

Charging infrastructure scholarship for electric vehicle adoption: current trends and future agendas

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Abstract

Purpose – This study offers a review of electric vehicle (EV) charging infrastructure scholarship, aiming to identify key publication trends, collaborative research networks, dominant thematic clusters and emerging future research directions. The paper contributes by mapping the conceptual and thematic evolution of EV infrastructure research to guide scholars, policymakers and industry stakeholders.

Design/methodology/approach – A mixed-method bibliometric and thematic content analysis was conducted using 498 peer-reviewed articles from the Scopus database spanning 2013–2024. Advanced techniques such as co-word analysis, conceptual structure mapping and thematic clustering were applied using the Bibliometrix R package. Additionally, a conceptual framework was proposed based on the diffusion of innovation and resource-based view theories.

Findings – The results reveal five core thematic areas: charging infrastructure and optimization, battery technologies and V2G systems, sustainability integration, policy and governance frameworks and behavioral dimensions of EV adoption. The study highlights evolving research areas including blockchain-enabled charging, charge scheduling under uncertainty, electromobility governance and lifecycle environmental assessments. Country collaboration analysis reveals strong ties between China, the USA and the UK, underscoring global cooperation. Future research directions emphasize the need for user-centered infrastructure planning, integrated optimization models and adaptive energy management frameworks.

Research limitations/implications – The study is limited to Scopus-indexed publications and excludes non-journal sources such as conference proceedings and books. Future research may expand the dataset across other databases and adopt systematic review methods to delve deeper into specific themes.

Practical implications – The study provides actionable insights for EV manufacturers, infrastructure developers and service providers. Recommendations include prioritizing fast-charging infrastructure, adopting blockchain for transaction security and aligning with circular economy principles in battery usage and recycling.

Social implications – By enhancing charging infrastructure and addressing range anxiety, the findings support increased public acceptance of EVs. Broader adoption may contribute to urban sustainability, reduced carbon emissions and improved public health outcomes.

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Originality/value – This is one of the first comprehensive bibliometric and thematic syntheses focused specifically on EV charging infrastructure. The proposed conceptual framework and detailed future research agenda offer novel contributions to advancing sustainable mobility research and practice.

Keywords Electric vehicles, Charging infrastructure, Sustainable mobility, Bibliometric analysis, Blockchain, Diffusion of innovation, Resource-based view

Paper type Literature review

1. Introduction

The global surge in electric vehicle (EV) adoption, fueled mainly by environmental concerns and the need for sustainable transportation, has heightened the demand for well-planned and expansive charging infrastructure (Illahi, Choudhari, Charly, O'Mahony, & Caulfield, 2024; Horesh, Zhou, & Quinn, 2023). EVs, recognized for their potential to reduce greenhouse gas emissions, are gaining popularity as governments and industries shift toward cleaner technologies (San Loh & Noland, 2024; Ahmad, Chaveesuk, & Chaikasoonthorn, 2025; Prakhar, Jaiswal, Gupta, & Gupta, 2024c). However, the widespread adoption of EVs is influenced by various factors, including social perception, environmental consciousness (Gupta, Prakhar, & Jaiswal, 2025), financial incentives and the availability of charging stations (Lee, Baig, Talpur, & Shaikh, 2021; Ng, Law, & Zhang, 2018). Among these, insufficient charging infrastructure remains a significant barrier, particularly in densely populated areas where range anxiety persists (Liu, Vlachokostas, Si, & Kontou, 2024; Sun, 2021; He, Kuo, & Sun, 2022). Additionally, research has highlighted how consumer preferences and interactions with charging infrastructure shape adoption patterns (Hardman *et al.*, 2018). Efforts to address this gap include alternative approaches such as battery rental and swapping, which aim to enhance accessibility and affordability (Farinloye *et al.*, 2024; Hu, Yang, Sun, & Zhang, 2023). However, these advancements present challenges, such as strain on existing electricity grids to meet the growing demand for EV charging (Ampah *et al.*, 2022). Furthermore, cybersecurity considerations have become increasingly relevant as charging networks expand, necessitating secure and resilient infrastructure (Ronanki & Karneddi, 2024). As EV technology evolves, addressing infrastructure challenges becomes increasingly urgent, necessitating a broad understanding of current trends, barriers and opportunities.

Several motivations drive this study. First, the rapid evolution of the EV industry requires up-to-date knowledge to identify research gaps and future directions. Second, the transition to EVs is critical for reducing greenhouse gas emissions, making the development of charging infrastructure a key focus for climate change mitigation. Third, policymakers and governments must thoroughly understand the existing literature to create effective incentives, regulations and infrastructure investments. Finally, industry stakeholders such as manufacturers and charging network operators need insights into market trends, consumer preferences and technological advancements to guide strategic decisions. In particular, studies on the role of demand management strategies in enhancing service sustainability provide relevant insights into optimizing EV charging infrastructure (Rajani, Heggde, Kumar, & Chauhan, 2022).

Key research gaps exist in exploring and extending existing knowledge by providing content analysis of academic trends in areas such as the scalability of charging infrastructure, user experience across different charging technologies, regional disparities in infrastructure development and the long-term sustainability of these networks. Prior studies have employed multi-criteria decision-making and structural modeling methodologies to address similar challenges in different supply chain sectors (Kashav, Garg, & Kumar, 2023; Kumar, 2017; Kumar, Gupta, & Gupta, 2021). Applying such frameworks to the EV charging domain can offer structured insights into overcoming limitations. Moreover, reviewing international experiences, such as the UK's EV charging infrastructure policies, can inform best practices and strategic implementations (Chen *et al.*, 2020).

This study aims to comprehensively synthesize the current academic landscape, offering a valuable resource for researchers, policymakers and industry stakeholders. By identifying

these gaps and proposing a future research agenda, this review informs policy, supports infrastructure development and provides insights into evolving market dynamics, thereby contributing to the rapid development of electric mobility. This study examined the existing literature on EV adoption from 2013 to 2024. The bibliometric analysis method employed in the current study has been used in earlier studies (Prakhar, Jaiswal, & Gupta, 2024b). The research explores explicitly the following research questions:

- RQ1. What are the publication trends in EV charging infrastructure research?
- RQ2. What are the collaboration patterns in EV charging infrastructure research, and which networks or regions are most prominent?
- RQ3. What are the key topics and themes explored in EV charging infrastructure research?
- RQ4. What are the emerging areas for future research in EV charging infrastructure, and how can these address current limitations and support sustainable EV adoption?

Research objectives aligned with the research questions and study focus are as follows:

- RO1. To analyze the publication trends in EV charging infrastructure research.
- RO2. To examine collaboration patterns in EV charging infrastructure research and determine the most prominent networks and regions.
- RO3. To classify and synthesize the key topics and themes explored in EV charging infrastructure research.
- RO4. To identify emerging research areas and propose a future research agenda that addresses current limitations and supports sustainable EV adoption.

2. Research methods

Figure 1 presents a process for evaluating and choosing research publications on EVs and charging infrastructure in social science domains. For this study, the bibliometric data emerged from Scopus. Scopus was chosen due to its wide range of peer-reviewed academic journals, consistent indexing quality, multidisciplinary scope and strong referencing tracking capabilities. For the extensive database and consistent data quality, Scopus has also been extensively identified and recommended in bibliometric studies (Gupta, Jaiswal, & Gupta, 2024; Jaiswal *et al.*, 2022, 2023; Prakhar *et al.*, 2024a, 2024b, 2024d; Jaiswal & Gupta, 2023). Following the initial selection from 34,132 papers, a final selection of 498 articles remained for in-depth study using particular inclusion criteria. Using advanced bibliometric methods such as Bibliometrix (R package), the final dataset enabled the identification of future research questions and factorial and theme assessments.

3. Results and discussion

3.1 Word cloud and country collaboration map

The most significant trends in EV adoption and charging infrastructure are shown in the word cloud (Figure 2). The predominant word, “EV,” (320 occurrences), highlights the essential relevance of the topic. “Charging (batteries)” (256 occurrences) emphasizes their vital role in enabling general EV use by highlighting significant research interest in battery technology and related charging methods. The terms “charging stations” (107 occurrences) and “secondary batteries” (95 occurrences) reflect important areas of research targeted on infrastructural expansion and energy storage solutions, suggesting major academic work aimed at resolving practical and technological barriers to EV deployment. Furthermore, advancing this primary objective are “charging infrastructures” (69 occurrences) and “electric vehicle charging” (68

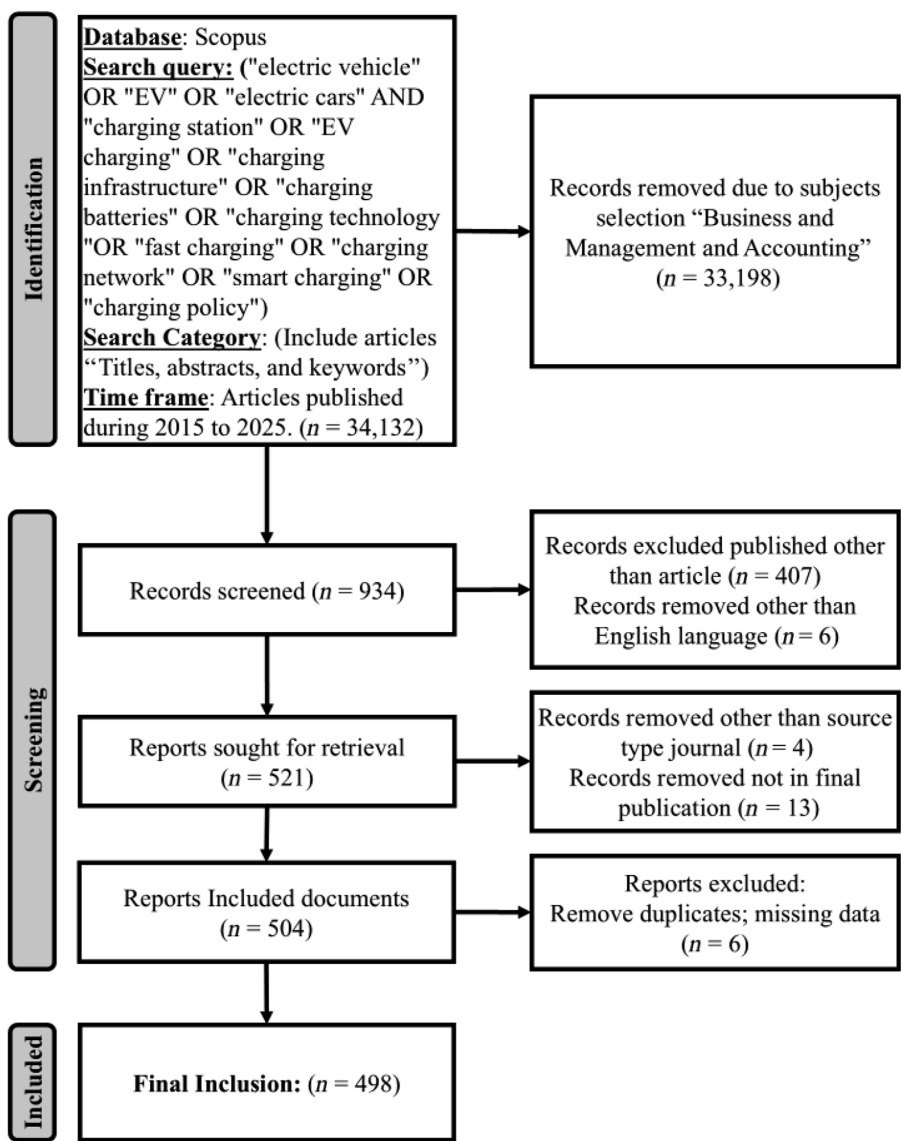
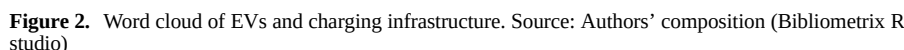


Figure 1. Data inclusion criteria (based on PRISMA guidelines). Source: Authors' composition

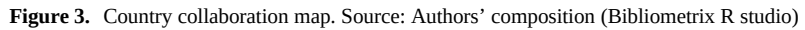
events), therefore underlining the need for expanding and readily available infrastructure networks for successful EV integration. Methodological methods are also more important; "integer programming" (51 occurrences) and "optimization" (41 occurrences) show significant usage of quantitative techniques targeted at enhancing infrastructure design, operational efficiency and resource management. Moreover, the keyword "vehicle-to-grid" (39 occurrences) indicates notable studies on energy exchange and its possibilities to improve the energy system's resilience through EV integration with power grids. Terms like "decision making" and "transportation infrastructure" (44 occurrences) indicate continuous research on the regulations and strategic planning required for the ideal integration of EVs within more



The country collaboration map (Figure 3) shows international research cooperation on EV adoption and charging infrastructure. China is among the most active countries, collaborating with the US (22), Hong Kong (ten) and the UK (ten). These partnerships highlight China's leadership in worldwide EV technology and infrastructure research and encourage international knowledge exchange. The US has strong scientific partnerships with China (22), the Netherlands (three), Hong Kong (three) and other European and Asian nations. It shows the US's deliberate focus on global expertise and collaboration in challenging EV infrastructure problems. The UK's frequent partnership with China, Germany and Brazil promotes cross-regional electric mobility research. Germany has strong European and international partnerships, enhancing its EV research and policy role. India's research connections, especially with Ethiopia (three), Australia and the UK (two each), show its rising interest and strategic emphasis on sustainable mobility solutions in developing countries.

Key area	Research gap	Future research directions
Battery and charging technology	Limited integration of advanced battery management with dynamic charging solutions	Explore next-generation battery technologies combined with real-time smart charging strategies
Charging infrastructure development	Insufficient scalable models for comprehensive charging network deployment	Develop scalable, adaptable and user-centered infrastructure planning models using advanced analytics
Vehicle-to-grid (V2G) integration	Lack of standardized models and practical frameworks for V2G applications	Establish practical guidelines and industry standards for V2G technology deployment in various grid scenarios
Methodological approaches	Scarcity of integrated optimization approaches tailored for EV infrastructure complexities	Enhance multi-criteria optimization models incorporating economic, environmental and operational factors
Policy and strategic planning	Inadequate understanding of policy impacts and strategic frameworks on EV adoption	Investigate policy interventions and develop comprehensive strategic frameworks to accelerate EV adoption

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The conceptual structure map (Figure 4) presents four primary research clusters derived from factorial analysis, offering detailed insights into the core thematic areas of scholarly work on EV adoption and charging infrastructure.

The largest and thickest cluster, Cluster 1 (purple), includes charging infrastructure development, battery technology, user behavior and operational dynamics. Within this cluster, [Biresselioglu, Demirbag Kaplan, and Yilmaz \(2018\)](#) investigate European motivators and hurdles to EV adoption, including regulatory incentives, infrastructural preparation and consumer views. Additionally, [Tarei, Chand, and Gupta \(2021\)](#) examine similar constraints in



India, stressing high initial costs, limited charging facilities and consumer concerns regarding vehicle performance and reliability. These studies show that EV adoption challenges are several and require specific policy interventions and improved infrastructure. The location of strategic battery charging stations is investigated by [Guo, Yang, and Lu \(2018\)](#). The study shows that range anxiety and accessibility strongly influence infrastructure placement decisions, emphasizing the need for user-centered metrics in planning models. [Chen, Kockelman, and Hanna \(2016\)](#) examine how operational and charging infrastructure decisions affect shared, automated EV fleet performance and efficiency. [Zhang, Gajpal, Appadoo, and Abdulkader \(2018\)](#) optimize EV routing and charging station integration to reduce energy consumption and increase operational efficiency. The terms “battery electric vehicles,” “charging stations,” “vehicle-to-grid” and “secondary batteries” represent the emphasis on technology acceptance, infrastructure optimization and user-centric EV adoption.

Cluster 2 (red) focuses on rigorous methodology and strategic planning for infrastructure management. [He et al. \(2022\)](#) provide a location-allocation model for public charging infrastructure in highly populated urban areas, promoting the strategic importance of data visualization in infrastructure development. [Zhang et al. \(2022a\)](#) provide optimization algorithms for routing shared autonomous EVs, explicitly considering route and service time uncertainty. [Qin, Gusrialdi, Paul Brooker, and T-Raissi \(2016\)](#) and [Wang, Huang, Xu, and Barclay \(2017\)](#) use numerical analysis and optimization models to lower bus charging demand charges and operational costs for electric bus networks. In addition, [Zeng, Wang, and Qu \(2022\)](#) study the importance of battery degradation in electric bus system charge scheduling, highlighting lifetime issues in infrastructure development. This cluster includes “integer programming,” “optimization” and “transport planning,” indicating advanced analytical and operational solutions to solve complex logistical and infrastructure problems.

Cluster 3 (green) addresses greenhouse gas emissions and sustainability issues, highlighting EV adoption’s environmental impact. Cluster 4 (blue) highlights electric buses and public transportation, indicating a strong academic interest in specialized modes of transportation and their infrastructure. These clusters highlight specific but important study areas that expand the wider research environment, enhancing EV-related research domain knowledge. [Table 2](#) lists the future research avenues based on the conceptual structure map.

3.4 Thematic clustering

Based on the content analysis of articles within each of the nine thematic clusters ([Figure 5](#)), this study briefly addresses each one and recommends potential future research questions (FRQs). The conceptual framework is organized using thematic clustering ([Prakhar et al., 2024b](#)). [Figure 5](#) illustrates a strategic thematic analysis of charging infrastructure research within the broader context of EV adoption, dividing research subjects according to their level of development degree (density) and relevance (centrality). Motor themes, niche themes, essential themes and emerging or declining themes are shown on the thematic map. Motor topics are dense and central, with EV sustainability dominating research in smart charging, V2G connectivity, renewable energy and carbon footprint reduction. Research on charging station allocation, optimization methods, range anxiety and incentive structures is concentrated but decentralized in niche fields like charge scheduling. High centrality but low-density themes dominate EV adoption research, with charging infrastructure including charging network optimization, battery swapping, routing algorithms and multi-objective optimization approaches. Themes like electromobility challenges show shifting study areas addressing infrastructural, policy and adoption limits, gaining more integration or losing academic strength. This analysis highlights the growing importance of sustainable charging options and smart grid integration while indicating charge scheduling research gaps that need practical implementation. To improve EV network expansion and efficiency, charging infrastructure must be optimized using advanced modeling approaches. [Figure 5](#) systematically overviews current patterns and emerging study directions, helping

Table 2. Future research avenues based on conceptual structural map

Key area	Research gap	Future research directions
Charging infrastructure development and user behavior	Insufficient integration of user-centric concerns (range anxiety and convenience) in infrastructure planning	Develop user-focused charging infrastructure frameworks that comprehensively address adoption barriers like range anxiety and infrastructure accessibility
Battery technology and vehicle-to-grid integration	Limited practical frameworks and standardized applications of battery technology and V2G integration	Explore standardized, scalable V2G integration solutions, incorporating next-generation battery technologies for practical grid interaction
Methodological optimization and spatial planning	Scarcity of robust optimization and spatial analytical models accommodating uncertainty and operational dynamics	Advance integrated optimization methodologies, explicitly accounting for uncertainty, spatial constraints and lifecycle impacts in planning processes
Environmental sustainability and emissions	Limited studies quantifying direct impacts of infrastructure strategies on emissions reduction	Quantify environmental benefits and emission reduction potentials of various infrastructure deployment strategies through targeted empirical research
Electric buses and public transport systems	Lack of specialized optimization models addressing the specific infrastructure and operational challenges of electric bus systems	Create tailored operational models for electric bus networks that integrate battery lifecycle management and efficient scheduling strategies
Lifecycle and economic assessments	Inadequate lifecycle and economic analysis in the context of varied regional deployment scenarios	Conduct detailed lifecycle assessments and economic analyses to inform policy and strategic decisions across diverse geographical and operational contexts
Source(s): Authors' composition		

researchers and policymakers organize infrastructure development and EV adoption research. Documents from each cluster are listed below according to theme.

3.4.1 EV and sustainability. This cluster includes 80 documents representing an important collection of studies on the relationship between EV adoption and sustainability. The main research themes focus on V2G systems, advanced charging technologies, integrating renewable energy, reducing carbon footprints and planning infrastructure to enhance energy resilience. The themes include broader sustainability concepts like system dynamics, uncertainty management and policy-driven shifts toward e-mobility. This collection of research highlights the increasing focus on integrating EV infrastructure with sustainable energy systems. [Ekren, Hakan Canbaz, and Güvel \(2021\)](#) explore the design of hybrid solar-wind charging stations through HOMER software, offering a techno-economic framework for off-grid renewable charging solutions. [Mehrjerdi and Rakhshani \(2019\)](#) highlight how combining V2G technology with solar power can effectively lower operational costs and address grid uncertainties, highlighting the importance of regional renewable systems in EV charging strategies. This research stream also includes infrastructure efficiency and spatial planning. [He, Kockelman, and Perrine \(2019\)](#) presents a framework to improve the placement of fast charging stations to enhance long-distance travel across the US, adding to the discussion on accessibility and network efficiency. [Harrison and Thiel \(2017\)](#) examine how changes in charging infrastructure affect EV market dynamics in Europe, highlighting the connection between infrastructure readiness and market competitiveness. The theme includes improvements in demand forecasting and behavioral modeling. [Jahangir et al. \(2019\)](#) employ a rough artificial neural network to forecast charging demand influenced by travel behavior, tackling an important issue in infrastructure use. [Quddus, Kabli, and Marufuzzaman \(2019\)](#) present a multifaceted expansion model that combines renewable sources with V2G

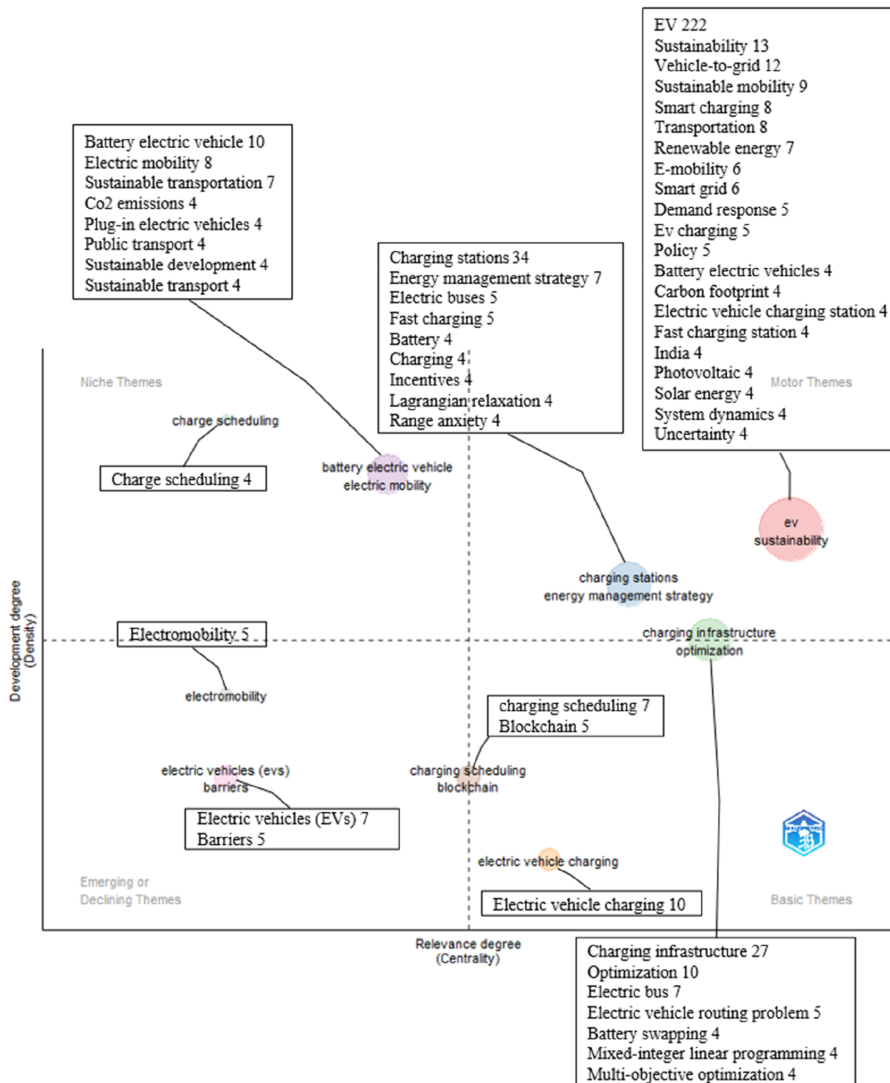


Figure 5. Thematic map. Source: Authors' composition (bibliometrix R studio)

systems and a better choice of location while considering capacity and policy constraints. Wang, Jochem, and Fichtner (2020) tackle the challenges of uncertainty in scheduling and demand by creating a random optimization model that aids in dynamic charging scheduling, highlighting the importance of real-time decision-making in changing conditions. This cluster highlights the importance of integrating EV infrastructure with sustainable energy systems in contemporary research.

3.4.2 Charging stations and energy management strategy. This cluster includes 52 documents that analyze the strategic placement and management of EV charging stations, highlighting optimization techniques, demand-side factors and operational strategies to improve energy efficiency. The main themes focus on planning for charging station locations, strategies for energy management, the development of fast-charging infrastructure, policy

incentives and addressing range anxiety. This area of research integrates engineering models with behavioral insights to enhance infrastructure deployment in the public and private sectors. Enhancing charging location is a key aspect of this cluster. [Cavadas, Homem De Almeida Correia, and Gouveia \(2015\)](#) present a mixed-integer programming model to optimize the placement of slow-charging stations in urban settings, considering driver tour behavior to ensure that infrastructure planning reflects actual usage patterns. [Guo et al. \(2018\)](#) explore how user-related factors like range anxiety and distance convenience influence the placement of charging stations, highlighting the importance of location convenience in planning EV infrastructure. [Qin et al. \(2016\)](#) perform a numerical analysis of fast-charging strategies for electric buses, highlighting their ability to lower demand charges and operational expenses. [Wang et al. \(2017\)](#) developed their study by presenting a scheduling framework designed for urban bus fleets. This framework improves recharging activities to maintain the availability of services and reduce the impact on the electrical grid. Hybrid infrastructure planning models address energy management strategies and user satisfaction. [Yang, Guo, and Zhang \(2017\)](#) propose a method for network design that merges battery swapping with traditional charging, aiming to improve user experience and infrastructure use. The model considers service availability and customer satisfaction, providing a valuable planning tool for network operators. Policy incentives are an important aspect of this cluster. [Liu, Sun, Zheng, and Huang \(2021\)](#) present evidence from China that demonstrates how incentive structures can effectively promote the adoption of EVs and influence the development of charging infrastructure. [Pevec et al. \(2020\)](#) explore the psychological aspects of range anxiety using survey analysis, highlighting the need to tackle perceived charging limitations to build consumer confidence. The studies in this cluster enhance the knowledge of charging station deployment by highlighting the connections between space optimization, energy management, user behavior and policy design.

3.4.3 Charging infrastructure and optimization. This cluster focuses on advanced modeling techniques, including mixed-integer linear programming, multi-objective optimization and routing problem formulations. It focuses on infrastructure planning for electric buses, battery swapping systems and the integration of renewable energy sources. Space optimization is an essential focus in this cluster. [Asamer, Reinthaler, Ruthmair, Straub, and Puchinger \(2016\)](#) propose a model for positioning charging stations that aligns with the needs of urban taxi services, considering factors such as trip density and service coverage. [Yi and Bauer \(2016\)](#) suggest optimization models that consider energy use to inform infrastructure placement, aiming to reduce costs while enhancing energy efficiency. These studies highlight the important role of geographic data analysis in improving the use and accessibility of infrastructure. Research in this area focuses on integrating renewable energy sources and storage technologies into the design of charging stations. [Sun \(2021\)](#) introduces a framework for multi-objective optimization that integrates fast-charging stations with wind power, photovoltaic systems and energy storage. This work points out how hybrid systems can enhance energy resilience and reduce dependence on the grid. [Zhang, Sun, Ding, and Yang \(2019\)](#) provide a life cycle assessment of EV charging infrastructure in China, evaluating the environmental choices associated with its components. An additional prevalent theme is decision-making in uncertain circumstances and the associated risks for stakeholders. [Liu and Wei \(2018\)](#) utilize a fuzzy TOPSIS method to assess risks associated with public-private partnerships in developing EV charging infrastructure, offering a systematic way to evaluate investment potential and consistency in policies. [Fang et al. \(2020\)](#) create an evolutionary game model that integrates user preferences and incentives to simulate how infrastructure adoption evolves in an integrated environment. The cluster explores innovative mixtures for the EV routing problem. [Zuo, Xiao, You, Kaku, and Xu \(2019\)](#) introduce a time-window-based EV routing problem that incorporates an inclined unpredictable charging function, reflecting the non-linear characteristics of battery charging. This method offers valuable insights for logistics and public transport systems seeking to incorporate EVs with minimal errors. These studies collectively demonstrate the complexity and attention of research focused on

optimizing charging infrastructure. This cluster focuses on integrating operational models, environmental assessments and policy considerations to tackle the complex challenges of planning and deploying scalable EV infrastructure systems.

3.4.4 Charging scheduling and blockchain. This cluster consists of ten documents and highlights an evolving research area centered on two main themes: scheduling for EV charging and blockchain systems for authentication, security and transaction management in charging. The emerging literature in this area highlights initial efforts to enhance EV charging networks' reliability, efficiency and transparency using advanced digital and organized technologies. Charging scheduling is an important point within the cluster, with numerous studies aimed at efficient energy consumption, reducing problems at charging stations and enhancing the coordination of mobile or fleet-based charging systems. [Li, Son, and Jeong \(2024\)](#) present a scheduling framework that incorporates mobile charging stations to address evolving charging needs in urban areas, enhancing the adaptability of infrastructure deployment. [Li et al. \(2023\)](#) present a decomposition-based optimization approach for coordinating vehicle charging and operations in automated container terminals, tackling the limitations of fast-changing technology in industrial logistics settings. The studies highlight the crucial role of intelligent scheduling algorithms in improving the operational efficiency of EV systems in diverse applications.

Additionally, blockchain has become essential for creating secure, decentralized and transparent charging systems. [Fu, Dong, Li, Ju, and Liu \(2021\)](#) explore a case study in Shanghai that investigates the potential of blockchain to improve urban EV charging services by fostering trust, automating payments and lowering intermediary costs. [Parameswarath, Gope, and Sikdar \(2022\)](#) introduce a privacy-focused authentication protocol that utilizes autonomous identity and verifiable credentials, allowing users to manage and secure their access to EV charging services. This study highlights the security benefits of blockchain technology in protecting sensitive user data. [Zhou, Wang, Wang, Yu, and Tang \(2024\)](#) thoroughly review planning and scheduling challenges in battery electric bus systems, highlighting recent developments in digital control systems, such as blockchain and algorithmic scheduling methods. [Sundarakani, Rajamani, and Madmoune \(2024\)](#) explore how blockchain can enhance sustainable EV performance in the UAE, offering evidence of its ability to improve infrastructure resilience and operational transparency in developing markets. This set of documents engages in a discussion about the future of digital transformation in EV charging systems.

3.4.5 Electric vehicle charging. This cluster includes six documents examining EV charging processes' coordination and strategic enhancement. This cluster addresses challenges such as enhancing charging station use, integrating ride-sourcing services, coordinating with the power grid and developing new wireless charging technologies. This cluster highlights strategies focused on users and systems to enhance the reliability, accessibility and scalability of EV charging services. [Cai, Mo, Geng, Tang, and Chen \(2023\)](#) present a model to manage EV charging within diverse vehicle fleets engaged in various mobility services. Their framework connects charging requirements with ride-sourcing logistics, enhancing vehicle availability and charging efficiency in busy urban areas. [Guillet and Schiffer \(2023\)](#) introduce a multi-agent system designed for a coordinated search of charging stations in uncertain conditions, allowing EV users to make distributed decisions and adapt their routes effectively. This cluster prominently includes advancements in charging technology. [Mubarak, Üster, Abdelghany, and Khodayar \(2021\)](#) explore the design of strategic networks for in-motion wireless charging, providing insights into how mobile charging infrastructure can help overcome range limitations and decrease congestion at charging stations. The study highlights the increasing focus on dynamic charging solutions, which enhance infrastructure flexibility and minimize reliance on fixed charging assets. [Shao and Yin \(2024\)](#) introduce a multi-objective optimization framework that integrates the management of EV charging, power grid loads, energy storage systems and solar power from a system-level perspective. This approach promotes sustainable and resilient energy consumption strategies by aligning EV charging operations with the broader goals of smart grids. [Zaidi, Oulamara, Idoumghar, and Basset \(2024\)](#) introduce an optimization model to improve operational

efficiency by maximizing satisfied charging demands with uniform charging infrastructure. Their work highlights how intelligent allocation can boost charger usage and enhance user satisfaction.

3.4.6 Electromobility. This cluster includes five documents examining electromobility's conceptual, managerial, and policy aspects. This collection of studies examines the development routes, key stakeholders, market views and regional strategies related to the shift toward electric mobility. It takes a systems-level approach, focusing on the institutional, socioeconomic and strategic factors that affect the adoption and governance of EVs. [Agbesi, Ruffino, and Hakovirta \(2024\)](#) examine the roles of various stakeholders and new trends in the United States, highlighting the significant relationships between manufacturers, governments, energy providers and consumers that influence the EV landscape. The study highlights the importance of coordinated efforts and policy alignment to ensure a smooth and sustainable shift to electric mobility. Case studies from this cluster provide valuable insights into implementing electromobility's spatial and governance challenges. [Drożdż \(2019\)](#) examines the growth of electromobility in Poland, highlighting the role of regulations and the existing infrastructure challenges. [Hrudkay and Jaroš \(2019\)](#) explore how electromobility has developed in Slovak municipalities, highlighting the impact of local governance, funding challenges and planning frameworks on its adoption at the municipal level. Consumer behavior and market management are also significant areas of focus. [Maličková, Dzuro, Barilová, and Lauko \(2022\)](#) examine marketing management practices in light of increasing EV adoption, highlighting the need for retail strategies to adjust to changing consumer expectations and mobility preferences. [Rovňák, Kalistová, Stofejová, Benko, and Salabura \(2022\)](#) examine how the public views sustainable mobility and the adoption of EVs, providing evidence of the consistency or inconsistency between policy communications and user perspectives.

3.4.7 Electric vehicles and barriers. This cluster includes 11 documents that examine the challenges related to the adoption of EVs. It focuses on the various obstacles related to infrastructure, economics, behavior and policy, especially in emerging and transitioning markets. The studies seek to explore the complex factors influencing resistance to EV diffusion and to suggest strategies that encourage wider adoption. [Biresselioglu et al. \(2018\)](#) offer a thorough examination of the factors that motivate and discourage individuals, exploring the decision-making processes involved in EV adoption throughout Europe. Their research identifies barriers as technical, financial and psychological, providing a foundation for comprehending consumer hesitancy. [Rietmann and Lieven \(2019\)](#) provide a comprehensive review of global policy measures aimed at promoting EV mobility, assessing their effectiveness and adaptability in various regulatory and socioeconomic environments. This cluster also faces significant economic and infrastructure challenges. [Sheng, Sreenivasan, Sharp, Wilson, and Ranjitkar \(2020\)](#) evaluate the economic viability of dynamic inductive charging infrastructure in New Zealand, focusing on a public-private partnership model. They identify capital intensity and technological uncertainty as significant barriers to adoption. [Zhang, Teoh, and Zhang \(2022b\)](#) utilize a Bayesian network combined with geographic information systems to improve site selection for charging stations, addressing spatial accessibility challenges through informed planning. [Virmani et al. \(2023\)](#) provide a thorough analysis of the adoption challenges faced by emerging economies. The study highlights significant barriers such as high initial costs, insufficient infrastructure and low consumer awareness. It suggests a framework for addressing these issues through stakeholder collaboration, targeted policy incentives and educational campaigns for users.

3.4.8 Battery electric vehicle and electric mobility. This cluster includes 34 documents and focuses on key themes, including reducing carbon emissions, integrating with public transport, ensuring life-cycle sustainability, planning for charging infrastructure and understanding the behavioral factors that affect the choice of battery EVs. Strategic infrastructure planning is an important area of study. [Xie, Liu, Li, Lin, and Huang \(2018\)](#) present a model for long-term planning of inter-city fast charging networks, which seeks to enhance the feasibility of battery EV travel and improve regional connectivity. [Liu, Liu, Le, Guo, and He \(2019\)](#) propose a data-

driven method to identify public charging stations, improving urban accessibility and the efficiency of infrastructure using intelligent spatial analytics. This cluster of studies explores how battery EVs contribute to sustainable logistics and public transport systems. [Gong, Tang, Liu, Xue, and Wang \(2019\)](#) introduce a model for resource scheduling aimed at enhancing the efficiency of EV charging stations, illustrating the role of effective scheduling in promoting sustainable transportation goals. [Lebeau, Macharis, and Van Mierlo \(2016\)](#) further examine the role of battery EVs in urban freight and logistics through a conjoint-based analysis, highlighting the main factors that affect operators' preferences and the adoption of BEVs in commercial fleets. This cluster also demonstrates life cycle and multiple-criteria sustainability assessment methods. [Onat, Kucukvar, Tatari, and Zheng \(2016\)](#) utilize a combined life-cycle sustainability assessment and multi-criteria decision-making framework to assess the best distribution of alternative passenger vehicles, including battery EVs, in the US market. It highlights the trade-offs between environmental, economic and social performance in strategies for deploying vehicles. The cluster points out the obstacles to battery EV adoption, especially in developing economies. [Tarei et al. \(2021\)](#) explore the challenges of adoption in India, highlighting cost sensitivity, infrastructure issues and policy gaps as significant barriers. These findings are crucial for guiding transition strategies in emerging markets.

3.4.9 Charging scheduling. This cluster consists of four documents focused on developing and evaluating models for optimizing EV charge scheduling, emphasizing real-time coordination, system performance and operational uncertainties. This cluster of studies examines charge scheduling as an essential operational element for managing load distribution, improving service quality and prolonging battery life, especially in public and fleet-based EV systems. Numerous studies examine how scheduling frameworks can be applied in unpredictable or real-world settings. [Kim, Son, Lee, and Ha \(2017\)](#) examine EV charging in uncertain conditions, highlighting key performance indicators like wait times and system throughput. Their modeling method enhances infrastructure use and service reliability, especially in busy urban areas. [Zeng et al. \(2022\)](#) examine how battery degradation affects charging strategies for electric buses within bus transit systems. Their findings highlight the need to consider the entire lifecycle when making scheduling decisions, which helps ensure smooth operations and lower maintenance costs over time. [Zeng, Wang, and Qu \(2024\)](#) incorporate uncertain variables and real-world limitations into a scheduling model for electric bus networks, thus improving the practical relevance of theoretical models for travel operators. Their framework tackles the issues of charging station availability and travel time uncertainties, providing a thorough method for dynamic fleet coordination. [Hiremath and Mallapur \(2024\)](#) present a technological approach that involves a cloud-assisted charge scheduling mechanism for vehicular ad hoc networks using deep recurrent neural networks. This model focused on quality of service and shows how advanced machine learning can be used for predictive and adaptive scheduling in distributed EV networks. These studies enhance our understanding of charge scheduling by combining technological, operational and environmental aspects. Future research should explore the following FRAs as mentioned in [Tables 3 and 4](#).

3.5 Conceptual framework based on thematic analysis

The proposed theoretical framework ([Figure 6](#)) emphasizes charging infrastructure and battery-related factors while combining the diffusion of innovation (DOI) theory and the resource-based view (RBV) to understand better the factors impacting the adoption of EVs. Key independent variables include charging infrastructure availability ([Murugan & Marisamynathan, 2024b](#); [Ahmad, Chaveesuk, & Chaiyasoonthorn, 2025](#)), charging technology advancements ([Will & Schuller, 2016](#)) (e.g. fast and smart charging), battery swapping ([Murugan & Marisamynathan, 2024a](#)), energy storage solutions ([Bulut & Özcan, 2024](#)) and supportive charging policies ([Chonsalasin et al., 2024](#)). These factors align with DOI attributes such as observability, compatibility and relative advantage, enhancing the perceived benefits and ease of EV adoption ([Stacks & Salwen, 2014](#)). From an RBV

Table 3. Future research avenues based on thematic clustering

Key area	Research gap	Future research direction
<i>Niche themes</i>		
Charging scheduling and blockchain	Limited real-world deployment of blockchain-integrated EV systems and lack of standardized protocols	Develop decentralized blockchain protocols aligned with charging networks and investigate user acceptance in pilot programs
Charge scheduling	Insufficient consideration of battery degradation and dynamic traffic conditions in charge scheduling models	Integrate battery lifecycle modeling with real-time stochastic scheduling for transit and fleet operations
<i>Motor themes</i>		
EV and sustainability	Need for comprehensive models integrating sustainability metrics with infrastructure scalability	Propose integrated frameworks for smart grid connectivity, renewable use and carbon reduction within EV infrastructure
<i>Emerging/declining themes</i>		
Electromobility	Limited empirical evidence from developing countries on stakeholder coordination and local governance	Conduct multi-stakeholder case studies to evaluate electromobility deployment across local governance structures
Electric vehicles and barriers	Lack of integrated frameworks addressing socio-economic and policy-related adoption barriers	Formulate multi-dimensional adoption models combining financial incentives, user education and infrastructure growth
<i>Basic themes</i>		
Charging infrastructure and optimization	Scarcity of unified multi-criteria optimization frameworks combining routing, energy sources and location strategies	Design hybrid optimization models incorporating environmental, spatial and operational trade-offs at network scale
Electric vehicle charging	Lack of coordinated frameworks combining user behavior, grid constraints and charging station dynamics	Develop simulation-based decision tools to model interaction between user demand, grid load and infrastructure capacity
Charging stations and energy management strategy	Need for adaptive energy management strategies under varied operational contexts and emerging demand profiles	Explore AI-driven adaptive scheduling and demand response models tailored for urban and rural energy ecosystems
Battery electric vehicle and electric mobility	Insufficient integration of BEVs in long-term strategic planning and limited life-cycle assessments in diverse regions	Apply scenario-based modeling and dynamic LCA approaches to assess BEV deployment impacts in different regional contexts
Source(s): Authors' composition		

perspective, robust charging infrastructure and advanced battery technologies are considered strategic resources that provide competitive advantages to firms, facilitating wider EV adoption (Barney, 2001). By addressing customer concerns and improving the overall value proposition of EVs, mediating factors like perceived convenience, accessibility, range security and technology trust have an additional impact on the adoption process. In order to encourage the adoption of EVs, this integrated approach highlights the complex interactions among resource capabilities, customer attitudes and technology advancements.

4. Implications

4.1 Theoretical contribution

This study makes several significant contributions to the literature on electric vehicle (EV) adoption and charging infrastructure while offering valuable theoretical implications for future

Table 4. FRQs on the basis of each thematic cluster

Thematic cluster	Future research questions (FRQs)
Charging scheduling and blockchain	<i>FRQ1. How can blockchain improve the transparency and security of EV charging transactions in decentralized networks?</i> <i>FRQ2. What are the barriers to adoption of blockchain-based EV charging models among different user groups and infrastructure providers?</i>
Charge scheduling	<i>FRQ3. How can real-time traffic data and stochastic energy demand be integrated into charge scheduling for public EV fleets?</i> <i>FRQ4. What are the trade-offs between battery longevity and charging frequency in dynamic EV scheduling models?</i>
EV and sustainability	<i>FRQ5. How can sustainability metrics be embedded into infrastructure planning for EVs across diverse geographical regions?</i> <i>FRQ6. What is the role of V2G integration in achieving long-term carbon neutrality in urban transport systems?</i>
Charging infrastructure and optimization	<i>FRQ7. What hybrid optimization models can simultaneously manage charger location, renewable energy sourcing, and grid stability?</i> <i>FRQ8. How can real-time optimization algorithms adapt to fluctuating EV demand and renewable energy availability?</i>
Electric vehicle charging	<i>FRQ9. How can EV user behavior be modeled to predict charging patterns under varying pricing and congestion conditions?</i> <i>FRQ10. What strategies can be developed to integrate grid feedback, renewable input, and user choice in charging operations?</i>
Charging stations and energy management strategy	<i>FRQ11. How can adaptive energy management systems be designed to respond to peak load challenges in urban EV charging hubs?</i> <i>FRQ12. What incentive mechanisms can align user behavior with energy-efficient charging practices in shared infrastructure models?</i>
Electromobility	<i>FRQ13. How do local policies and governance structures influence electromobility diffusion across different socioeconomic settings?</i> <i>FRQ14. What collaborative models between municipalities and private sectors can accelerate electromobility infrastructure in small cities?</i>
Electric vehicles and barriers	<i>FRQ15. How can targeted incentives address perceived financial and performance barriers to EV adoption in low-income communities?</i> <i>FRQ16. What policy frameworks best support the removal of institutional and infrastructural barriers to EV adoption in emerging markets?</i>
Battery electric vehicle and electric mobility	<i>FRQ17. How can BEVs be integrated into multimodal public transport systems to reduce urban congestion and emissions?</i> <i>FRQ18. What regional differences influence user acceptance of BEVs, and how can these be addressed through tailored infrastructure planning?</i> <i>FRQ19. How can life-cycle environmental and economic impacts of BEVs be compared with conventional and hybrid vehicle systems across regions?</i>

Source(s): Authors' composition

research. It is among the earliest comprehensive bibliometric and thematic syntheses focusing exclusively on EV charging infrastructure, setting it apart from prior reviews that primarily explored EV adoption from a technological or supply chain perspective. By analyzing 498 peer-reviewed articles published between 2013 and 2024, the study identifies key publication trends, international research collaborations, dominant thematic areas and emerging frontiers in EV infrastructure research. This granular focus offers a much-needed consolidation of knowledge in a rapidly evolving domain and is a critical resource for scholars, policymakers and practitioners.

The study adopts a dual methodological approach by combining advanced bibliometric techniques such as co-word analysis and conceptual structure mapping with in-depth thematic content analysis. This enables the identification and classification of established and emerging

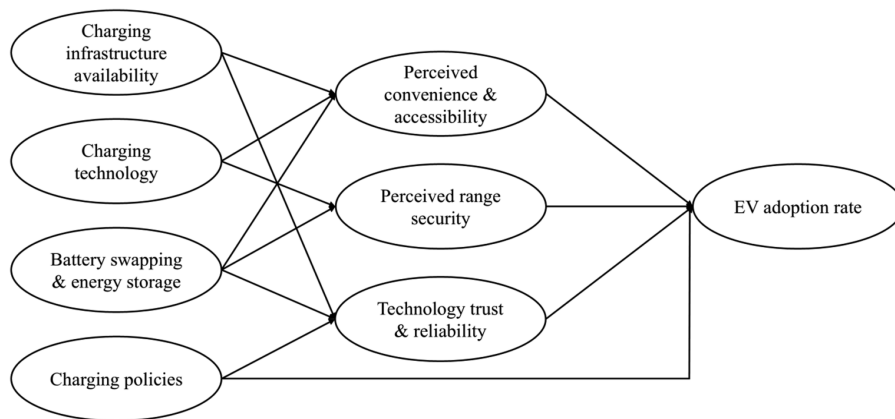


Figure 6. Conceptual framework. Source: Authors' composition

themes across the literature. Integrating quantitative mapping with qualitative interpretation enriches the field's understanding by offering a multidimensional view of research progress and direction. The outcome is a systematic overview of nine thematic clusters and five major research themes, allowing scholars to navigate better the complex ecosystem of EV charging infrastructure scholarship.

The research proposes a novel conceptual framework grounded in the diffusion of innovation (DOI) theory and the resource-based view (RBV), offering a theoretical lens to understand EV infrastructure adoption. The framework conceptualizes charging technology, infrastructure availability, policy support and battery innovations as strategic resources that influence adoption through perceived benefits, compatibility and observability, i.e. core attributes of the DOI theory. Simultaneously, it highlights how infrastructure and technological assets provide firms with competitive advantages, aligning with the RBV. This theoretical integration contributes to understanding how innovation diffusion interacts with organizational resource capabilities to shape market behaviors.

This study broadens the research agenda by incorporating underexplored yet increasingly vital dimensions, such as digital transformation (e.g. blockchain applications in EV charging), behavioral responses (e.g. range anxiety and user acceptance) and governance mechanisms in infrastructure deployment. These insights extend the theoretical boundaries beyond technical optimization, including perspectives from behavioral economics, digital ecosystems and institutional governance. Analyzing motor, niche, emerging and declining themes encourages future theoretical development using socio-technical systems theory, institutional theory and inclusive innovation models.

The findings provide direction for future theoretical inquiry by identifying thematic gaps such as limited empirical studies in developing countries, the absence of standardized V2G frameworks and the need for integrated optimization models. These gaps signal the potential for building localized theories of infrastructure adoption, stakeholder collaboration and adaptive energy management. By emphasizing contextual factors like governance structures, user-centric planning and regional disparities, the study contributes to the evolving discourse on inclusion and transitions toward sustainable mobility. The proposed research agenda encourages scholars to develop globally relevant and locally sensitive theories, thereby enriching the theoretical foundations of sustainable transportation and innovation adoption.

4.2 Policy implication

The findings of this study offer several valuable implications for policymakers aiming to accelerate the transition toward electric mobility through effective charging infrastructure

strategies. One of the key takeaways is the need for user-centric infrastructure planning. Policies should prioritize the quantity and the strategic location of charging stations, especially in urban areas where range anxiety and convenience significantly influence user adoption. The research underscores the value of spatial optimization models that account for actual driving patterns, range anxiety and socio-demographic usage clusters. Policymakers are encouraged to incentivize the integration of renewable energy sources and vehicle-to-grid (V2G) systems into the charging ecosystem. This aligns with the study's emphasis on sustainability and energy resilience. Establishing clear national standards for interoperability, smart grid integration and V2G protocols will promote investment confidence and ensure smoother coordination among stakeholders. Given the rapid digitalization of mobility infrastructure, regulatory bodies should consider formulating cybersecurity frameworks and digital trust policies – especially with the emergence of blockchain-enabled charging systems. Pilot programs supported by government subsidies can validate blockchain's role in secure transactions, automated billing and decentralized charging governance.

The study also highlights the importance of multi-stakeholder collaboration, suggesting that public–private partnerships (PPPs) can significantly enhance infrastructure scalability and innovation. Drawing from international case studies, governments should adopt adaptive governance models that encourage experimentation and localized infrastructure deployment, particularly in developing and underserved regions. Finally, to address adoption barriers in emerging economies, targeted policies should be designed to lower the upfront cost of EV ownership, offer tax rebates or subsidies for home and public charging installations and enhance user education through awareness campaigns that clarify economic, environmental and operational benefits. Through a coordinated blend of technical, financial, behavioral and regulatory instruments, policymakers can create a supportive ecosystem for sustainable EV infrastructure development.

4.3 Social implication

This study underscores the broader societal benefits of developing robust EV charging infrastructure, particularly regarding environmental sustainability, public health and urban living standards. By expanding charging accessibility and reducing range anxiety, the findings support greater public confidence and acceptance of EVs, especially among hesitant consumers. This transition is expected to significantly lower urban air and noise pollution levels, directly contributing to improved respiratory health, reduced stress from traffic noise and overall enhancements in urban quality of life. The research also highlights the potential for EV infrastructure to play a transformative role in promoting environmental consciousness and sustainable consumption behaviors within communities. As governments and municipalities implement visible and accessible EV infrastructure, public awareness and social normalization of clean mobility solutions will likely increase, reinforcing positive social attitudes toward climate-resilient transportation. Moreover, the study reflects the importance of ensuring equitable access to charging stations, especially in underserved regions and among vulnerable populations. Social inclusion in infrastructure development will be essential for addressing disparities in green technology adoption. Community engagement initiatives, participatory planning processes and targeted education campaigns are recommended to ensure that diverse social groups, particularly in emerging economies, are not left behind in the clean mobility transition. Furthermore, integrating digital innovations such as blockchain and smart grids in EV infrastructure can help democratize access, improve service transparency and foster a sense of trust in the system. Users gaining more control and visibility over their mobility data and energy usage may cultivate a more informed, responsible and engaged citizenry, reinforcing social sustainability goals.

4.4 Limitations and future scope

This study provides a comprehensive bibliometric and thematic analysis of EV charging infrastructure research, but certain limitations need to be acknowledged. The analysis is

confined to Scopus-indexed journal publications, which excludes other important sources of knowledge such as conference proceedings, books, technical reports and grey literature. This constraint may result in the omission of emerging insights from fast-developing domains or regional contexts not widely represented in indexed journals. Future studies can overcome this limitation by integrating data from multiple academic databases (e.g. Web of Science, IEEE Xplore and ScienceDirect) and incorporating non-journal sources to enrich the review.

The study relies heavily on quantitative bibliometric techniques, which, although robust for mapping publication trends and thematic clusters, may not capture the contextual depth and methodological richness of individual studies. A deeper understanding of specific themes – such as policy analysis, user behavior or blockchain integration – can be achieved through systematic literature reviews or meta-analytical approaches, providing more nuanced insights into the state of research. The conceptual framework based on the diffusion of innovation and resource-based view theories has not yet been empirically validated. Future research should explore its applicability in real-world settings by conducting case studies, surveys or simulation-based modeling, thereby enhancing the practical relevance of the theoretical integration. This study identifies future research directions but does not exhaustively explore regional disparities, especially those affecting infrastructure deployment and EV adoption in developing countries. Addressing such gaps could involve investigating local governance structures, public–private partnerships and user preferences through fieldwork or regional comparative studies. In light of these limitations, future research could benefit from multi-disciplinary approaches, combining engineering, behavioral science and policy analysis to design inclusive, adaptive and user-centered charging infrastructure systems. Such studies would support the formulation of context-sensitive strategies for sustainable EV adoption across diverse socioeconomic and geographic landscapes.

5. Conclusion

This study provides a comprehensive and structured overview of the EV charging infrastructure research landscape from 2013 to 2024. Using a mixed-method approach combining bibliometric analysis and thematic content synthesis, it analyzed 498 peer-reviewed articles from the Scopus database. The study identifies the most influential publication trends, collaboration patterns, core research themes and emerging areas in EV charging infrastructure scholarship through advanced tools such as co-word analysis, conceptual structure mapping and thematic clustering. The analysis revealed five dominant thematic areas: charging infrastructure and optimization, battery technologies and vehicle-to-grid (V2G) systems, sustainability integration, policy and governance frameworks and behavioral dimensions of EV adoption. Additionally, the research uncovered evolving themes such as blockchain-enabled charging, intelligent charge scheduling, electromobility governance and lifecycle environmental assessments. The study's conceptual structure further clarified the intellectual organization of the field, highlighting clusters centered on infrastructure planning, battery and energy systems, optimization techniques, public transport electrification and emission reduction.

This study includes insights from policy, user behavior, infrastructure optimization and environmental sustainability, in contrast to earlier studies such as [Barbosa *et al.* \(2022\)](#) and [Soares, Reis, Vieira, Hernández-Callejo, and Boloy \(2023\)](#), which focused primarily on technology and supply chain elements. Recent studies such as [Prakhar, Jaiswal, Gupta, & Tiwari, 2024e](#), [Prakhar *et al.* \(2025\)](#) and [Prakhar *et al.* \(2024c\)](#), which highlight the significance of entrepreneurial ecosystems, EV an opportunity and limitations, tourist perception and EV adoption behavior, are further enhanced by this study. A key contribution of this research is developing a novel conceptual framework that integrates the Diffusion of Innovation (DOI) theory with the resource-based view (RBV). This framework underscores how technological resources such as fast-charging stations, battery swapping and innovative charging technologies interact with perceived user benefits (e.g. compatibility, convenience and observability) to influence adoption behavior and competitive positioning. The

framework offers a strategic lens for researchers and practitioners to evaluate EV infrastructure readiness and innovation diffusion. From a policy standpoint, the findings advocate for user-centric and data-driven infrastructure planning, incorporating real-world driving behavior, range anxiety and urban-rural disparities. Policy interventions should also emphasize renewable energy integration, standardization of V2G systems and blockchain-backed digital trust mechanisms. Multi-stakeholder collaboration, adaptive governance and targeted financial incentives are recommended, particularly in developing regions, to overcome adoption barriers and ensure inclusive mobility transitions. Socially, the study reinforces the role of EV infrastructure in improving urban livability, reducing environmental and noise pollution and promoting sustainable mobility behavior. It highlights the need for equitable access, public education and technological trust-building to engage all segments of society in the clean mobility shift. Integrating digital platforms and transparent transaction systems is further emphasized to foster consumer trust and engagement.

While the study makes significant contributions, it is limited to Scopus-indexed journal articles and primarily emphasizes quantitative mapping techniques. Future research could extend the analysis to other databases, incorporate qualitative reviews or meta-analyses and empirically test the proposed conceptual framework. Additionally, localized studies in emerging markets and comparative analyses of governance models could further enrich the discourse. This study serves as a critical reference point for academics, policymakers and industry stakeholders by synthesizing EV charging infrastructure research's evolution, structure and direction. It consolidates past efforts and lays out a robust and actionable agenda for future studies that aim to support the global transition toward sustainable, efficient and inclusive electric mobility systems.

CRediT author statement

Rachana Jaiswal: Conceptualization, Supervision, Methodology, Software, Writing – Reviewing and Editing, Formal Analysis and Project administration. *Shashank Gupta*: Data Curation, Writing – Original draft preparation, Methodology, Visualization and Investigation. *Prakhar*: Writing – Original draft preparation, Methodology and Software.

Data availability

Data will be available on reasonable request.

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