. J. (2020). A mixed analysis of perceptions of electric and hybrid vehicles. Energy Policy, 136, 111076. https://doi.org/10.1016/J.ENPOL.2019.111076

Jang, S., & Choi, J. Y. (2021). Which consumer attributes will act crucial roles for the fast market adoption of electric vehicles?: Estimation on the asymmetrical & heterogeneous consumer preferences on the EVs. Energy Policy, 156, 112469. https://doi.org/10.1016/J.ENPOL.2021.112469

Jia, W., & Chen, T. D. (2021). Are Individuals' stated preferences for electric vehicles (EVs) consistent with real-world EV ownership patterns? Transportation Research Part D: Transport and Environment, 93, 102728. https://doi.org/10.1016/J.TRD.2021.102728

Khandakar, A., Rizqullah, A., Berbar, A. A. A., Ahmed, M. R., Iqbal, A., Chowdhury, M. E. H., & Zaman, S. M. A. U. (2020). A case study to identify the hindrances to widespread adoption of electric vehicles in qatar. Energies, 13(15). https://doi.org/10.3390/en13153994

Khurana, A., Kumar, V. V. R., & Sidhpuria, M. (2020). A Study on the Adoption of Electric Vehicles in India: The Mediating Role of Attitude. Vision, 24(1), 23–34. https://doi.org/10.1177/0972262919875548

Kiger, M. E., & Varpio, L. (2020). Thematic analysis of qualitative data: AMEE Guide No. 131. Medical Teacher, 42(8), 846–854. https://doi.org/10.1080/0142159X.2020.1755030

Kong, D., Xia, Q., Xue, Y., & Zhao, X. (2020). Effects of multi policies on electric vehicle diffusion under subsidy policy abolishment in China: A multi-actor perspective. Applied Energy, 266, 114887. https://doi.org/10.1016/J.APENERGY.2020.114887

Krishnan, V. V., & Koshy, B. I. (2021). Evaluating the factors influencing purchase intention of electric vehicles in households owning conventional vehicles. Case Studies on Transport Policy, 9(3), 1122–1129. https://doi.org/10.1016/J.CSTP.2021.05.013

Künle, E., & Minke, C. (2022). Macro-environmental comparative analysis of e-mobility adoption pathways in France, Germany and Norway. Transport Policy, 124, 160–174. https://doi.org/10.1016/J.TRANPOL.2020.08.019

Lashari, Z. A., Ko, J., & Jang, J. (2021). Consumers' intention to purchase electric vehicles: Influences of user attitude and perception. Sustainability (Switzerland), 13(12). https://doi.org/10.3390/su13126778

Li, J., Jiao, J., & Tang, Y. (2020). Analysis of the impact of policies intervention on electric vehicles adoption considering information transmission—based on consumer network model. Energy Policy, 144, 111560. https://doi.org/10.1016/J.ENPOL.2020.111560

Ma, S. C., & Fan, Y. (2020). A deployment model of EV charging piles and its impact on EV promotion. Energy Policy, 146, 111777. https://doi.org/10.1016/J.ENPOL.2020.111777

Mandys, F. (2021). Electric vehicles and consumer choices. Renewable and Sustainable Energy Reviews, 142, 110874. https://doi.org/10.1016/J.RSER.2021.110874

Mathew, N., & Varaprasad, G. (2020). Technology advancement: Factors influencing the adoption of Electric Vehicles in India. 2020 International Conference on System, Computation, Automation and Networking, ICSCAN 2020. https://doi.org/10.1109/ICSCAN49426.2020.9262449

Michael, L. K., K V, S., Hungund, S. S., & Fernandes, M. (2022). Factors influencing adoption of electric vehicles–A case in India. Cogent Engineering, 9(1). https://doi.org/10.1080/23311916.2022.2085375

Ministry of Road Transport & Highways, Government of India. (2023). Ministry of Road Transport and Highways. https://morth.nic.in/road-transport

Moeletsi, M. E. (2021). Socio-economic barriers to adoption of electric vehicles in South Africa: Case study of the gauteng province. World Electric Vehicle Journal, 12(4), 1–11. https://doi.org/10.3390/wevj12040167

Mohammadzadeh, N., Zegordi, S. H., Husseinzadeh Kashan, A., & Nikbakhsh, E. (2022). Optimal government policy-making for the electric vehicle adoption using the total cost of ownership under the budget constraint. Sustainable Production and Consumption, 33, 477–507. https://doi.org/10.1016/J.SPC.2022.07.015

Munshi, T., Dhar, S., & Painuly, J. (2022). Understanding barriers to electric vehicle adoption for personal mobility: A case study of middle income in-service residents in Hyderabad city, India. Energy Policy, 167, 112956. https://doi.org/10.1016/J.ENPOL.2022.112956

Murugan, M., & Marisamynathan, S. (2022a). Analysis of barriers to adopt electric vehicles in India using fuzzy DEMATEL and Relative importance Index approaches. Case Studies on Transport Policy, 10(2), 795–810. https://doi.org/10.1016/J.CSTP.2022.02.007

Murugan, M., & Marisamynathan, S. (2022b). Elucidating the Indian customers requirements for electric vehicle adoption: An integrated analytical hierarchy process – Quality function deployment approach. Case Studies on Transport Policy, 10(2), 1045–1057. https://doi.org/10.1016/J.CSTP.2022.03.017

Nimesh, V., Manoj, B. S., Bhaduri, E., Mahendra Reddy, V., & Kishore Goswami, A. (2024). Estimating personal electric vehicle demand and its adoption timeframe: A study on consumer perception in Indian metropolitan cities. Case Studies on Transport Policy, 101246. https://doi.org/10.1016/J.CSTP.2024.101246

Noel, L., Zarazua de Rubens, G., Kester, J., & Sovacool, B. K. (2020). Understanding the socio-technical nexus of Nordic electric vehicle (EV) barriers: A qualitative discussion of range, price, charging and knowledge. Energy Policy, 138, 111292. https://doi.org/10.1016/J.ENPOL.2020.111292

O'Neill, A. (2023). Countries with the largest population 2023. Statista. https://www.statista.com/statistics/262879/countries-with-the-largest-population/

Ogunkunbi, G. A., Al-Zibaree, H. K. Y., & Meszaros, F. (2022). Modeling and Evaluation of Market Incentives for Battery Electric Vehicles. Sustainability (Switzerland), 14(7), 1–11. https://doi.org/10.3390/su14074234

Orme, B. K. (2010). Getting started with conjoint analysis : strategies for product design and pricing research (2nd ed.). Madison, WI : Research Publishers.

Pillai, A., Curtis, J., & Tovar Reaños, M. A. (2022). Spatial scenarios of potential electric vehicle adopters in Ireland. Case Studies on Transport Policy, 10(1), 93–104. https://doi.org/10.1016/j.cstp.2021.11.008

Pradeep, V. H., Amshala, V. T., & Raghuram Kadali, B. (2021). Does perceived technology and knowledge of maintenance influence purchase intention of BEVs. Transportation Research Part D: Transport and Environment, 93, 102759. https://doi.org/10.1016/J.TRD.2021.102759

Ramadan, M., & Othman, M. (2023). Psychological antecedents of electric vehicle adoption in the West Bank. Transportation Letters. https://doi.org/10.1080/19427867.2023.2266184

Ramesan, S., Kumar, P., & Garg, S. K. (2022). Analyzing the enablers to overcome the challenges in the adoption of electric vehicles in Delhi NCR. Case Studies on Transport Policy, 10(3), 1640–1650. https://doi.org/10.1016/J.CSTP.2022.06.003

Rao, V. R. (2010). Conjoint Analysis. Wiley International Encyclopedia of Marketing. https://doi.org/10.1002/9781444316568.WIEM02019

Rodrigues, R., Albuquerque, V., Ferreira, J. C., Dias, M. S., & Martins, A. L. (2021). Mining electric vehicle adoption of users. World Electric Vehicle Journal, 12(4). https://doi.org/10.3390/wevj12040233

Ruoso, A. C., & Ribeiro, J. L. D. (2022). An assessment of barriers and solutions for the deployment of electric vehicles in the Brazilian market. Transport Policy, 127, 218–229. https://doi.org/10.1016/J.TRANPOL.2022.09.004

Schulz, F., & Rode, J. (2022). Public charging infrastructure and electric vehicles in Norway. Energy Policy, 160, 112660. https://doi.org/10.1016/J.ENPOL.2021.112660

Sierzchula, W., Bakker, S., Maat, K., & Van Wee, B. (2014). The influence of financial incentives and other socio-economic factors on electric vehicle adoption. Energy Policy, 68, 183–194. https://doi.org/10.1016/j.enpol.2014.01.043

Sun, W., Yuan, M., & Zhang, Z. (2022). Promoting Consumer Adoption of Electric Vehicles from a Standard-Information-Behavior Perspective. Information (Switzerland), 13(6), 1–18. https://doi.org/10.3390/info13060291

Tiseo, I. (2023). Transport CO2 emissions shares by type. Statista. https://www.statista.com/statistics/1185535/transport-carbon-dioxide-emissions-breakdown/

VAHAN SEWA, Vehicle Class Wise Vehicle Category Group Data For All State. (2024). Parivahan. https://vahan.parivahan.gov.in/vahan4dashboard/vahan/vahan/view/reportview.xhtml

Verma, V. K., & Chandra, B. (2018). Sustainability and customers' hotel choice behaviour: a choice-based conjoint analysis approach. Environment, Development and Sustainability, 20(3), 1347–1363. https://doi.org/10.1007/S10668-017-9944-6/FIGURES/6

Wee, S., Coffman, M., & Allen, S. (2020). EV driver characteristics: Evidence from Hawaii. Transport Policy, 87, 33–40. https://doi.org/10.1016/J.TRANPOL.2019.12.006

White, L. V., Carrel, A. L., Shi, W., & Sintov, N. D. (2022). Why are charging stations associated with electric vehicle adoption? Untangling effects in three United States metropolitan areas. Energy Research & Social Science, 89, 102663. https://doi.org/10.1016/J.ERSS.2022.102663

Xia, Z., Wu, D., & Zhang, L. (2022). Economic, Functional, and Social Factors Influencing Electric Vehicles' Adoption: An Empirical Study Based on the Diffusion of Innovation Theory. Sustainability (Switzerland), 14(10). https://doi.org/10.3390/su14106283

Xue, C., Zhou, H., Wu, Q., Wu, X., & Xu, X. (2021). Impact of incentive policies and other socio-economic factors on electric vehicle market share: A panel data analysis from the 20 countries. Sustainability (Switzerland), 13(5). https://doi.org/10.3390/su13052928

Zhang, X., Xie, J., Rao, R., & Liang, Y. (2014). Policy incentives for the adoption of electric vehicles across countries. Sustainability (Switzerland), 6(11), 8056–8078. https://doi.org/10.3390/su6118056

Zhuge, C., Wei, B., Shao, C., Dong, C., Meng, M., & Zhang, J. (2020). The potential influence of cost-related factors on the adoption of electric vehicle: An integrated micro-simulation approach. Journal of Cleaner Production, 250, 119479. https://doi.org/10.1016/j.jclepro.2019.119479