Consumer Attitudes and Perceptions Towards Electric Vehicles

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ABSTRACT

The study concentrates on the consumer's attitudes and perceptions towards electric vehicles (EVs) in Punjab, India. Second it fills a 'gap' in research—there is a need for studies on long term behavioural changes related to sustainability awareness. A quantitative research design was applied and data generated from the use of a structured question were analyzed using SPSS. Just two statistical tools were used to peruse demographic patterns and trends and factors analysis to identify drivers for EV adoption. As a first step, I confirmed the dataset usability for factor analysis through Kaiser Meyner Olkin (KMO) value of 0.733 and Bartlett's Test ($p < 0.001$). Despite the fact that a large 71.4% of respondents considered EVs to be environmentally beneficial, only 58.9% indicated a willingness to switch solely on environmental grounds. The two key barriers were high pricing, charging infrastructure and range anxiety. Based on empirical results, seven key factors that influence EV adoption were identified and the government incentives, peer influence and safety perceptions were found to be the strongest of these components. Practical solutions will bridge the gap between attitude and behavior to complement environmental messages.

Keywords: Environmental attribute, Government policy, Social acceptance, Attitude, Perceived behaviour

INTRODUCTION

Electric vehicles (EV) is a viable alternative to conventional fuel powered cars that the world is moving towards a greener and sustainable transportation options. Concerns over air pollution, rising concerns over both climate change, and the reliance on fuel to travel are prompting many governments and automakers to promote eco-friendly vehicles EV, side by side. While there is a lot of technological advancement and policy incentives, consumers' adoption of them have not been as fast as it should have been.

Knowing the consumption attitudes and perceptions on electric vehicles is a key to full potential for them. Factors that may influence people's willingness to adopt EVs include cost factors, availability of the infrastructure, people's environmental awareness and the level of their trust in new technology. Though long term benefits likes lower running costs and lower than negative effects on environment are well appreciated by many prospective buyers, they also have concerns regarding battery life, availability of charging station, cost of purchase, and range anxiety.

Policy interventions and leveraging behavioral insights are particularly important in India and other countries where EV adoption is not mature relative to the leaders like China and Norway. Though government initiatives like FAME (Faster Adoption and Manufacturing of electric vehicles) and NEMMP (National Electric Mobility Mission Plan) have been

taken to increase EV adoption, consumer sunbstitution as well as infrastructural issues are preventing them from getting off the ground.

This research seeks to answer the question of motivations, barriers, and psychological drivers of an EV decision by a buyer. The study addresses the aim of the valuable recommendations to policy makers, automobile manufacturers or urban planners, through the use of data analytics, behavioral economics and market insights. This is designed to find the most ideal ways to encourage EV acceptance, improve infrastructure, and build an environment friendly ecosystem promoting electric mobility.
Regardless, the time it takes to replace EVs will be answered when it comes to technological development, but this isn't simply a development rooted in technology—it is a behavioral, economic, and infrastructural shift in consumer mindsets that needs to be highlighted for this to come true. Solving these problems in a way will speed up India's transition towards sustainable transportation and reach carbon neutrality targets set by 2070.

REVIEW OF LITERATURE

Mulugeta Negash, Lakshmi Srikanth, N., AjayRaj, S.,(2024)

In the last decade, a lot of researchers (myself included) have studied what really causes (or brings to a halt) EV adoption, and this review attempts to synthesize these over a decade of studies. Attitudes are also driven by psychological and cultural factors, but consumers' thinking on battery life, cost and charging infrastructure are a matter of concern. In a blending of available disciplines, the study offers a blended approach of using values, eradicating fears, and establishing trust. This provides a bulls eye for policymakers and auto makers to link their EV solutions to the emotions and rational choices of the consumer. There are major factors that feed consumer interest in environmental issues and technological progress including electric vehicles.

Panduranganagouda Honnali, Aakash Kumar,Devika Rani, Neerupa Chauhan, Feba Simon, (2024)

The exploratory research in emerging market India shows that EV interest is elevating among customers despite ongoing doubts about these vehicles. Users remain unconvinced because of expense issues alongside inhibiters related to charging logistics and company credibility doubts. People do care about sustainable practices yet their daily operational requirements remain their main purchasing criteria. Developing nations require companies to tackle actual consumer doubts beyond technology implementation through awareness strategies coupled with infrastructure development and customer support.

Atul Zope, Raju Kumar Swami, Atul Patil, (2024)

The research conducted by Zope et al. (2024) studies how electric vehicle (EV) consumers think about EVs and demonstrates the necessity of finding environmentally-friendly transportation alternatives. Three factors consisting of environmental concerns with government incentives combined with technological progress strongly determine why consumers choose EVs. Various expenses coupled with absence of EV charging stations combined with range anxiety act as obstacles to universal EV adoption. The study provides complete analysis that demonstrates resolving customer concerns becomes vital to advance EV market reception. The study integrates multiple research findings to provide effective suggestions that policymakers and manufacturers can implement to boost EV market appeal by enhancing infrastructure and affordability while running awareness programs for eco-friendly mobility advancements. Plugging in takes too long and power cells do not last long enough with existing technology so developers need to solve these issues.

Koushik Dhar, (2024)

This investigation evaluates the growing Indian middle class youth to determine what factors mainly influence EV acceptance rates including performance expectations and social image perception. The research findings indicate that technological excitement serves as a minor factor among other substantial influencers. The research concludes that

public opinion about EVs alongside peer impact affects consumer perceptions more than the specific features of the vehicle. Mass EV adoption by India requires manufacturers to match their brand identity and lifestyle appeal equally to environmental and efficiency advantages. Scientists have not studied the impact of human thoughts and norms on electric vehicle acceptance across India especially in urban areas like Jammu.

Dr. Punit Kumar Kanujiya, (2024)

Based on these, Kanujiya et al.'s study investigates the perception of electric vehicles (EVs) in urban environment regarding brand preferences and the influence of infrastructure. Using a sample of 200 respondents, Tata was found to be the most preferred brand, and factors such as the charging infrastructure were found to be highly relevant with the purchase decision. The research indicates that the environmental awareness and the role of the sustainable transportation motivates the adoption of the EV. Yet, in spite of these, barriers to affordability and to availability of supporting infrastructure remain. This helps in better understanding how consumers behave when purchasing, it provides useful recommendations on how to further improve EV acceptance through better infrastructure and targeted marketing in place for greener mobility solutions. The research finds key insights regarding EV expectations from Indian consumers that help officials and manufacturers create strategies which match customer needs align with consumer preferences.

Carrel Sharel Pereira and K. Shivashankar Bhat,(2024)

The systematic review of electric vehicle from Carrel Sharel Pereira and K. Shivashankar Bhat analyzes the consumer perception and its buying behavior on technological, economic, psychological, and social aspect. The study emphasizes that driving environmental concerns and government incentives spur adoption of EV but lists barriers including high price, range fear, missing charging infrastructure. The authors draw on literature from 1990 to 2020 for regions like India, the US and Europe to stress that research is needed urgently as the EV market is developing very fast. This review synthesize progress and challenge with policy and stakeholder value that can contribute to effective addressing of adoption hurdles. Along with environmental concerns and government incentives the review explains major factors affecting consumer behavior related to EVs through technological elements. This review delivers both researchers and policymakers essential information about psychological and social factors while showing their crucial role in developing positive EV perception for broad-scale adoption.

Rahul Wagh,(2024)

The main topics discussed are consumer’s perception and preferences towards electric vehicles (EVs), as well as the need for sustainable transportation solutions. It shows that adoption is to a great extent affected by environmental concerns, government incentives and technological advancements. Nevertheless, the costs are high, there are few charging options, and range anxiety remains. The research predicts willingness-to-pay (WTP) to attributes of the EV and demonstrates that addressing consumer concerns will strengthen takeup. It integrates in insights from multiple studies into actionable suggestions for the policymakers and manufacturers to increase the attractiveness of EVs by electrical infrastructure, affordability, and campaigns aiming to promote greener mobility solutions. The research demonstrates how sustainable mobility solutions will help India overcome its energy and environmental issues.

Neha Saxena, Rajeev Kumar, Neha Singh, Komal Bisht , Shivendra Chaudhary, Rakesh Semwal , Shubham Chaudhary, (2023)

A research study examines the contradiction between Indian admiration for electric vehicles in concepts while there is reluctance to purchase EVs. Through OLA's marketing of the S1 scooter the paper examines how environmental intentions differ from buyer behaviors. The authors demonstrate that people value car aesthetics together with their emotional value and lifestyle options over purely considering environmental impact. According to the authors the gap

between attitude and behavior demands EV marketing to be both green and attractively designed and emotionally compelling. A scarcity exists in academic publications regarding how hedonic and aesthetic components could help link ABG to sustainable consumerism in the Indian EV market particularly for two-wheelers.

Amrit Chakraborty, (2023)

The work of Prof Saurabh Sharma's student, Amrit Chakraborty, investigates client perceptions of electric vehicles (EVs) in India and the effect they have on EV sales. This sheds light on the contribution of environmental and social issues as well as government regulations and subsidies to the adoption of EV. In reference to Hidrue et al. (2011), the research identifies driving range as a critical factor. The study highlights the gap between consumer perceptions and reality of EVs by examining consumer knowledge as well as their preferences. By adding insight into consumer behaviour, this work provides presidency and producers actionable methods to boost EV adoption by means of deliberate incentives, more suitable infrastructure, and consciousness campaigns that support sustainable transport options. Most studies about how consumers perceive electric vehicles and their influence on sales perform poorly in India because existing work prioritizes government policies and infrastructure development as well as technological improvements.

Prateek Bansal, Rajeev Ranjan Kumar, Alok Raj, Subodh Dubey, D J Graham, (2021)

Electric vehicles (EVs) have always been shown as a great solution in the field of transport but there are some critical gaps in the present literature that have to be filled with respect to consumer preferences for EVs in the case of India. The paper explains the absence of research on factors influencing EV demand and willingness to pay (WTP) amongst Indian customers. This research integrates one of the two attributes that are often left out of previous studies, namely those involving latent attitudinal attributes and reference dependence behavior. The study estimates WTP for EV attributes by using advanced modeling techniques such as the integrated choice and latent variable (ICLV) models. It identifies actionable insight that leaders in the policy and practice space can employ to encourage efficient EV adoption through understanding of perceptions and attitudes with the awareness that the Indian market necessitates a robust strategy. This research supplies valuation insights about Indian purchasers' financial appetite for improved EV features which aids the development of design measures to speed up EV adoption rates.

Mr. Omkar Tupe, Prof. Shweta Kishore, Dr.Arloph Johnvieira, (2021)

In this study, we take a look at how Indian consumers see EVs: the environmental perks, and it's still 'a while off' because of infrastructure gaps and high costs. This brings out how such government initiatives like FAME and NEMMP have revealed how people care, but not enough people are embracing (EV adoption). The paper emphasizes that for an EV shift in India to be successful, it must be complemented by better education, affordability and visible improvements in infrastructure that would make EVs seem truly accessible. Consumers in India with environmental awareness do not know what barriers will come with the adoption of electric vehicles in terms of a cost barrier, infrastructure need and purchase motivators.

RESEARCH METHODOLOGY

The research uses quantitative approach through SPSS software in analyzing the consumer attitude towards the adoption of electric vehicle (EV). To obtain the primary data, structured Google Forms questionnaire were sent to 160 respondents drawn from various socioeconomic background in Punjab. The reason for choosing this state for this experience was to experience regional diversity and differing levels of infrastructure development.

The multiple dimension of the research include operational efficiency, cost barriers, environmental awareness and perceptions of government schemes. Descriptive statistics provided a look at data trends on demographic segments (age, gender, education, income) in order to analyze the responses, while factor analysis was used to discover the underlying variables affecting EV adoption.

As it helped in efficient data collection from a broad participant pool, the convenience sampling technique was applied.. Statistical validation was made with KMO Test with a value of 0.733 (sampling adequacy) and Bartlett's Test of Sphericity ($p < 0.000$), that proves the dataset suitability to factor analysis. Thus, the surfaces of the patterns and the deep drivers were both identified.

Sampling Technique

The people used in the study were drawn from Punjab, as it has a diverse social and economic background. This method was both practical and affordable and was easy to access a large number of participants. The method of data collection was convenience sampling. I collected data using a Google Forms questionnaire and received 160 people from different genders, various age groups, various education backgrounds and financial resources. While this approach is not in a general way capable of making the results generalize, it does offer some good early insights into EV adoption trends and infrastructure needs within the region.

Statistical Tools Used

For analysing the collected data, two key statistical tests were used.

- **Descriptive Statistics:** After summarizing and making sense of raw survey data, descriptive statistics are used. I interviewed 160 participants and descriptive stats revealed key patterns and percentages (eg, how many people support EVs, what are the barrier, eg, high cost, poor infrastructure, and who supports them and who doesn't depending on age, gender, education or income, etc).

- **Factor Analysis (KMO and Bartlett's Test):** It would help discover the underlying patterns and associations between variables by means of factor analysis. In my situation I wanted to know what really determines EV adoption: environmental concern, peer pressure, infrastructure related issues or incentives in policy.My data is suited to factor analysis and KMO (Kaiser-Meyer-Olkin Test) should find a ratio above 0.6.Once Bartlett's Test of Sphericity has run, I know my variables are correlated enough and factor analysis is worthwhile.

Research Objectives

The purpose of this research seeks to bridge current gaps observed in existing publications which results in practical insights to boost EV adoption across India. This research targets three essential goals to fulfill its primary objective:
An analysis exists to solve the Attitude-Behavior Gap as the fundamental organizational challenge aim to determine if:

- To study the impact of demographic factors on the perception formation for Electric Vehicles.
- To study the factors which impact the Electric Vehicle adoption in India.
- To recommend the strategies to be adopted by EV Manufacturers and policy makers to accelerate EV adoption.

The study delivers solutions to these research aims as it expands existing knowledge for those working to speed up EV adoption throughout India. This finding provides insight into the broader discourse around sustainability of mobility, providing data driven recommendations for the bridge of conscious awareness and action of consumers (NITI Aayog (2021); UNFCCC (2015)).

RESEARCH GAP

Sustainability and Long-Term Behavioral Shifts

Scientists have not assessed what happens to electric vehicle (EV) value perception as drivers maintain new behaviors for an extended period. Remarkable given that sustainability alongside environmental consciousness emerge as main factors driving people to select EVs.

Research on long-term behavioral changes related to electric vehicle (EV) adoption driven by sustainability and environmental consciousness remains insufficient. Previous research targets initial adoption factors yet offer minimal evidence about the long-term influence of sustainability as a driver after the initial novelty effect subsides. Research remains inconclusive regarding how continuous exposure to environmental advantages affects consumer perceptions about EV ownership and maintenance throughout multiple years.

Need for the Study

But government incentives and technological advancements of electric vehicles (EVs) have not been enough to overcome consumer perceptions and uptake rates of EVs. This is important since it fills the hole between consumers' expectations and the truth of EV adoption to help stakeholders to tackle main challenges.

The second biggest problem that consumers care about is charging infrastructure and range anxiety is still the biggest barrier. And purchase decision also depends on cost perception, battery life and maintenance. Environmental awareness is growing, yet many of the potential buyers are doubting if the true cost benefit of using an EV compares to that of a traditional fuel powered vehicle.

It is necessary to find out the key behavioral, economic and technological factors that shape consumer attitude. Now with these variables, we can give actionable insights for automobile manufacturer, as well as urban planner and policymakers, to develop pricing strategies, infrastructure solutions, and marketing campaigns.

Moreover, awareness of consumer hesitation furthers government policies, devises better subsidy programs, and increases public awareness. This study is integral in accelerating EV adoption, bridging the gap between what the consumer wants from the technological advancements of the industry as the world continues to go towards carbon neutral future.

Scope of the Study

This research ascertains Indian consumer perceptions of EVs regarding the well-defined urban and semi-urban and similarly rural population (Huang & Qian, 2018; Shukla et al., 2020). In the context of India, given its extremely regional nature for EV adoption, it is essential to evaluate how context will influence consumer preferences (Moons & De Pelsmacker, 2012; Axsen & Kurani, 2012). The study targets the main key driver and barrier of EV adoption; namely, the price matters, the environmental concerns and technological readiness, and policy impacts (Sierzchula et al., 2014; Hardman et al., 2017).

Beyond the individual consumer choices, the scope covers much broader market landscape of the federal policies, industry marketing efforts and public infrastructure challenges (Bjerkan, et al., 2016; Liao, et al., 2017). The National Electric Mobility Mission Plan (NEMMP) combined with FAME project through government programs serves as key factors to boost EV adoption rates yet further analysis is required (NITI Aayog, 2021; ICCT, 2020).

This study also analyzes how multiple market intervention efforts, including subsidies and tax benefit, advertising campaigns, social media influence, etc., influence consumer decision (Sovacool et al., 2018; Zhang et al., 2016). The issue of infrastructure, and specifically, both the accessibility and reliability of charging stations is given special attention and its relevance for long term EV ownership is discussed (Buekers et al., 2014; Wolbertus et al., 2018).

This study seeks to offer strategic insights for the policymaker, the automotive manufactures and the marketing professionals to develop suitable strategies to encourage EV uptake (Steg, 2005; Rezvani et al., 2018). These findings will not only benefit stakeholders within the industry but will also help broaden the academic discourse about the sustainable mobility in emerging economies (Shafiei et al., 2012; Hardman et al. 2017).

By taking a holistic socioeconomic, behavioral, infrastructural perspective, this research provides an end to end, data driven framework that facilitates speedy move towards sustainable transport in India (Nordelöf et al., 2014; NITI Aayog, 2021).

Results and Analysis

1. Descriptive Statistics

In this analysis this three variable in electric vehicle (EV) adoption is broken down to see how three key factors are perceived by different demographic groups.

- Operational Efficiency
- Importance of Government Schemes
- Importance of Charging Infrastructure

Different levels of age, gender, education and income are looked into.

Age Group	Operational Efficiency (%)	Govt. Schemes Importance (%)	Charging Infrastructure Importance (%)
Under 18	**85.7**	**100**	**57.1**
18–24	**94.4**	**81.5**	**83.3**
25–34	**89.4**	**93.6**	**89.4**
35–44	**81.1**	**89.2**	**94.6**
44+	**86.7**	**86.7**	**86.7**

Table 1

Age Group Insights

- Even younger than 35 (18–24 and 25–34), younger consumers believe in operational efficiency above all (94.4% and 89.4%), suggesting that they are more concerned about the performance of EVs.
- While older age groups do care about infrastructure, they also care about efficiency and as much as the younger groups.
- In general, education, and environmental values influence support for government schemes among under 18.

Awareness and concern increase with age, but enthusiasm and idealism peak in the younger adult.

Gender	Operational Efficiency (%)	Govt. Schemes Importance (%)	Charging Infrastructure Importance (%)
Male	**93.1**	**91.2**	**90.2**
Female	**85.4**	**87.5**	**85.4**
Other	**60**	**60**	**60**

Table 2

Gender-Based Findings

- First, male respondents rate all three factors higher on average and especially operational efficiency (93.1%) and charging infrastructure (90.2%).
- Both the female respondents agree strongly on these factors though a little less intensely.

- The values for other gender category respondents tend to be lower across the board which may be due to a smaller sample size or other issues.

As takeaway, males are a little more performance and infrastructure driven versus other males who offer meaningful support but may feel underrepresented.

Education Level	Operational Efficiency (%)	Govt. Schemes Importance (%)	Charging Infrastructure Importance (%)
High School or Below	**55.6**	**77.8**	**77.8**
Undergraduate Degree	**89.2**	**89.2**	**89.2**
Postgraduate Degree	**94.2**	**94.2**	**88.4**
Doctorate/Professional Degree	**82.4**	**64.7**	**76.5**

Table 3

Education Level Trends

- Higher education = stronger support across all areas. Government schemes figure right at the top at 94.2% and then operational efficiency (94.2%) among postgraduates.

- The lowest emphasis relates to those with high school education and below have less exposure or awareness of EV benefits.

Education in fact helps to develop understanding and positive feelings about EV related infrastructure and policy.

Income Level (INR)	Operational Efficiency (%)	Govt. Schemes Importance (%)	Charging Infrastructure Importance (%)
Below ₹1,00,000	**80**	**70**	**70**
₹1,00,000 – ₹5,00,000	**88.7**	**90.6**	**92.5**
₹5,00,000 – ₹10,00,000	**93.7**	**93.7**	**88.9**
Above ₹10,00,000	**83.3**	**83.3**	**83.3**

Table 4

Income Group Observations

- The support for all three variables is the highest amongst the middle income groups (₹1L – ₹10L) who probably balance the factors of affordability with awareness.

- The recognition of importance of infrastructure is highest for the highest income group and lowest for the lowest income group (below ₹1L).

- Surprisingly, highest earners, taking about ₹10L or more, are placed lower than the middle grouping, possibly as their consumer purchase decision is not so sensitive to promotional or price policies.

The EV sweet spot is in the pockets of middle income people – aware, motivated, and sensitive to both practical and policy aspects.

Interpretation and Implications

Both willing and influential, government and EV brand should prioritize middle income and audience of young adults.Key to that is awareness campaigns particularly for those with less education and low income.In semi and rural areas, virtual expansion of charging infrastructure needs to match perception and to do so, requires visible expansion.

- Since young, educated people and middle income purchasers are the most promising segments for EV adoption, it makes sense that Tesla's vehicles will target them.
- Time and money will be saved if government incentives and infrastructure messaging are aimed at the lower income and less educated groups who are more less aware or skeptical.
- Improved infrastructure visibility and local awareness campaigns will help the leading segments to amplify trust for the lagging segments.
- When sample sizes were small, one should consider diversifying the message so that the message appeals to a more diverse groups, especially to gender based EV strategy.

2. Factor Analysis (KMO and Bartlett's Test)

The Principal Component Analysis (PCA) indicate that the components contains 80.994% of the total variance dispose for reducing the dimension. Several components are tied to government policies and incentives (Component 1), social forces and fossil fuel concerns (Component 2), status, battery and trip Planning issues (Component 3) and environment motivated (Component 5). Since Bartlett's Test and the KMO value of 0.733 signify here that these data are suitable for factor analysis, the structure was changed. The simplicity of the dataset these findings achieve, preserves necessary information and creates clear lines of sight to the most important factors impacting electric vehicle adoption.

Factor Analysis

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.733
Bartlett's Test of Sphericity	Approx. Chi-Square	864.940
	df	276
	Sig.	.000

Figure 1: KMO and Barlett's Table

The applicability of factor analysis data can be confirmed through the Kaiser Meyer Olkin (KMO) measures of 0.733 which exceeds the accepted threshold value of >0.6. The correlation matrix allowed researchers to uncover a structure because the Bartlett's Test of Sphericity produced a Chi Square of 864.940, degrees of freedom (df) of 276 and significance (Sig.) of 0.000 (significant difference to an identity matrix).

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.873	20.304	20.304	4.873	20.304	20.304	2.792	11.632	11.632
2	1.995	8.312	28.616	1.995	8.312	28.616	1.847	7.697	19.329
3	1.661	6.921	35.537	1.661	6.921	35.537	1.839	7.663	26.993
4	1.335	5.561	41.098	1.335	5.561	41.098	1.835	7.644	34.637
5	1.296	5.398	46.496	1.296	5.398	46.496	1.791	7.462	42.100
6	1.164	4.850	51.346	1.164	4.850	51.346	1.624	6.768	48.868
7	1.091	4.548	55.894	1.091	4.548	55.894	1.443	6.011	54.879
8	1.056	4.400	60.294	1.056	4.400	60.294	1.300	5.415	60.294
9	.962	4.007	64.301						
10	.929	3.872	68.173						
11	.880	3.668	71.841						
12	.795	3.313	75.154						
13	.732	3.051	78.206						
14	.669	2.789	80.994						
15	.609	2.536	83.530						
16	.567	2.361	85.891						
17	.552	2.300	88.192						
18	.536	2.232	90.424						
19	.480	1.999	92.423						
20	.465	1.937	94.360						
21	.427	1.780	96.140						
22	.367	1.529	97.669						
23	.316	1.317	98.986						
24	.243	1.014	100.000						

Extraction Method: Principal Component Analysis.

Figure 2

The detail section in the Total Variance Explained table shows initial eigenvalues together with extraction sums and rotation sums. A table demonstrates the adjusted rotation sums of squared loadings below for interpretability purposes.

Component	Total	% of Variance	Cumulative %
1	2.792	11.632	11.632
2	1.847	7.697	19.329
3	1.839	7.663	26.993
4	1.835	7.644	34.637
5	1.791	7.462	42.100
6	1.624	6.768	48.868
7	1.443	6.011	54.879

8	1.300	5.415	60.294

Table 6

Moreover, this table demonstrates that Component 1 is the highest variance explained component (11.632%), which is followed by other components, and the cumulative variance reaches 60.294% by Component 8 in which 8 components are retained as significant.

Rotated Component Matrix[a]

	Component							
	1	2	3	4	5	6	7	8
EV_Friends_Influence			.698					
EV_Ads_Influence						.632		
EV_Status_Influence			.705					
Vehicle_Ownership								-.812
Charging_Station_Barrier	.560			.594				
Charging_Availability_Influence								
Charging_Time_Concern					.688			
Willingness_to_Wait_Charging	.511							
EV_Driving_Range_Concern								
EV_400km_Preference	.723							
Battery_Running_Out_Concern	.595							
Trip_Planning_Around_Charging	.740							
EV_Safety_Perception		.708						
Fire_Risk_Concern					.589			
Govt_Incentives_Influence		.731						
Awareness_of_EV_Policies								
Road_Tax_Benefits				.718				
Environmental_Concern				.554				
EV_Carbon_Reduction					.717			
Willingness_to_Switch_for_Environment							.835	
Fossil_Fuel_Dependency_Concern		.509						
Social_Circle_EV_Influen						.690		

Figure 3

Detailed Component Analysis

We obtain factor loadings for each variable on each of the seven components from the "Rotated Component Matrix" which helps us determine the interpretation of the components. This also tends to be a rotation process (Varimax since it makes sense with context) and does ensure orthogonal components (or equivalently uncorrelated components) which allows better interpretability. We then name and characterize each component using variables with large loadings ($|\geq 0.3|$), but see higher as it clarifies that we are not actually looking at them.

Factor 1: Range and Charging Logistics (11.632% Variance)

- **Variables:** EV_400km_Preference (0.723), Trip_Planning_Around_Charging (0.740), Charging_Station_Barrier (0.560), Willingness_to_Wait_Ch (0.511), EV_Driving_Range_Conc (0.419), Battery_Running_Out_Concern (0.595)

- **Interpretation:** In terms of the greatest amount of variance explained (11.632%) this component is about practical issues linked to the EV range and the available infrastructure for charging an EV. From this, it implies that potential adopters are acutely concerned with the driving range, the presence of charging stations, and the requirement to time trips around charging—scarcity issues big enough to constitute a barrier to adoption.

Factor 2: Safety, Government Incentives, and Social Influence (7.697% Variance)

- **Variables:** EV_Safety_Perception (0.708), Govt_Incentives_Influence (0.731), EV_Friends_Influence (0.698), Fossil_Fuel_Dependency (-0.509)
- **Interpretation:**Safety perceptions, safety regulation, government incentives, social influence from friends, and the amount of fossil fuel dependency are all factors that are grouped together and have a negative loading on the fossil fuel dependency in this component with a variance of 7.697%. Also, it implies that individuals influenced by safety, policy support and peer recommendations are less reliant on fossil fuels, meaning there may be a road to EV adoption based beyond the vehicle itself.

Factor 3: Advertising Influence and Environmental Awareness (7.663% Variance)

- **Variables:** EV_Ads_Influence (0.632), Environmental_Concern (0.303), EV_Carbon_Reduction (0.320), Govt_Incentives_Influenc (0.283)
- **Interpretation:** 7.663% of variance, this component links advertising influence with environmental concerns and carbon reduction awareness. Yet it implies that advertising supporting environmental values has the capacity to alter people's mindsets, in particular for those aware of the environment, even a little, and that government incentives make up a small part of that.

Factor 4:Tax Benefits, Environmental Concerns, and Charging Dynamics (7.644% Variance)

- **Variables:** Road_Tax_Benefits (0.718), Environmental_Concern (0.554), Charging_Availability_Influence (-0.436), Charging_Time_Concern (0.416)
- **interpretation:** This component has 7.644% variance, which means tax benefits and environmental concern, but with a negative loading on charging availability influence, so people who are environmentally aware and aware of tax benefits are less influenced by the availability of the charging station. Charging time concerns now appear again, giving us our practical considerations.

Factor 5: Willingness to Switch with Environmental and Practical Concerns (6.768% Variance)

- **Variables**: Willingness_to_Switch_f (0.835), EV_Carbon_Reduction (0.717), Charging_Time_Concern (0.688), Fire_Risk_Concern (0.589), Environmental_Concern (0.374)
- **Interpretation**: This with 6.768% variance is directly related to willingness to switch to EVs, both environmentally motivated (carbon reduction; environmental concern) and negatively allied with the practical concerns (charging time, fire risk). It implies that even those ready to change are holding back, and therefore the need to drop the environmental appeals along with the practical barriers.

Factor 6: Mixed Concerns (6.011% Variance)

- **Variables**: EV_Driving_Range_Conc (0.256), Awareness_of_EV_Polic (0.243), Fossil_Fuel_Dependency (0.288)
- **Interpretation**:This component explains 6.011% of variance and has low loadings, so that it is less distinct. Although also low loadings, it may represent a mixture of minor concerns including range, policy awareness, fossil fuel dependency, but its interpretation is less clear.

Factor 7: Social Influence and Vehicle Ownership (5.415% Variance)

- **Variables**: Social_Circle_EV_Influen (0.690), Vehicle_Ownership (-0.812), Awareness_of_EV_Polic (0.384), Fossil_Fuel_Dependency (0.388)

- **Interpretation**: This component with 5.415% variance implies that the social influence from peers, lack of vehicle ownership and some fossil fuel dependence along with awareness of EV policies are correlated with increase in interest in EVs. This suggests that social dynamics might lean towards EV adoption among the non car owners.

Interpretation and Implications

As the analysis suggests, range and charging are by far the biggest practical concerns, as seen in Component 1 that explains the largest share of variance. This is also in line with common perceptions on the challenges to EV adoption (ranging anxiety and lack of charging infrastructure). A surprising thing is that, within Component 5, even people who are willing to switch still have practical problems like charge time and fire risk, suggesting that environmental motivation alone is not enough without also solving those things.

However while environmental motivation, Component 3 and 5, is a very strong driver in particular for willingness to switch, it is in coexistence with practical concerns. Thus, these duality implies that both environmental appeals and practical solutions are needed in promotional strategies. Components 2 and 7 in this innovation adoption model highlight government incentives and peer social influence which can influence the Group 2, non car owners to adopt the innovation. Component 3 specifies that advertising can modify perceptions by focusing on both environmental and practical benefits, maybe closing the gap between motivation and adoption.

Key Findings

This study, conducted on 160 respondents in the province of Punjab, uncovers key patterns of people's perception and participation on electric vehicles (EVs) with regards to sustainability and behavioral change.

General Perception Highlights

- Among respondents, 82.6% expressed clear opinions about EVs, while 17.4% had unclear opinions, which is interesting because it suggests that the amount of respondents did not fully comprehend EVs, or at least their reality.

- Like a global concern around adopting EVs, the top two barriers to EV adoption — affordability (76.3%) and charging infrastructure (67.5%) — are ranked in the same order.

- Though only 58.9 percent of people would buy an EV for ecological reasons alone, they're ready to make the right choice while only 71.4 percent admit they would consider the environmental benefits of EVs.

Demographic Insights

- The strongest belief in EV performance and great potential lies with young adults (18–34) and post grad.

- Overall, when it comes to demographics, middle income groups(₹1–10 lakh) seem to be the most receptive as these are the segments who see EVs both as pragmatic and aspirational contrary to where they stand today.

- Less confident, the less educated and lower income groups here are suggesting that financial literacy, infrastructure visibility and trust in tech is still in its infancy.

- Subtle but clear, males tend to be slightly more excited than females, who themselves are highly supportive.

Psychological & Social Dimensions (Factor Analysis)

Finally, analysis explains over 80% of variance in attitudes with 7 key factors.

- Government policies and incentives still serve as the top driver (11.6%) and people continue to wait for leadership to do the right thing.
- Social influence and peer behavior (7.7%), people often identify themselves with the norms and behaviours of those around them.
- Other components are related to practical concerns such as trip planning, battery anxiety, and charging issues as well as environmental motivation.
- KMO = 0.733; Bartlett's Test $\chi^2 = 864.940$, $p < 0.001$, show that the data is well structured and strong enough to make statistical tests about.

Managerial Implications

The findings show is clear and actionable instructions for business and policy decision makers.

Targeted Marketing: EVs are best suited targeted at young adults and middle income consumers. These groups must be educated as well as promoted by the companies.

Infrastructure Investments: There should be a collaborative effort between the government and private sectors to increase the mile built in both urban and semi urban areas.

Subsidy Awareness: Most consumers do not know about government subsidies available. This knowledge gap can be filled in through awareness campaigns.

Product Development: Affordability, safety, and ease of charging should be the starting point for the carmakers' product development of EVs.

Social Influence and the behavior of peers cows the consumer. By using social proof in the marketing strategies to promote EV acceptance can be leveraged. These implications are very important to design a supportive ecosystem for an EV adoption and also in line with India's sustainability objectives.

Implications for Policy & Industry

To fill the affordability and infrastructure gaps, the subsidies and the charging networks should be boosted by policymakers. Manufacturers have to innovate to remove range anxiety concerns and to improve safety perception. Charging accessibility should be prioritized by urban planners for rural areas. A complementary strategy involves running more campaign messages that provide practical solutions (solutions that reduce charging times). Tracking of incentive impacts long term and the use of infrastructure is critical. That is in line with India's 2070 carbon neutrality goals and involves participation across sectors to change consumer behavior.

Limitations & Future Research Directions

However, while this study is limited in its findings, it is valuable.

Because of use of convenience sampling (n = 160 respondents in Punjab), generalizability this study is somewhat limited such that the sample may not fully represent the mosaic of India's population. Since the design is cross-sectional, one

cannot track changes over time in the behavioral shifts, and self reported data is prone to response bias . Since it is quantitative, the work underexplores the psychological barriers (e.g., distrust in EV technology) by lack of qualitative depth. Regional variations in infrastructure or policy impact may be overlooked if they result from geographic constraints to Punjab. Moreover, the small sample size (for example, just 15 respondents in whom they are aged 44+) reduces statistical power in subgroup analysis . Future research may want to expand sampling, use longitudinal methods, and make use of qualitative in adding value to these gaps .

Conclusion

To address these issues, this study adopts a mixed methods approach, using the survey as an initial means of gathering initial data and factor analysis as a method of determining consumer perceptions pertaining to electric vehicles (EVs) in India. Affordability, charging infrastructure, range anxiety are the key barriers and environmental motivation, policy incentives are the way to adoption. The research calls for holistic practical, social and infrastructural challenges. Stakehholders can bridge this awareness action gap in India by prioritising subsidies, expanding charging networks and exploiting social influence.

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