


Bibliometric Analysis of Electric Vehicle Adoption and Market Trends

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Article Info	ABSTRACT
<p>Article history:</p> <p>Received March, 2025 Revised March, 2025 Accepted March, 2025</p> <hr/> <p>Keywords:</p> <p>Electric vehicles, Bibliometric analysis, EV adoption, Charging infrastructure, Sustainability</p>	<p>The adoption of electric vehicles (EVs) has emerged as a crucial solution to reduce carbon emissions and enhance sustainable transportation. This study conducts a bibliometric analysis to examine research trends, influential authors, and thematic developments in EV adoption and market trends. Using Scopus as the data source and VOSviewer for analysis, this study identifies key research clusters, including consumer behavior, charging infrastructure, environmental impact, and technological advancements. The findings reveal a significant increase in EV-related research, particularly in recent years, with the United States, China, and India leading contributions. Keyword analysis highlights critical themes such as government policies, battery technology, and vehicle-to-grid integration. Despite progress, challenges such as high upfront costs, limited charging infrastructure, and regional disparities persist. The study suggests future research directions focusing on battery sustainability, AI-driven mobility solutions, and smart grid integration. This bibliometric analysis provides valuable insights for researchers, policymakers, and industry stakeholders, contributing to the advancement of electric mobility research.</p> <p><i>This is an open access article under the CC BY-SA license.</i></p> 

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1. INTRODUCTION

The global transportation sector is undergoing a transformative shift towards sustainability, with electric vehicles (EVs) emerging as a crucial alternative to internal combustion engine (ICE) vehicles. This transition is driven by increasing environmental concerns, advancements in battery technology, and stringent government regulations aimed at reducing carbon emissions [1]. EV adoption has gained significant momentum over the past decade,

with major economies such as the United States, China, and the European Union leading the way in production and consumption. The growing interest in EVs has resulted in extensive research on market trends, technological advancements, and policy implications. However, despite the progress made, there remain various challenges that hinder the widespread adoption of EVs, necessitating a comprehensive bibliometric analysis to understand the research landscape in this field.

The rising demand for sustainable transportation solutions has encouraged both industry stakeholders and researchers to explore the potential of EVs as a viable alternative to traditional vehicles. Governments worldwide have implemented policies, including tax incentives, subsidies, and stricter emission regulations, to accelerate the adoption of EVs [2]. Additionally, advancements in lithium-ion battery technology and charging infrastructure have significantly improved the efficiency and affordability of EVs, making them increasingly attractive to consumers. These developments have led to a surge in academic publications focusing on various aspects of EV adoption, market trends, consumer behavior, and technological innovations.

Despite the increasing body of research, the literature on EV adoption remains fragmented, with studies covering diverse aspects such as charging infrastructure, government policies, battery performance, and consumer preferences. A bibliometric analysis allows for the systematic mapping of this research domain, highlighting key trends, influential authors, and thematic evolutions over time. By analyzing academic publications, citation networks, and research clusters, scholars can identify gaps in existing knowledge and suggest future research directions [3]. Such an analysis is particularly crucial in a rapidly evolving field like EV adoption, where technological advancements and policy shifts continuously reshape market dynamics.

Given the growing importance of electric mobility, it is essential to understand the research trajectory and dominant themes in this domain. Bibliometric analysis provides a quantitative approach to evaluating scientific literature, enabling researchers to assess publication trends, citation impact, and collaboration networks. Such an analysis can help bridge the knowledge gap between academia and industry, ensuring that research efforts align with practical challenges and opportunities in the EV market. As the global automotive industry continues to evolve, a bibliometric study of EV adoption

and market trends will serve as a valuable resource for researchers, policymakers, and industry stakeholders alike.

Although significant progress has been made in the field of EV adoption, the existing literature is vast and multidisciplinary, making it difficult to obtain a comprehensive overview of the research landscape. The rapid expansion of academic publications has led to scattered findings, with studies focusing on specific aspects such as technology, policy, infrastructure, and consumer behavior without a unified perspective. Moreover, the interplay between market trends and adoption factors remains complex and requires systematic investigation. A bibliometric analysis is needed to synthesize the existing body of research, identify key themes, and reveal research gaps that need further exploration. Without such an analysis, policymakers and industry leaders may struggle to derive actionable insights from the extensive but dispersed body of literature on EV adoption and market trends. This study aims to conduct a bibliometric analysis of electric vehicle adoption and market trends to provide a systematic and quantitative overview of research developments in this field.

Overview of Electric Vehicle Adoption

The adoption of electric vehicles (EVs) has been a growing area of research over the past decade, with scholars examining various factors influencing their market penetration. Studies indicate that EV adoption is driven by technological advancements, policy interventions, and changing consumer preferences [4]. Researchers have identified multiple barriers and enablers, such as government subsidies, charging infrastructure, and cost reductions in battery technology, that influence EV diffusion [5]. While some regions have experienced rapid adoption due to strong policy support, others still struggle with infrastructural and economic constraints [6]. Several models have been proposed to understand EV adoption, including the Technology Acceptance Model (TAM) and the Diffusion of Innovation (DOI) theory. These frameworks highlight factors

such as perceived usefulness, ease of use, and social influence in shaping consumer behavior [7]. Furthermore, life cycle assessment (LCA) studies have been conducted to evaluate the environmental benefits of EVs compared to internal combustion engine (ICE) vehicles, demonstrating their potential in reducing greenhouse gas emissions [8].

Market Trends in Electric Vehicle Adoption

Market trends in EV adoption have been influenced by several key factors, including policy incentives, technological advancements, and consumer awareness. According to recent studies, the global EV market has been expanding rapidly, with China, the United States, and Europe leading in sales and production. The introduction of cost-effective battery technologies, such as lithium-ion and solid-state batteries, has played a crucial role in making EVs more affordable and competitive [9]. Moreover, the expansion of public charging networks and improvements in battery range have alleviated consumer concerns regarding range anxiety [10]. The role of original equipment manufacturers (OEMs) in shaping market trends has also been extensively studied. Major automotive companies such as Tesla, Nissan, and Volkswagen have made significant investments in EV technology, contributing to the increased availability of EV models across various segments [11]. Additionally, shared mobility solutions, such as electric car rentals and ride-sharing platforms, have further promoted EV adoption by offering consumers alternative ways to experience electric mobility without the need for ownership [12].

Policy and Regulatory Frameworks

Government policies play a crucial role in accelerating EV adoption, as evidenced by various studies examining their impact on market dynamics. Incentives such as tax credits, subsidies, and rebates have been instrumental in making EVs more accessible to consumers [13]. Countries such as Norway and the Netherlands have implemented aggressive EV promotion policies, resulting in significantly higher adoption rates compared

to regions with weaker incentives [14]. Regulatory frameworks aimed at reducing carbon emissions and promoting sustainable transportation have also influenced the EV market. Emission reduction targets set by the European Union, China's New Energy Vehicle (NEV) policies, and the U.S. federal tax incentives for EV purchases are examples of regulatory interventions that have shaped industry trends [15]. However, disparities in policy effectiveness highlight the need for a comprehensive and globally coordinated approach to EV promotion.

Technological Innovations and Battery Development

Technological advancements have been a focal point in EV research, particularly in battery performance and energy efficiency. Lithium-ion batteries, the dominant energy storage technology in EVs, have seen significant improvements in energy density, charging speed, and cost reductions over the past decade [16]. Researchers have explored alternative battery technologies, such as solid-state batteries, which promise enhanced safety and longevity [17]. Additionally, developments in vehicle-to-grid (V2G) technology have been investigated for their potential to enhance grid stability and integrate renewable energy sources [18]. Charging infrastructure is another critical area of research, with studies emphasizing the need for widespread and fast-charging networks to support EV adoption. Wireless charging technology and ultra-fast charging stations are emerging solutions that aim to reduce charging times and improve user convenience [19]. Moreover, advancements in autonomous and connected vehicle technologies are expected to further shape the future of EV adoption by enabling smart mobility solutions and enhancing driving efficiency [20].

Consumer Behavior and Adoption Barriers

Understanding consumer attitudes toward EVs is essential for improving adoption rates. Research indicates that perceived cost, range anxiety, and charging infrastructure availability are key determinants influencing purchasing

decisions [21]. Additionally, social influence and environmental consciousness play a significant role in shaping consumer preferences, with studies showing that individuals with pro-environmental attitudes are more likely to adopt EVs [22]. Economic barriers remain a major concern, particularly in developing markets where the initial cost of EVs is significantly higher than ICE vehicles. Although battery prices have been decreasing, affordability continues to be a limiting factor for mass adoption [23]. Furthermore, research highlights the importance of consumer education and awareness campaigns in dispelling misconceptions about EV performance and sustainability benefits [24].

2. METHODS

3. RESULTS AND DISCUSSION

3.1 Description of Documents

Documents by year

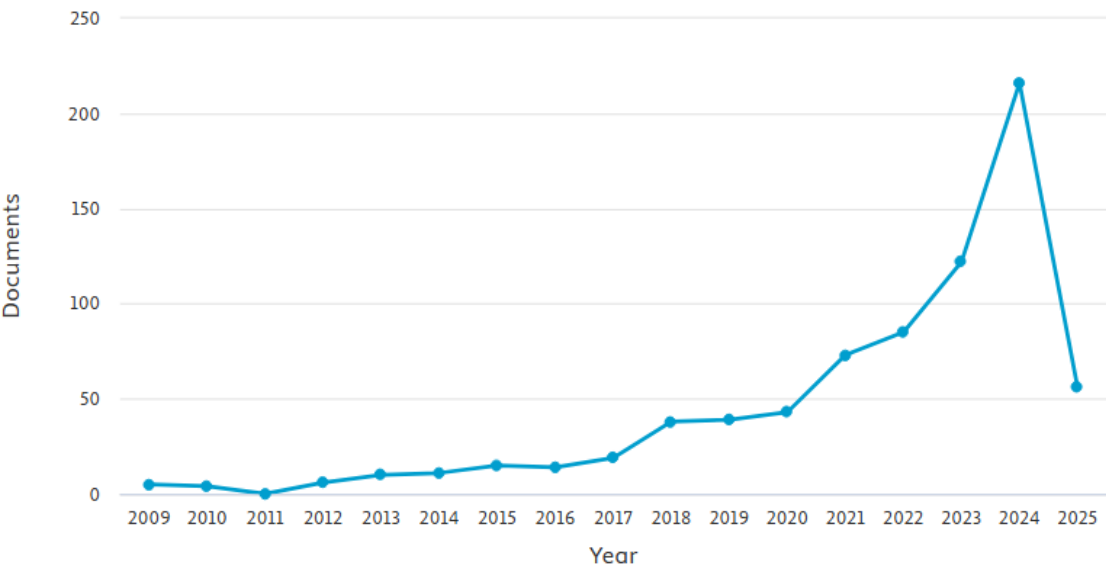


Figure 1. Documents by Year
Source: Scopus Database, 2025

This visualization presents the number of academic documents published per year on the topic of electric vehicle adoption and market trends, as extracted from Scopus. The trend indicates a steady but slow increase in publications from 2009 to approximately 2018, followed by a noticeable

This study employs a bibliometric analysis to systematically examine the research landscape on electric vehicle (EV) adoption and market trends. The methodology involves retrieving relevant academic literature exclusively from the Scopus database, using predefined keywords related to EV adoption, market trends, charging infrastructure, and policy frameworks. The collected data will be analyzed solely using VOSviewer to identify key research trends, citation networks, and influential authors. Additionally, co-occurrence analysis of keywords and thematic mapping will be conducted to reveal the intellectual structure of the field. The study follows a systematic approach, including data cleaning, network visualization, and trend analysis, to ensure a comprehensive understanding of the research evolution.

growth from 2019 onwards. A significant surge in research output is observed between 2021 and 2023, reaching its peak in 2024 with over 200 publications. However, there is a sharp decline in 2025, which may be attributed to incomplete data for the year or a potential reduction in research interest.

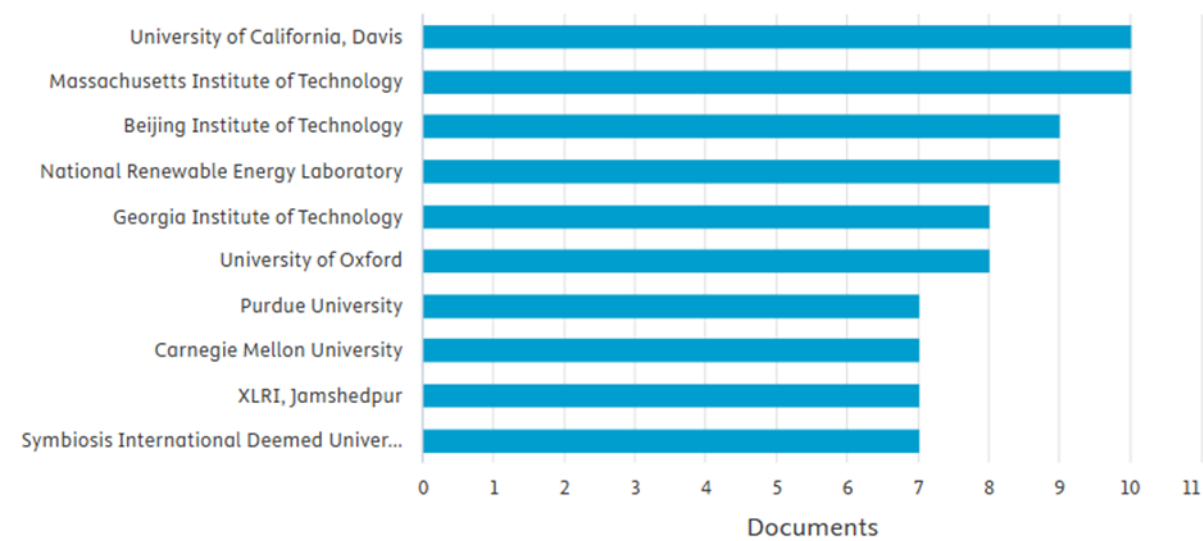


Figure 2. Documents by Affiliation

Source: Scopus Database, 2025

This visualization displays the top contributing institutions in research related to electric vehicle adoption and market trends, based on the number of published documents. The University of California, Davis and the Massachusetts Institute of Technology (MIT) lead with the highest number of publications (11 documents each). They are followed closely by the Beijing Institute of Technology and the National Renewable Energy Laboratory, both with 9 documents. Other notable contributors include Georgia Institute

of Technology, University of Oxford, Purdue University, and Carnegie Mellon University, each producing between 7 to 8 documents. The presence of universities and research institutions from multiple countries highlights the global academic interest in EV research. Additionally, the inclusion of XLRI, Jamshedpur, and Symbiosis International Deemed University suggests that emerging institutions from developing regions are also contributing to this field.

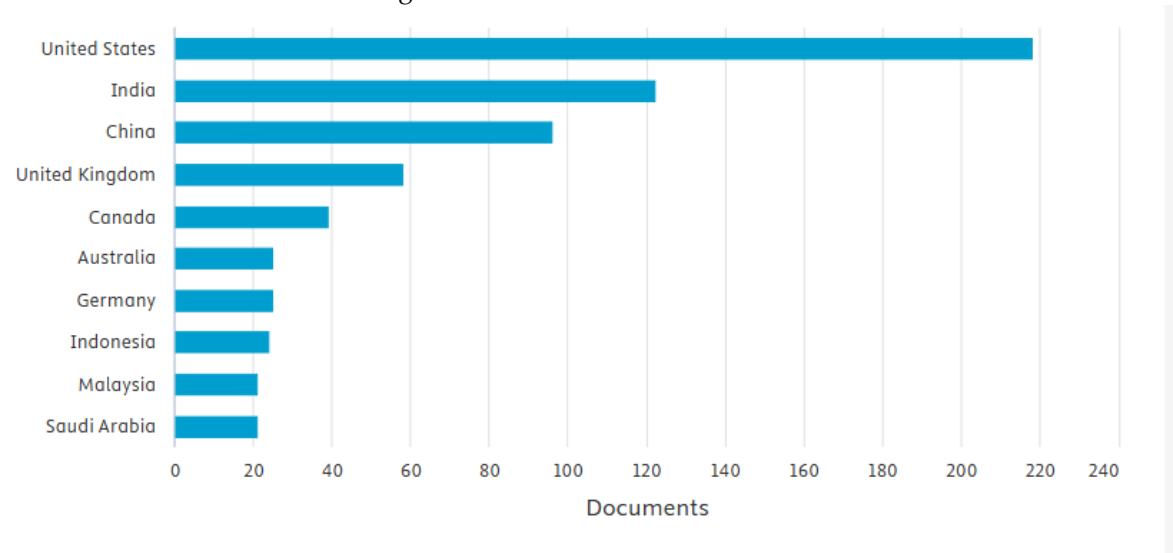


Figure 3. Documents by Country

Source: Scopus Database, 2025

This visualization illustrates the number of academic documents related to

electric vehicle (EV) adoption and market trends by country. The United States leads in

EV-related research with the highest number of publications, surpassing 200 documents. India follows in second place with a significant contribution, exceeding 120 documents, while China ranks third with slightly fewer publications. The United Kingdom, Canada, and Australia also contribute substantially, though at a lower scale. Other notable contributors include Germany, Indonesia, Malaysia, and Saudi Arabia, each producing between 20 to 40 documents. The dominance of the United

3.2 Keyword Co-Occurrence Network Visualization

States indicates its strong research focus on EV adoption, supported by technological advancements, policy initiatives, and market dynamics. The high research output from India and China suggests growing academic interest in EVs in emerging economies, driven by government policies and market expansion. The presence of contributions from diverse geographic regions highlights the global nature of EV research and its increasing importance across developed and developing countries.

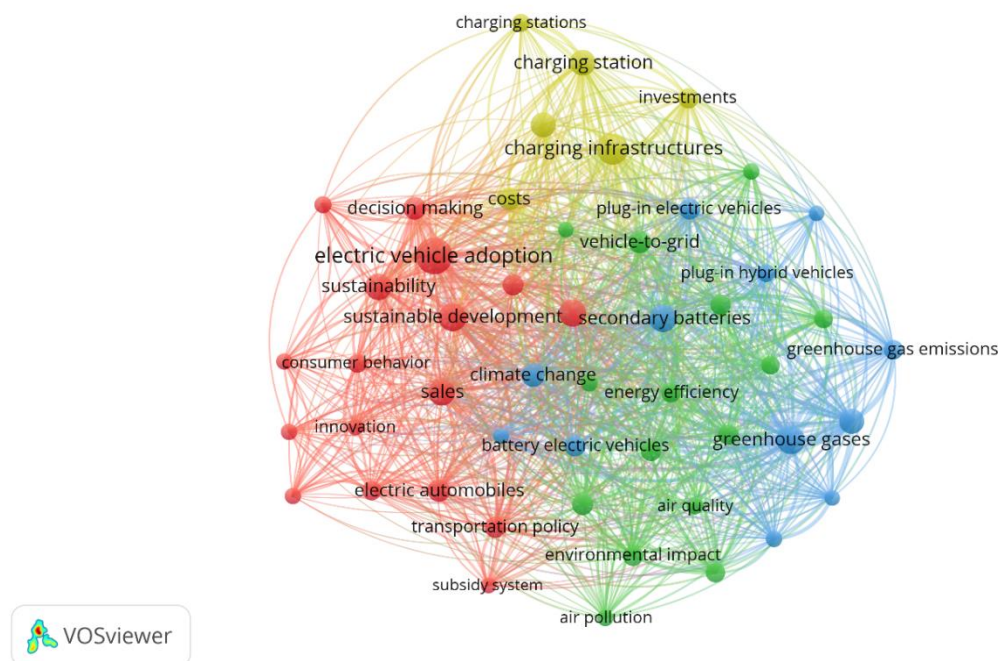


Figure 4. Network Visualization

Source: Data Analysis, 2025

This VOSviewer visualization represents a bibliometric network of keywords associated with research on electric vehicle (EV) adoption and market trends. The nodes represent keywords, while the edges signify co-occurrence relationships, meaning keywords frequently appearing together in research publications are more interconnected. The different colors indicate clusters of related terms, highlighting distinct thematic areas in EV research. The red cluster, centered around “electric vehicle adoption,” “sales,” “consumer behavior,” and “decision making,” focuses on market dynamics, adoption challenges, and consumer-related aspects of EVs. This suggests that a significant

portion of the research examines how consumer preferences, sales trends, and decision-making factors impact EV adoption. Studies in this area likely address issues such as policy incentives, pricing strategies, and technological acceptance models that influence consumer behavior.

The yellow cluster, which includes “charging stations,” “charging infrastructure,” “investments,” and “vehicle-to-grid,” highlights the infrastructural and investment-related aspects of EV adoption. This indicates that charging infrastructure plays a crucial role in research, as it remains one of the primary barriers to widespread EV adoption. Studies in this domain focus on the

expansion of charging networks, technological advancements in fast-charging solutions, and the integration of EVs into smart grids through vehicle-to-grid (V2G) technology. The blue cluster, with terms like "greenhouse gas emissions," "air quality," "environmental impact," and "climate change," focuses on the environmental implications of EV adoption. This suggests that researchers are keenly exploring how EVs contribute to sustainability goals, reduce carbon footprints, and improve air quality compared to internal combustion engine vehicles. The strong interconnections within

this cluster indicate the broad consensus on EVs as a key solution to mitigate climate change effects. The green cluster, which includes "battery electric vehicles," "energy efficiency," "plug-in hybrid vehicles," and "secondary batteries," highlights research on EV technology and energy management. This suggests an emphasis on battery advancements, efficiency improvements, and hybrid vehicle alternatives in academic literature. As battery costs decrease and efficiency increases, this cluster will likely continue to expand in future research.

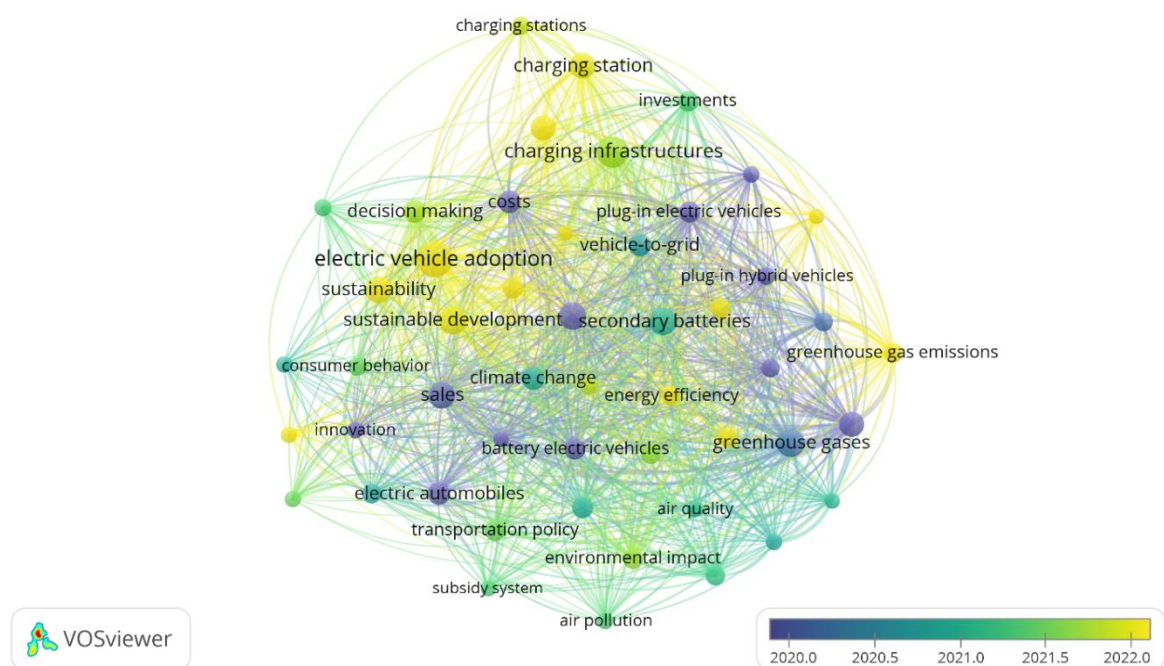


Figure 5. Overlay Visualization

Source: Data Analysis, 2025

This VOSviewer visualization represents a bibliometric analysis of keywords related to electric vehicle (EV) adoption and market trends, with a color gradient indicating the average publication year of each term. The color scale at the bottom right shows that older research (from around 2020) is represented in purple/blue, while more recent research (closer to 2022) is in green/yellow. This helps illustrate the evolution of research focus in the EV field over time. The core topics, such as "electric vehicle adoption," "secondary batteries," "climate change," and "greenhouse gas

emissions," appear in the blue and green shades, suggesting that these have been dominant research themes since 2020, with ongoing interest in recent years. Meanwhile, terms in yellow, such as "charging infrastructures," "charging station," "investments," and "innovation," indicate newer research trends, suggesting that the focus has shifted toward charging infrastructure development, investment strategies, and innovation in EV technologies. This shift aligns with global efforts to enhance charging networks and promote sustainable transportation policies.

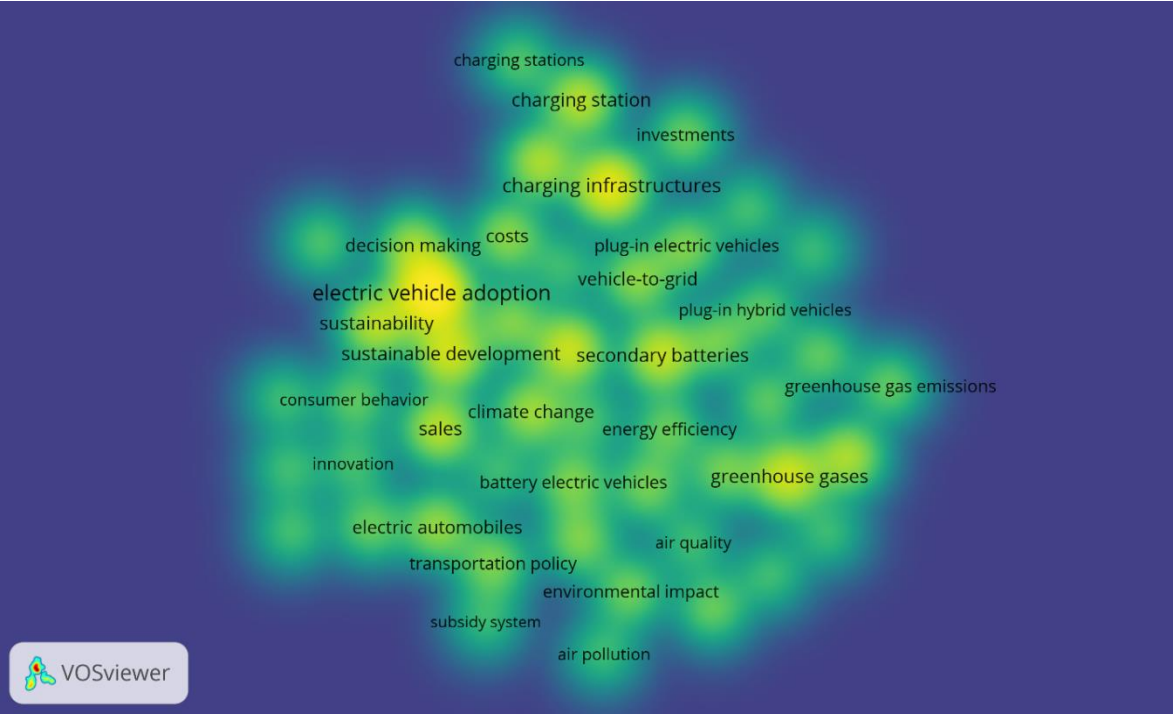


Figure 6. Density Visualization
Source: Data Analysis, 2025

This VOSviewer heatmap visualization represents the density of keyword occurrences in academic research on electric vehicle (EV) adoption and market trends. The yellow areas indicate high-frequency keywords that have been extensively studied, while green areas show moderately occurring terms, and dark blue areas indicate lower-frequency terms. The most highly researched topics are concentrated around "electric vehicle adoption," "sustainability," "sales," "greenhouse gases," "secondary batteries," and "charging infrastructures," suggesting that these are the primary focal points of EV-related research. The broad distribution of keywords across the visualization suggests a

3.3 Citation Analysis

multidisciplinary approach to EV research, encompassing technological, environmental, economic, and policy aspects. The prominence of terms like "charging station," "plug-in hybrid vehicles," and "climate change" indicates a growing focus on improving EV infrastructure and assessing its environmental impact. Meanwhile, the less dense outer regions contain terms like "subsidy system" and "transportation policy," implying that while policy-related research is present, it may not be as extensively explored as core technological and adoption-related themes. This heatmap highlights the research priorities within the EV domain and suggests potential gaps where further studies could be valuable.

Table 1. Top Cited Documents

Citations	Author	Title	Source
995	[8]	The influence of financial incentives and other socio-economic factors on electric vehicle adoption	Energy Policy
918	[25]	Advances in consumer electric vehicle adoption research: A review and research agenda	Transportation Research Part D: Transport and Environment

859	[26]	A review on the state-of-the-art technologies of electric vehicle, its impacts and prospects	Renewable and Sustainable Energy Reviews
566	[27]	Adoption of electric vehicle: A literature review and prospects for sustainability	Journal of Cleaner Production
457	[28]	Cost projection of state of the art lithium-ion batteries for electric vehicles up to 2030	Energies

Source: Scopus, 2025

3.4 Co-Authorship Visualization

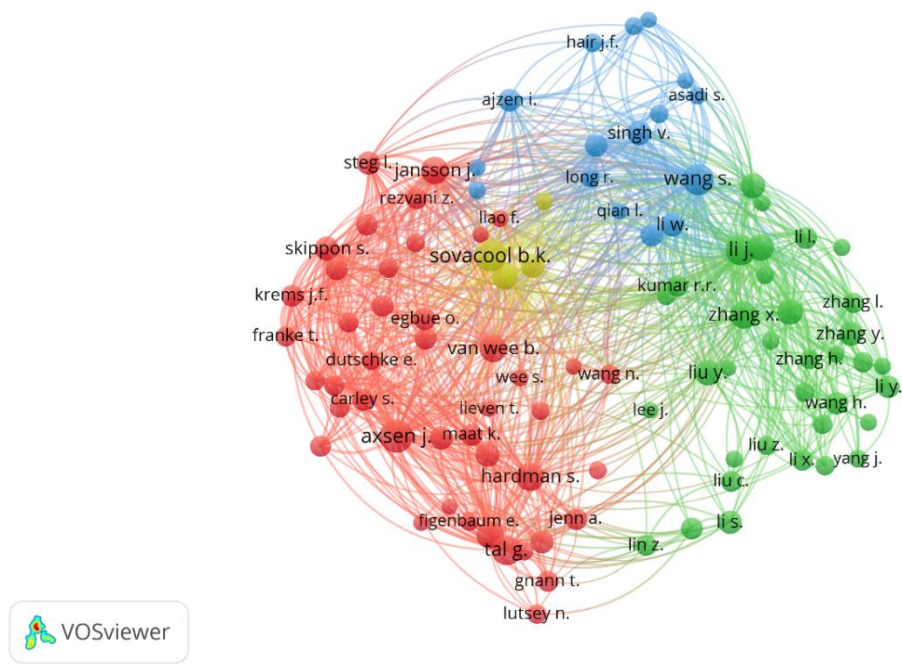


Figure 7. Author Visualization
Source: Data Analysis, 2025

This VOSviewer co-authorship network visualization represents the collaboration patterns among researchers in the field of electric vehicle (EV) adoption and market trends. The nodes represent individual authors, and the edges indicate co-authorship relationships. The different colors signify distinct research clusters, highlighting groups of researchers who frequently collaborate. The red cluster, which includes scholars like Sovacool B.K., Jansson J., and Aksen J., appears to focus on consumer

behavior, policy, and social acceptance of EVs. The green cluster, featuring authors such as Zhang X., Wang N., and Liu C., likely deals with technological advancements, battery innovations, and energy efficiency in EVs. The blue cluster, consisting of researchers like Wang S., Singh V., and Asadi S., may be more aligned with economic modeling, charging infrastructure, and market analysis. The central position of Sovacool B.K. suggests a highly influential researcher bridging different thematic areas within EV research.

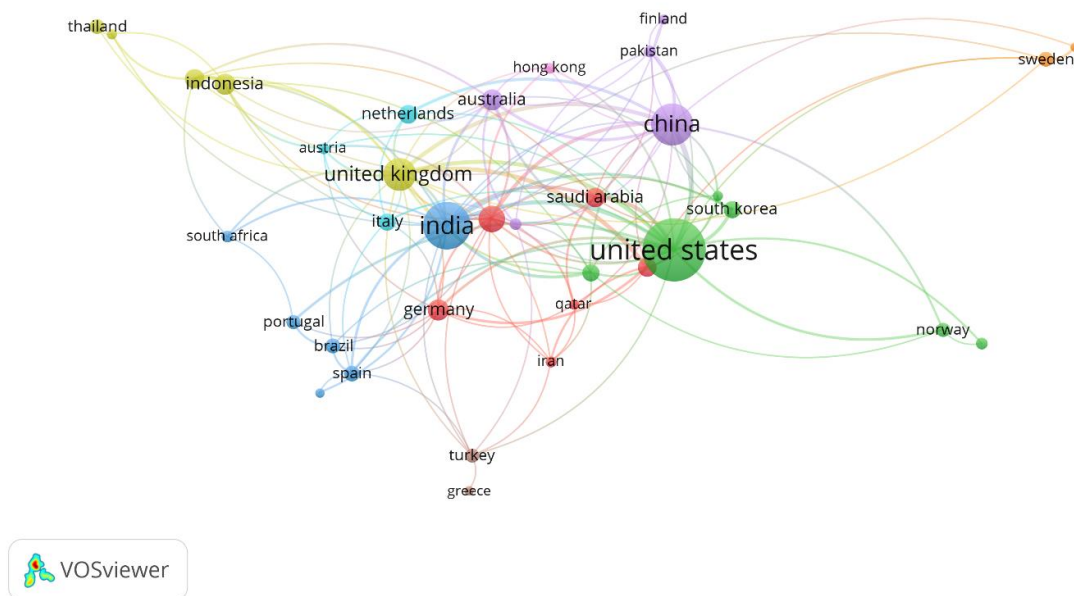


Figure 8. Country Visualization

Source: Data Analysis, 2025

This VOSviewer co-authorship network visualization depicts the collaboration patterns between different countries in electric vehicle (EV) adoption and market trends research. The nodes represent countries, while the edges indicate international research collaborations, with thicker edges signifying stronger partnerships. The United States, India, China, and the United Kingdom are the most prominent contributors, with the United States at the center, suggesting its dominant role in global EV research collaborations. The color-coded clusters highlight regional research partnerships, with China and India forming a closely linked network, while European countries such as the United Kingdom, Germany, and the Netherlands exhibit strong ties. South Korea, Norway, and Sweden appear as significant contributors in a separate cluster, likely reflecting their strong governmental support for EVs and sustainability initiatives. The presence of Indonesia, Thailand, and Saudi Arabia suggests emerging research efforts from developing economies, indicating a growing global interest in EV research.

DISCUSSION

Key Trends in Electric Vehicle Adoption Research

The bibliometric analysis of electric vehicle (EV) adoption and market trends highlights a significant growth in academic research over the past decade. The increasing number of publications, particularly in recent years, suggests a growing interest in EVs as a sustainable transportation solution. This trend aligns with global efforts to reduce carbon emissions and transition towards cleaner energy sources. The surge in publications in 2023 and 2024, as observed in the analysis, may be attributed to heightened policy interventions, advancements in EV technology, and greater public awareness. However, the noticeable decline in 2025 may reflect incomplete data for the year or a shift in research priorities. The co-authorship network analysis reveals that EV research is highly collaborative, with strong connections between leading institutions and researchers. The presence of distinct research clusters suggests a multidisciplinary approach, incorporating technological, environmental, economic, and policy perspectives. Scholars such as Sovacool B.K. and Wang S. emerge as

central figures, indicating their influential role in shaping EV research. Moreover, the involvement of institutions from diverse geographical regions demonstrates the global relevance of EV adoption, with leading contributions from the United States, China, India, and several European nations.

Major Research Themes Identified

The keyword co-occurrence analysis provides valuable insights into the dominant themes in EV research. The study identifies four major clusters: consumer behavior and market adoption, charging infrastructure and investment, environmental sustainability, and technological advancements. The prominence of "electric vehicle adoption," "sales," and "consumer behavior" within the red cluster underscores the importance of understanding the factors influencing EV purchase decisions. This aligns with prior studies emphasizing the role of incentives, range anxiety, and charging infrastructure availability in shaping consumer attitudes. The yellow cluster, focusing on charging infrastructure, highlights a key challenge in EV adoption. Keywords such as "charging stations," "vehicle-to-grid," and "investments" suggest that research efforts are increasingly directed toward improving charging accessibility and efficiency. The presence of "investment" within this cluster signifies the financial implications of expanding EV infrastructure, indicating that both public and private sector funding play a crucial role in scaling EV adoption. The blue and green clusters emphasize the environmental benefits and technological innovations associated with EVs. Keywords such as "greenhouse gas emissions," "air quality," and "climate change" reinforce the narrative that EVs are integral to achieving sustainability goals. Simultaneously, the strong connection between "secondary batteries," "energy efficiency," and "plug-in hybrid vehicles" indicates continued advancements in battery technologies and energy management strategies. These themes collectively highlight the interplay between policy, technology, and market adoption in driving the transition to electric mobility.

Policy Implications and Market Dynamics

Government policies remain a significant driver of EV adoption, as evidenced by the widespread research focus on incentives, subsidies, and transportation policies. Countries such as Norway and China have implemented aggressive policies to accelerate EV adoption, including substantial tax exemptions, direct subsidies, and stringent emission regulations. The bibliometric analysis underscores the role of regulatory frameworks in shaping market trends, with keywords such as "subsidy system" and "transportation policy" appearing in multiple research clusters. Market dynamics, particularly the role of automakers and industry stakeholders, are also crucial in understanding EV adoption. The analysis highlights the presence of terms related to "sales," "innovation," and "consumer behavior," suggesting that market-oriented factors play a key role in shaping the trajectory of EV adoption. The shift toward shared mobility solutions, such as electric ride-hailing and car-sharing services, further reinforces the evolving nature of EV market trends. Additionally, the growth of battery manufacturing and supply chain networks has been a focal point in recent research, reflecting the increasing importance of localized production and resource management in the EV industry.

Challenges and Research Gaps

Despite the progress made in EV research, several challenges remain. One of the most prominent barriers is the high upfront cost of EVs, which continues to deter widespread consumer adoption. Although battery costs have been decreasing, the initial purchase price remains a concern for many consumers, particularly in developing markets. The keyword "costs" appearing in multiple clusters suggests that financial constraints are a persistent research topic. Another significant challenge is the development of charging infrastructure. While considerable advancements have been made in increasing the number of charging stations, issues related to charging speed, grid

capacity, and accessibility persist. The bibliometric analysis reveals a strong research focus on "charging infrastructure" and "vehicle-to-grid," indicating that scholars are actively exploring solutions to optimize charging networks. However, more research is needed to assess the feasibility of integrating renewable energy sources with EV charging systems. Consumer hesitancy due to range anxiety and charging convenience is another area requiring further investigation. Studies have shown that potential EV buyers are often concerned about the availability and reliability of charging stations, which can influence their purchasing decisions. Research on behavioral economics and psychological factors related to EV adoption is still developing, and future studies could delve deeper into how perceptions of EV usability evolve over time. From a policy perspective, discrepancies in EV adoption rates across different regions highlight the need for more localized research. While developed nations have seen significant progress, emerging economies still face barriers related to infrastructure, affordability, and policy implementation. Future research should focus on comparative studies analyzing the effectiveness of different policy interventions across diverse socioeconomic contexts.

Future Research Directions

The findings from this bibliometric study suggest several future research directions. First, more studies on battery recycling and second-life applications are needed, as sustainability concerns related to battery disposal are becoming increasingly relevant. The analysis indicates a limited focus on battery end-of-life management, despite its significance in the broader EV ecosystem. Second, the integration of EVs with smart grids and renewable energy sources presents a promising area for further exploration. The presence of "vehicle-to-grid"

in the keyword network suggests growing interest, but additional research is required to assess the scalability and economic viability of such technologies. Third, the role of artificial intelligence (AI) and big data in EV adoption is an emerging research avenue. With the increasing digitalization of transportation, AI-driven predictive analytics, machine learning-based EV routing, and data-driven policy interventions could play a crucial role in shaping the future of electric mobility. Finally, future research should focus on longitudinal studies examining consumer behavior changes over time. Understanding how consumer perceptions and attitudes toward EVs evolve with technological advancements and policy changes can provide valuable insights for stakeholders in both the public and private sectors.

4. CONCLUSION

The bibliometric analysis of electric vehicle adoption and market trends provides a comprehensive overview of the evolving research landscape. The findings highlight the increasing interest in EV research, the multidisciplinary nature of the field, and the importance of policy, technology, and market dynamics in driving adoption. While significant progress has been made, several challenges, including cost, infrastructure, and consumer perceptions, remain. Addressing these challenges requires continued collaboration between researchers, policymakers, and industry stakeholders. Future studies should explore emerging areas such as battery sustainability, smart grid integration, and AI-driven mobility solutions to further advance the field. By identifying key research gaps and trends, this study contributes to a deeper understanding of the electric vehicle ecosystem and provides a foundation for future investigations.

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