Sustainability and Adoption of Electric Vehicles in India: A Study Analysis for Future Mobility

Priya Sequeira
Sr. Asst. Professor, PG Department of Business Administration,
Alva's Institute of Engineering & Technology
priyasequiera@aiet.org.in

Justin Pais
Asst. Professor, PG Department of Business Administration,
Alva's Institute of Engineering & Technology
justipais024@gmail.com

Vijay Joshi
Sr. Asst. Professor, PG Department of Business Administration,
Alva's Institute of Engineering & Technology
vjvijay@outlook.com

Sandeep Acharya
Student, PG Department of Business Administration,
Alva's Institute of Engineering & Technology, sandeepracharya24@gmail.com

Abstract:

The transition toward sustainable mobility has positioned electric vehicles (EVs) as a critical solution for reducing carbon emissions and environmental degradation in India. This study examines the interplay between sustainability awareness, reliability perceptions, circular economy practices, and charging infrastructure in shaping EV adoption and user satisfaction. A mixed-method research design was adopted, comprising quantitative survey responses from 200 EV owners and qualitative insights from 25 industry experts. The quantitative analysis included descriptive statistics, correlation, ANOVA, and regression techniques to test four hypotheses. Results indicate that sustainability awareness significantly enhances perceived environmental benefits ($p < 0.05$), while reliability strongly predicts owner satisfaction. Awareness of circular economy practices positively influences support for recycling and responsible end-of-life battery management. Furthermore, charging infrastructure availability emerges as a significant determinant of EV usability and adoption intention. Qualitative findings reinforce these results, highlighting challenges in battery lifecycle sustainability, charging network expansion, and the need for stronger circular economy implementation in the EV ecosystem. The study provides practical implications for policymakers, manufacturers, and environmental stakeholders by emphasizing the importance of sustainability education, infrastructure development, and resource-efficient design. Overall, this research contributes to the growing body of EV sustainability literature and offers actionable insights to accelerate India's transition to a cleaner and more circular transportation future.

Keywords: Electrical Vehicles, Sustainability, Circular Economy, Reliability, Environment

Introduction: The Automotive sector in India is poised for a major transformation as the country goes towards a way to reduce carbon footprints and cleaner fuel options. Among the more promising interests is electric vehicles (EVs) with zero tailpipe emission while also potentially reducing air pollution in cities and greenhouse gases. The regulatory side has been supported by the Indian government which has incentivized EV adoption through programs like Faster Adoption and Manufacturing of Electric Vehicles (FAME) that provides both producers incentives to produce, as well as buyers a substantial grant toward their purchase. India has seen a big jump in the number of EVs, with several companies entering and coming up with various products suiting the need of environmentally friendly transportation.

The commitment to sustainability is a fundamental driver of electric vehicles' widespread adoption. In the EV business, sustainability extends beyond simply lowering emissions. The production process, particularly for batteries, entails obtaining raw materials such as lithium, cobalt, and nickel, which raises serious environmental and social concerns. To address these concerns, the industry must incorporate more sustainable practices into the full lifecycle of electric vehicles. Another important consideration is reliability; as consumers shift from traditional automobiles to EVs, they are becoming increasingly concerned about battery life, maintenance expenses, charging infrastructure, and overall vehicle performance.

The concept of a circular economy, by contrast, could provide a good framework for increasing sustainability in the EV ecosystem. The approach toward a more circular economy tries to minimise wastage and bring about a responsible use of resources by encouraging reuse, repair, refurbishment and recycling of materials. This translates into making a sustainable battery of its own, refining systems for recycling batteries, and pushing the use of remanufactured components.

Through this study, we aim to understand the current state of the EV industry in India with respect to these key attributes, to identify different challenges and opportunities for realising reliability, sustainability & circular economy integration and perception of EV owners and experts associated with the industry.

Conceptual Model:

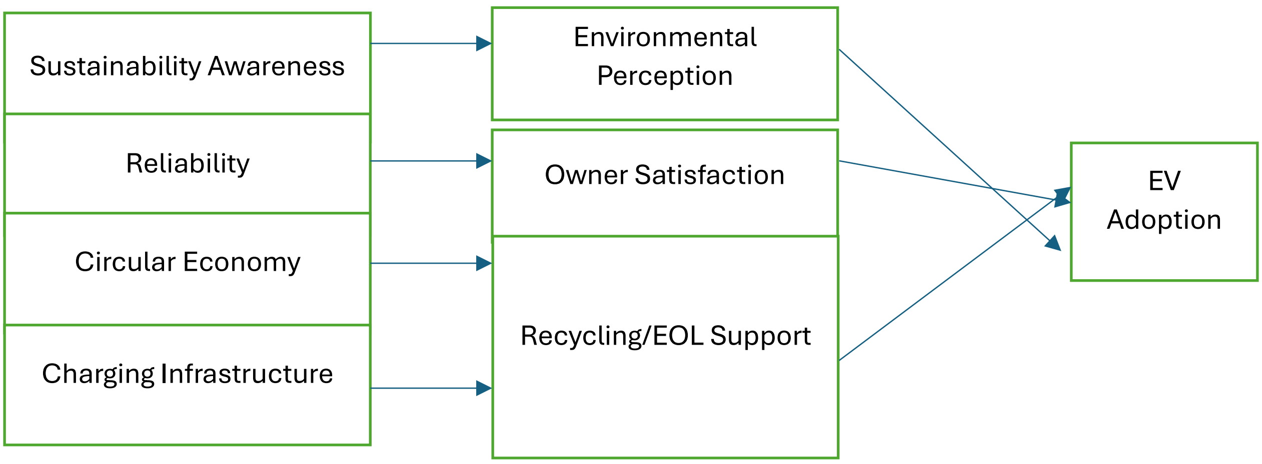

Figure 1: Conceptual Model

1. Sustainability and the EV Ecosystem

Sustainability has emerged as a central pillar in electric vehicle literature. Numerous studies emphasize that EVs offer significant environmental benefits during the usage phase, including reduced greenhouse gas emissions, lower air pollution, and improved urban air quality (Sierzchula et al., 2014; Breetz et al., 2018). However, researchers also highlight that the sustainability of EVs must be assessed across the entire lifecycle, especially battery production and disposal, which contribute substantially to environmental impacts (Ellingsen et al., 2016). Raw material extraction—particularly lithium, cobalt, and nickel—has been associated with ecological disturbances, social risks, and carbon-intensive processes (Dunn et al., 2015).

Studies in the Indian context show increasing awareness of lifecycle sustainability concerns among consumers, policymakers, and manufacturers (Ghosh, 2020). The introduction of government schemes such as FAME has been instrumental in reinforcing sustainability goals by incentivizing cleaner mobility options (NITI Aayog, 2021). Thus, literature firmly establishes that sustainability perceptions influence consumer acceptance and broader industry evolution.

2. Reliability as a Determinant of EV Adoption

Reliability has repeatedly been cited as a decisive factor influencing EV adoption. Research highlights consumer apprehensions about battery degradation, limited driving range, performance uncertainty, and high replacement costs (Rezvani et al., 2015). Charging infrastructure inadequacy is another common barrier, often linked to range anxiety and lower perceived convenience (Li et al., 2017).

In developing economies like India, reliability concerns become even more prominent due to climate factors, road conditions, lack of skilled technicians, and infrastructural gaps (Kumar & Chakraborty, 2021). Studies show that positive experiences with battery performance and charging reliability significantly enhance user satisfaction and long-term acceptance (Hardman et al., 2018).

3. Circular Economy Practices in the EV Industry

Recent literature highlights circular economy principles as critical to addressing the sustainability limitations of EVs. Circular economy frameworks promote resource efficiency through battery reuse, repurposing, remanufacturing, and advanced recycling systems (Geissdoerfer et al., 2017). Lithium-ion battery recycling, in particular, has gained global attention due to its potential to reduce mining pressures and environmental damage (Harper et al., 2019).

Studies also indicate that consumers' acceptance of second-life batteries and recycling practices positively impacts the long-term sustainability of EVs (Cicconi et al., 2012). In India, research suggests that the EV sector lacks structured recycling systems, creating opportunities for policy interventions and private sector initiatives (TERI, 2021).

4. Consumer Perception, Satisfaction, and Adoption

Multiple studies show that EV adoption is shaped by a combination of environmental perceptions, reliability evaluations, perceived economic benefits, and policy incentives (Hidrue et al., 2011). Consumers who perceive EVs to be sustainable, reliable, and technologically advanced report higher satisfaction and stronger purchase intentions (Krishnan et al., 2022).

In India, recent literature notes that consumer preferences are shifting as awareness grows regarding environmental concerns, fuel prices, and technological advancements (Gupta et al., 2023). Satisfaction with EV performance and confidence in the charging ecosystem significantly influence both positive word-of-mouth and repeat purchase intention.

Based on the conceptual model and the theoretical insights drawn from the literature, the following hypotheses were developed to examine the key factors influencing Electric vehicle (EV) perception, satisfaction, and adoption in India.

Research Objectives

The objective of the study, based on the research study, is as below

1. To examine the influence of sustainability awareness, reliability perceptions, and circular economy knowledge on electric vehicle (EV)
2. To Analyse the role of charging infrastructure availability and battery lifecycle, environmental perception, and long-term sustainability of EV.
3. To explore expert insights on the challenges and opportunities related to EV sustainability, including battery production, recycling, and technological advancement.

H1: There is a significant relationship between the awareness of sustainability practices and the environmental benefits of electric vehicles.

This hypothesis is grounded in the sustainability literature, which suggests that consumer awareness of lifecycle impacts, emissions reduction, and eco-friendly practices enhances their perception of EVs as environmentally beneficial.

H2: There is a significant relationship between the reliability of electric vehicles and owner satisfaction.

Research consistently highlights reliability battery performance, maintenance, and charging convenience as a major determinant of consumer satisfaction and long-term acceptance of EVs. This hypothesis examines how reliability factors influence the satisfaction levels of EV owners.

H3: There is a significant relationship between the reuse, repurposing, remanufacturing of Electric Vehicles battery and Owner Purchase Decisions.

Circular economy principles emphasize reuse, repair, remanufacturing, and recycling. This hypothesis evaluates whether higher awareness of these practices translates into stronger consumer support for sustainable battery disposal and end-of-life management systems.

H4: There is a significant relationship between the availability of charging infrastructure and the adoption and usability of electric vehicles.

Charging infrastructure availability is widely recognized as a critical barrier or enabler for EV adoption. This hypothesis assesses how infrastructure access influences both the uptake and day-to-day usability of EVs among Indian consumers.

Theoretical Framework

The theoretical foundation of this study is grounded in established models that explain technology adoption, environmentally responsible behaviour, and sustainable resource utilization. The following theories provide the conceptual basis for examining how sustainability awareness, reliability, circular economy practices, and charging infrastructure influence electric vehicle (EV) adoption in India.

1. Theory of Planned Behavior (Ajzen, 1991)

The Theory of Planned Behavior (TPB) is one of the most widely used models to explain individual decision-making regarding environmentally conscious behaviors. According to TPB, behavioral intention is determined by three factors: **attitude**, **subjective norms**, and **perceived behavioral control**. This theory is appropriate for EV adoption because consumers' decisions are shaped by their attitudes toward environmental benefits, social influence, and the perceived ease or difficulty of using the vehicle.

In the context of this study, TPB supports the relationship between **sustainability awareness and environmental perception**, as consumers with positive environmental attitudes are more likely to recognize the ecological benefits of EVs (H1). TPB also aligns with the role of **charging infrastructure and perceived behavioral control**, where accessible charging facilities enhance the feasibility and usability of EVs, thereby influencing adoption (H4).

2. Technology Acceptance Model (Davis, 1989)

The Technology Acceptance Model (TAM) explains how users accept and adopt technological innovations based on two key constructs: **Perceived Usefulness (PU)** and **Perceived Ease of Use (PEOU).** EVs, being advanced technological products, fit well within this framework. Reliability, battery performance, ease of charging, and maintenance contribute to consumers' perceptions of the usefulness and convenience of EVs.

This theory supports **H2,** which proposes a significant relationship between the reliability of EVs and owner satisfaction. If consumers perceive an EV to be reliable, easy to maintain, and convenient to charge, their satisfaction increases, which can further promote adoption. TAM therefore provides a strong theoretical basis for understanding how technical performance influences consumer attitudes and behavior.

3. Diffusion of Innovation Theory (Rogers, 2003)

The Diffusion of Innovation (DOI) theory explains how new technologies spread within a social system. The rate of adoption is influenced by five key attributes: **Relative Advantage, Compatibility, Complexity, Trialability,** and **Observability**. EV adoption reflects these characteristics—consumers evaluate the relative advantage in terms of sustainability, economic savings, and performance; compatibility with lifestyle; complexity related to charging and battery management; and observability through the experiences of existing EV users.

This theory strengthens the understanding of factors influencing EV adoption behaviours, particularly the roles of reliability, infrastructure, and perceived environmental benefits. As such, DOI complements **H1, H2, and H4** by providing a broader understanding of adoption patterns in emerging markets like India.

4. Circular Economy Theory (Ellen MacArthur Foundation, 2013)

Circular Economy Theory emphasizes resource efficiency and waste minimization through the principles of **reuse, repair, remanufacture, and recycle**. Within the EV sector, circular economy principles focus on sustainable battery lifecycle management, including second-life applications, improved recycling technologies, and responsible end-of-life (EoL) processing.

This theory directly supports **H3**, which examines the relationship between consumer awareness of circular economy practices and their support for recycling and EoL management. As batteries are one of the most resource-intensive components of EVs, circular economic practices play a critical role in ensuring long-term sustainability and mitigating environmental risks.

5. Sustainability Theory / Triple Bottom Line (Elkington, 1997): Sustainability Theory, particularly the Triple Bottom Line concept, highlights the importance of balancing **environmental, economic,** and **social** dimensions in decision-making. EV adoption aligns with this framework as it offers environmental benefits (reduced emissions), economic value (lower operating costs), and social advantages (better air quality and public health).

This theory reinforces **H1** by supporting the idea that sustainability awareness influences how consumers perceive the environmental benefits of EVs. It also provides context for understanding how government incentives, consumer consciousness, and industry practices contribute to environmentally responsible mobility.

Research Methodology

This study employed a mixed-method research design integrating quantitative survey data with qualitative expert insights to examine the factors influencing electric vehicle (EV) sustainability perception and adoption in India.

Quantitative Method: Quantitative data were collected through a structured questionnaire administered to **200 respondents**, comprising EV owners and potential users in PAN India. A **convenience sampling** technique was adopted due to the accessibility of participants. The instrument measured sustainability awareness, reliability, charging infrastructure, circular economy awareness, environmental perception, satisfaction, and adoption intention using a **5-point Likert scale**.

Quantitative analysis included descriptive statistics, reliability assessment (Cronbach's alpha), correlation analysis, and regression modelling to test the proposed hypotheses.

Qualitative Method: To complement the quantitative findings, **25 industry experts** were selected through **purposive sampling** for semi-structured interviews. The experts represented EV manufacturers, battery specialists, charging infrastructure providers, and sustainability professionals. Interviews focused on sustainability challenges, reliability issues, and circular economy practices.

Qualitative data were analysed using **thematic analysis,** allowing identification of recurring patterns that supported the interpretation of survey results.

Ethical Considerations: Participation in both the survey and interviews was voluntary, and anonymity and confidentiality were maintained. Informed consent was obtained prior to data collection.

The mixed-method approach enabled triangulation of quantitative and qualitative evidence, providing a comprehensive understanding of consumer perceptions and industry perspectives related to EV sustainability, reliability, circular economy practices, and adoption.

Result & Analysis:

H1: Relationship Between Awareness of Sustainability Practices and Environmental Benefits of Electric Vehicles

Table: 1- Model Summary (H1)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.666[a]	.444	.421	.45773

Table: 2- ANOVA (H1)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	31.936	8	3.992	19.053	.000[b]
	Residual	40.019	191	.210		
	Total	71.955	199			

ISBN code 978-93-83302-82-6

ANOVA: The ANOVA test indicated a statistically significant effect of sustainability awareness on perceived environmental benefits of EVs **(F = 19.053, p < 0.05)**, confirming variation in perceptions across levels of awareness.

Correlation Analysis: A moderate positive correlation was observed between sustainability awareness and environmental perception **(r = 0.666, p < 0.01)**, indicating that higher awareness is associated with stronger perceived environmental benefits.

Regression Analysis: Regression results show that sustainability awareness is a significant predictor of perceived environmental benefits **(R^2 = 0.44, p < 0.01)**.
The model explains 44**%** of the variance, suggesting that awareness contributes meaningfully to perceptions but is not the sole influencing factor.

H2: Relationship between the Reliability of Electric Vehicles and Owner Satisfaction

Table: 3- Model Summary (H2)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.728[a]	.530	.525	.41447

Table: 4- ANOVA (H2)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	38.114	2	19.057	110.937	.000[b]
	Residual	33.841	197	.172		
	Total	71.955	199			

ANOVA: The ANOVA results indicate a statistically significant effect of EV reliability on owner satisfaction of EV (F= 110.937, **p < 0.05)**. This confirms that satisfaction levels differ based on the reliability perceived by EV owners.

Correlation Analysis : A strong positive correlation was found between reliability and owner satisfaction **(r = 0.728, p < 0.01)**, indicating that higher reliability is associated with higher satisfaction among EV owners.

Regression Analysis: Regression results show that reliability significantly predicts owner satisfaction **(R^2 = 0.530, p < 0.001)**. The model explains 53**%** of the variance in satisfaction, suggesting that reliability is a major determinant of EV owner satisfaction.

H3: Relationship Between the reuse, repurposing, remanufacturing of Electric Vehicles battery and Owner Purchase Decisions

Table: 5- Model Summary (H3)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.420[a]	.176	.168	.54859

Table: 6- ANOVA (H3)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12.667	2	6.333	21.045	.000[b]
	Residual	59.288	197	.301		
	Total	71.955	199			

ANOVA: The ANOVA results show a statistically significant effect of perceived Reuse, Repurpose, Remanufacture on purchase decisions **($F= 21.045$, $p < 0.05$)**. This indicates that purchase intentions differ across levels of perceived resale value.

Correlation Analysis: A moderately strong positive correlation was observed between Reuse, Repurpose, Remanufacture and purchase decisions **($r = 0.42$, $p < 0.01$)**, indicating that higher perceptions of resale value are associated with a greater likelihood of purchasing an EV.

Regression Analysis: Regression results confirm that resale value significantly predicts purchase decisions **($R^2 = 0.17$, $p < 0.001$)**. Perceived resale value accounts for 17**%** of the variance in purchase decisions, suggesting that it is an important financial determinant in EV adoption.

H4: Relationship Between charging infrastructure availability and adoption and usability of electric vehicles

Table: 7- Model Summary (H4)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.604[a]	.365	.349	.48521

Table: 8- ANOVA (H4)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	26.283	5	5.257	22.328	.000[b]
	Residual	45.672	194	.235		
	Total	71.955	199			

ANOVA: The ANOVA results indicate a statistically significant effect of charging infrastructure availability on adoption and usability of electric vehicles **($F= 22.328$, $p < 0.05$)**. This confirms that support for sustainable recycling practices varies across levels of owner awareness.

Correlation Analysis: A strong positive correlation was found between charging infrastructure availability on adoption and usability of electric vehicles **($r = 0.604$, $p < 0.01$)**.

Regression Analysis: Regression analysis shows that charging infrastructure availability on predicts adoption and usability of electric vehicles **($R^2 = 0.365$, $p < 0.001$)**. Charging infrastructure availability accounts for **36.5%** of the variance in usability of electric vehicles.

Findings of Quantitative Analysis:

H1: Findings from the analyses are important for policymakers and industry partners. For policymakers, the strong relationship between sustainability perception and environmental advantages perceived reveals that public campaigns focused on informing consumers about environmental consequences of EVs could potentially lead to an increase in EV adoption. Higher acceptance by consumers can be achieved through educational programs focusing on the benefits of sustainability in reducing emissions and energy efficiency.

In conclusion, the significant relationship between sustainability awareness and the perceived environmental benefits of electric vehicles, as evidenced by the ANOVA, correlation, R^2, and regression results, underscores the importance of education and awareness in shaping owners' perceptions. Efforts to improve sustainability knowledge can help reinforce the environmental value of EVs and ultimately contribute to the expansion of the electric vehicle market.

H2: There are significant implications for EV producers and other industry stakeholders due to the strong correlation between satisfaction and reliability. Regarding manufacturers, the results indicate that improving vehicle reliability should be a top priority to increase owner satisfaction and brand loyalty. Investments in research and development that focus on enhancing the durability and dependability of EV components, such as batteries and electric motors, can lead to higher satisfaction rates and reduce warranty claims.

The focus on dependability draws attention from legislators to the necessity of rules that guarantee EVs' excellent performance and quality. Government programs that give incentives for the development of reliable and durable EV technologies can help drive industry-wide improvements in vehicle reliability, ultimately leading to higher satisfaction among owners.

In conclusion, the significant relationship between EV reliability and owner satisfaction, as demonstrated by the ANOVA, correlation, R^2, and regression results, emphasizes that reliability is a key determinant of satisfaction in the electric vehicle market. By focusing on enhancing vehicle reliability, manufacturers can improve customer experiences and build long-term brand loyalty.

H3: The outcomes of this analysis hold critical relevance for EV manufacturers, dealers, and policymakers. For manufacturers and dealers, the significant relationship between resale value and purchase decisions suggests that providing assurances regarding the long-term value of EVs can enhance buyer confidence and increase sales. Marketing campaigns that emphasize the retained value of EVs, backed by real-world resale data, can attract more buyers. Manufacturers might also consider offering buyback guarantees or trade-in incentives to further reassure buyers about the resale value of their vehicles.

Policymakers can also play a role by offering financial incentives that help maintain high resale values, such as tax rebates or other benefits for used EVs. Additionally, creating a robust market for pre-owned EVs could further enhance the perceived resale value, making EVs a more appealing choice for new buyers.

For potential buyers, the resale value of an EV provides a form of financial security, mitigating concerns about depreciation and offering confidence that the vehicle will preserve its value over time. The positive relationship between resale value and purchase decisions suggests that buyers prioritize long-term financial considerations when deciding to invest in an EV.

In conclusion, the significant relationship between resale value and owner purchase decisions, as demonstrated by the ANOVA, correlation, R^2, and regression results, highlights the importance of resale value in shaping buyer behavior. Manufacturers and policymakers should focus on ensuring competitive resale values to enhance buyer confidence and drive the adoption of electric vehicles.

H4: The results of this analysis carry significant implications for industry stakeholders, policymakers, and environmental organizations. For EV manufacturers and industry stakeholders, given the strong correlation between support for recycling and awareness of the circular economy, initiatives to educate owners about sustainable practices can enhance participation in recycling and EOL management programs. Manufacturers can collaborate with environmental organizations and governments to develop campaigns that highlight the importance of recycling batteries and other EV components.

Authorities can aid in these initiatives by establishing rules and providing financial incentives to owners who properly recycle their vehicles. For instance, providing cash rewards for recycling or putting in place laws that mandate the safe disposal of batteries could drive higher participation in EOL management initiatives. Additionally, governments can invest in the development of recycling infrastructure to ensure that owners have convenient and accessible options for recycling their EVs at the end of their life cycle.

For EV owners, awareness of circular economy practices not only influences their support for recycling but also encourages them to adopt more sustainable behaviors. By understanding the environmental benefits of recycling and responsible disposal, owners are more prone to contribute to the sustainability of the EV industry and the broader environment.

In conclusion, the significant relationship between awareness of circular economy practices and support for recycling and EOL management, as demonstrated by the ANOVA, correlation, R^2, and regression results, highlights the importance of education and awareness in fostering sustainable behavior among EV owners. Industry stakeholders and policymakers should prioritize efforts to increase awareness and support recycling initiatives to promote the long-term sustainability of electric vehicles.

Qualitative Analysis based on Experts: This thematic analysis explores expert opinions on the environmental implications of electric vehicles (EVs), focusing on key areas such as battery production, disposal, technological advancements, and policy interventions. By analyzing the views of experts, this study aims to identify significant themes that address the challenges and opportunities in the transition to sustainable EVs.

Methodology: The data analysed was derived from a series of expert responses on various aspects of EV technology and sustainability. Thematic analysis was conducted following Braun and Clarke's (2006) six-phase method:

- Familiarization with the dataset,
- Generation of initial codes,
- Searching for themes by clustering related codes,
- Reviewing themes to ensure consistency,
- Defining and naming themes based on the broader context,
- Writing the report by integrating findings into a coherent narrative.

Key Themes:

Theme 1: Environmental Impact of EVs vs. Gasoline Vehicles

Theme 2: Primary Sources of Pollution in EVs Theme 3:
EVs and Sustainability
Theme 4: Biggest Environmental Impacts of EVs Theme 5:
Challenges in Battery Production
Theme 6: Future Pollution from EVs by 2050 Theme 7:
Technological Advancements
Theme 8: Future of EV Sustainability
Theme 9: Challenges in Global Recycling Systems
Theme 10: Government Policies and Incentives

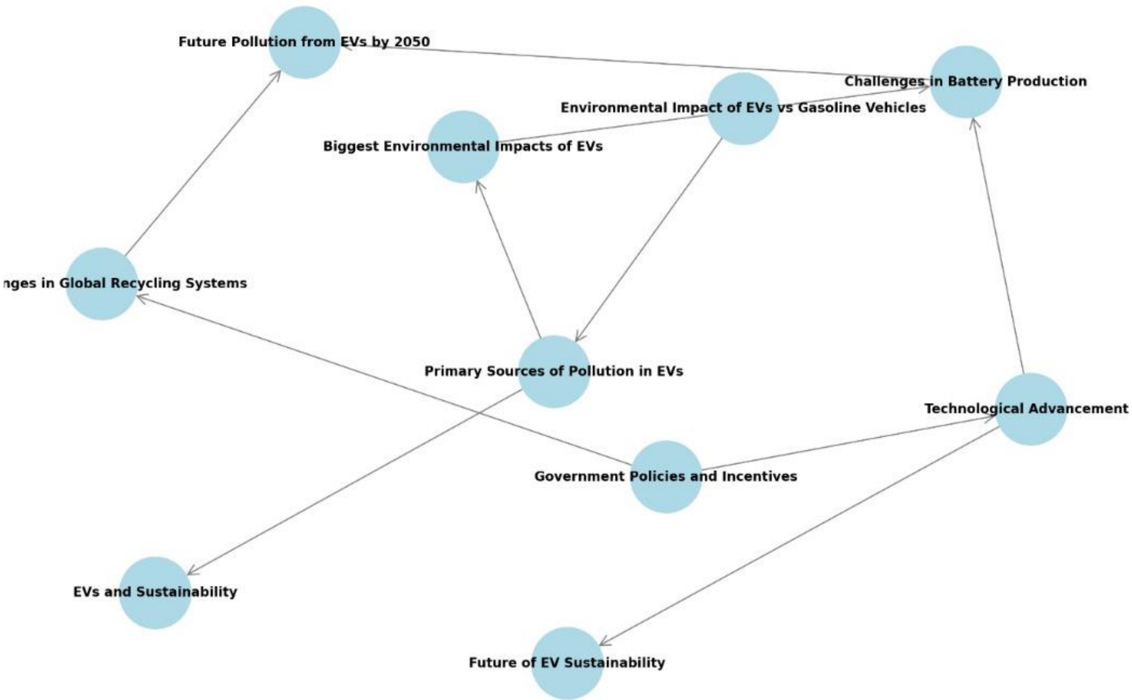

Figure 2 : Interdependency map of themes in thematic analysis

Qualitative Analysis:

Theme 1: Environmental Impact of EVs vs. Gasoline Vehicles

Experts expressed mixed but generally positive views on the overall environmental impact of EVs when compared to gasoline vehicles. The majority recognized EVs as being more environmentally friendly, largely due to their lack of direct emissions. However, the lifecycle environmental impact was noted as a significant concern, particularly regarding battery production.

Positive perceptions focused on the reduction of tailpipe emissions and the potential to to include green energy into networks of charging stations.

Concerns were mainly directed at the resource-intensive nature of battery production and disposal, which was seen as a significant offset to the environmental benefits.

Theme 2: Primary Sources of Pollution in EVs

The primary sources of pollution highlighted by experts included battery production, disposal, and electricity generation for charging. Battery production, particularly the extraction and refinement of raw materials like lithium, cobalt, and nickel, was repeatedly flagged as a major contributor to pollution.

Many experts identified the manufacturing process as the area with the greatest need for innovation, including developing less resource-intensive production techniques.

Several experts also highlighted battery disposal and the lack of a global recycling infrastructure as ongoing environmental risks.

Theme 3: EVs and Sustainability

Although the majority of experts agreed that EVs have the potential to be environmentally friendly, several expressed caution. Neutral and disagreeing perspectives pointed to long-term environmental risks, such as the challenges of scaling up production sustainably and the dependency on non-renewable resources for battery materials.

Supporters of EV technology underscored the importance of integrating renewable energy sources in the EV charging infrastructure, believing that this could significantly improve the environmental footprint.

Theme 4: Biggest Environmental Impact of EVs

Experts largely agreed that the production phase, specifically battery manufacturing, has the greatest environmental impact within the lifecycle of an EV. This theme ties closely to concerns around the mining of raw materials that not only creates pollution but also has social and geopolitical consequences.

Concerns about battery disposal were also voiced by experts as a growing challenge, with current recycling methods being insufficient to manage future volumes of spent batteries.

Theme 5: Challenges in Battery Production

The harmful environmental effects of EV battery production were emphasized, with experts expressing concerns about the resource-intensive nature of the materials used. Most experts described battery production as somewhat harmful, with only a few labeling it as extremely harmful.

The use of water, mining methods, and the environmental damage brought on by extraction activities in nations with relaxed environmental laws were among the main issues.

Theme 6: Future pollution from EV's by 2050

The majority of experts believed that EVs might become a substantial cause of pollution by 2050 if battery manufacture and disposal practices aren't changed significantly. This subject emphasized how EVs are perceived as a way to reduce transportation-related emissions, but if their life cycles are not properly managed, they could end up becoming an environmental issue.

The main sources of potential future pollution, according to contributors, are the environmental effects of large-scale mining operations and the pollution caused by the production of batteries.

Theme 7: Technological Advancements

Technological innovation, particularly in battery recycling and the development of sustainable materials, was widely viewed as crucial for mitigating the environmental impact of EVs. Advances in solid-state batteries, longer-lasting batteries, and enhanced recycling techniques were seen as promising trends that could reduce the reliance on finite raw materials and lower the environmental footprint.

Experts frequently cited advances in battery technology as a key area that could transform the industry and make EVs more sustainable in the long term.

Theme 8: Future of EV Sustainability

The experts overwhelmingly believed that technological advancements would have a transformative impact on EV sustainability. Innovations in battery production and energy storage are anticipated to address a large number of the current environmental challenges, making the industry more sustainable.

However, a minority of experts cautioned that while technology would improve sustainability, challenges such as scaling production sustainably and ensuring equitable access to materials may remain.

Theme 9: Challenges in Global Recycling System

The establishment of a global recycling system for EV batteries was considered a major challenge by most experts. Concerns about the high cost of infrastructure, insufficient technological development, and lack of global cooperation were common themes.

Experts also highlighted consumer and manufacturer resistance as barriers to creating effective recycling initiatives, stressing the need for government intervention to drive behavioral and infrastructural changes.

Theme 10: Government Policies and Incentives

Numerous specialists promoted governmental initiatives that incentivize sustainable practices and address pollution from battery production and disposal. Tax incentives for sustainable manufacturing practices, research and development (R&D) grants, and regulations on battery disposal were frequently mentioned as effective tools for promoting a more sustainable EV industry.

The need for support for renewable energy infrastructure was also emphasized, as experts argued that shifting the EV charging grid towards renewable energy would significantly reduce the overall environmental footprint of EVs.

This thematic analysis highlights the complexity of the environmental impact of EVs, revealing both optimism about their potential and concerns about the long-term challenges posed by battery production and disposal. Although switching to electric vehicles reduces transportation-related emissions, there are serious environmental dangers that call for technological improvement, global cooperation, and government policies to be fully realized as a sustainable solution. Experts agree that advances in battery technology and recycling processes will be key to ensuring that the EV sector can lessen its environmental effects, but emphasize the urgency in addressing resource extraction and battery lifecycle management to avoid creating new environmental problems by 2050.

Conclusion

The study titled "Sustainability and Adoption of Electric Vehicles in India: A Study Analysis for Future Mobility" provides a comprehensive understanding of how sustainability awareness, reliability perceptions, circular economy knowledge, and charging infrastructure availability shape the adoption and usability of electric vehicles in the Indian context.

The findings clearly align with the study objectives, which sought to examine the influence of sustainability awareness, reliability, circular economy practices, and infrastructure availability on EV perception and adoption. The results establish that awareness of sustainability practices significantly strengthens the perception of EVs as environmentally beneficial, validating the role of informed environmental consciousness in influencing positive attitudes towards electric mobility. At the same time, the study reveals that reliability remains the most decisive factor in determining owner satisfaction, highlighting that technical performance and operational dependability are critical for sustained acceptance.

Furthermore, the results indicate that awareness of circular economy practices such as battery reuse and remanufacturing positively contributes to purchase decisions, reinforcing the importance of lifecycle thinking in promoting sustainable consumption behavior. The strong influence of charging infrastructure availability on adoption and usability confirms that practical accessibility remains a cornerstone for mainstreaming EVs.

Taken together, the study concludes that the successful transition towards sustainable electric mobility in India requires a balanced integration of environmental awareness, reliable technology, structured circular economy systems, and robust infrastructure development. The convergence of these factors directly supports the broader goal of future-ready, low-carbon transportation, thereby affirming that sustainability in the EV ecosystem extends beyond emissions reduction to encompass responsible resource management, consumer confidence, and long-term environmental stewardship.