FUTURE-DRIVEN CHOICES: ADVANCED TECHNOLOGIES SHAPING CONSUMER SUSTAINABILITY

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ABSTRACT

With a focus on electric vehicles (EVs), this study examines how emerging technologies like artificial intelligence (AI), the Internet of Things (IoT), and renewable energy are influencing consumer behavior towards sustainability. It looks at factors that influence EV adoption, such as government policies, consumer perceptions of sustainability, and technological advancements. It also looks into how these technologies improve energy efficiency . Using a mixed-methods approach, the study aims to uncover the complex relationship between technology and environmental responsibility. Its findings provide useful information for researchers, businesses, and governments looking to promote sustainable futures through technology and informed consumer choices.

Keywords:- Sustainability, Consumer Behavior, Cutting-edge Technology, Electric Vehicles (EVs), Circular Economy

1 Introduction:

The relationship between consumer sustainability and cutting-edge technology has drawn more scholarly and policy attention at an era of fast technological advancement and increased environmental concerns. In addition to changing production and consumption patterns, emerging technologies like artificial intelligence (AI), the Internet of Things (IoT), and renewable energy developments are also influencing consumer behavior to make more sustainable decisions (Geng et al., 2021; Jabbour et al., 2020). New opportunities for environmentally responsible living are being created by these technology advancements, particularly in the form of intelligent, energy-efficient goods and services.

One of the leading innovations in the sustainability space, electric vehicles (EVs), are a prime example of how cutting-edge technologies are changing consumer choices and environmental behavior. A number of variables, including as favorable government legislation, heightened environmental consciousness, advancements in battery and charging technology, and shifting consumer perceptions of sustainability, are contributing to the broad adoption of EVs (Rezvani et al., 2015; Li et al., 2017). By encouraging product lifetime efficiency, cutting emissions, and optimizing energy use, these innovations also play a crucial role in the development of circular economies (Bocken et al., 2016).

Research Gap:

Although modern technologies are increasingly being incorporated into sustainable practices, little research has been done on how they directly affect consumer behavior. Current research mostly concentrates on the operational effectiveness or environmental advantages of technology, but it does not fully examine how these advancements influence consumer attitudes, choices, and adoption of sustainable practices (Gershoff & Frels, 2015).

1) **Integration of Technology and Behavior:** Although innovations centered on sustainability, such as AI-powered energy solutions, smart home systems, and green manufacturing methods, are becoming more prevalent, little is known about how these technologies affect customer behavior (Bohnsack et al., 2014).
2) **Adoption Barriers and Motivators**: Little is known about the reasons behind consumers' reluctance or excitement regarding the adoption of these technologies, especially in a variety of sociocultural and economic circumstances (Wilson et al., 2020).
3) **Behavioral Changes in Response to Innovation**: Research frequently ignores the ways in which new technologies can result in long-lasting behavioral changes, such more brand loyalty or sustainable consumption patterns (Sheth et al., 2011).
4) **Demographic and Cultural Nuances:** According to Kotler and Keller (2016), there aren't many empirical research that look at how consumer responses differ depending on demographics like age or cultural background and how marketing tactics should change correspondingly.
5) **Strategic Implications for Marketers:** According to Wang et al. (2018), there aren't many well-defined frameworks that can assist marketers in bridging the gap between changing consumer sustainability preferences and technology innovation.

Research Objectives

1) **To examine the influence of sustainability-oriented innovations** (e.g., AI-enabled EV systems, IoT-based charging infrastructure) on consumer attitudes and behaviors toward electric vehicle adoption.

2) **To identify key motivators and barriers** affecting consumer decisions to adopt electric vehicles in different sociocultural and economic settings.

3) **To assess whether electric vehicle usage leads to long-term behavioral shifts** such as a preference for sustainable transport and increased brand loyalty.

4) **To explore how demographic and cultural factors** (age, gender, income, education) influence consumer perceptions and adoption of electric vehicles.

5) **To propose a marketing and policy framework** that effectively bridges technological innovation and evolving consumer sustainability preferences in the EV market.

Research Hypothesis:-

A. Based on the demographic Influences on Feature Preferences

1) **H_{01}:** There is no significant difference in EV feature preferences between male and female respondents.

   H_{11}: There is a significant difference in EV feature preferences between male and female respondents.

2) **H_{02}:** Age group does not significantly influence EV feature preferences.

   H_{12}: Age group significantly influences EV feature preferences.

3) **H_{03}:** Income level does not significantly affect preference for smart or premium EV features.

   H_{13}: Income level significantly affects preference for smart or premium EV features.

B. Based on the psychological and Behavioral Factors

H_{04}: There is no significant correlation between trust in EV technology and willingness to adopt EVs.

H_{14}: There is a significant positive correlation between trust in EV technology and willingness to adopt EVs.

H_{05}: Cost sensitivity has no significant effect on the intention to adopt EVs.

H_{15}: Cost sensitivity has a significant negative effect on the intention to adopt EVs.

H_{06}: There is no significant correlation between belief in advanced sustainability technologies and concern about battery lifespan.

H_{16}: There is a significant positive correlation between belief in advanced sustainability technologies and concern about battery lifespan.

C. Sustainability Perceptions and Policy Attitudes

H_{07}: Perceived environmental benefits of EVs do not influence support for government EV adoption policies.

H_{17}: Perceived environmental benefits of EVs positively influence support for government EV adoption policies.

H_{08}: Perceived inadequacy of charging infrastructure does not affect willingness to purchase EVs.

H_{18}: Perceived inadequacy of charging infrastructure negatively affects willingness to purchase EVs.

H_{09}: Awareness of government incentives does not influence attitudes toward EV adoption.

H_{19}: Awareness of government incentives positively influences attitudes toward EV adoption.

D. Factor Structure Validation

H_{010}: Consumer perceptions of EVs cannot be explained by two distinct factors.

H_{10}: Consumer perceptions of EVs can be explained by two distinct factors:

(a) Perceived Benefits & Trust in EV Technology

(b) Cost Sensitivity

2. Literature Review

Consumer Behavior Theories

To comprehend behavior prediction and intention, the Theory of Planned Behavior (TPB) has been widely used. Ajzen (2020) talked on its broad application in a variety of fields, emphasizing its capacity to explain decision-making, including the adoption of technology and sustainable practices. Ajzen (2020). Additionally, research like Paul et al. (2016) highlights the relevance of TPB for eco-conscious behavior by showing how well it predicts the use of green products. Paul and associates, 2016. In a similar vein, recent studies have extended the Technology Acceptance Model (TAM), a fundamental paradigm for researching technology adoption, to examine digital health and educational platforms. Liu & Ma (2023), for example, demonstrated the effectiveness of TAM in elucidating users' behavioral intentions when utilizing AI products. Ma and Liu, 2023.

Recent research has focused on integrating Value-Belief-Norm (VBN) theory and Norm Activation Model (NAM) to better understand behaviour related to sustainability, in addition to the Theory of Planned Behaviour (TPB) and the Technology Acceptance Model

(TAM). According to Steg and Vlek (2009), moral commitments and personal beliefs have a big impact on pro-environmental behaviour, particularly when it comes to highly involved decisions like buying electric cars (EVs). According to Stern (2000), sustainable transportation decisions can be influenced by personal norms that are triggered by awareness of the effects on the environment.

Furthermore, social impact and environmental concerns have been added to the Unified Theory of Acceptance and Use of Technology (UTAUT) to account for the adoption of green technologies. Hedonic motivation and enabling factors are particularly significant for EV users, according to Dwivedi et al. (2020), who showed the effectiveness of UTAUT2 in describing behavioural intentions connected to smart and green technology.

Studies on EV Adoption Trends

A combination of psychological and sociodemographic factors influence the adoption of electric vehicles (EVs). Madrid (2023) found that environmental awareness and income levels, in addition to obstacles such a lack of suitable charging infrastructure, are important factors in the adoption of EVs. Madrid in 2023. Similarly, Jain et al. (2023) emphasized the necessity for customized approaches by highlighting issues including high upfront costs and policy inefficiencies in the Indian context. Jain and associates, 2023. Research also looks at adoption's psychological obstacles. Vieira et al. (2023) showed how people's preparedness to switch to sustainable transportation is limited by psychological inertia and competing objectives. 2023; Vieira et al.

A multifaceted view of EV adoption that encompasses psychological, economic, and infrastructure factors is highlighted by emerging studies. In a thorough analysis, Rezvani et al. (2015) found that perceived behavioural control, innovativeness, and environmental concern were important psychological determinants of EV purchase intention. On the basis of infrastructure readiness and regional policy frameworks, they did, however, also see notable variation.

Bansal and Kumar (2022) cited range anxiety, policy ambiguity, and ignorance as the main deterrents in the Indian context. They promoted more government incentives and open communication of information. Sovacool et al. (2018) emphasised the significance of lifestyle compatibility globally, demonstrating that adoption is higher among those whose daily habits correspond with the benefits and constraints of electric vehicles.

Technological Advancements in EVs

The expansion of the EV market has been propelled by technological advancements in battery performance and energy economy. In order to investigate the dynamics of the EV industry, Khusanboev et al. (2023) used predictive analytics, emphasizing the significance of efficiency and range improvements for gaining the trust of consumers. Furthermore, Sarsia et al. (2023) emphasized that sustainable design and advancements in charging infrastructure are essential to the long-term scalability of EVs.

Innovation in technology has become both a catalyst and a barrier to consumer acceptance. Egbue and Long (2012) state that the most frequently mentioned technical issues influencing the adoption of EVs are still battery cost, energy density, and charging periods. However, developments like ultra-fast charging stations and solid-state batteries have the potential to improve customer attitudes (Tarpenning, 2021).

Future adoption scenarios are being mapped concurrently using AI-driven forecasting and machine learning. In order to demonstrate that technology advancement on its own is insufficient in the absence of systematic policy support and market alignment, Chaturvedi et al. (2023) used neural networks to model EV market adoption under alternative policy and cost frameworks.

3.Conceptual Framework Diagram

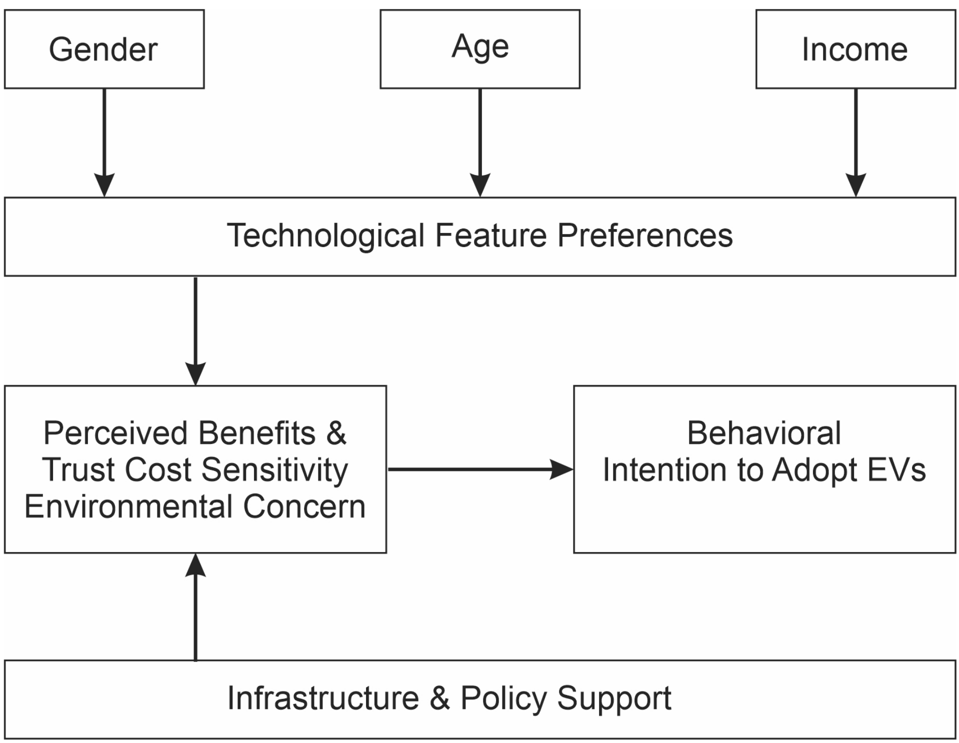

Fig 1: Conceptual Framework of EV

4. Data Analysis

1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	MALE	96	92.3	92.3	92.3
	FEMALE	8	7.7	7.7	100.0
	Total	104	100.0	100.0	

Table 1: Gender

Source: Primary data

The respondents' gender distribution is shown in the table. Of the 104 participants, 96 were men, making up 92.3% of the sample, and only 8 were women, making up 7.7%. The cumulative proportion, which reaches 100%, attests to the coverage of the entire sample.

AGE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Below 25	48	46.2	46.2	46.2
	25-34	56	53.8	53.8	100.0
	Total	104	100.0	100.0	

Table 2: Age

Source: Primary data

The respondents' age distribution is shown in the table along with their opinions and preferences for electric cars (EVs). Of the 104 participants, 48 (46.2%) are under the age of 25, while 56 (53.8%) are between the ages of 25 and 34. This suggests that young individuals, mainly those aged 25 to 34, make up the bulk of responders. This demographic profile implies that younger people, who might be more tech-savvy, environmentally sensitive, and receptive to embracing new transportation technologies like electric vehicles, have a significant influence on opinions and attitudes toward EV adoption in this study.

Income_Level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Below Rs 50,000	96	92.3	92.3	92.3
	Rs.50,000-Rs.1,00,000	8	7.7	7.7	100.0
	Total	104	100.0	100.0	

Table 3: Income

Source: Primary data

The table displays the income-level distribution of respondents concerning their views on electric vehicles (EVs). A significant majority, **96 out of 104 respondents (92.3%)**, reported earning **below Rs 50,000 per month**, while only **8 respondents (7.7%)** fall into the **Rs50,000–Rs1,00,000** income bracket. This indicates that the study predominantly captures the perspectives of individuals from **lower-income groups**. Given the cost sensitivity typically associated with this segment, their attitudes toward EV adoption may be significantly influenced by the affordability and long-term economic benefits of electric vehicles. These insights are crucial for policymakers and manufacturers aiming to promote EVs among price-conscious consumers.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.759
Bartlett's Test of Sphericity	Approx. Chi-Square	415.807
	Df	21
	Sig.	.000

Table 4: Factorial Validity by KMO and Bartlett's Test

Source: Primary data

A Principal Component Analysis with varimax rotation was conducted to identify underlying factors influencing consumer perceptions of electric vehicles (EVs). The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.759, indicating suitability for factor analysis. Bartlett's Test of Sphericity was significant ($\chi^2(21) = 415.807$, $p < .001$), supporting the presence of correlations among items.

	Component	
	1	2
Factor 1: Perceived Benefits & Trust in EV Technology		
High upfront cost	-.104	
Limited availability of charging infrastructure.	.681	
Concerns about battery lifespan.	.996	
Lack of government incentives	.921	
Factor 2: Consumer Attitudes and Behaviors		
I believe advanced technologies make EVs more sustainable.		.097
I am willing to pay a premium for products that contribute to sustainability.		.708
I trust that EVs will play a significant role in the circular economy.		.297
Extraction Method: Principal Component Analysis. Rotation Method: Oblimin with Kaiser Normalization.		
Rotation converged in 5 iterations.		

Table No.5: Loading of scale items on factors by Rotated Factor Matrix

Two components were extracted, accounting for 72.43% of the total variance:

- **Factor 1:** "Perceived Benefits & Trust in EV Technology", accounting for 56.47% of the variance, included variables such as belief in technological sustainability, concerns about charging infrastructure and battery lifespan, and trust in EVs' role in the circular economy.
- **Factor 2:** **"**Cost Sensitivity", explaining 15.96% of the variance, was primarily represented by the perceived high upfront cost of EVs.

These findings suggest that while consumers value the environmental and technological benefits of EVs but cost remains a distinct and significant barrier to adoption

	Perceived Benefits & Trust in EV Technology	Cost Sensitivity
Perceived Benefits & Trust in EV Technology	1	
Cost Sensitivity	0.403	1
Extraction Method: Principal Component Analysis.		
Rotation Method: Oblimin with Kaiser Normalization.		

Table No.6: Correlation Matrix

Table No. 4's correlation matrix shows how the variables "Cost Sensitivity" and "Perceived Benefits & Trust in EV Technology" relate to one another. These two variables have a somewhat good association, as indicated by their correlation coefficient of 0.403. This implies that there is a moderate propensity for people to become more cost sensitive as perceived advantages and confidence in electric vehicle (EV) technology rise. Put another way, buyers who are more aware of the benefits and who have greater faith in EV technology might nevertheless be aware of the financial ramifications. When factors are presumed to be associated, the Principal Component Analysis extraction method and the Oblimin with Kaiser Normalization rotation method are employed.

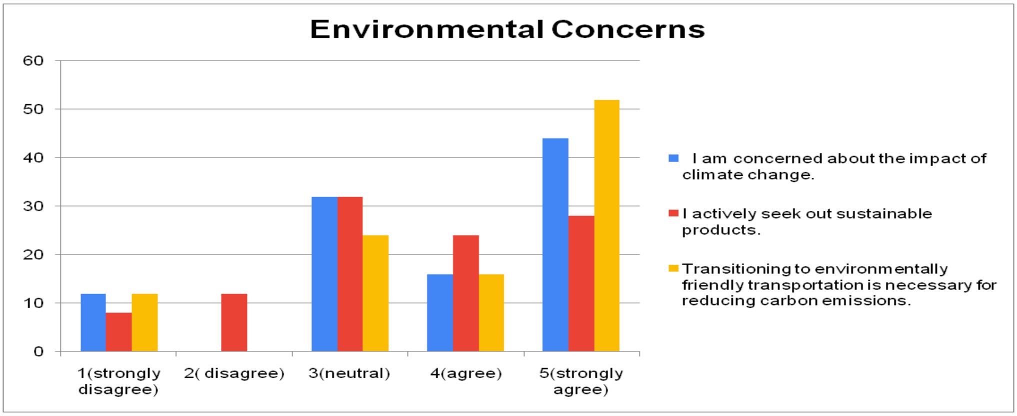

Fig 2 :Environmental concerns displayed

The graph below illustrates the distribution of technological feature preferences between male and female respondents. Both genders show high preference for Fast Charging and Enhanced Battery Range. Smart Driving Assistance is slightly more favored by males. Connectivity Features are selected similarly by both. While core features like charging speed and range are universally appealing, males show a marginally higher interest in smart tech (assistance features). This indicate a gender-based variation in enthusiasm for autonomous or semi-autonomous features.

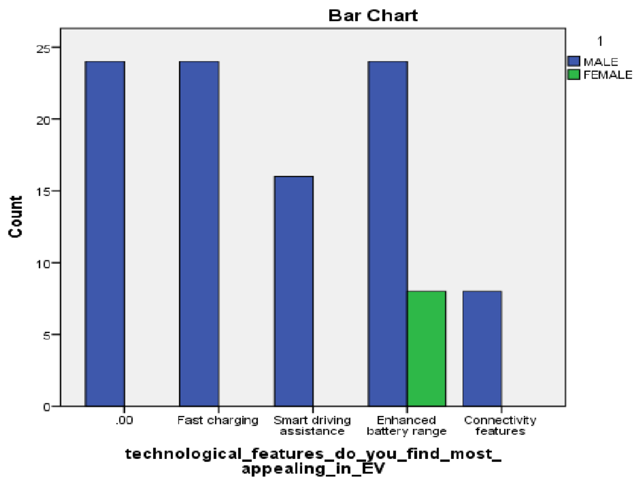

Fig 3: Technology feature vs gender

The graph below compares how different age groups rate various EV technological features. Younger respondents (e.g., under 30) show higher interest in Connectivity Features and Smart Assistance. Older respondents seem more focused on Battery Range and Charging Speed. Digital native age groups prioritize integration and automation, whereas older consumers may prioritize practical features like longer range and faster charging, aligning with a usage-driven mindset.

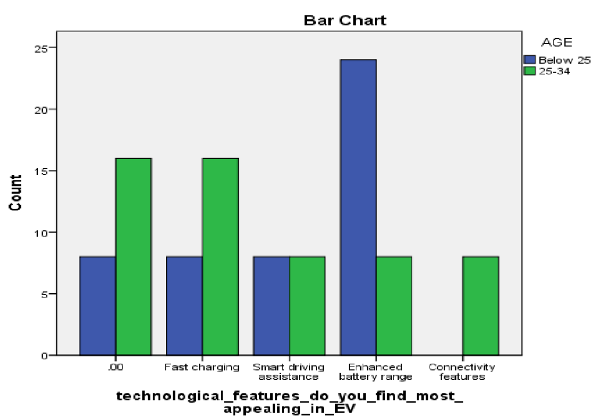

Fig 4: Technology feature vs age

The below graph shows how EV feature preferences vary by income level. Higher-income groups prefer advanced features such as Smart Driving Assistance and Connectivity. All income groups show interest in Fast Charging and Battery Range, but less variation here. Income may influence interest in premium or "smart" features — those with higher disposable income may value innovation and tech integration more. Meanwhile, efficiency-related features are universally desirable.

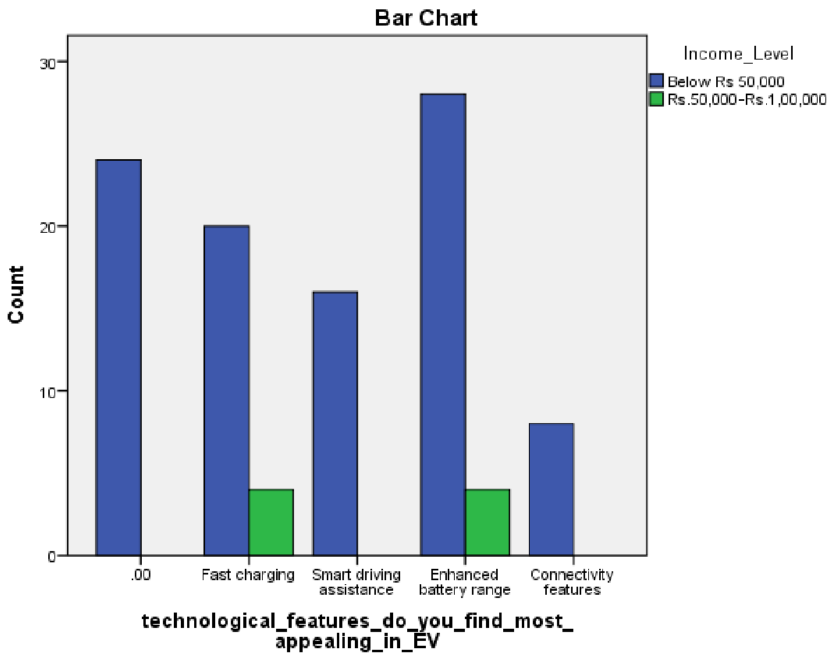

Fig 5: Technology feature vs income

The distribution of respondents' preferences for technological features in electric cars (EVs), broken down by income level, is depicted in the bar chart. "Enhanced battery range" is the most desirable feature across all income levels, especially for those making less than Rs50,000, indicating a significant desire for extended driving range between charges. To a lesser degree, this lower-income demographic also favors smart driving assistance and fast charging. Although they are much less represented, respondents in the Rs50,000–Rs1,00,000 income category also expressed some interest in faster charging and longer battery life. In both income ranges, the least preferred features are those like connectedness. According to these results, most buyers, particularly those with low incomes, choose functional and performance-enhancing aspects like battery life and charging efficiency over luxuries or convenience-based EV innovations. This knowledge can help marketers and manufacturers adjust EV features and messaging to appeal to consumers on a tight budget.

Correlations

		Concerns about battery lifespan.	I believe advanced technologies make EVs more sustainable.
Concerns about battery lifespan.	Pearson Correlation	1	.764**
	Sig. (2-tailed)		.000
	N	104	104
I believe advanced technologies make EVs more sustainable.	Pearson Correlation	.764**	1
	Sig. (2-tailed)	.000	
	N	104	104

**. Correlation is significant at the 0.01 level (2-tailed).

Table 7:-Concerns about battery lifespan correlated to
Belief that advanced technologies make EVs more sustainable

The open-ended question "What additional features or policies would encourage you to adopt an EV?" has the following responses " Advance features, More battery capacity, More battery range , Repair problems, Quick charging capabilities (e.g., 30 minutes to 80% charge) would make EVs more convenient, "Financial Incentives, Charging Infrastructure Expansion".

According to the comments, the main concerns of prospective EV adopters are affordability, convenience, and technological performance. In particular:

a. Improved Battery Life and Advanced Features:

Improved technological characteristics, including better automation or connectivity, are of appeal to participants.

Increased battery capacity and range are highly desired, indicating that "range anxiety" is still a major adoption hurdle.

In order to match EV use with consumer expectations for ease comparable to that of conventional vehicles, quick charging capabilities—such as charging to 80% in 30 minutes—are considered crucial.

b. Issues with Repair and Maintenance:

Some responders bring up "repair problems," expressing concerns about the dependability of EV systems, the availability of skilled technicians, or after-sales care.

c. Policy and Financial Incentives:

It is noted that financial incentives—like tax exemptions, subsidies, or lower registration costs—are significant motivators.

Since EVs are frequently thought of as expensive up front, respondents are looking for additional financial reasons to invest in them.

d. Extension of Charging Infrastructure:

Widespread and sufficient infrastructure for charging is deemed essential. EV adoption may stagnate in the absence of easy access to charging stations, particularly for individuals without private parking.

The open-ended question" In your opinion, how can EVs contribute to a sustainable future? " has the following responses" By providing less price, protection of UV zone, Eva reduce the pollution and high usage of fuel, repair problems, increase renewable Energy Sources: Ensure a significant portion of the energy used to charge EVs comes from renewable sources, Reduced greenhouse gas emissions, Renewable energy integration. Sustainable transportation, Closed-loop recycling, Pollution free can avoid toxic environment "

According to the results, consumers view electric vehicles (EVs) as significant contributors to sustainability because of the following:

a. Environmental Advantages:

Lower Emissions and Pollution:

EVs can assist lower air pollution and greenhouse gas emissions, which are important for reducing climate change and enhancing public health, according to several respondents.

The claims that EVs can greatly lessen urban environmental degradation are reflected in phrases like "pollution free" and "avoid toxic environment."

Keeping the Ozone Layer Safe:

EVs may help minimise dangerous emissions that influence atmospheric layers, according to references to the "Protection of UV zone," which is interpreted as the ozone layer.

b. Energy Efficiency and Renewable Energy Integration:

Utilising Renewable Energy Sources

In order to maximise sustainability, a number of comments stress how crucial it is to charge EVs using renewable energy sources like solar or wind.

EVs' contribution to a low-carbon future is strengthened when they are integrated into a renewable energy system.

Support for the Energy Transition:

In order to make energy consumption more sustainable over time, EVs are viewed as instruments for moving away from heavy reliance on fossil fuels.

c. Waste Reduction and the Circular Economy:

Closing the loop on recycling:

The reference to "closed-loop recycling" indicates understanding that, in order to reduce waste and environmental effect, EVs—including their batteries—should be a part of a sustainable product lifetime.

d. Social and Economic Aspects:

Accessibility and Affordability

One respondent associates sustainability with affordability, suggesting that increasing EVs' affordability may encourage wider adoption and, consequently, a larger environmental impact.

Considerations for Maintenance and Repair:

Despite being a primary worry, the reference to "repair problems" also suggests that durability, reparability, and serviceability—all of which reduce electronic waste—must be a part of a sustainable EV future.

5. Future Scope:

The study identifies a number of directions for further research and useful use.In order to comprehend larger viewpoints, future study can broaden to include more different demographic groups, such as people from rural locations or higher income levels. Furthermore, as EV infrastructure and technology advance, longitudinal studies could monitor shifting attitudes. In order to attract cost-conscious customers, industry cooperation may also be able to investigate cost-cutting measures, especially for battery technology and charging infrastructure. Future research might also examine the psychological obstacles to EV adoption, including as risk perception and technology confidence, and evaluate the efficacy of legislative tools like public awareness campaigns and subsidies. Lastly, a crucial component of research on sustainable mobility may be the incorporation of renewable energy sources into EV charging infrastructure and the assessment of their influence on consumer choice.

6. Conclusion:

The study thoroughly investigates consumer attitudes, inclinations, and worries regarding the uptake of electric vehicles (EVs), especially in the Indian setting. According to the research, electric cars are becoming more and more popular as a practical and ecological form of transportation, particularly among younger people (ages 25 to 34), who are typically more open to new technology and environmental causes. Nevertheless, the study also identifies important obstacles that still prevent broad adoption, albeit the generally favorable opinion.

One important finding of the factor analysis was the identification of two significant factors that impact consumer attitudes: "Cost Sensitivity" and "Perceived Benefits & Trust in EV Technology." The former shows faith in EVs' technological capabilities, environmental benefits, and compatibility with the circular economy. Numerous attendees conveyed hope regarding EVs' potential to lower pollution, encourage the integration of clean energy, and facilitate a sustainable transportation ecology. However, the latter highlights a recurring issue—high upfront costs—that is especially noticeable among responders from lower-income groups. Even those who are generally technologically and environmentally conscious seem to be greatly influenced by this budgetary limitation when making purchases.

The data also shows that demographic variables like wealth, age, and gender influence consumer preferences. Although everyone appreciates features like quick charging and extended battery life, younger and wealthier demographics are more likely to be interested in cutting-edge technologies like smart driving assistance and connectivity functions. These findings are further supported by open-ended comments, which highlight the need for better repair and maintenance services, faster charging infrastructure, and larger battery capacity. Furthermore, policy recommendations like tax breaks, government subsidies, and wider public charging stations are thought to be essential for facilitating widespread EV adoption.

From a wider angle, respondents think that by reducing greenhouse gas emissions, decreasing reliance on fossil fuels, and facilitating the switch to renewable energy systems, EVs may significantly contribute to environmental sustainability. In order to reduce electronic waste and maintain long-term ecological balance, some additionally emphasized the significance of closed-loop recycling and repairability.

In summary, the shift to electric vehicles is accelerating, but it calls for a coordinated and inclusive strategy. Even though environmental consciousness and technical advancement are rising, post-purchase assistance, infrastructural preparedness, and cost are still important issues that require attention. To fully realize the potential of electric vehicles in promoting a sustainable future, these gaps must be closed by industry cooperation, legislative initiatives, and ongoing consumer education.

Funding acknowledgement

No funds were required since it was a survey based research

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