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Electric Vehicle Adoption in India: A Narrative Review and Analysis of National and State-Level Trends Across Vehicle Categories

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Abstract

Electric vehicles (EVs) represent a critical pathway toward sustainable transportation and the reduction of vehicular emissions. This study combines a narrative review of theoretical and empirical literature with a descriptive analysis of EV adoption trends across India from FY2016–17 to FY2024-25. The findings highlight the role of economic, technological, behavioural, and policy-related factors in shaping EV adoption. The analysis reveals significant expansion in EV sales, with electric two-wheelers and three-wheelers dominating the market while four-wheelers continue to show relatively low penetration. Considerable regional disparities were observed, with large states leading in absolute sales volume and smaller states and Union Territories recording higher penetration rates. A comparative profile of high- and low-performing states, assessed on both absolute EV sales and EV adoption rate, indicates that charging infrastructure and population density are the strongest differentiators of EV performance, while literacy rate and per capita income do not emerge as associated factors. Bottom-performing states are predominantly in the North-Eastern region, suggesting that geographic remoteness, difficult terrain, and limited market size are deeper structural barriers to EV adoption. The study underscores the need for differentiated policy strategies focused on infrastructure expansion, affordability-oriented incentives, and region-specific interventions to accelerate India's EV transition.

Keywords: electric vehicles, EV adoption, state-level analysis, charging infrastructure, sustainable mobility; regional disparity.

JEL Classification: Q42; Q56; R41.

Introduction

The transport industry is one of the largest contributors to global GHG emissions, contributing to over 20% of CO_2 emissions from fossil fuel consumption and has increased by 80% since 1990 (Statista, 2023). In 2023 alone, it is estimated to have emitted approximately 8.4 $GtCO_2$, making it the second biggest source of emissions in the world. In this context, India is encountering a particularly urgent problem with road transport, making up 12% of the Indian energy-related CO2 emissions (IEA, 2023).

The health impacts of transport emissions extend beyond the environment. Several studies have associated the respiratory diseases, cardiovascular diseases and premature death with vehicular emissions, especially in highly populated urban areas (Miller et al., 2019; Solanki et al., 2016). These environmental and public health concerns have given a new impetus to the global shift to cleaner and more sustainable transportation systems.

In this transition, electric vehicles (EVs) are becoming a viable option to replace the traditional internal combustion engine vehicles (ICEVs). EVs offer several advantages, including lower (GHG) emissions, improved energy efficiency, reduced reliance on fossil fuels, and reduced operating and maintenance costs (Soman et al., 2019; Sen et al., 2021; Chang et al., 2023; Trung & Urmee, 2024). Their environmental benefits are further enhanced when combined with renewable energy-based electricity systems (Mersky et al., 2016). Recognising these advantages, and to promote the use of EVs, governments worldwide, including India, have implemented a range of policy initiatives, including subsidies for buying the vehicles, tax benefits, expanding charging infrastructure, and promoting EV manufacturing. Over the last few years, the EV market in India has witnessed a tremendous surge, especially in the two-wheeler and three-wheeler categories (Vahan Dashboard, 2025). Many government initiatives have also been instrumental in enhancing EV adoption, including the Faster Adoption and Manufacturing of Electric Vehicles (FAME) scheme and several state-level EV policies (NITI Aayog, n.d.).

Over the last decade, a series of institutional programmes, policy interventions and reforms in the infrastructure space have helped India make its EV transition. Figure 1 highlights the key policy measures taken between 2011 and 2020 in India's EV transition.

Figure 1: Timeline of major EV policy developments in India (2011–2020)

Source: Adapted from E-Amrit, NITI Aayog.

The timeline highlights the progressive development of the EV policy framework in India from the inception of setting up institutions and planning towards EV missions to scaling up incentives and infrastructure. These policy measures laid the foundation for the recent growth observed in India's EV market. Yet, there are significant disparities in the extent to which EVs are used in different Indian states, depending on their economic, infrastructural, urbanisation, industrialisation, and policy-related factors.

Although considerable research exists in this field, there is still some fragmentation because the literature does not incorporate theoretical concepts along with empirical evidence in an Indian scenario. Earlier researchers have looked at one particular factor, like consumer attitude or technology limitations, or even government support, but few provide a broad perspective that links into national and sub-national adoption patterns. This research attempts to contribute to the field by offering an overview of the prevailing theoretical models and empirical findings and a descriptive analysis of the trends in sales of electric vehicles across different vehicle types and states. The objectives are threefold: (i) to present theoretical and empirical findings, (ii) to show differences in EV adoption across the regions, and (iii) to compare high- and low-EV performing states based on important socio-economic and infrastructure factors. The paper is organized into sections on the theoretical review, empirical review, methodology, results and discussion, and conclusion.

1. Theoretical Review

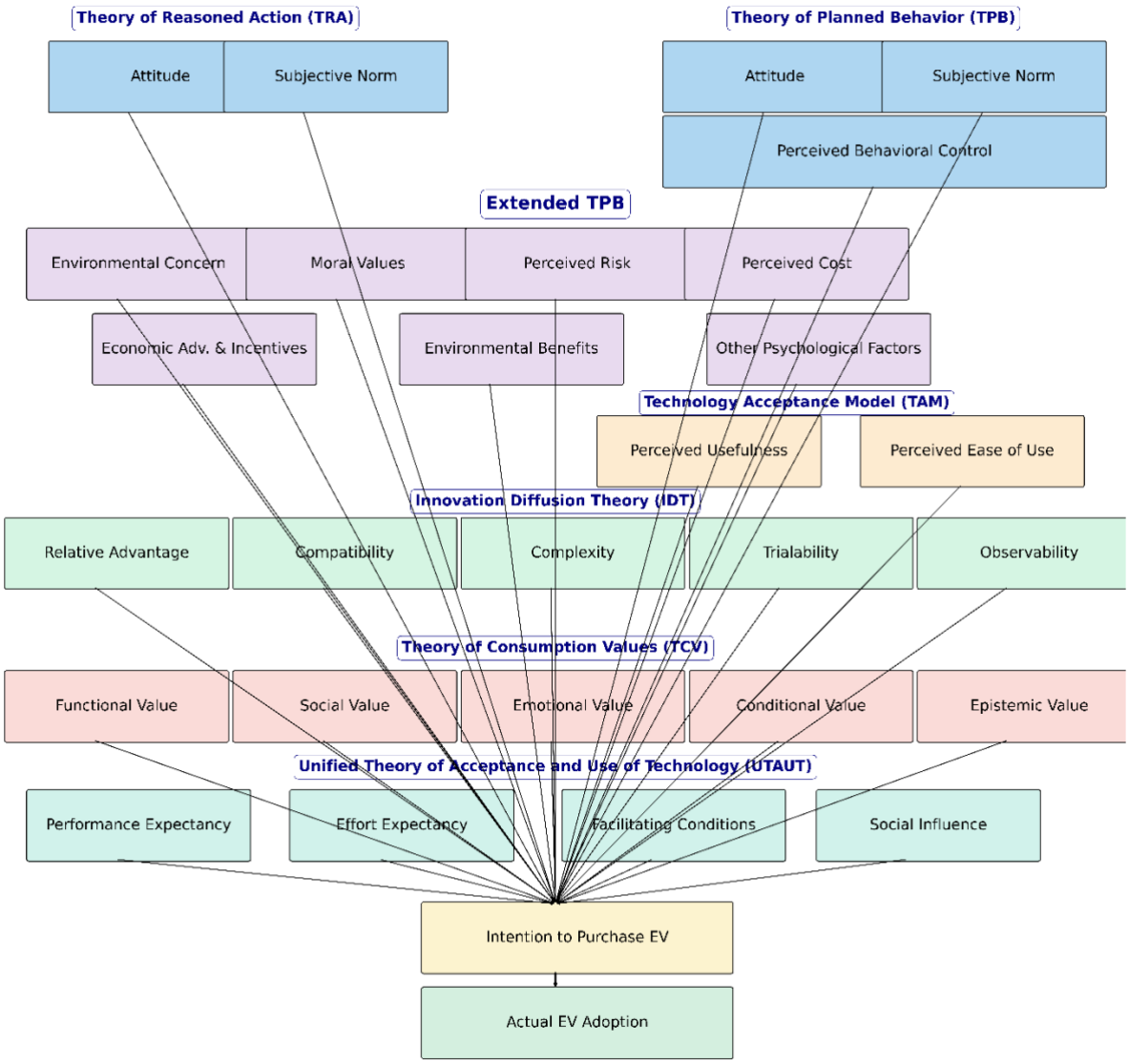
The theoretical basis behind the adoption of EVs involves various considerations that impact the choice of individuals for adopting EVs from conventional automobiles. The theory is usually drawn upon more than one perspective, including the "Theory of Reasoned Action" that was first formulated in the early sixties by Fishbein & Ajzen (1975). According to this theory, a person's behavioural intention and attitudes determine actual behaviour. From the perspective of EV adoption, this theory helps to understand the effect of personal beliefs and societal expectations on an individual when considering EV adoption. This theory, along with others like the Theory of Planned Behaviour, Technology Acceptance Model (TAM), Unified Theory of Acceptance and Use of Technology (UTAUT), and Theory of Consumption Value, provides a framework for understanding factors driving EV adoption.

Attitude is an individual's feeling (positive or negative) to perform a behaviour, whereas subjective norm is concerned with the influence that the individual feels from others around him. Both these factors significantly affect intention to purchase an EV. The opinions, behaviours, and norms of others in an individual's social network strongly influence EV adoption decisions as well as usage intention towards E2W. Further in extension of TRA, Ajzen (1985) has developed a new theory called the Theory of Planned Behaviour (TPB). The TPB was developed as an extension of the TRA because it was realised that people do not always act with complete freedom or control over their choices. TPB adds the idea of Perceived Behavioural Control, which refers to the degree to which an individual feels in control of performing a specific behaviour. In this model, a person's intention to perform a behaviour is shaped by three main elements: their attitude toward the behaviour, the social influence (subjective norms), and the extent to which they think they can actually perform the behaviour. In the context of EVs, this relates to how potential buyers perceive the cost, features, usability, and their overall ability to adopt and use EVs effectively. This theory is extensively applied in transportation research to predict consumers' purchase intention of an EV.

Ajzen (1991) asserts that additional constructs, or variables, may be included in the TPB if they account for a sizable amount of the variance in intentions. Consequently, the theory has undergone numerous extensions; for instance, Shalender & Sharma (2021) extended TPB to incorporate environmental concern and moral values to explore the determinants of Indian consumers' EV adoption intentions.

Murtiningrum et al. (2022) integrated perceived risk, perceived cost, economic advantages, incentive programs, and environmental benefits to add value to the explanation of consumer behaviour in Indonesia. More recently, Deka et al. (2023) applied an extended TPB framework to examine the role of gain motivation in shaping EV adoption intentions among Indian consumers.

Figure 2: Theoretical Framework for Electric Vehicle Adoption



Source: Author's own compilation using Python

In the late 1980s, Davis introduced the Technology Acceptance Model (TAM), which states that a person's actual use of a technology is determined by their intention to use it. These intentions, in turn, are influenced by two key perceptions, namely perceived usefulness and perceived ease of use. For EVs, perceived usefulness is a belief EVs are environmentally friendly, more powerful, quieter, smoother and faster, and cheaper to fuel. Perceived ease of use relates to the effort needed to operate an EV, including factors like ease of charging, availability of charging stations, ease of operation and overall convenience compared to traditional vehicles.

The Rogers Innovation Diffusion Theory (1995) provides an understanding of the process of technology diffusion in society. It asserts that adoption is contingent on five factors: the perceived benefit over existing options (relative advantage), how well it matches users' needs and values (compatibility), the complexity of understanding and using it, the chance to try it before full use (trialability), and how visible its results are to others (observability). Verma et al. (2020) used IDT to identify the perception of consumers towards EVs.

The UTAUT model, put forth by Venkatesh et al. (2003), states that behavioural intentions are a key determinant in actual technology use. The Unified Theory of Acceptance and Use of Technology (UTAUT) is a synthesis of the various technology adoption models. It recognizes four elements that influence an individual's decision to use a technology: performance expectancy, effort expectancy, social influence, and facilitating conditions. These factors are also moderated by individual differences in gender, age, experience, and the voluntary use of technologies. In their study, Vijayvargiya et al. (2023) used the UTAUT model to develop a questionnaire survey that included elements that shape the acceptance and use of new technologies or new vehicle types, such as electric cars.

2. Empirical Review

Studies highlight multiple factors influencing the shift from conventional vehicles to EVs, including technical, environmental, economic, and demographic drivers (Biresselioglu et al., 2018). Lower road tax, free tolls, and preference for certain lanes are the policy tools that encourage the adoption of electric vehicles, with government interventions mediating the relationship between price, awareness, infrastructure, and consumer intention (Joshi et al., 2022).

Technical characteristics play an integral role in promoting EVs. Battery capacity and charging duration, along with the overall reliability of the vehicle, are major technical factors. Short driving range and lengthy charging time because what is known as range anxiety, which acts as a barrier to purchasing EVs by customers (Neubauer & Wood, 2014). Design, performance, and vehicle safety are also other crucial factors, especially for young buyers (Jayasingh et al., 2021). Battery durability and warranty assurance further fosters trust in EV technology (Huang, 2021).

The economic aspect still plays an important role in EV adoption, as consumers weigh costs against benefits (Inumarthi & Ram Kishen, 2023). Affordability, operating cost, and fuel efficiency are significant in influencing the positive attitudes in India (Jayasingh et al., 2021). Reduced operating and maintenance cost will also help to increase economic viability in terms of the total cost of owning EVs. Moreover, the cost of fuels and electricity is a factor that determines the competitiveness of the EVs. Higher fuel costs increase the economic benefits of electric vehicles, making them more economically viable (Zöldy, 2026). Purchase price is found to be the most critical barrier across regions due to high battery costs (Gómez Vilchez et al., 2019; Fawakherji et al., 2023). However, the more the price of an ICEV becomes equal to the price of EVs, the greater the adoption rate (K V et al., 2022).

Environmental awareness significantly influences EV purchase decisions. Consumers increasingly perceive EVs as a means to demonstrate ecological responsibility (Flores & Jansson, 2021). Studies conducted in Asia, Europe and Africa reveal that increased environmental concern leads to higher adoption intention (Thananusak et al., 2017; Loudiyi et al., 2022). In India, over 60% of respondents preferred e-bikes due to perceived environmental benefits (Shakya et al., 2024). However, in some cases, environmental concern affects

purchase intention indirectly through attitudes (Jayasingh et al., 2021). In addition, consumers' environmental beliefs can decrease risk perceptions and increase consumers' intent to buy electric vehicles (Yang & Lan, 2023).

Subjective norms and social networks strongly affect adoption, as people think about social approval before buying the product (Thuy & Hong, 2019). In India, consumers reject vehicles which perceived as socially unacceptable (Jayasingh et al., 2021). Therefore, word-of-mouth, peer choices, and norms of the neighbourhood are found to influence the usage intention (Inumarthi & Ram Kishen, 2023). Personal values and lifestyle congruence are other behavioural factors contributing to adoption. Customers who identify with sustainability are more inclined toward EVs (K V et al., 2022).

Incentives from the government and investment in the infrastructure will be critical factors for the adoption of EVs. Economic incentives such as purchase tax exemptions, toll exemptions, and other financial benefits have been found to encourage electric vehicle adoption (Aasness & Odeck, 2015). In the US, rebate policy has been very successful, where for each $1000 rebate, BEV registrations increased by 2.6% to 9.4% (Jenn et al., 2018). Instant rebates have proven to be more useful compared to tax credits or usage-based approaches (Shafiei et al., 2018).

Apart from financial incentives, there are also non-financial incentives which aid in uptake. Availability of high-occupancy vehicle lanes increased registration of PHEVs by 31% in the US, whereas toll-free access and priority parking promoted uptake in Europe (Santos & Davies, 2020). However, the availability of charging stations will continue to remain as a major concern. The shortage of charging infrastructure at homes and along the highway can result in people refraining from short and long trips using an electric car (Murugan & Marisamynathan, 2022, 2023). On the other hand, expansion of charging stations is likely to aid the adoption of EVs and has been positively correlated with EV adoption (Nigam et al., 2025).

The theoretical and empirical part of research demonstrates that the diffusion of EVs is indeed a complex process and results from the interaction of different types of technological, economic, social, and institutional variables. This literature review has made it clear that it is essential to use a multi-faceted approach, considering both general and local variables.

3. Data and Methodology

This study adopts a two-pronged methodological approach. First, a narrative review of theoretical and empirical literature is undertaken to synthesise existing evidence on EV adoption. Second, a descriptive analysis of state-level EV registration data is conducted to examine adoption trends and compare associated variables across top- and bottom-performing states.

To identify relevant studies, a keyword-based literature search was conducted using Google Scholar. The search employed combinations of terms related to EV adoption (e.g., electric vehicle adoption, EV adoption, EV demand, EV uptake, EV diffusion), behavioural aspects (e.g., adoption intention, purchase intention, consumer acceptance, consumer behaviour), determinants (e.g., drivers, determinants, barriers, enablers), and policy and infrastructure (e.g., charging infrastructure, policy, electric mobility, sustainable mobility, green mobility, socioeconomic factors, and sociodemographic factors), along with related terms.

Following the keyword search, the titles and abstracts of the retrieved studies were screened for relevance, and only those aligned with the objectives of the present review were selected for detailed assessment. Studies examining EV adoption and its determinants, drivers, barriers, and enablers in both global and Indian contexts were included. In contrast, studies focusing primarily on engineering design, battery chemistry, vehicle components, charging technologies, or other technical aspects unrelated to EV adoption were excluded.

Data and Variables

The descriptive analysis is based on secondary data from the VAHAN Dashboard, a government platform that provides statistics on vehicle registrations across various categories by state. The detailed state-level assessment is conducted for FY2024–25, whereas national-level trends are analysed across the full study period from FY2016–17 to FY2024–25. The study examines EV adoption for the three main vehicle categories: electric two-wheelers (E2Ws), electric three-wheelers (E3Ws) and electric four-wheelers (E4Ws). Examination of adoption patterns, identification of regional disparities and comparison of category-wise performance is done using descriptive statistical measures like totals, percentages, growth rates or penetration rates. The EV adoption rate is the percentage of EV registrations in relation to the total vehicle registrations.

$$EV\ Adoption\ Rate = \frac{EV\ Registration}{Total\ Vehicle\ Registration} \times 100 \quad (1)$$

For the comparative profile analysis, states are ranked on two metrics: absolute EV sales and EV adoption rate; the top five and bottom five states for each indicator are identified. Union Territories (UTs) are excluded from the analysis for comparability in terms of administrative set-up, population size and allocation of resources between states and UTs. Further, there were incomplete data for important variables in several UTs. The data period for the associated variables is based on data availability.

Table 1: Data Sources and Reference Period for Associated Variables

Variable	Data Source	Period
EV Sales, EV Adoption Rate and Total Vehicle Registration	VAHAN Dashboard, Ministry of Road Transport and Highways (MoRTH)	2024-25
Public Charging Stations (PCS)	Ministry of Power, Government of India, Lok Sabha Unstarred Question No. 5309	As on March 28, 2025
Road Density	Basic Road Statistics of India 2018-19, Ministry of Road Transport & Highways, Government of India	2018-19
Literacy Rate	Annual PLFS Report	2023-24
Urbanization Rate	Census of India (2011), Population Projection Report	2024-25
Population Density	Census of India (2011), Population Projection Report	2024-25
Per Capita NSDP	Handbook of Statistics on Indian Economy, Reserve Bank of India	2022-23

Source: Authors' own compilation.

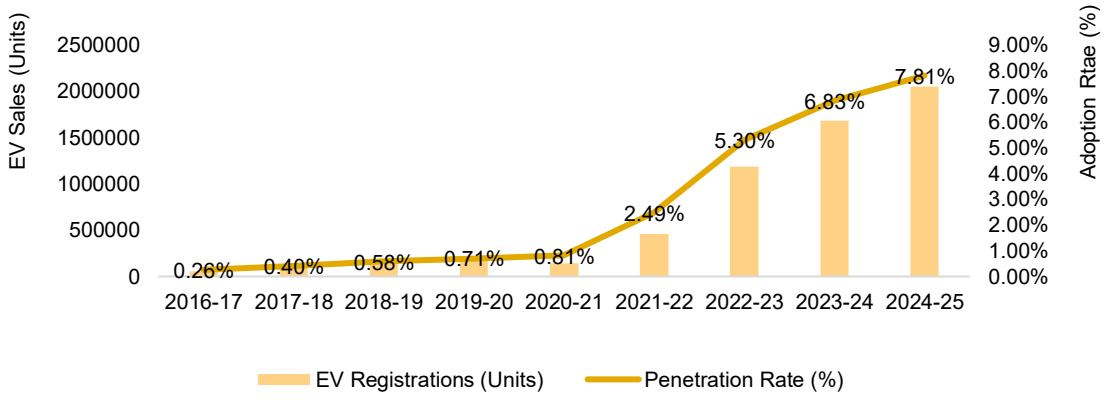
5. Results and Discussion

The Indian automobile industry has been a key contributor to economic growth, technological innovation, and employment generation, contributing significantly to GDP. India is the third largest automotive market in the world owing to its sizeable domestic demand base and favourable demographics. The two-wheeler segment dominates the market, accounting for almost 80 per cent of total sales in FY2024-25, followed by four-wheelers and three-wheelers (VAHAN Dashboard, 2025).

5.1 National-Level Trends

There has been an exceptional rise in India's use of electric vehicles in the last decade. As per the data presented in Figure 3, sales have risen from 17,655 vehicles in FY2016-17 to 250,000 vehicles in FY2024-25, and the penetration rate has grown from 0.26% to 7.81%. Nevertheless, sales have soared dramatically since FY2020-21 because of favourable government policies, the lowering cost of batteries, and technological innovations.

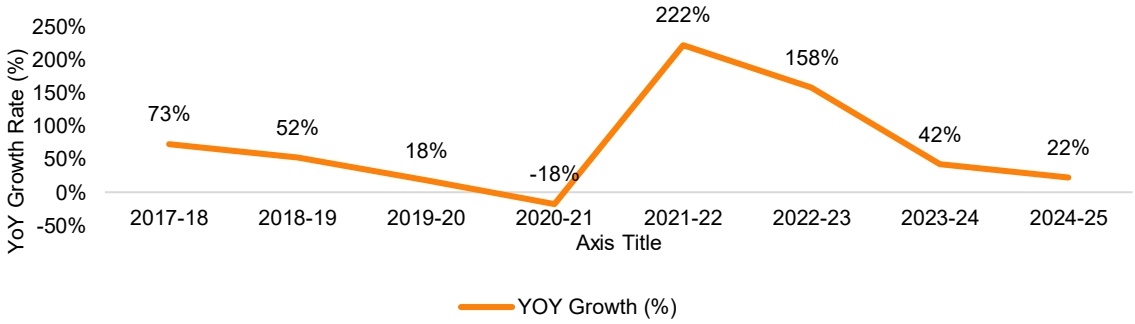
Figure 3: Trends in Electric Vehicle Sales in India (FY2016–17 to 2024–25)



Source: Ministry of Road Transport and Highways, Government of India, VAHAN Dashboard (April 2016–March 2025).

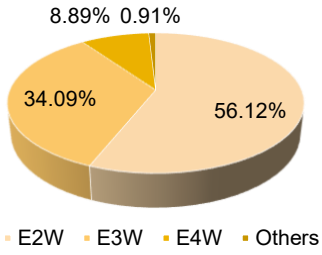
While the overall trend shows substantial progress, year-on-year (YoY) growth provides a more detailed view of market dynamics. The trend in sales growth of YoY EVs has been up and down, with a 18% dip in FY2020-21 as a result of the pandemic, but a remarkable surge in FY21-22 with the highest increase of 222% (Devi et al., 2023). Growth continued to be positive after that but slowly declined to 22% in FY2024–25 (Figure 4).

Figure 4. YoY Growth of EV Sales in India (FY2017–18 to FY2024–25)



Source: Ministry of Road Transport and Highways, Government of India, VAHAN Dashboard (April 2017–March 2025).

Figure 5. EV Sales Share by Vehicle Category in India (FY2024–25)



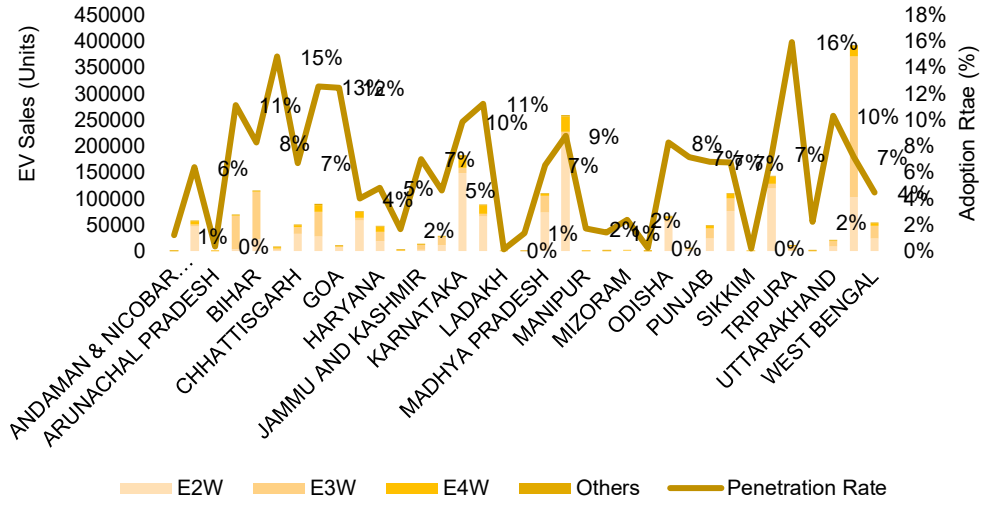
Source: Ministry of Road Transport and Highways, Government of India, VAHAN Dashboard (April 2024–March 2025).

These growth dynamics can further be understood by examining the distribution of EV sales across different vehicle categories in FY2024–25 (Figure 5). The two-wheelers (E2Ws) segment recorded the maximum share of EV sales in FY2024–25, accounting for 56.12% of the total. This was followed by 3 wheelers (E3W) with 34.09%, 4 wheelers (E4W) with 8.89% and others with 0.91%.

5.2 State Level Analysis

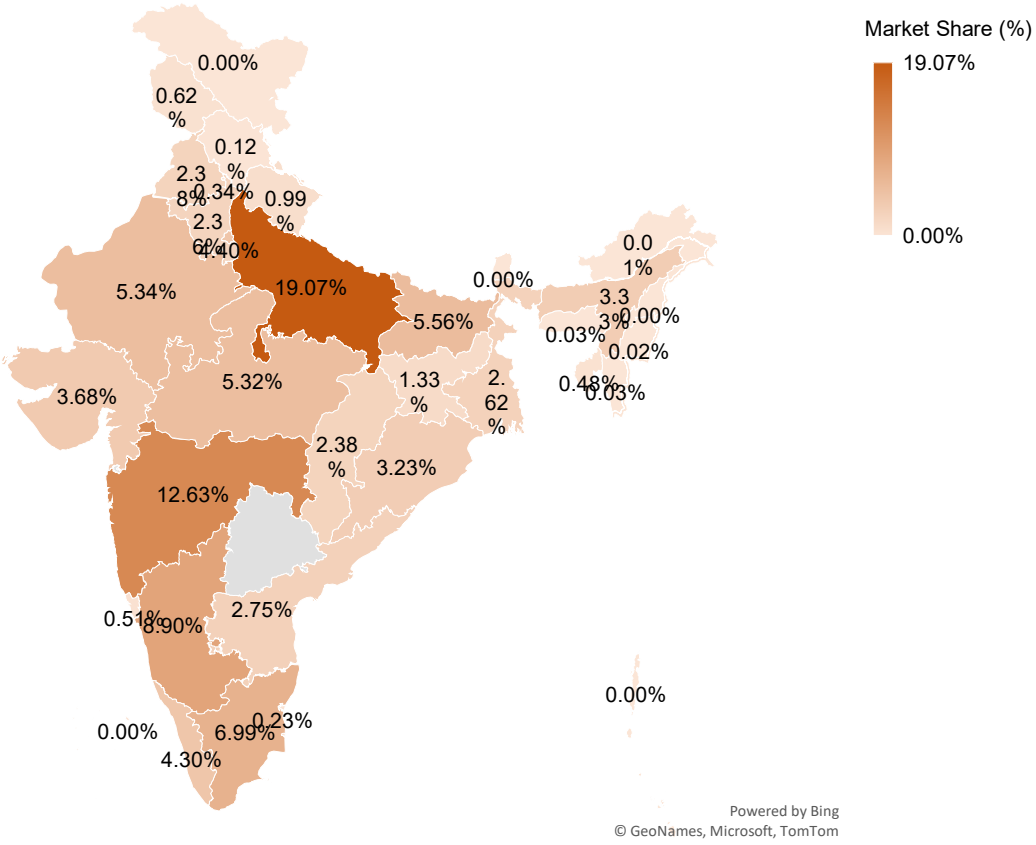
There is much regional disparity in EVs in India, influenced by various factors like socioeconomic, demographic, and infrastructure-related. According VAHAN Dashboard, two key dimensions of such heterogeneity across the states for FY24-25 are: market share and penetration rates. Based on market share, some states have a considerable share in adoption. Uttar Pradesh with the largest share of EV registrations is on top, followed by Maharashtra (12.63%), Karnataka (8.90%), Tamil Nadu (6.99%), and Bihar (5.56%) (Grover, 2025). Together these five states have constituted over 50 per cent of the EVs sold in India. A different picture emerges when penetration rates are used, as a percentage of total vehicles. Adoption is disproportionately high in several smaller states and Union Territories, but with limited sales. Penetration is significantly higher than the national average for Tripura (16%), Chandigarh (15%), Delhi (13%), Goa (12%), Kerala (11%) and Assam (11%).

Figure 6. State-wise EV adoption in India (FY2024–25)



Source: VAHAN Dashboard, MoRTH, India (Apr. 2024–Mar. 2025).

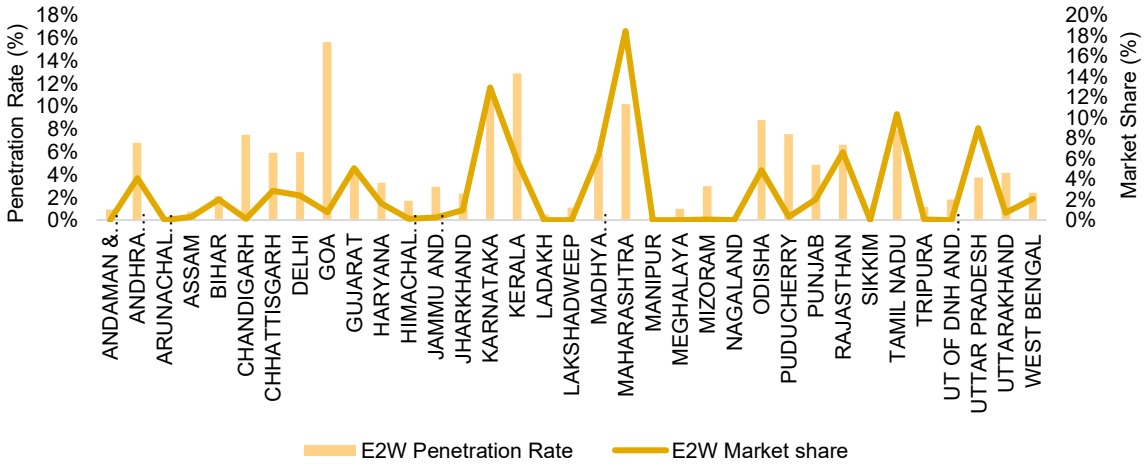
Figure 7. State-Wise EV Market Share in India (FY2024–25)



Source: Ministry of Road Transport and Highways, Government of India, VAHAN Dashboard (April 2024–March 2025).

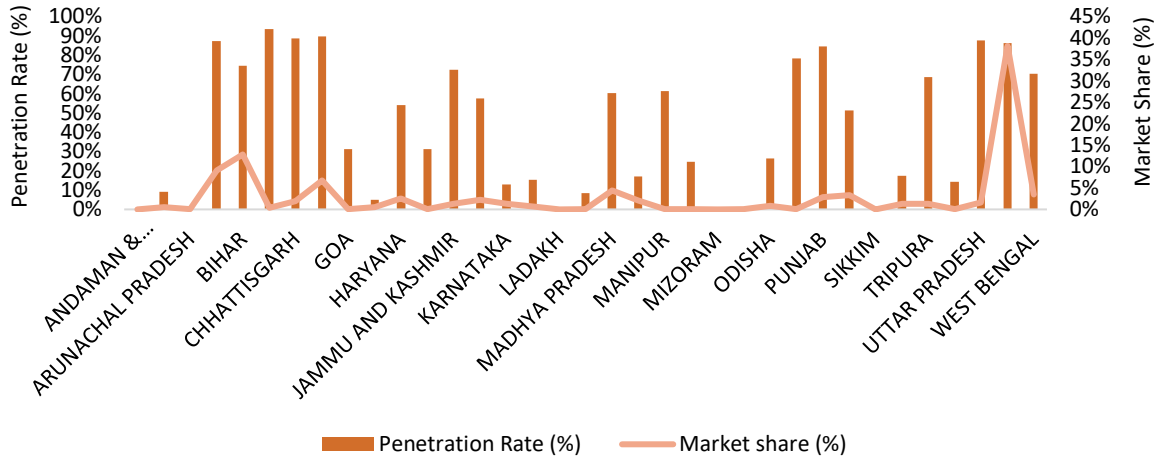
Although the aggregate level analysis at the state level emphasizes the disparity in the adoption, the disaggregation of categories into E2W, E3W, and E4W provides additional insights on how adoption rates vary among different states.

Figure 8: State-wise adoption trends of E2Ws in India (FY2024–25)



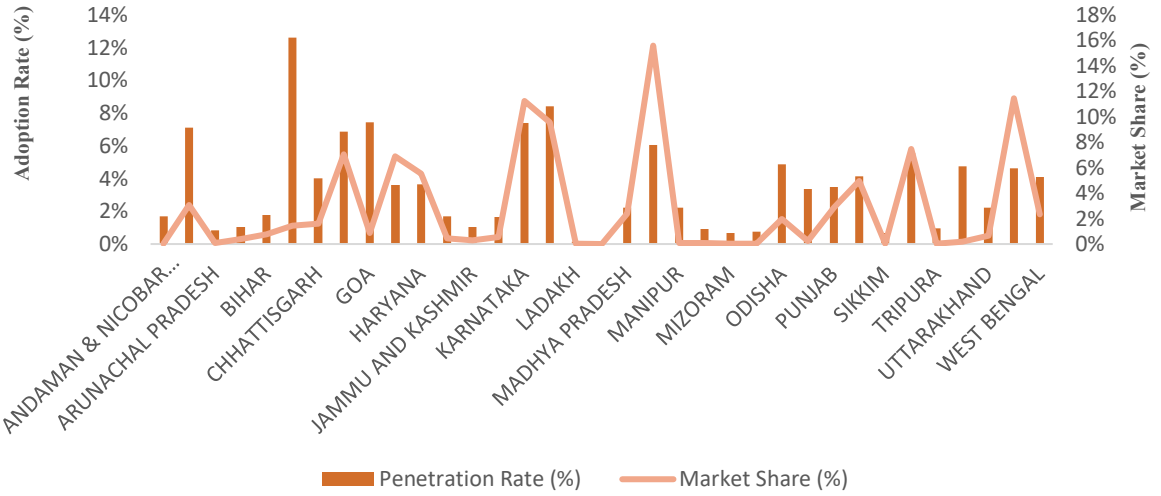
Source: Ministry of Road Transport and Highways, Government of India, VAHAN Dashboard (Apr. 2024 – Mar. 2025).

Figure 9: State-wise adoption trends of E3Ws in India (FY2024–25)



Source: Ministry of Road Transport and Highways, Government of India, VAHAN Dashboard (April 2024–March 2025).

Figure 10. State-wise adoption trends of E4Ws in India (FY2024–25)



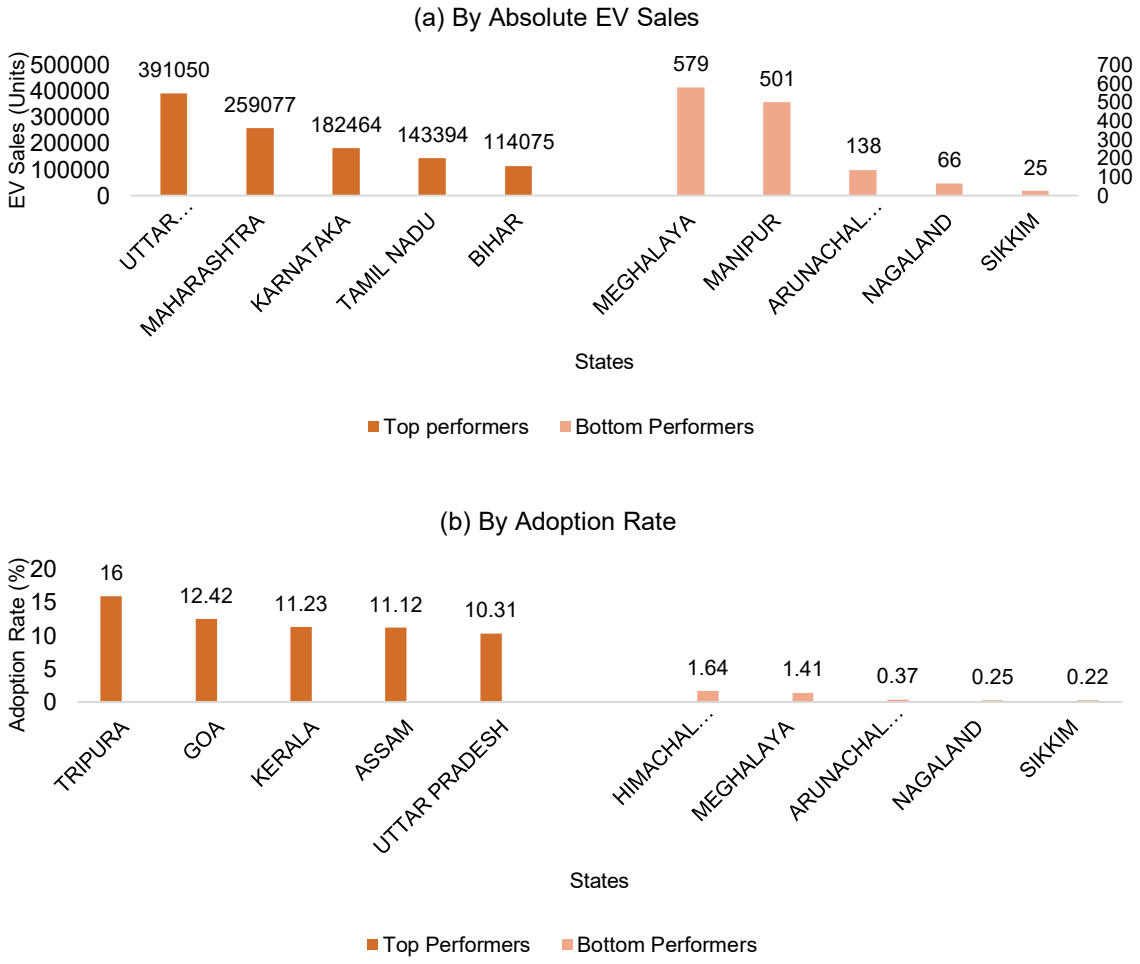
Source: Ministry of Road Transport and Highways, Government of India, VAHAN Dashboard (April 2024–March 2025).

5.3 Comparative Profile of High and Low-Performing States

The Comparative Profile Analysis is based on the top 5 states and bottom 5 states, excluding the Union Territories, based on two parameters – EV Sales (absolute) and EV Adoption Rate. The top 5 and bottom 5 states based on the above-mentioned parameters for FY 2024-25 have been shown in Figure 11a and Figure 11b.

In part (a), it can be seen that states like Uttar Pradesh, Maharashtra, Karnataka, Tamil Nadu, and Bihar are among the top 5 states in terms of EVs sold and contribute to over 50% of the total EVs sold, whereas the percentage contribution from Sikkim, Nagaland, Arunachal Pradesh, Manipur, and Meghalaya individually is below 1%, which reflects the dominant influence of population size and market scale.

Figure 11. Top 5 vs Bottom 5 Performing States (FY2024–25)



Source: VAHAN Dashboard, MoRTH, India (Apr. 2024–Mar. 2025).

Determinants Associated with EV Sales

Comparing the values of associated variables between the top 5 and bottom 5 EV performing states highlights some interesting trends. Of these, public charging stations appear to be the most important discriminant. The combined total for the top 5 states exceeds 50%, while that of bottom 5 states is less than 1%. There is also a clear contrast with population density, suggesting that greater markets mean greater EV sales. However, there are several variables that have counterintuitive patterns. This stark difference between top and bottom states is explained by the fact that those at the bottom of the list have a higher average literacy rate (90.9%) when compared to those at the top (82.3%), meaning that education does not mean EV adoption.

Likewise, the urbanisation rate of both groups is almost the same (36.8% vs. 35.6%), meaning that the adoption of EVs is not directly related to urbanisation rates. Similarly, per capita NSDP is not a good indicator of adoption patterns, as Sikkim has the highest per capita income (₹5,20,466) among all ten states, yet has EV sales of merely 25 units. In general, the analysis shows that the availability of charging stations and the size of the EV market are the two most important factors behind EV adoption at the state level, whereas income, literacy and urbanisation are not, with geographic remoteness and low population density being the most significant obstacles for bottom-performing states.

Determinants Associated with the EV Adoption Rate

The analysis of associated variables based on EV adoption rate reveals both consistent and new patterns compared to absolute EV sales analysis. Charging infrastructure (PCS) and population density continue to be strong differentiators, with top performing states holding significantly higher values on both counts. When EV registrations are expressed as a proportion of total vehicle registrations, road connectivity and degree of urbanisation emerge as more meaningful determinants of EV penetration. There is no clear association between EV adoption and education or per capita NSDP; bottom states have similar or higher scores on both measures. In conclusion, factors such as charging infrastructure, population density, road connectivity and urbanization seem to affect the EV adoption rate, while factors like income and literacy are not deterministic.

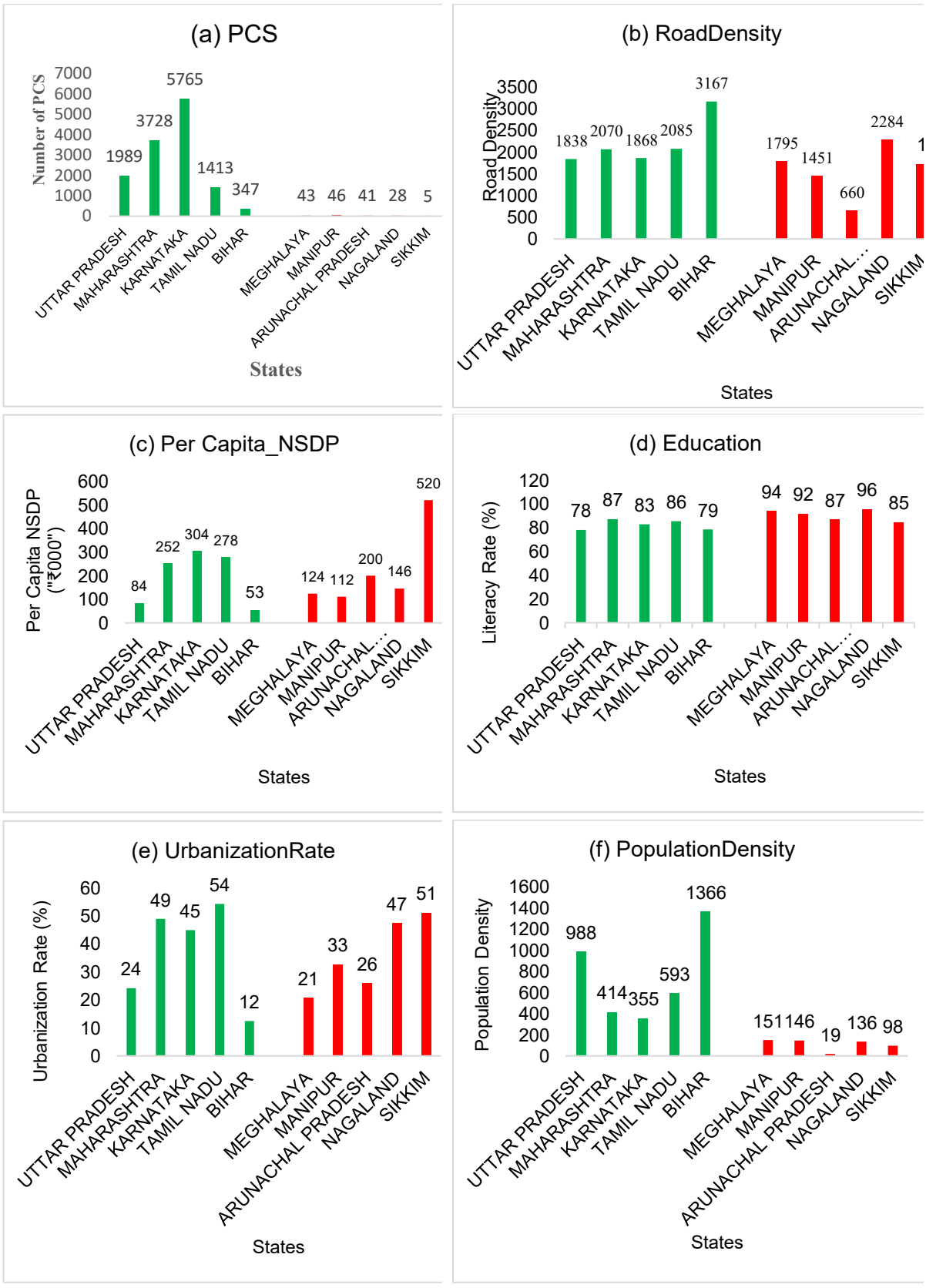
For both analyses, the lowest performing states are primarily from the North-Eastern region of India, and these states include Sikkim, Nagaland, Arunachal Pradesh and Meghalaya, consistently featuring in the bottom group under both measures. The clustering of the regions indicates that the failure of EV use in these regions is due to regional concerns, for example, difficult terrain, low population density, small market size, and not due to socio-economic considerations, for instance, income or literacy.

The lack of association between per capita NSDP and EV adoption implies that higher income alone might not sufficiently explain variations in EV adoption across Indian states. One possible reason for this could be the dynamic characteristics of the Indian electric vehicle market, in which adoption of electric vehicles depends more on infrastructure availability than on economic prosperity. In support of this view, Nigam et al. (2025) have shown that infrastructure, in particular charging infrastructure, is statistically significant for explaining state-level EV adoption, whereas traditional socioeconomic factors are insignificant, attributing this to the nascent phase of the Indian electric vehicle market. In such a context, the availability of charging facilities may represent a more immediate and binding constraint to EV adoption than purchasing power, suggesting that infrastructure readiness currently plays a more decisive role than income in shaping interstate adoption patterns.

In the same vein, the non-association of the literacy rate shows that education levels by themselves will not boost the adoption of electric vehicles without the presence of an enabling environment. The state-level data further corroborates this trend. The states like Sikkim, Meghalaya, Manipur, and Nagaland have high literacy rates, yet they still have low adoption of EVs along with poor charging facilities. This shows that although more literate people are quick to adopt electric vehicle, the lack of charging infrastructure to support adoption becomes a limitation (Dua et al., 2021; Chhikara et al., 2021).

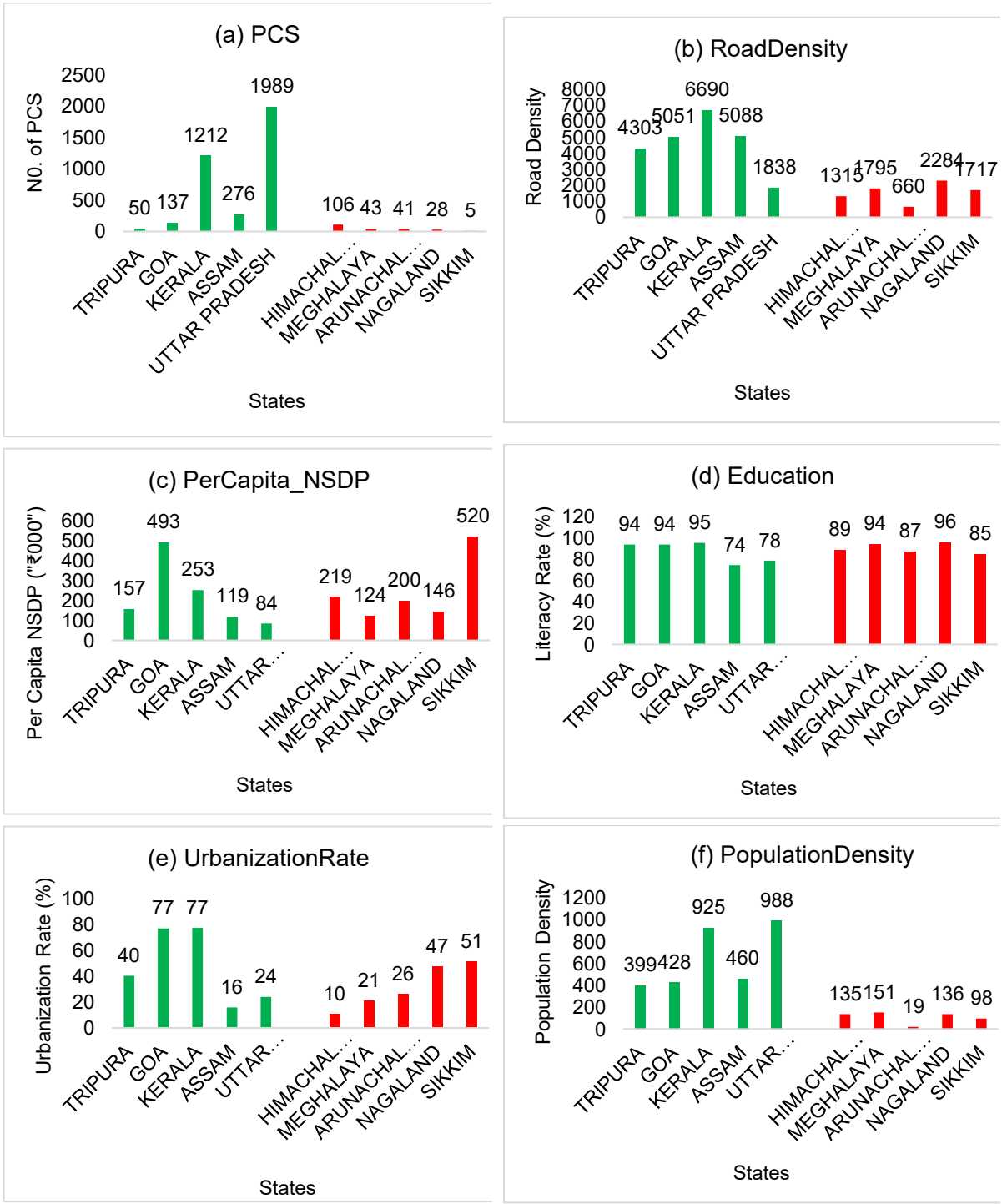
Together, these results indicate that the Indian transition to electric vehicles might benefit more from the infrastructure-led policy approach, where the focus is on building up the charging infrastructure and improving the transport infrastructure rather than depending exclusively on policies related to affordability.

Figure 12. Associated Variables in Top vs. Bottom 5 States by EV Sales



Source: Authors' own compilation based on data from multiple government sources

Figure 13: Top vs. Bottom 5 States by EV Adoption Rate



Source: Authors' own compilation based on data from multiple government sources.

Although this research sheds light on the issue at hand with the use of a narrative review and descriptive analysis, there are several limitations that are inherent to this type of work. First, it involves a narrative review. The advantage of this type of review lies in its flexibility; it enables researchers to develop a series of interconnected arguments. However, unlike SLR, it lacks structural elements. Secondly, this research makes use of only one year of data for descriptive analysis purposes. Thirdly, the analysis is largely aggregate, focusing on market share and penetration at the state level without exploring them at a deeper level in individual

states or the policy landscape. Lastly, there is a lack of econometric or statistical modelling techniques, making conclusions about causal factors of adoption difficult.

These restrictions also suggest directions for further research. The systematic review may improve the methodological rigour and facilitate the extraction of theory consisting of uniform findings. If the analysis could be expanded to include several years, the researchers would be able to track the adoption patterns and better assess the effect of policies. The use of econometric or statistical models would further bolster causal explanations by providing a connection between adoption outcomes and socio-economic, infrastructural and policy variables.

Conclusion and Policy Recommendations

This study combined a narrative review of theoretical and empirical literature with a descriptive analysis of EV adoption trends in India. The findings suggest that India's EV transition is shaped by a combination of economic, technological, behavioural, and policy-related factors. While declining operating costs, environmental awareness, and policy support have accelerated EV adoption, factors such as limited charging infrastructure, range anxiety, and high upfront costs continue to constrain wider diffusion.

The analysis shows that India's EV market expanded significantly between FY2016–17 and FY2024–25, with electric two-wheelers (E2Ws) and electric three-wheelers (E3Ws) dominating overall adoption, while electric four-wheelers (E4Ws) continue to exhibit relatively low penetration. Considerable regional disparities were also observed, with populous states such as Uttar Pradesh, Maharashtra, and Karnataka leading in sales volume, while smaller states and Union Territories such as Delhi, Chandigarh, and Puducherry recorded comparatively higher penetration rates.

A comparative profile of high and low-performing states reveals that charging infrastructure (PCS) and population density are the strongest differentiators of both absolute EV sales and EV adoption rate. Notably, literacy rate and per capita income do not emerge as determining factors; bottom-performing states record higher average literacy and comparable income levels, yet show near-zero EV adoption. This pattern is further reinforced by the geographical clustering of bottom-performing states in the North-Eastern region, where difficult terrain, sparse population, and limited market size represent deeper structural barriers independent of socioeconomic conditions.

These findings highlight the need for differentiated policy approaches across regions and vehicle categories, as a uniform policy framework may not be equally effective across all Indian states. Geographically challenged states, particularly those in the North-Eastern region, require targeted structural interventions to overcome infrastructure constraints. Policy efforts in these states should prioritise the expansion of public charging infrastructure, improvements in transport connectivity, and region-specific incentive packages to encourage private investment in EV infrastructure. In contrast, high-volume states such as Uttar Pradesh require policies aimed at scaling and sustaining the existing EV ecosystem through the development of fast-charging corridors, integration of charging infrastructure with urban and commercial transport networks, and strengthening battery servicing and recycling facilities. Furthermore, financial incentives, awareness creation, and behavioural interventions should complement these infrastructure investments to accelerate EV adoption across different vehicle categories. Such differentiated policy strategies would enable states to address their region-specific constraints while supporting a more balanced and sustained EV transition across India.

Credit Authorship Contribution Statement

Jyoti contributed to the conceptualization of the study, data curation, formal analysis, and the preparation of the original manuscript draft. Mor, K. provided supervision, validated the research process and findings, and contributed to the critical review and editing of the manuscript. The corresponding author confirms that all authors have reviewed and approved the final version of the manuscript and that the contribution statements accurately reflect each author's role in the work.

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Conflict of Interest Statement

The author declares that there are no financial, professional, or personal conflicts of interest that could have influenced the research, analysis or interpretation presented in this article.

Data Availability Statement

The data supporting the findings of this study were obtained from publicly available secondary sources, including the VAHAN Dashboard, Ministry of Road Transport and Highways, Ministry of Power, Reserve Bank of India, Census of India, and the Periodic Labour Force Survey. The compiled dataset used in the analysis is available from the corresponding author upon reasonable request.

Ethical Approval Statement

This study is based on the analysis of publicly available secondary data and previously published literature. Therefore, ethical approval was not required.

References

Aasness, M. A., & Odeck, J. (2015). The increase of electric vehicle usage in Norway - incentives and adverse effects. *European Transport Research Review*, 7, 34. https://doi.org/10.1007/s12544-015-0182-4

Ajzen, I. (1985). From Intentions to Actions: A Theory of Planned Behaviour. In: Kuhl, J., Beckmann, J. (eds) Action Control. *SSSP Springer Series in Social Psychology*. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-69746-3_2

Ajzen, I. (1991). The theory of planned behaviour. *Organizational Behaviour and Human Decision Processes, 50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Biresselioglu, M. E., Kaplan, M. D., & Yilmaz, B. K. (2018). Electric mobility in Europe: A comprehensive review of motivators and barriers in decision making processes. Transportation Research Part A: Policy and Practice, 109, 1-13. https://doi.org/10.1016/j.tra.2018.01.017

Chang, S. Y., Huang, J., Chaveste, M. R., Lurmann, F. W., Eisinger, D. S., Mukherjee, A. D., ... & Knipping, E. (2023). Electric vehicle fleet penetration helps address inequalities in air quality and improves environmental justice. *Communications Earth & Environment*, 4(1), 135. https://doi.org/10.1038/s43247-023-00799-1

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

Davis, F. (1989) Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, *13*, 319-340. https://doi.org/10.2307/249008

Deka, C., Dutta, M. K., Yazdanpanah, M., & Komendantova, N. (2023). Can gain motivation induce Indians to adopt electric vehicles? Application of an extended theory of planned behaviour to map EV adoption intention. *Energy Policy, 182*, 113724. https://doi.org/10.1016/j.enpol.2023.113724

Devi, R. S., Selvam, K., & Sudha, V. (2023). A sales trend analysis of e-vehicles (EVs) in India and Tamil Nadu. *International Journal of Emerging Knowledge Studies, 2*(10), 406–409. https://ijeks.com/wp-content/uploads/2023/10/IJEKS2-10-002.pdf

Dua, R., Hardman, S., Bhatt, Y., & Suneja, D. (2021). Enablers and disablers to plug-in electric vehicle adoption in India: Insights from a survey of experts. *Energy Reports*, 7, 3171-3188. https://doi.org/10.1016/j.egyr.2021.05.025

Fawakherji, M., Benhaddou, D., Race, B., Carrollia, B., & Santamaria, W. (2023, June). Determinants of Electric Vehicle Adoption and Integration with Public Transportation through Park-and-Ride. In 2023 *International Wireless Communications and Mobile Computing* (IWCMC) (pp. 74-80). IEEE. https://doi.org/10.1109/IWCMC58020.2023.10182837

Fishbein, M., & Ajzen, I. (1975). Belief, Attitude, Intention and Behaviour: An Introduction to Theory and Research (p. 290). Reading, MA: Addison-Wesley. https://people.umass.edu/aizen/f&a1975.html

Flores, P. J., & Jansson, J. (2022). SPICe - Determinants of consumer green innovation adoption across domains: A systematic review of marketing journals and suggestions for a research agenda. *International Journal of Consumer Studies*, *46*(5), 1761–1784. https://doi.org/10.1111/ijcs.12810

Gómez Vilchez, J. J., Smyth, A., Kelleher, L., Lu, H., Rohr, C., Harrison, G., & Thiel, C. (2019). Electric car purchase price as a factor determining consumers' choice and their views on incentives in Europe. *Sustainability*, *11*(22), 6357. https://doi.org/10.3390/su11226357

Grover, C. (2025). UP–Maharashtra comparative analysis report. Invest UP, Government of Uttar Pradesh. https://invest.up.gov.in/wp-content/uploads/2025/01/UP-Maharashtra_120125.pdf

Huang, F. H. (2021). User behavioral intentions toward a scooter-sharing service: An empirical study. *Sustainability*, *13*(23), 13153. https://doi.org/10.3390/su132313153

IEA (2023). Transitioning India's Road Transport Sector, IEA, Paris https://www.iea.org/reports/transitioning-indias-road-transport-sector

Inumarthi, S., & Ram Kishen, Y. (2023). Key Factors to Analyse the Customer Adoption of Electric Two-Wheelers in India. *Academy of Marketing Studies Journal*, 27(4), 1-8. https://www.abacademies.org/articles/key-factors-to-analyze-the-customer-adoption-of-electric-twowheelers-in-india.pdf

Jayasingh, S., Girija, T., & Arunkumar, S. (2021). Factors influencing consumers' purchase intention towards electric two-wheelers. *Sustainability*, 13(22), 12851. https://doi.org/10.3390/su132212851

Jenn, A., Springel, K., & Gopal, A. R. (2018). Effectiveness of electric vehicle incentives in the United States. *Energy Policy*, 119, 349-356. https://doi.org/10.1016/j.enpol.2018.04.065

Joshi, N., Malhotra, M., & Singh, J. (2022). Assessing adoption intention of electric vehicles in India: The mediating role of government policies. *European Journal of Transport and Infrastructure Research*, 22(1), 1-16. https://doi.org/10.18757/ejtir.2022.22.1.5973

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

Loudiyi, H., Chetioui, Y., & Lebdaoui, H. (2022). Economics of electric vehicle adoption: An integrated framework for investigating the antecedents of perceived value and purchase intent. International *Journal of Economics and Financial Issues*, *12*(5), 29-38. https://doi.org/10.32479/ijefi.13328

Mersky, A. C., Sprei, F., Samaras, C., & Qian, S. (2016). Effectiveness of incentives on electric vehicle adoption in Norway. *Transportation Research. Part D, Transport and Environment, 46*, 56–68. https://doi.org/10.1016/j.trd.2016.03.011

Miller, J., Bandivadekar, A., & Sathiamoorthy, B. (2019). Health impacts of air pollution from transportation sources in Delhi. Council on Clean Transportation (ICCT). https://theicct.org/wp-content/uploads/2021/06/ICCT_factsheet_health_impact_airpollution_Delhi_20190627_1.pdf

Ministry of Power, Government of India. (2025). Lok Sabha Unstarred Question No. 5309. Government of India. https://www.powermin.gov.in/static/uploads/2025/08/4f2aa0533eeeabdc5909fea6a21c47f3.pdf

Ministry of Road Transport and Highways, Government of India. (2019). Basic Road Statistics of India 2018-19. Government of India. https://www.pib.gov.in/PressReleasePage.aspx?PRID=1843072&reg=48&lang=2

Ministry of Road Transport and Highways, Government of India. (2025). VAHAN dashboard: Vehicle registration statistics for India. https://vahan.parivahan.gov.in

Ministry of Statistics and Programme Implementation, Government of India. (2024). Annual Periodic Labour Force Survey (PLFS) Report 2023-24. Government of India. https://www.mospi.gov.in/sites/default/files/publication_reports/AnnualReport_PLFS2023-24L2.pdf

Murtiningrum, A. D., Darmawan, A., & Wong, H. (2022). The adoption of electric motorcycles: A survey of public perception in Indonesia. *Journal of Cleaner Production*, 379, 134737. https://doi.org/10.1016/j.jclepro.2022.134737

Murugan, M., & Marisamynathan, S. (2022). Estimation of two-wheeler users' mode shift behaviour and policy analysis to encourage electric-bike adoption in India. *Case Studies on Transport Policy*, *10*(3), 1673-1685. https://doi.org/10.1016/j.cstp.2022.06.006

Murugan, M., & Marisamynathan, S. (2023). Mode shift behaviour and user willingness to adopt the electric two-wheeler: A study based on Indian road user preferences. *International Journal of Transportation Science and Technology,* *12*(2), 428-446. https://doi.org/10.1016/j.ijtst.2022.03.008

Neubauer, J., & Wood, E. (2014). The impact of range anxiety and home, workplace, and public charging infrastructure on simulated battery electric vehicle lifetime utility. *Journal of Power Sources*, 257, 12-20. https://doi.org/10.1016/j.jpowsour.2014.01.075

Nigam, N., Samanta, D., & Senapati, S. (2025). Determinants of electric vehicle adoption: insights from Indian states. *International Journal of Social Economics*, *52*(1), 91-107. https://doi.org/10.1108/IJSE-06-2023-0479

NITI Aayog. (n.d.). National level policy. E-Amrit. Retrieved May 28, 2026, from https://e-amrit.niti.gov.in/national-level-policy

Office of the Registrar General & Census Commissioner, India. (2020). Population Projections for India and States 2011-2036. Ministry of Home Affairs, Government of India. https://ruralindiaonline.org/en/library/resource/population-projections-for-india-and-states-2011-2036/

Reserve Bank of India. (2023). Handbook of Statistics on Indian Economy. Reserve Bank of India. https://swadeshishodh.org/wp-content/uploads/2024/09/Handbook-of-Statistics-on-the-Indian-Economy-2023-24-1.pdf

Rogers, E. M. (1983). Diffusion of innovations (3rd ed.). New York, NY: Free Press.

Santos, G., & Davies, H. (2020). Incentives for quick penetration of electric vehicles in five European countries: Perceptions from experts and stakeholders. *Transportation Research Part A: Policy and Practice*, 137, 326-342. https://doi.org/10.1016/j.tra.2018.10.034

Sen, A., Miller, J., Bandivadekar, A., Sharma, M., Nagar, P. K., Singh, D., & Callahan, J. (2021). Understanding the emissions impacts of large-scale vehicle electrification in India. *ICCT Working Paper*. https://theicct.org/wp-content/uploads/2021/06/EV-emissions-impacts-India-apr2021-01.pdf

Shafiei, E., Davidsdottir, B., Fazeli, R., Leaver, J., Stefansson, H., & Asgeirsson, E. I. (2018). Macroeconomic effects of fiscal incentives to promote electric vehicles in Iceland: Implications for government and consumer costs. *Energy Policy*, *114*, 431-443. https://doi.org/10.1016/j.enpol.2017.12.034

Shalender, K., & Sharma, N. (2021). Using extended theory of planned behaviour (TPB) to predict adoption intention of electric vehicles in India. *Environment, Development and Sustainability*, *23*(1), 665-681. https://doi.org/10.1007/s10668-020-00602-7

Solanki, H. K., Ahamed, F., Gupta, S. K., & Nongkynrih, B. (2016). Road transport in Urban India: Its implications on health. *Indian Journal of Community Medicine*, *41*(1), 16-22. https://doi.org/10.4103/0970-0218.170959

Soman, A., Kaur, H., Jain, H., & Ganesan, K. (2020). India's Electric Vehicle Transition: Can Electric Mobility Support India's Sustainable Economic Recovery Post COVID-19? New Delhi: Council on Energy, Environment and Water (CEEW). https://www.ceew.in/sites/default/files/CEEW-Indias-EV-Transition-Post-COVID-19-22Dec20_0.pdf

Statista Research Department. (2024, September 6). Transportation emissions worldwide - statistics & facts. Statista. https://www.statista.com/topics/7476/transportation-emissions-worldwide/?srsltid=AfmBOop24a276nF5iYCdO3-jVhEKQv-VkqgACZVIY7mHhp0P33d-Qlvz#google_vignette

Thananusak, T., Rakthin, S., Tavewatanaphan, T., & Punnakitikashem, P. (2017). Factors affecting the intention to buy electric vehicles: Empirical evidence from Thailand. *International Journal of Electric and Hybrid Vehicles, 9*(4), 361-381. https://doi.org/10.1504/IJEHV.2017.089875

Trung, N. T., & Urmee, T. (2024). Electrifying Vietnam's streets: Identifying the determinants of electric two-wheelers uptake. *Transportation Research Part D: Transport and Environment*, *129*, 104116. https://doi.org/10.1016/j.trd.2024.104116

Verma, M., Verma, A., & Khan, M. (2020). Factors influencing the adoption of electric vehicles in Bengaluru. *Transportation in Developing Economies*, *6*(2), 17. https://doi.org/10.1007/s40890-020-0100-x

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, *27*(3), 425–478. https://doi.org/10.2307/30036540

Vijayvargiya, S., Sharma, T., Mule, B. R., Verma, A. K., Das, B., & Paul, M. (2023). Identification of Factors Influencing the Adoption and Use of Electric Cars on Indian Roads Based on Public Perception. In *International Conference on Transportation and Development* 2023 (pp. 265-275). https://doi.org/10.1061/9780784484883.023

Yang, Y., & Lan, J. (2023). SEM-based analysis of factors influencing the purchase intention of electric vehicle consumers. Frontiers in Business, Economics and Management, 9(2), 18–26. https://doi.org/10.54097/fbem.v9i2.8991

Zöldy, M. (2026). *Energy prices and policy incentives as determinants of electric vehicle adoption: A total cost of ownership analysis*. *European Transport Studies, 3*, 100049. https://doi.org/10.1016/j.ets.2025.100049

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