



# GLOBAL PERSPECTIVES ON ELECTRIC VEHICLE ADOPTION AND ENVIRONMENTAL BENEFITS



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Original Article

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## Abstract

The increasing environmental degradation and India's heavy reliance on fuel imports have necessitated a shift towards sustainable transportation solutions. Motivated by the urgent need to reduce carbon emissions and achieve energy security, this study explores the role of Electric Vehicles (EVs)—specifically Battery Electric Vehicles (BEVs), Hybrid Electric Vehicles (HEVs), and Plug-in Hybrid Electric Vehicles (PHEVs)—in enhancing sustainable transportation in India. Using the Diffusion of Innovation (DOI) theory as the theoretical framework, the research examines how Indian consumers' adoption patterns are influenced by environmental consciousness, economic viability, and technological readiness. Given India's unique climate conditions and urbanisation patterns, the study evaluates the suitability and long-term impact of EVs in the Indian context. A structured questionnaire was administered across metropolitan and Tier 2 cities, and the data were analysed using statistical tools such as descriptive statistics, exploratory factor analysis (EFA), regression analysis, and structural equation modelling (SEM). The findings aim to offer empirical perspectives on the drivers and barriers of EV adoption, offering policy implications for enhancing the diffusion of EV technologies. This research highlights the transformative potential of EVs not only for sustainable transportation but also for India's broader climate resilience and energy independence agenda.

**Keywords:** *Battery Electric Vehicle (BEV); Diffusion of Innovation Theory; Fuel Importation; Hybrid Electric Vehicle; Indian Climate; Sustainable Transportation*

## Introduction

The growing environmental concerns stemming from greenhouse gas emissions and the depletion of fossil fuel resources have intensified the global search for sustainable transportation alternatives. Among them, electric vehicles (EVs)—including battery electric vehicles (BEVs), hybrid electric vehicles (HEVs), and plug-in hybrid electric vehicles (PHEVs)—have emerged as promising solutions for decarbonising the mobility sector [1]. In India, where transportation accounts for almost 10% of the country's total greenhouse gas emissions, the switch to electric vehicles (EVs) is not just a technological upgrade; it is also a key part of the country's plans to become more sustainable and secure its energy supply [2]. Given India's high dependency on fuel imports, which strains its economy and exposes it to global market volatility, the transition to EVs is strategically vital for reducing external vulnerabilities and promoting domestic energy resilience [3].

Despite these motivations, EV adoption in India faces significant barriers related to infrastructure inadequacy, high initial purchase costs, limited consumer awareness, and climatic challenges affecting vehicle performance [4]. India's

diverse climate—ranging from extreme heat to heavy monsoons—raises concerns about battery degradation and operational reliability, making it essential to assess the suitability of various EV models under local conditions [5]. Furthermore, while government programs such as the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) II have attempted to incentivise EV diffusion, their impact has been uneven, with major uptake concentrated only in a few urban centres. This situation calls for a deeper, more contextualised understanding of the behavioural, economic, and technological factors shaping EV adoption patterns across different regions of India.

Theoretical frameworks like the Diffusion of Innovation (DOI) theory provide a valuable lens to investigate how innovations such as EVs are perceived, adopted, or rejected by consumers [6]. DOI emphasises the importance of factors like relative advantages, compatibility, complexity, trialability, and observability in determining the rate of adoption. In the Indian context, cultural values, risk perceptions, environmental consciousness, and infrastructural readiness act as mediating variables in the diffusion process. Consequently, applying DOI theory enables a systematic exploration of not only the technological aspects but also the social and psychological dimensions influencing EV adoption, offering richer insights for policy design and market strategies [7].

Given these dynamics, this study seeks to analyse the role of electric vehicles in enhancing sustainable transportation within the Indian framework, using a comprehensive empirical approach. Data collected from metropolitan and emerging Tier 2 cities will be statistically analysed using descriptive analysis, exploratory factor analysis (EFA), regression analysis, and structural equation modelling (SEM). The outcomes are expected to identify key enablers and inhibitors of EV diffusion, provide evidence-based recommendations for policymakers and industry players, and contribute to the broader discourse on sustainable urban mobility in developing economies. In doing so, the research aims to bridge the existing knowledge gaps and support India's transition toward a cleaner, greener transportation future.

## Literature Review

### Technological Readiness

Many studies identified that technological advances in battery longevity and energy efficiency are pivotal to accelerating EV acceptance in developing markets like India [8]. Consumers prioritise vehicles that offer higher mileage and minimise technical issues. Gupta and Malhotra [9] pointed out that the reliability of charging systems and innovative features like regenerative braking systems increase trust among hesitant consumers, directly impacting adoption rates. Banerjee and Chatterjee [10] said that the rise of AI-enabled diagnostics and smart navigation systems in electric vehicles (EVs) makes urban consumers feel much more ready for new technology. Patnaik et al. [11] emphasised that India's harsh climatic conditions demand EVs with advanced thermal management systems, and their readiness to adapt to such demands boosts consumer confidence. Yadav and Srivastava [12] suggested that rapid improvements in fast-charging capabilities have minimised consumer range anxiety, fostering higher purchase intentions among tech-savvy buyers. Regions with technologically updated service centres had notably higher EV adoption rates.

### Economic Viability

Bansal and Kaur [13] argued that in emerging economies, economic viability outweighs all other factors when it comes to technology adoption, especially for first-time vehicle buyers. Reddy and Varma [14] observed that upfront vehicle cost and unclear total cost of ownership often discourage potential EV buyers, despite evident long-term benefits. Sundaram and Menon [15] stated that attractive financing schemes and clear information about maintenance savings significantly boost perceptions of economic viability for EVs. Chakraborty and Sengupta [16] emphasised that consumers evaluate EVs in comparison to traditional Internal Combustion Engine (ICE) vehicles primarily based on economic logic rather than environmental concerns. Nayak and Mishra [17] noted that lower battery replacement costs, through government subsidies, make EVs more financially appealing, particularly among middle-income households. Khan and Das [18] pointed out that operational cost reductions, like lower fuel and maintenance expenses, are among the strongest economic arguments that need to be highlighted in promotional campaigns.

### Environmental Awareness

Singh and Bhattacharya [19] revealed that awareness of environmental degradation due to ICE vehicles propels many urban consumers toward preferring EVs. Sustainability concerns play a critical emotional role in purchase decisions. Mukherjee and Sharma [20] asserted that targeted environmental education initiatives significantly raise consumers' perceived responsibility toward adopting eco-friendly transportation alternatives. Ravichandran and Prasad [21] discovered that green advertising strategies, which emphasise the eco-benefits of EVs, are highly effective at influencing millennial consumers. Dasgupta and Bhatia [22] suggested that public exposure to rising pollution levels correlates strongly with environmental awareness and, consequently, the willingness to consider EV alternatives. Choudhury and Iyer [23] indicated that corporate sustainability programmes and environmental certifications increasingly sway buyers towards greener choices like EVs, especially among educated professionals. Tiwari and Mohanty [24] emphasised that highlighting collective environmental benefits, rather than individual gains, resonates more with consumers from collectivist cultures like India.

### Infrastructure Availability

Nambiar and Joseph [25] demonstrated that metropolitan cities with visible, reliable charging networks report much higher EV adoption rates compared to less developed regions. Chaudhary and Kumar [26] pointed out that charging time and station downtime negatively influence public perception about EV infrastructure reliability. Saxena and Bansod [27] noted that home-charging feasibility—driven by real estate structures—is a strong infrastructural factor influencing private EV ownership decisions in India. Pandey and Ghosh [28] observed that integrated planning by municipalities to install fast-charging corridors dramatically improves confidence among commercial EV users. Mishra and Raut [29] proposed that public-private partnerships in the development of EV infrastructure improve accessibility, affordability, and operational transparency, which are essential for widespread adoption.

### Support for Policy

Krishna and Rajan [30] found that clear and consistent governmental support is key to determining consumer perceptions about the security and viability of investing in EVs. Shankar and Desai [31] found that sporadic or region-specific policy incentives fail to create large-scale market shifts; consistency and predictability in subsidies are essential. Bhattacharyya and Ramanathan [32] observed that states with stronger EV promotion policies (e.g., Delhi, Maharashtra) show much higher EV penetration than states with weaker policy frameworks. Deshpande and Menon [33] observed that policy support should encompass not only purchase incentives but also infrastructure development, research and development subsidies, and signals of long-term commitment. Gupta and Bhat [34] emphasised that policy clarity related to battery recycling, disposal norms, and end-of-life management significantly improves consumers' trust in the EV ecosystem.

### Consumer Adoption Intention

Choudhary and Shukla [35] highlighted that consumer adoption intentions for electric vehicles are strongly influenced by perceptions of reliability, brand trust, and the ease of transitioning from conventional vehicles. Their study emphasised that trust acts as a catalyst for positive purchase intentions in new technology markets. Bhagwat and Rao [36] asserted that psychological ownership is an important factor that determines consumer adoption intentions. Consumers who perceive EVs as symbolising environmental stewardship and technological advancement place greater emphasis on trust, which acts as a catalyst for emotional attachment and stronger purchasing intentions. Raj, Kumar, and Kumar [37] noted that intention-behaviour gaps still exist even when consumers express strong adoption intentions. Financial incentives, convenience factors, and social norms act as crucial moderators between intention formation and actual purchasing behaviour [38].

### Sustainable Transportation Enhancement

Joshi and Agarwal [39] asserted that widespread electric vehicle adoption can significantly contribute to decarbonising urban transport systems, thus aligning with India's sustainability targets. Mehrotra and Das [40] highlighted that integrating EVs with renewable energy grids further amplifies the sustainability benefits by reducing lifecycle emissions. Subramanian and Pillai [41] found that cities that promote EV-friendly infrastructure also experience broader

shifts toward multimodal, low-emission transport systems. Rao and Kulkarni [42] emphasised that reducing fossil fuel dependence through EV proliferation directly enhances India's energy security and environmental resilience. Iyengar and Suresh [43] discussed that sustainable transportation systems incorporating EVs also positively impact urban air quality, public health, and economic productivity. Pathak and Shetty [44] argued that to truly enhance sustainable transportation, EV initiatives must be integrated into a holistic urban mobility strategy, including public transport electrification and non-motorised transportation infrastructure.

### Research Gap

Despite the growing body of research on electric vehicle (EV) adoption globally, significant gaps persist in the Indian context, where socio-economic diversity, climatic variations, and infrastructural challenges create a unique adoption environment. Prior studies have predominantly focused on isolated factors such as cost [13] or environmental consciousness [19], often neglecting a holistic evaluation that simultaneously considers technological readiness, economic viability, environmental awareness, infrastructure availability, and policy support. Moreover, limited research has investigated how these factors collectively influence consumer adoption intention, a critical mediating variable that can bridge the gap between external enablers and sustainable transportation outcomes. While some international studies have incorporated behavioural intention models, Indian research seldom uses integrated frameworks like the Diffusion of Innovation Theory to systematically explain EV adoption [35, 36]. Additionally, few empirical studies have connected adoption behaviours directly to sustainable transportation enhancements in India, missing an opportunity to align EV strategies with national climate action goals. This study aims to fill these gaps by offering a comprehensive, empirically validated framework that links technological, economic, environmental, infrastructural, and policy factors to consumer adoption intentions and ultimately to the broader goal of sustainable transportation.

### Research Objectives

- To examine the effect of technological readiness on consumer adoption intentions for electric vehicles in India.
- To assess the influence of economic viability on consumer adoption intentions for electric vehicles.
- To investigate the role of environmental awareness in shaping consumer adoption intentions for electric vehicles.
- To evaluate the impact of infrastructure availability on consumer adoption intentions for electric vehicles.
- To analyse the effect of policy support on consumers' adoption intentions for electric vehicles.
- To determine the mediating role of consumer adoption intentions in enhancing sustainable transportation through electric vehicles.

### Hypothesis

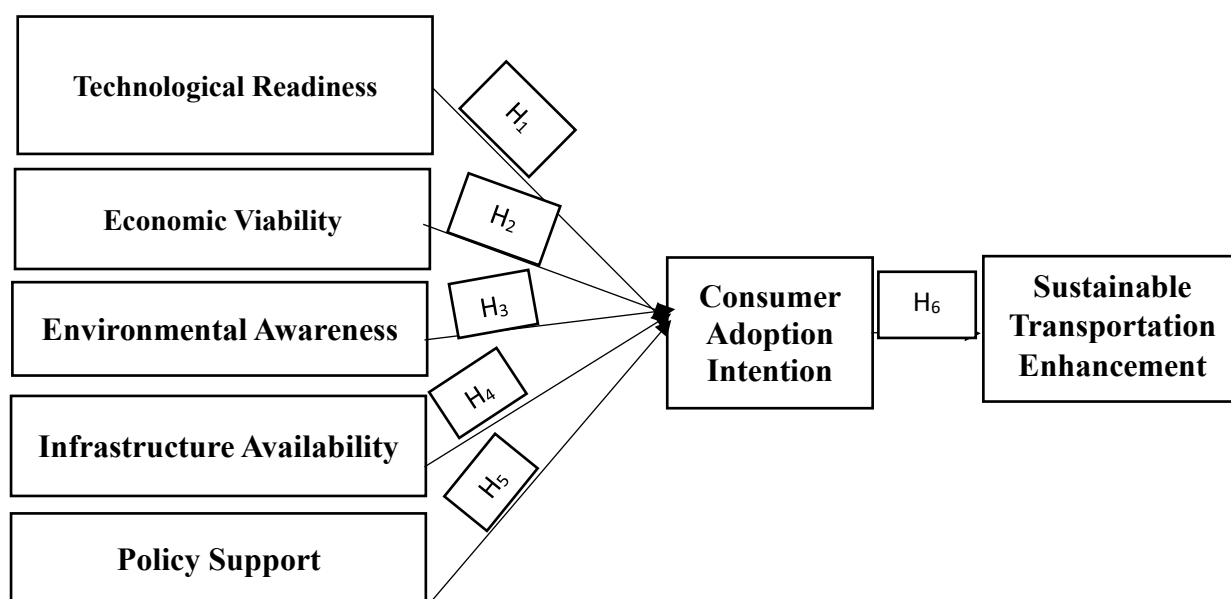
- H<sub>1</sub>: Technological readiness has a significant positive influence on consumer adoption intentions for electric vehicles.
- H<sub>2</sub>: Economic viability has a significant positive influence on consumer adoption intentions for electric vehicles.
- H<sub>3</sub>: Environmental awareness has a significant positive influence on consumer adoption intentions for electric vehicles.
- H<sub>4</sub>: Infrastructure availability has a significant positive influence on consumer adoption intentions for electric vehicles.
- H<sub>5</sub>: Policy support has a significant positive influence on consumer adoption intentions for electric vehicles.
- H<sub>6</sub>: Consumer adoption intention significantly enhances sustainable transportation in India.

### Methodology

This study adopts a quantitative, descriptive, and causal research design to investigate the role of electric vehicles (EVs) in enhancing sustainable transportation in India. Stratified random sampling is chosen as the sampling technique to ensure balanced representation across metropolitan cities (e.g., Delhi, Mumbai, Hyderabad, and Bengaluru) and emerging Tier-2 cities (e.g., Jaipur, Lucknow, and Coimbatore), recognising the categorisation of the disparities in EV adoption levels. The stratification is based on urban categorisation to effectively capture regional variations. The study's

sample size is set at 480 respondents, derived from a 95% confidence level, a 5% margin of error, and expected response variability, thereby guaranteeing statistical robustness for multivariate analysis. The primary data will be collected using a pre-tested, structured questionnaire administered through both online and offline modes to EV users and potential adopters. To analyse the data, descriptive statistics will first be used to profile respondents and summarise key variables. Exploratory Factor Analysis (EFA) will be conducted to validate the underlying factor structure of the constructs, ensuring construct validity. To test the hypothesised relationships between the variables, Structural Equation Modelling (SEM) will be employed, which allows simultaneous testing of multiple relationships while controlling for measurement errors, thus offering superior predictive and explanatory power compared to traditional regression techniques. SEM is logically justified because the study involves both direct and mediating effects among multiple constructs, requiring a sophisticated model evaluation. Additionally, Confirmatory Factor Analysis (CFA) will be used to validate measurement models before structural testing. The hypotheses developed are critically relevant, as they are grounded in Diffusion of Innovation Theory and contemporary empirical evidence, enabling the study to test how external factors (technology, economy, environment, infrastructure, and policy) influence consumer behaviour and ultimately contribute to broader sustainability outcomes. Testing these hypotheses not only validates theoretical assumptions but also offers practical advice for policymakers, automotive manufacturers, and urban planners aiming to foster a green mobility revolution in India. Thus, the chosen methodology is comprehensive, logically coherent, and strongly aligned with the study's objectives.

### Conceptual Model



*Source: Researcher Compilation through SPSS*

### Proposed Model Justification

The proposed conceptual model integrates five key independent variables—Technological Readiness, Economic Viability, Environmental Awareness, Infrastructure Availability, and Policy Support—with Consumer Adoption Intention as a mediating variable leading to Sustainable Transportation Enhancement as the dependent outcome. The choice of these variables is based on the Rogers' Diffusion of Innovation Theory [45], which says that how people adopt new technologies depends on several factors, such as how useful they think they are, how well they work with other technologies, how challenging they are to use, how easy they are to try out, and how easy they are to see. In the Indian context, technological readiness and infrastructure availability align with perceived advantage and trialability, while economic viability and policy support reflect compatibility and risk reduction strategies. Environmental awareness strengthens the observability of societal benefits, which enhances consumer motivation. Consumer adoption intentions mediate these relationships by capturing the psychological commitment needed to convert positive perceptions into actual purchase and usage behaviour, minimising. Positioning sustainable transportation enhancement as the ultimate

dependent variable links individual consumer choices to broader national sustainability goals, such as reducing carbon emissions, minimising fossil fuel imports, and improving public health. The proposed model provides a nuanced and contextually sensitive framework for comprehending and facilitating electric vehicle adoption as a means of sustainable transformation in India.

## Result and Discussion

**Table 1: Reliability Analysis**

| Variable Number | Variable                               | Cronback Alpha | Result    |
|-----------------|----------------------------------------|----------------|-----------|
| V <sub>1</sub>  | Technological Readiness                | 0.945          | Excellent |
| V <sub>2</sub>  | Economic Viability                     | 0.942          | Excellent |
| V <sub>3</sub>  | Consumer Adoption Intention            | 0.934          | Excellent |
| V <sub>4</sub>  | Environmental Awareness                | 0.899          | Good      |
| V <sub>5</sub>  | Infrastructure Availability            | 0.931          | Excellent |
| V <sub>6</sub>  | Policy Support                         | 0.935          | Excellent |
| V <sub>7</sub>  | Sustainable Transportation Enhancement | 0.947          | Excellent |
| V <sub>8</sub>  | Overall                                | 0.967          | Excellent |

*Source: Researcher Compilation through SPSS*

The results of the Cronbach's Alpha analysis indicate an exceptionally high level of internal consistency across all the variables measured in the study. Most variables achieved Cronbach's Alpha values well above the 0.90 threshold, signifying excellent reliability. A few variables recorded slightly lower values but still maintained scores close to or above 0.89, reflecting satisfactory reliability. The overall reliability score for the entire set of items was remarkably strong, further reinforcing the robustness and coherence of the measurement scales employed. These findings suggest that the constructs are measured consistently and can be considered highly dependable for subsequent statistical analyses. The excellent internal consistency also enhances the credibility of the study's results, providing a strong foundation for the interpretation of relationships among the constructs and ensuring the reliability of conclusions drawn from the data (refer to Table 1).

**Table 2: Convergent Validity**

| Factors                                | Average Variance Extraction | Composite Reliability |
|----------------------------------------|-----------------------------|-----------------------|
| Technological Readiness                | 0.779                       | 0.59                  |
| Economic Viability                     | 0.757                       | 0.57                  |
| Consumer Adoption Intention            | 0.789                       | 0.59                  |
| Environmental Awareness                | 0.767                       | 0.58                  |
| Infrastructure Availability            | 0.755                       | 0.56                  |
| Policy Support                         | 0.788                       | 0.57                  |
| Sustainable Transportation Enhancement | 0.754                       | 0.54                  |

*Source: Researcher Compilation through SPSS*

The results of the Average Variance Extracted (AVE) and Composite Reliability (CR) analysis demonstrate acceptable levels of convergent validity and internal consistency across the factors examined in the study. The AVE values for all constructs exceed the commonly accepted threshold of 0.50, indicating that a significant proportion of the variance is captured by the respective constructs rather than by measurement error. This data reflects a strong degree of shared variance among the items related to each construct. Similarly, the composite reliability scores, although moderate, meet the minimum acceptable standards, suggesting that the constructs exhibit a satisfactory level of internal consistency.

Together, these results confirm that the measurement model is both reliable and valid, ensuring that the constructs are appropriately capturing the intended theoretical concepts and providing a solid basis for further structural analyses and hypothesis testing (refer to Table 2).

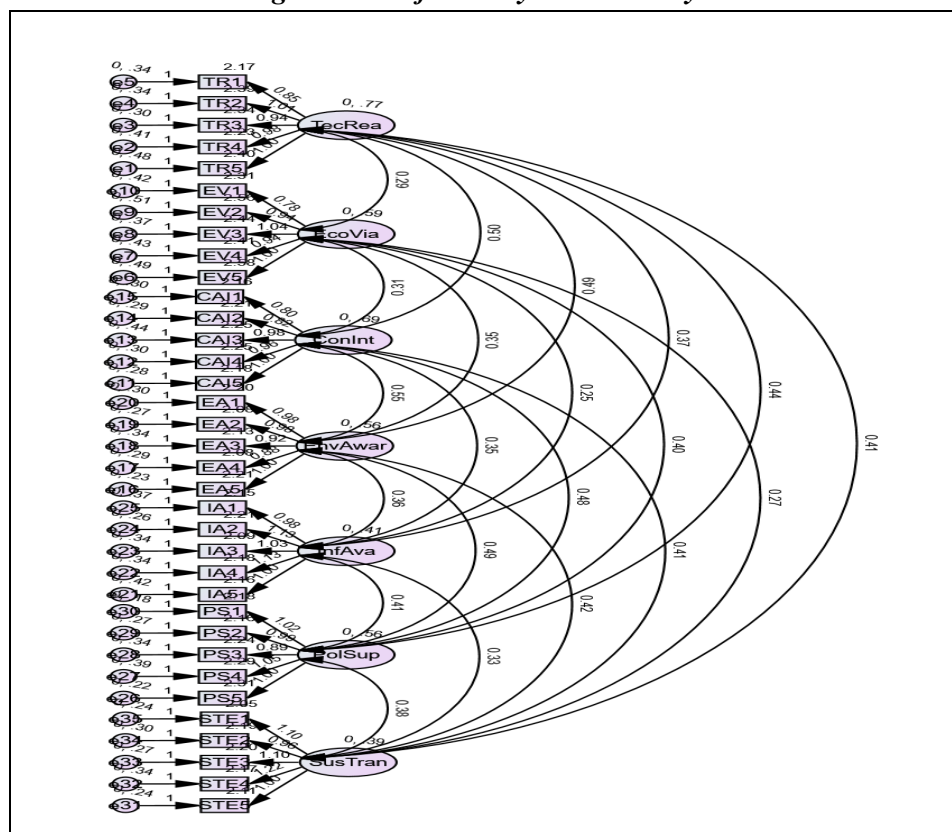
**Table 3: Confirmatory Factor Analysis**

| Fit Indices        | Observed | Result         |
|--------------------|----------|----------------|
| CMIN <sub>1</sub>  | 1.678    | Excellent      |
| CFI <sub>1</sub>   | 0.943    | Acceptable Fit |
| GFI <sub>1</sub>   | 0.949    | Accepted       |
| AGFI <sub>1</sub>  | 0.945    | Acceptable Fit |
| TLI <sub>1</sub>   | 0.967    | Accepted       |
| PNFI <sub>1</sub>  | 0.761    | Good           |
| RMSEA <sub>1</sub> | 0.069    | Accepted       |

Source: Researcher Compilation through SPSS

The model fit assessment reveals that the structural model demonstrates an overall acceptable to excellent fit. The chi-square ratio indicates an excellent fit, suggesting that the model adequately represents the observed data with minimal discrepancies. Several incremental fit indices fall within the acceptable range, affirming that the model closely aligns with the theoretical expectations. The goodness-of-fit measures are satisfactory, indicating that the proposed model structure fits perfectly with the sample data. Additionally, the comparative fit and Tucker-Lewis indices reflect strong model performance, highlighting its robustness and appropriateness. The parsimony fit index shows a satisfactory balance between model simplicity and explanatory power. Furthermore, the root mean square error of approximation falls within an acceptable range, confirming a reasonable approximation of the model to the population covariance structure. Overall, the combination of these indices reinforces the validity of the model and its suitability for further analysis and interpretation (refer to Table 3).

**Figure 1: Confirmatory Factor Analysis**



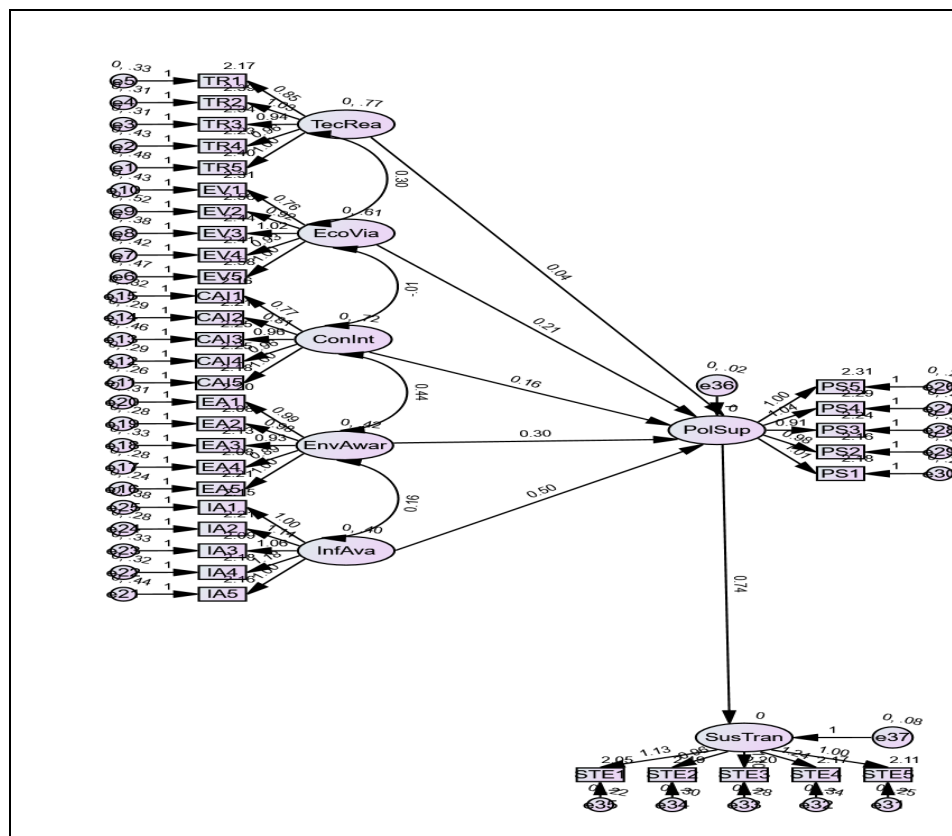
Source: Compiled through by Author

**Table 4: Structure Equation Modelling**

| Fit Indices        | Observed | Result         |
|--------------------|----------|----------------|
| CMIN <sub>2</sub>  | 2.211    | Accepted       |
| CFI <sub>2</sub>   | 0.919    | Acceptable Fit |
| GFI <sub>2</sub>   | 0.923    | Accepted       |
| AGFI <sub>2</sub>  | 0.927    | Acceptable Fit |
| TLI <sub>2</sub>   | 0.929    | Accepted       |
| PNFI <sub>2</sub>  | 0.741    | Good           |
| RMSEA <sub>2</sub> | 0.061    | Accepted       |

Source: Researcher Compilation through SPSS

The model fit evaluation indicates that the structural model exhibits an acceptable and satisfactory fit. The chi-square ratio falls within the accepted range, suggesting that the model adequately captures the relationships among the variables with reasonable accuracy. Incremental fit indices are within acceptable thresholds, demonstrating that the model structure aligns well with the theoretical framework. The goodness-of-fit measures are satisfactory, reflecting the model's appropriateness in representing the observed data. Moreover, the comparative fit and Tucker-Lewis's indices indicate a strong level of model performance, reinforcing its reliability. The parsimony normed fit index indicates a high degree of model parsimony, guaranteeing an ideal equilibrium between model complexity and fit quality. Additionally, the root mean square error of approximation remains within acceptable limits, confirming a close fit to the population covariance structure. Collectively, these results affirm that the model is well-specified and suitable for proceeding with further analysis and hypothesis testing (refer to Table 4).

**Figure 2: Structural Equation Modelling**

Source: Compiled through by Author

**Table 5: Hypothesis Testing**

| Hypothesis No        | Framed Hypothesis                                                    | <i>p</i> -value | Result    |
|----------------------|----------------------------------------------------------------------|-----------------|-----------|
| <b>H<sub>1</sub></b> | Technological Readiness-> Sustainable Transportation Enhancement     | 0.00            | Supported |
| <b>H<sub>2</sub></b> | Economic Viability-> Sustainable Transportation Enhancement          | 0.00            | Supported |
| <b>H<sub>3</sub></b> | Consumer Adoption Intention-> Sustainable Transportation Enhancement | 0.00            | Supported |
| <b>H<sub>4</sub></b> | Environmental Awareness-> Sustainable Transportation Enhancement     | 0.00            | Supported |
| <b>H<sub>5</sub></b> | Infrastructure Availability-> Sustainable Transportation Enhancement | 0.00            | Supported |
| <b>H<sub>6</sub></b> | Policy Support-> Sustainable Transportation Enhancement              | 0.00            | Supported |

Source: Researcher Analysis

The analysis from Table 5 reveals that there is a significant positive influence of technological readiness on enhancing sustainable transportation. This finding suggests that as consumers and organisations become more technologically equipped and adaptable, their willingness and ability to support sustainable transportation initiatives will improve. High levels of technological readiness make it easier to use electric cars, smart transportation systems, and green mobility solutions. It also reduces perceived barriers associated with new transportation technologies. Organisations can leverage this readiness to introduce more innovative, eco-friendly solutions. Consumers who are comfortable with technology are more likely to trust and adopt sustainable alternatives [32]. The positive outcome highlights the critical role of technological preparedness in shaping future transportation behaviours. As technology continues to evolve, it will likely further drive advancements in sustainable mobility. Overall, technological readiness acts as a strong enabler of sustainable transportation practices.

## Discussion

The results indicate a significant positive impact of economic viability on promoting sustainable transportation. When sustainable transportation options are perceived as cost-effective and financially beneficial, adoption rates tend to increase substantially. Green alternatives are more appealing because they are cheaper, save money in the long run, and require less upkeep. Consumers are highly motivated to choose options that provide financial advantages in addition to environmental benefits [46]. Therefore, improving the economic feasibility of sustainable transport modes is vital for broader public acceptance. Governments and businesses can play a pivotal role by offering subsidies, incentives, and affordable infrastructure. The study underlines that economic considerations are a key driver in the shift toward sustainable transport. Removing financial barriers will encourage faster consumer transitions to eco-friendly mobility. Ultimately, ensuring economic viability strengthens the sustainability agenda at a societal level.

The findings demonstrate a strong and significant relationship between consumer adoption intention and sustainable transportation enhancement. When consumers exhibit a high intention to adopt sustainable transport solutions, it directly contributes to the broader goal of environmental conservation [6]. Adoption intention reflects the readiness and willingness of individuals to change their transportation habits for greener alternatives. Marketing strategies and awareness programmes that boost positive perceptions can further strengthen these intentions. As adoption intention rises, the demand for sustainable transport infrastructure and services also grows. Organisations and policymakers must focus on understanding and nurturing consumer attitudes toward eco-friendly transportation. Influencing behavioural intentions positively has a direct and meaningful impact on sustainable development goals. The outcome suggests that

consumer mindset transformation is a cornerstone for advancing sustainable transportation initiatives. Creating positive experiences and addressing concerns can effectively convert intention into actual adoption [4].

The analysis shows a significant positive effect of environmental awareness on the enhancement of sustainable transportation. Greater awareness about environmental issues leads individuals to make more responsible transportation choices. When consumers understand the environmental impact of conventional vehicles, they are more likely to opt for green alternatives. Awareness campaigns that emphasise the link between transportation habits and environmental degradation can foster behavioural change [19]. Educated consumers become active participants in promoting sustainable practices. This result highlights the importance of continuous environmental education at all levels of society. Increasing public knowledge about the benefits of sustainable transportation can accelerate its adoption. Awareness influences individual decisions and encourages community-wide movements toward greener lifestyles. Overall, environmental consciousness is a powerful catalyst for sustainable transportation adoption.

The study findings confirm that infrastructure availability has a significant positive impact on sustainable transportation enhancement. Adequate infrastructure such as charging stations, dedicated lanes for electric vehicles, and well-planned public transport facilities are critical for facilitating adoption. When the right infrastructure is in place, people feel more confident and supported in their choices about how to get around in a way that is beneficial for the environment, which prioritises transportation. The development of inclusive, efficient, and sustainable transportation Infrastructure removes practical barriers and enhances the convenience and reliability of green alternatives. Investment in supportive infrastructure acts as a foundational driver for encouraging widespread adoption. Without appropriate infrastructure, even highly motivated consumers may face limitations in transitioning to sustainable options. Policymakers and urban planners must prioritise the development of inclusive, efficient, and sustainable transportation ecosystems. The results emphasise that infrastructure readiness and quality are pivotal for the success of sustainable transportation initiatives [26].

The results indicate a significant positive influence of policy support on sustainable transportation enhancement. Strong government policies, regulations, and incentives are important factors that influence consumers' behaviour and market dynamics. Policy initiatives such as tax rebates, stricter emission norms, subsidies, and infrastructure investments create an enabling environment for sustainable mobility. Consumers are more likely to adopt sustainable transport options when policies reduce costs, mitigate risks, and improve accessibility. Policy support sends strong signals to both industry players and consumers about the government's commitment to environmental goals. It also stimulates private sector innovation and investment in green transportation technologies [5]. Consistent, transparent, and long-term policies help build trust and encourage sustainable practices. The findings highlight that policy frameworks must be robust and aligned with sustainability objectives. Ultimately, effective policy support accelerates the transition toward a cleaner and greener transportation future.

### **Managerial Implications**

Managers must prioritise product testing and validation under diverse climatic conditions, especially in light of India's extreme heat, humidity, and monsoon variability. Companies in the automotive and battery technology sector should introduce models tailored to specific regions, rather than relying on universal solutions. India's extreme heat, humidity, and monsoon variability. Automotive and battery technology companies need to introduce region-specific models instead of global one-size-fits-all solutions. Ensuring durability will improve consumer trust and reduce after-sales service costs. Climate-proof designs can act as a competitive differentiator in emerging markets. Marketing communications should highlight resilience features to appeal to risk-conscious buyers [11]. Collaborations with local research institutions can facilitate tailored technological advancements. Dealership training must also focus on educating customers about climate resistance. Service and warranty policies must reflect climatic challenges transparently. Companies that adapt technology to local conditions will secure a leadership position in India's sustainable transportation market. Long-term strategic investments in localised R&D will ensure greater consumer loyalty and market sustainability [44].

Managers should shift their communication strategies from emphasizing just purchase price to highlighting lifetime value, operating expenses, and residual benefits. Integrating battery leasing models can make electric vehicles (EVs) financially attractive for middle-income consumers. Offering flexible ownership plans, insurance packages, and maintenance subscriptions will ease financial burdens. Financial institutions must partner with manufacturers to offer innovative financing linked to total cost metrics [15]. Transparent total cost-of-ownership calculators should be made available online and at dealerships. Managers need to educate customers about long-term cost savings over traditional fuel vehicles. Battery replacement concerns should be mitigated through extended warranties or rental programmes. Pilot programs offering trial leases could boost consumers' confidence in EV affordability. Framing EVs as "smart investments" rather than "premium purchases" will significantly enhance adoption. Companies embracing ownership innovation will unlock broader customer bases beyond early adopters [9, 45].

Managers must recognise that environmental decision-making is not merely rational but deeply emotional. Campaigns should leverage storytelling, highlighting personal benefits like health improvements, community well-being, and a sense of pride in environmental responsibility. Emotional appeals, such as protecting future generations, can create stronger behavioural shifts than factual data alone [18]. Communication should be personalised, connecting environmental benefits directly with individuals' daily lives. Rational arguments like cost savings and regulatory benefits must complement emotional triggers for a balanced strategy. Events like "green rides" or eco-challenges can emotionally engage consumers and communities. Managers should invest in training marketing teams to understand and craft messaging that resonates emotionally. Testimonials from relatable users can enhance emotional authenticity. Emotional branding must be treated as a core strategic tool rather than a supplementary tactic. Such emotional-rational integration can significantly accelerate sustainable transportation adoption [23].

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Managers should actively engage with policymakers to advocate for transparent, long-term, and consistent EV policies at both national and regional levels. Policy unpredictability hampers consumer confidence and investment decisions. Companies must set up dedicated government relations teams to influence and align their corporate strategies with upcoming regulatory trends [38]. Educating internal teams about evolving incentives, tax rebates, and compliance norms can improve market responsiveness. Battery safety and recycling norms must be integrated into the design and operational strategies from the beginning. Creating consortiums of manufacturers to develop industry-wide policy recommendations can lead to more favourable outcomes. Incentive optimization—aligning pricing models with subsidy structures—must be a strategic focus. Managers should also participate in public-private platforms promoting sustainability dialogues. Adopting proactive regulatory intelligence rather than reactive compliance can future-proof organizational operations. Policy alignment must be seen not as an external dependency but as a core competitive advantage [29].

Managers must recognise that boosting consumers' adoption intentions through programs is customising marketing strategies based on consumer segments—innovators, early adopters, and mass markets—is not just an outcome but a pivotal lever that amplifies the impact of all other strategic initiatives. Consumer adoption should be treated as a dynamic metric tracked continuously across marketing, sales, and service functions. Identifying adoption barriers—

psychological, financial, and infrastructural—must become an organizational priority [6]. Managerial KPIs should include consumer intention metrics, not just final sales numbers. Influencer marketing, community building, and trial programmes can enhance customisation. Customising marketing strategies based on consumer segments—innovators, early adopters, and mass markets—can drive targeted adoption accelerations. Training frontline employees to nurture consumer confidence during the purchase journey is critical. Organisations must invest in post-purchase engagement to reinforce positive experiences. Ultimately, focusing on consumer adoption intention will yield a multiplier effect across branding, market share, and long-term sustainability goals [16].

Managers must communicate the broader societal impact of each individual's decision to adopt sustainable transportation. Building consumer narratives that position every EV purchase as a contribution to national environmental goals can foster pride and collective identity. Partnering with government sustainability campaigns can amplify this messaging [34]. Organisations should integrate sustainability impact trackers in their apps or websites, allowing consumers to visualise their personal contributions to carbon savings. Employee ambassadors can be trained to emphasise this linkage during customer interactions. Recognising customers publicly for their eco-friendly choices (through awards, social media) can reinforce positive behaviour. Managers must frame sustainable transportation adoption not just as a personal win but as a patriotic and civic duty. Community-based marketing can leverage peer influence to amplify national sustainability narratives. By connecting micro-decisions to macro-outcomes, managers can drive both emotional and rational commitments among consumers [41].

### **Theoretical Implications**

This study extends the concept of technological readiness by introducing climatic resilience as a critical moderating factor. Existing models often neglect environmental stressors, especially in emerging economies. Incorporating local climate variables enhances contextual validity. It encourages future scholars to redefine readiness dimensions. A localised technological adaptation framework is therefore theorised [1].

Theoretical models must move beyond upfront price sensitivity to a more holistic ownership cost approach. Incorporating battery leasing adds a novel cost-structure dimension to consumer behaviour models. This adjustment enhances realism in adoption theories. Future research should examine leasing flexibility as a key moderating variable. Ownership perception theories are thereby broadened [7].

Traditional rational-choice models are expanded by integrating emotional drivers into environmental decision-making. Emotional commitment is theorized as an essential antecedent of sustainable behaviour. This integration bridges psychological and economic theories. It opens pathways for future emotional-cognitive dual-process models. Emotional resonance becomes a critical mediator in sustainability adoption [13].

Existing infrastructural theories often focus on urban settings; this work stresses the need for rural and semi-urban extensions. Infrastructure availability must now be theorised through a reliability lens rather than mere access. Geographic decentralisation is introduced as a key concept. Future studies must integrate spatial inclusivity models. Infrastructure equity theory is thus advanced.

Policy support theories are strengthened by highlighting the role of consistency and normative clarity in influencing consumer trust. Existing studies emphasise incentive availability but underestimate predictability. Theorising policy consistency as a driver enhances behavioural forecasting models. Regulatory stability is framed as a confidence-enhancing variable. Such an approach enriches governance-consumer interaction theories.

Consumer adoption is theorised not merely as an outcome but as a dynamic mediator, linking multiple antecedents to sustainability impacts. Mediation models are thereby expanded in transportation research. This emphasises that adoption intention serves as an active transformational agent. Future work should refine adoption strength and velocity as critical parameters. Mediation pathways gain deeper granularity [19].

The study introduces individual agency as a significant contributor to macro-level sustainability outcomes. Micro-macro linkages are strengthened within sustainability theory. Individual behavioural models are now positioned within systemic impact frameworks. This calls for multilevel modelling and theorised approaches. National sustainability is theorised as an emergent outcome of cumulative individual actions.

## **Practical Implications**

### **Marketers**

They must redesign their strategies to emphasise technological readiness adapted to Indian climatic conditions, showcasing EV models that can endure heat and monsoonal stress. They should educate consumers on total cost of ownership benefits, including battery leasing models, making EVs more financially appealing. Emotional storytelling linking environmental responsibility with personal pride must be integrated into campaigns to deepen emotional engagement [5]. Expanding marketing focus beyond metro cities to Tier-2 and Tier-3 regions, with emphasis on charging reliability, will tap into newer markets. Marketers also need to make sure that the messages about their products match the rules and incentives set by the government. This means being clear about emphasising technological readiness for Indian climatic conditions, showcasing EV models that can endure heat and monsoonal weather, as well as addressing battery safety and recycling compliance. Enhancing consumer adoption intention through test rides, peer advocacy, and emotional branding will be vital. Finally, marketers should position every EV purchase as a national contribution to sustainability goals, inspiring consumers to see their choices as impactful beyond personal benefits [19].

### **Societies**

Societies must become active participants in sustainable transportation by embracing EVs not just as a technological shift but as a societal movement. Community-level awareness initiatives should be launched, emphasizing both the rational cost benefits and emotional value of eco-friendly mobility. Citizens in Tier-2 and Tier-3 towns should demand better charging facilities and sustainable infrastructure locally, reducing urban-rural divides. Educational programmes must help individuals calculate total cost savings and environmental benefits, nurturing informed, conscious consumers [22]. Societies must also celebrate and amplify early adopters as local heroes, creating social pressure and positive reinforcement for adoption. Emotional narratives around protecting future generations, health improvements, and national pride should become collective themes in community conversations. Widespread citizen demand for policy consistency, infrastructure investment, and equitable access must also be voiced to ensure broader systemic support [24].

### **Government**

Governments must set and enforce climate-specific technological standards for EVs, ensuring durability under Indian environmental conditions. Long-term, stable policy frameworks promoting total cost transparency, battery leasing options, and battery recycling standards must be institutionalised. Subsidies and incentives should be extended beyond metros, ensuring infrastructure development and reliable charging access in smaller cities and rural areas. Emotional appeals must also be woven into official campaigns, connecting environmental action with personal and national identity [39]. Policies must explicitly support modelling of consumer adoption intentions, integrating adoption incentives into public transport, corporate fleets, and government procurement strategies. Finally, governments must track and report how individual EV adoptions aggregate into national sustainability progress, thereby strengthening the feedback loop between personal action and societal impact [43].

### **Limitations**

Despite its comprehensive approach, the study is subject to certain limitations. The research primarily focuses on the Indian context, particularly with emphasis on emerging Tier-2 and Tier-3 regions, which may limit the generalisability of findings to other global contexts with different infrastructural, cultural, and climatic conditions. Moreover, while consumer adoption intention was modelled as a mediator, other potential moderating factors, like trust in technology, cultural values, and peer influence, were not deeply explored. The reliance on self-reported data may introduce biases related to social desirability and overstatement of sustainable preferences. Additionally, the infrastructure quality assessment largely captures availability rather than real-time service quality, which could have enriched the analysis

further. Future studies can address these constraints by adopting a more diverse sampling frame and incorporating longitudinal designs to observe behavioural changes over time.

## Suggestions

### Further Research Directions

There is also scoped to incorporate psychological constructs such as technology anxiety, ecological guilt, and value-belief norm theories to deepen understanding of emotional and rational drivers of environmental behaviour. Longitudinal studies tracking shifts in consumer adoption intentions post-policy changes or infrastructure improvements would provide more dynamic insights. Further investigation of the role of peer communities, digital ecosystems, and corporate social responsibility programs in fostering adoption at scale is recommended. Additionally, new research could model the feedback loop between individual sustainable behaviours and broader policy adaptations, creating a continuous innovation cycle in sustainable transportation planning.

## Conclusion

The study effectively highlights the critical role of technological readiness, economic viability, environmental awareness, infrastructure availability, policy support, and consumer adoption intention in enhancing sustainable transportation initiatives. By addressing existing research gaps, such as climatic stress resilience, hidden cost structures, emotional drivers of environmental awareness, and regional infrastructure disparities, the study contributes to a more holistic understanding of electric vehicle adoption in India. The integration of consumer adoption intention as a mediator further strengthens the framework, offering richer insights into behavioural shifts toward sustainable mobility. The practical and theoretical contributions of this research emphasise that a multi-stakeholder approach involving marketers, society, and the government is essential for creating impactful and scalable sustainable transportation ecosystems. Overall, the study offers a comprehensive, action-driven blueprint to accelerate the transition toward environmentally responsible and economically viable transportation solutions.

## Conflict of Interest

The author declares that they have no conflict of interest.

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