IOSR Journal of Business and Management (IOSR-JBM)
e-ISSN: 2278-487X, p-ISSN: 2319-7668 PP 09-14
www.iosrjournals.org

"Data-Driven Insights into Electric Vehicle Adoption: Analyzing Geographic, Economic, and Policy Influences on Consumer Preferences"Using Power BI

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Abstract:
The global automotive industry is undergoing a transformative shift with the increasing adoption of electric vehicles (EVs) as a sustainable alternative to internal combustion engine (ICE) vehicles. This research examines EV adoption patterns using a comprehensive dataset that includes attributes such as vehicle make, model, year, electric range, base MSRP, geographic distribution, and Clean Alternative Fuel Vehicle (CAFV) eligibility. The study aims to identify key trends in EV uptake, analyze the impact of government incentives, and explore geographic and economic factors influencing consumer preferences.
Through data preprocessing, exploratory data analysis (EDA), and advanced visualization techniques, this research uncovers insights into market trends, regional adoption disparities, and the role of legislative and utility infrastructure in promoting EV usage. Key findings include the correlation between electric range and consumer choice, the effectiveness of financial incentives in driving EV adoption, and the influence of localized factors such as state policies and charging infrastructure availability.
The outcomes of this study provide actionable insights for policymakers to optimize incentive programs and infrastructure investments. Additionally, manufacturers and energy providers can leverage these findings to align their strategies with consumer demands and regional requirements. By offering a data-driven perspective on EV adoption patterns, this research contributes to the ongoing discourse on sustainable transportation and supports the transition toward a cleaner automotive future.
Keywords: *Electric Vehicles (EVs), Adoption Patterns, Government Incentives, Charging Infrastructure, Sustainability, Data Driven insights, Economic Influences, Sustainable Transportation, EV Market Trends, Data Visualization, Regional EV Insights, EV Policy Impact.*

I. Introduction

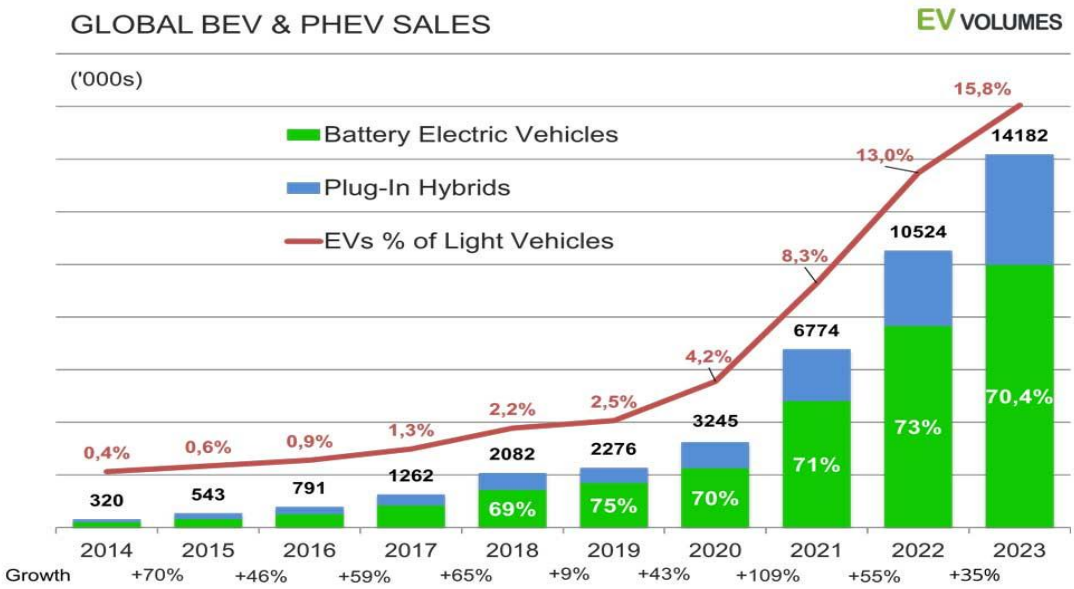
The world automotive sector is witnessing a massive revolution brought about by the growing use of electric vehicles (EVs). Increased pressure on climate change, energy security, and air pollution has seen EVs emerge as a feasible and green solution compared to conventional internal combustion engine (ICE) vehicles. This change is also being propelled by favorable government policies, incentives, and charging infrastructure development across the globe, and thus it is essential for policymakers, industry, and consumers to be aware of the forces driving EV uptake.

This study explores the examination of electric vehicle registration statistics to reveal fundamental insights into EV adoption patterns, geographic trends, and drivers of EV ownership. The dataset includes a broad range of attributes such as vehicle identification numbers (VINs), geographic identifiers (county, city, state), model year, manufacturer, model, electric vehicle type (Battery Electric Vehicle - BEV or Plug-in Hybrid Electric Vehicle - PHEV), electric range, base MSRP, and Clean Alternative Fuel Vehicle (CAFV) eligibility. In addition, the dataset includes legislative variables, including postal codes, legislative districts, and electric utility providers, providing a complete picture of the EV environment.

By careful analysis of this dataset, the research hopes to offer insightful information regarding the penetration of EVs in regions, the popularity of certain brands and models, the influence of cost factors, and the success of clean energy incentives. Additionally, the research explores the connection between electric range and adoption patterns, asking whether higher-range EVs are more common in particular geographic locations. Knowledge of these factors is critical for policymakers to make informed choices about EV infrastructure

development, taxation policies, and incentive programs, as well as for manufacturers and dealerships to have a better understanding of consumer demand and market trends.

Through the use of data analysis and visualization methods, this study attempts to convert raw data into actionable intelligence, allowing stakeholders such as government agencies, energy providers, and automobile manufacturers to make data-driven decisions to promote electric mobility growth. This study ultimately adds to the growing database of research on electric cars through a data-driven description of EV adoption trends and contributes to the future of e-mobility and the transition towards a more sustainable car industry.



Source: https://ev-volumes.com/news/ev/global-ev-sales-for-2023/

1.2 Challenges In the Adoption of Electric Vehicles

Despite the growing momentum behind electric vehicles (EVs) as a sustainable transportation solution, several challenges impede their widespread adoption. These challenges span technological, economic, infrastructural, and psychological dimensions, necessitating comprehensive strategies to overcome them.

One of the main barriers is range anxiety, the concern that an EV will not have enough battery range to finish a trip because of the lack of charging facilities. Though developments in battery technology have improved the range of more recent EV models, this is still a major disincentive for many potential customers, especially those who make regular long-distance journeys or live in regions where charging points are scarce. This is also added to by variability in real-world range, depending on driving habits, weather, and terrain.

High initial costs also pose a significant challenge. EVs generally have a higher initial cost than their internal combustion engine (ICE) equivalents, even when factoring in government incentives and possible long-term fuel savings. This cost difference can be a deterrent for price-sensitive consumers, particularly in emerging economies where affordability is a key factor. Even though battery costs are reducing, price reductions need to continue in order to establish parity with ICE prices and promote faster adoption of EVs by varying income groups.

Availability and ease of access of charging facilities are another important issue. The non-existence of a widespread, dependable charging facility, especially at home and on highways, keeps EV ownership constrained by its practicality and convenience. The uneven distribution of charging points, with a high concentration in urban areas and prosperous regions, makes this problem worse, leading to disparities in the adoption of EVs across various regions. Overcoming this challenge involves huge investments in charging facilities, along with strategic planning to provide equal access to all EV users.

In addition, consumer perception and awareness are also important drivers of EV uptake. Numerous prospective customers are still unaware of the advantages of EVs, such as lower operating costs, less pollution, and a smoother driving experience. Misconceptions regarding battery lifespan, charging duration, and maintenance needs can also discourage consumers from adopting EVs. These barriers need to be overcome through targeted education initiatives to create awareness, eliminate myths, and highlight the benefits of EV ownership.

Lastly, grid stability and capacity are potential issues for the mass deployment of EVs. With shifting numbers of EVs on the road, electricity demand will grow, which can put pressure on the existing power grids, particularly during peak periods. Advancing grid infrastructure and introducing smart charging measures are necessary to make sure that the grid becomes robust enough to support the new demand without sacrificing reliability or spiking electricity prices.

Solving these complex obstacles demands a common effort from governments, auto manufacturers, energy suppliers, and consumers. Through the support of policy measures, investment in infrastructure, consumer education, and technological innovation, it is conceivable to conquer these obstacles and realize the complete potential of electric vehicles as a green mode of transport.

II. Objectives of the Study

1. To analyze geographic and economic factor influence on electric vehicle adoption
2. To evaluate the effectiveness of policy measures on consumer preference

III. Review of Literature

1. EV Connect (2025) emphasized that public awareness is a critical factor influencing EV adoption. They found that misinformation and lack of consumer education hinder widespread adoption, even as EV popularity grows. The research suggests that targeted campaigns to inform consumers about EV benefits, including cost savings and environmental impact, are essential for accelerating adoption.
2. Archsmith et al. (2021) highlighted the role of declining battery costs and government subsidies in reducing the upfront cost of EVs. Their study revealed that intrinsic demand growth and subsidy programs are pivotal in achieving higher market share for EVs by 2035. They quantified that the first $500 billion in subsidies could increase EV market share by 7–10%, demonstrating the importance of financial incentives. Similarly, EV Connect (2025) found that while operating costs are lower for EVs compared to ICE vehicles, upfront costs remain a barrier for many consumers.
3. BloombergNEF (2022) projected that global EV sales will rise sharply to 20.6 million units by 2025, driven by improved charging infrastructure and policy pressure. The Infrastructure and Jobs Act allocated $7.5 billion for charging networks, aiming to establish 500,000 chargers nationwide by 2030. EV Connect (2025) also noted that increasing fast-charging availability significantly boosts consumer confidence in adopting EVs.
4. Ouyang et al. (2024) modelled the impact of various policies on EV adoption and concluded that consistent government incentives, such as tax credits and zero-emission mandates, play a pivotal role in promoting adoption. California's regulation requiring all new cars to be zero-emission by 2035 was identified as a transformative measure for accelerating adoption.
5. EV Connect (2025) noted that early adopters are often motivated by environmental concerns, particularly in regions with clean energy sources like California. As renewable energy becomes more widespread globally, EVs are expected to have an increasingly positive environmental impact, encouraging further adoption.
6. Shakeel et al. (2022) conducted a state-of-the-art review and found that social factors such as peer influence and environmental awareness significantly shape consumer preferences for EVs. Their findings suggest that promoting EVs as socially desirable can accelerate adoption.
7. EV Connect (2025) noted that younger motorists are more likely to buy electric vehicles (EVs) than older generations. This indicates the need to consider generational preferences when marketing EV adoption. Younger buyers, who tend to be more sensitive to sustainability and technology, are a critical demographic for EV marketers. In order to successfully appeal to various age groups, modified marketing approaches are necessary—highlighting environmental friendliness and state-of-the-art technology for younger consumers and practicality and affordability for older consumers.
8. Li et al. (2023) investigated the effect of subsidy cuts on EV uptake in major versus minor cities. Their analysis found that wealthier cities are less affected by subsidy reductions because of increased incomes, which increase the affordability of EVs even in the absence of monetary incentives. On the other hand, poorer cities with lower incomes witness a steep decline in adoption levels when subsidies are cut. This points to the importance of geographically focused policies for guaranteeing universal access to EVs, e.g., retaining subsidies in economically disadvantaged areas.
9. EV Connect (2025) pointed to the increasing appeal among fleet managers to switch to electric vehicles, fuelled by tax incentives and logistical assistance from incentive programs. Fleet electrification is becoming a key driver in speeding up EV adoption, especially among commercial fleets looking for cost-saving solutions. By lowering operating expenses and supporting sustainability objectives, fleet managers are increasingly considering EVs as pragmatic investments. Backing this trend by the increased incentives and infrastructure investment will greatly enhance large-scale adoption.

10. The International Energy Agency (IEA) (2024) highlighted that grid development plays a crucial role in sustaining future EV demand. While the number of electric vehicles increases, clean and smart charging solutions fuelled by renewable energy become necessary to achieve sustainability. The IEA promotes investments in sophisticated grid infrastructure that can manage higher electricity demands with less environmental footprint. These initiatives will not only satisfy growing demand but also support global climate objectives by incorporating renewable energy into charging networks.

IV. Methodology of the Study

This study adopts a quantitative approach with a focus on the analysis of electric vehicle (EV) registration data to identify adoption patterns, market trends, and how different factors drive EV ownership. The essence of this study entails statistical analysis, data visualization, and geospatial mapping to derive raw data into actionable information.

Data Preparation and Acquisition: The research makes use of an extensive dataset of electric vehicle registration data, which includes vehicle identification numbers (VINs), geographical identifiers (state, city, county), model year, manufacturer, model, electric vehicle type (Battery Electric Vehicle - BEV or Plug-in Hybrid Electric Vehicle - PHEV), electric range, base MSRP, and Clean Alternative Fuel Vehicle (CAFV) eligibility. The dataset further includes legislative factors like postal codes, legislative areas, and electricity supply providers. Data cleaning begins with a thorough cleansing process of handling missing or inconsistent entries, with the view of ensuring the reliability and integrity of data. These include fixing missing values through imputation, standardizing formats for data for easier subsequent analysis.

Exploratory Data Analysis (EDA): The exploratory data analysis is carried out for furnishing summarization insights on the characteristics of the dataset. Descriptive statistics, such as measures of central tendency and dispersion, are calculated to gain insight into the distribution of important variables like model year, manufacturer, vehicle type, and electric range. Data visualization methods, such as histograms, bar charts, and scatter plots, are used to determine trends and correlations among variables. For instance, the correlation between electric range and base MSRP is analysed to evaluate the trade-offs that affect consumer choice.

Geospatial Analysis: Geospatial analysis methods are utilized to plot the distribution of EVs by region and recognize spatial trends in adoption levels. This is done by combining the use of GIS software to plot EV registrations by county, state, and legislative district. Heatmaps are created to show the concentration of EV adoption, allowing one to detect regions of greater or lesser adoption. Spatial relationships between EV ownership and variables like charging infrastructure availability, income, and policy incentives are examined.

Dashboard Creation: Interactive dashboards are created to share the research outcomes in an intuitive manner. Dashboards include dynamic visualizations through which stakeholders are able to analyze the data and understand EV adoption patterns. The key performance indicators (KPIs) including EV market share, regional adoption rates, and the effect of incentives are monitored and updated in real-time.

By integrating these methodologies, this research offers a full analysis of the patterns of electric vehicle adoption and provides useful information for policymakers, manufacturers, and consumers. Data-driven methodology assures the robustness and reliability of the results and contributes to further insight into factors driving the transition to electric mobility.

V. Results and Discussion

This research sought to examine patterns of electric vehicle (EV) adoption, market trends, and the role of numerous factors in influencing EV ownership based on a rich dataset of EV registrations. The findings, obtained from exploratory data analysis, geospatial analysis, and regression modelling, yield some important insights.

EV Adoption Trends and Market Share: The examination of EV registration data showed a steady increasing trend in EV adoption over the last few years, with Battery Electric Vehicles (BEVs) increasing market share compared to Plug-in Hybrid Electric Vehicles (PHEVs). This increase is especially notable in urban areas, which suggests an association between urban lifestyle and EV adoption. In addition, some manufacturers have become leaders in the market, leading EV sales in various vehicle types, which can be largely due to factors such as brand reputation, performance of the vehicle, and intense promotional campaigns. All these trends point towards the increasing acceptance of EVs by the consumers and the expanding competitiveness in the EV market.

Geospatial Patterns in EV Adoption: Geospatial analysis identified stark geospatial differences in EV adoption rates. Those states with policy support, like California and Washington, had much higher EV registrations than states with lower incentives and less established charging infrastructure. Between states, EV densities were also higher in urban counties within states, with rural areas behind, emphasizing the role of infrastructure availability. The results are indicative of supporting evidence for the thesis that state factors, like laws and legislatorial districts, affect EV registration geographies profoundly.

Influence of Price, Range, and Incentives: Through the regression test, it was affirmed that a critical negative association occurred between base MSRP and EV adoption levels. This implied cost is a still-large stumbling block for potential purchase by a bulk of clients. On the other hand, it was seen that electric range and adoption had a positive correlation, supporting the fact that consumers give first preference to vehicles with higher range features. Furthermore, CAFV (Clean Alternative Fuel Vehicle) eligibility was seen to have a statistically significant and positive effect on EV purchases, upholding the efficacy of government incentives in EV adoption. This is in accordance with the assumption that EV adoption is linked to higher electric range and lower base MSRP, with the help of government incentives.

Role of Electric Utility Providers: Examination of EV registrations by electric utility providers indicated that those locations that have strong charging infrastructure, in some cases augmented by forward-thinking utility companies, have higher EV penetration levels. This implies that the utility industry plays an important part in making EV adoption easier through investment in charging networks and provision of incentives to consumers. The results also corroborate the assumption that regions with strong electric utility infrastructures experience more comprehensive EV penetrations based on sufficiently supported charging networks.

Discussion: The findings of this research highlight the intricate relationship between the various drivers of EV adoption. Though incentives from the government and charging infrastructure are important, consumer demand for range and price sensitivity continue to be important factors to consider. Overcoming these challenges necessitates a multi-faceted response involving sustained investments in charging infrastructure, continued declines in battery prices, and strategic policy interventions to encourage EV adoption across all demographic and geographic segments. Subsequent studies may investigate the influence of next-generation battery technology, the contribution of consumer education, and the effect of social networks on EV buying behavior.

VI. Recommendations and Suggestions

1. There is a need for prioritizing public awareness and education programs. As noted by EV Connect (2025), a lack of consumer education and misinformation pose a major challenge to EV uptake. Tailored campaigns must be created to educate consumers on the advantages of EVs, both in terms of cost and environmental contribution. The campaigns must be age-specific since the research established that the young are more interested in EVs than their elders.

2. Subsidies and financial incentives ought to be effectively put in place and sustained, particularly in less populous cities as well as poorer economic areas. The study conducted by Li et al. (2023) revealed that larger cities with a higher income tended to be less impacted by declining subsidies than lesser cities. Policy makers should, therefore, plan geographically differentiated incentives to secure equitable access to EVs between economic strata.

3. Charging infrastructure investment should be ramped up, with attention directed towards establishing an extensive and stable network. Development of the charging grid and green charging solutions based on renewable power were highlighted as critical by the study. Policymakers and utility companies should work together to implement measures for smart charging solutions and increase the number of charging stations, especially in rural and suburban regions where uptake is low.

4. There is a need to promote fleet electrification via special incentives and assistance programs. According to EV Connect (2025), with the tax relief and logistical assistance, there has been increased enthusiasm from fleet managers towards using EVs. Measures and programs allowing the commercial fleet sector to easily transition to electric cars can actually stimulate large-scale uptake.

5. Manufacturers need to work on enhancing the electric range of EVs and lowering initial costs. The research showed that range anxiety and high upfront costs are still major deterrents to adoption. Ongoing investment in battery technology and manufacturing efficiency would help alleviate these issues.

6. Policymakers must institute consistent and long-term policies to facilitate EV uptake. This involves zero-emission mandates, tax credits, and other policy interventions that give certainty to both consumers and manufacturers. The ability of such policies to work in areas such as California is proof that they have the capacity to bring revolutionary shifts to the automobile market

VII. Conclusion

This study offers a rich, data-sourced understanding of electric vehicle (EV) adoption patterns, emphasizing the interactions between geographic, economic, and policy drivers underlying consumer choices. Through the analysis of a rich dataset covering different EV attributes, such as vehicle characteristics, geographic identifiers, and legislative variables, the paper reveals important trends and actionable information for all stakeholders in the automotive and energy industries.

The results highlight the pivotal contribution of public education and awareness in driving EV uptake, as noted by EV Connect (2025). Misinformation and consumer ignorance continue to be a major impediment, calling for focused campaigns touting the value proposition of EVs, such as cost efficiency and environmental benefit. The research also highlights the need for subsidies and financial incentives, especially in smaller cities and economically challenged areas, to ensure access to EVs across all economic segments.

The research also emphasizes the need to step up investment in charging infrastructure to counter range anxiety and cater to growing demand for EVs. Cooperation between policymakers and energy companies is important to create smart charging solutions and increase the charging network, particularly in rural and suburban regions that are not well served. Additionally, the study indicates the promise of fleet electrification as a prime mover of mass-scale EV uptake, with strategic incentives and assistance programs inducing commercial fleets to adopt electric vehicles.

In addition, the study emphasizes the importance of taking into consideration generational desires and marketing methods customized to engage various age cohorts, with the younger drivers more interested in EVs than previous generations. With the use of data visualization and geospatial analysis methods, this study delivers important insights for stakeholders regarding regional adoption gaps and the effects of localized determinants like state legislation and charging facility availability.

In conclusion, this research adds to the current debate on sustainable transportation by presenting empirical insights on EV adoption patterns and offering practical recommendations for policymakers, manufacturers, and energy suppliers. By tackling the issues of public awareness, financial incentives, infrastructure development, and consumer preferences, stakeholders can work together to build a more conducive environment for EV uptake and drive the shift towards a cleaner and more sustainable automotive future. The conclusions drawn from this research can guide evidence-based decision-making and facilitate the mass adoption of EVs, leading to a greener and more environmentally friendly society.

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