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Proposed Study on the Factors Influencing Electric Vehicle Adoption in the Urban Public Sector of Hunan Province, China

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Abstract

The low rate of electric vehicle (EV) adoption in Hunan Province represents a multifaceted issue, stemming from a convergence of technical, economic, and governance-related challenges. Technically, critical obstacles include the limited availability and accessibility of EV charging infrastructure, suboptimal performance of EVs in various operational conditions, and a pronounced lack of technical literacy and knowledge among key stakeholders concerning EV technology and its benefits. Economically, the high upfront cost associated with EV ownership, elevated electricity tariffs for vehicle charging, and the uncertainty regarding the long-term financial returns pose substantial deterrents to adoption. Governance issues further complicate these challenges, as the diffusion of responsibilities across institutional actors, insufficient coordination between national and local governments, and regulatory weaknesses contribute to delays in infrastructure development and maintenance critical for EV adoption. Addressing these barriers requires a strategically coordinated approach, including investments in infrastructure, the introduction of financial incentives, and the strengthening of governance frameworks, all of which are essential to foster wider EV adoption within Hunan's public transportation sector. This studyapplies quantitative methodologies to evaluate the influence of technical and economic determinants on the adoption of EVs in Hunan, China. Through survey data collection and the application of advanced statistical techniques, the study aims to yield objective, reliable, and generalizable insights that can inform both policy formulation and strategic decision-making. Employing a systematic sampling method, the study will target a sample of 459 respondents from government bodies and public institutions, anticipating an adequate response rate to enable robust analysis using Smart PLS.

Keywords: Electrical vehicle adoption, urban public transportation, infrastructure governance mechanisms, charging infrastructure, electric vehicle performance, technical knowledge, vehicle cost, charging facility cost, economic benefits

1. Introduction

1.1 Background

The adoption of electric vehicles (EVs) across both private and public transportation sectors has garnered substantial global momentum, emerging as a pivotal approach in mitigating climate change, reducing dependency on fossil fuels, alleviating urban air pollution, and enhancing urban sustainability (Bhat, Verma, & Verma, 2022; Achiaw & Kanol, 2021; Carvalho, Delafave, & Balestieri, 2021). In densely populated urban centers, governments, industries, and urban planners are prioritizing the transition from internal combustion engine (ICE) vehicles to EVs to significantly reduce emissions and propel low-carbon development objectives (Jing, Yuan, Rezaei, Qian, & Zhang, 2020). This global shift towards EV adoption is driven by a confluence of environmental, economic, and technological factors, as nations worldwide aim to achieve targets outlined in international frameworks such as the Paris Agreement and the United Nations Sustainable Development Goals (SDGs) (Fournel, 2022; Liu, Wu, Qian, Wu, & Wang, 2021). The transportation sector, accounting for approximately 24% of direct CO_2 emissions from fuel combustion, is a major contributor to urban pollution, highlighting the urgency of transitioning to EVs, especially within urban public transportation networks (International Energy Agency [IEA], 2022).

In response, various global regions have implemented strategic policy initiatives to incentivize EV adoption. For instance, the European Union has established a commitment to phase out new internal combustion engine

vehicle sales by 2035 (European Environment Agency [EEA], 2024), while the United States introduced substantial financial incentives through the Inflation Reduction Act of 2022 to accelerate the EV transition (Jing et al., 2020). Norway has experienced one of the world's highest EV adoption rates, largely due to comprehensive government incentives and an extensive fast-charging network (Anastasiou, Fuehres, & Sousa-Zomer, 2018). In India, determinants such as initial purchase costs, vehicle range, charging infrastructure, environmental awareness, and government incentives have emerged as significant factors driving EV adoption (Bhat et al., 2022). In Brazil, studies highlight the importance of targeted policy interventions to address both financial and infrastructural challenges, thereby facilitating the transition towards sustainable transportation within private and public urban sectors (Carvalho et al., 2021). Technological advancements have also greatly influenced EV viability, with innovations in battery technology, the expansion of charging infrastructure, and the integration of vehicle-to-grid (V2G) capabilities enhancing EVs as sustainable alternatives to ICE vehicles. Between 2010 and 2020, the cost of lithium-ion batteries dropped by nearly 90%, markedly lowering entry barriers to EV ownership (IEA, 2022). Additionally, expanding charging networks are addressing "range anxiety," a critical consumer concern, especially within urban areas (Fournel, 2022; Di Foggia, 2021).

In the context of EV adoption, China, the world's largest emitter of carbon dioxide, confronts significant environmental challenges (China Meteorological Administration [CMA], 2023). Vehicle emissions alone contribute approximately 15% of the nation's CO_2 emissions. At the 75th United Nations General Assembly on September 22, 2020, China committed to reaching peak carbon emissions by 2030 and achieving carbon neutrality by 2060. The automotive sector's reliance on fossil fuels has exacerbated environmental issues, including air pollution and climate change, affecting ecosystem health, public well-being, and the overall quality of life (Hildemann et al., 2015). Given its high fossil fuel dependency, China's promotion of EV development represents a strategic reorientation in its approach to energy, aiming to reduce its carbon footprint and enhance environmental sustainability (CAAM, 2021). As the world's largest automotive market, China has enacted stringent regulations and incentive programs to stimulate EV production and adoption (Lu, 2022; Chen, Zeng, & Tan, 2021). Efforts in the transportation sector are not only focused on enhancing ICE efficiency but are also centered around increasing the share of alternative energy sources (Li, Gu, & Ma, 2017). With high energy efficiency, EVs are increasingly deployed to mitigate pressing environmental and energy-related concerns, making EV adoption one of the most impactful measures for lowering urban transportation emissions (Kawamoto et al., 2019; Li, Xiong, & Wang, 2020).

In urban settings, converting public sector fleets to EVs serves as a critical step toward low-carbon urban development, setting an example that can catalyze broader adoption within cities (Li, Chen, & Hong, 2016). For metropolitan regions like Hunan, integrating EVs into public transportation networks addresses challenges related to heightened energy consumption and pollution resulting from increased vehicle use (Huang, Tian, Lu, & Li, 2017). The replacement of conventional public fleets with electric buses and other EVs substantially reduces urban carbon emissions (Hunan Provincial Electric Vehicle Industry Association, 2021; Zhou, Wu, Wu, & Wang, 2020), aligning with China's urban low-carbon objectives and its international commitments under the Paris Agreement (Liu et al., 2021; Hao & Lei, 2021). Integrating EV charging stations with renewable energy sources further ensures that urban public transportation is powered by cleaner, more sustainable electricity sources (Zhang, Wang, Wang, & Bi, 2016), effectively reducing the environmental impact of energy production and advancing a shift towards renewables (Wu, Guo, Zhang, & Zeng, 2018).

Nevertheless, studies indicate that effectively promoting EV fleets within urban public transportation necessitates addressing both technical and economic challenges, along with strengthening urban infrastructure governance (Zhang, Li, & Wang, 2021). Essential elements of this approach include policy incentives, financial subsidies, the establishment of comprehensive charging infrastructure, and enhanced cross-sectoral collaboration (Liang, Zhang, & Huang, 2021). Strong governance mechanisms play a critical role in the planning and financing of charging infrastructure, coordinating stakeholders, and enforcing policies to support EV adoption (Luo, Li, Xu, & Zhang, 2018). Scholars increasingly emphasize the significance of such governance frameworks in the integration of EVs within urban transportation systems (Zhang, Li, & Wang, 2021; Wang, Liu, & Zhang, 2020). With current EV adoption rates in urban public transport remaining relatively low at approximately 10%, further research is necessary to evaluate the efficacy of policy incentives and urban infrastructure governance mechanisms in promoting EV uptake, particularly in the context of public transportation in China (Ramasamy, Qian, Zhai, & Liu, 2021). A comprehensive understanding of these factors is vital for developing informed policies and actions that can effectively foster the widespread adoption of EVs in urban public transportation systems (Wang et al., 2020).

1.2 Aims & Scope of Study

This study endeavors to conduct an in-depth investigation into the complex interactions between technical and economic determinants and infrastructure governance mechanisms that collectively drive the adoption of electric vehicles (EVs) in the urban public transportation sector. Concentrating on Hunan Province, this research seeks to yield critical insights that will support the formulation of evidence-based policies and the development of strategic implementation approaches aligned with China's ambitious carbon reduction targets and sustainable urban development objectives. Hunan, as a second-tier economic region, provides a distinctive context for analysis, offering an exemplary case that could inform policy applications in other comparably positioned regions across China. Furthermore, the study specifically targets urban public sector transportation modes, including buses, taxis, and municipal service vehicles, given their substantial potential to mitigate urban carbon emissions. This sector not only plays a pivotal role in public transit but also possesses unique operational characteristics that differentiate it from private urban transportation, thereby presenting distinct opportunities and challenges in advancing large-scale EV integration.

1.3 Research Questions

In line with problem statement, this study developed five (5) study questions and they are: (1) Does charging infrastructure, electric vehicle performance, and technical knowledge (technical factors) respectively as independent variables exert any direct influence on adoption of urban public sector electric vehicle transportation in Hunan, China? (2) Does vehicle cost, charging facilities cost, and economic benefits (economic factors) respectively as independent variables exert any direct influence on adoption of urban public sector electric vehicle transportation in Hunan, China? (3) Does charging infrastructure, electric vehicle performance, and technical knowledge (technical factors) respectively as independent variables exert any indirect influence on adoption of urban public sector electric vehicle transportation in Hunan, China through the mediation of infrastructure governance mechanisms? (4) Does vehicle cost, charging facilities cost, and economic benefits (economic factors) respectively as independent variables exert any indirect influence on adoption of urban public sector electric vehicle transportation in Hunan, China through the mediation of infrastructure governance mechanisms? and, (5) Do infrastructure governance mechanisms exert any influence on the adoption of urban public electric vehicle transportation in Hunan, China?

1.4 Research Objectives

In line with the problem statement, this study developed five study objectives and they are: (1) The charging infrastructure, electric vehicle performance, and technical knowledge (technical factors) respectively as independent variables exert direct influence on the adoption of urban public sector electric vehicle transportation in Hunan, China, (2) The vehicle cost, charging facilities cost, and economic benefits (economic factors) respectively as independent variables exert direct influence on the adoption of urban public sector electric vehicle transportation in Hunan, China, (3) The charging infrastructure, electric vehicle performance, and technical knowledge (technical factors) respectively as independent variables exert indirect influence on the adoption of urban public sector electric vehicle transportation in Hunan, China through the mediation of infrastructure governance mechanisms, (4) The vehicle cost, charging facilities cost, and economic benefits (economic factors) respectively as independent variables exert indirect influence on the adoption of urban public sector electric vehicle transportation in Hunan, China through the mediation of infrastructure governance mechanisms, and; (5) Infrastructure governance mechanisms exert influence on the adoption of urban public electric vehicle transportation in Hunan, China.

1.5 Theoretical Significance

The theoretical significance of this study is rooted in its comprehensive examination of the factors influencing electric vehicle (EV) adoption within urban public sector transportation, informed by two well-established theoretical frameworks: (1) the Extended Technology Acceptance Model (TAM2) (Venkatesh & Davis, 2000) and (2) Socio-Technical Systems Theory (Mumford, 2006). By integrating these frameworks, the study provides a nuanced, multi-constructal perspective on the EV adoption process in public transportation. First, TAM2, which explores the factors shaping user acceptance and utilization of technology, is applied here to assess how technical proficiency and EV performance impact adoption specifically within urban public transport. This study extends TAM2's utility by incorporating additional constructs—such as economic viability and the role of governance frameworks—thus underscoring that technological acceptance in the public sector is influenced not only by technical attributes but also by economic practicality and institutional structures (Venkatesh & Davis, 2000). This approach demonstrates the interconnectedness of technology acceptance with broader contextual factors, advancing TAM's applicability within a public sector setting.

Second, the application of Socio-Technical Systems Theory provides a foundation for analyzing how technical and economic determinants are mediated through infrastructure governance mechanisms. By aligning with Socio-Technical Systems Theory, which emphasizes the dynamic interplay between social and technical elements within organizational contexts, the study captures the intricate relationships among technological infrastructure, economic policies, and governance frameworks. This theoretical perspective allows for a comprehensive exploration of how these components co-evolve to facilitate the integration of novel technologies like EVs into public transportation. The study's findings contribute to a deeper understanding of the complex processes that shape EV adoption, providing valuable insights for future research and policy development in sustainable urban transport.

2. Literature Review

2.1 The Adoption of Electric Vehicles (EV) in Hunan

The adoption and popularity of electric vehicles (EVs) in Hunan Province are shaped by a variety of determinants, with urban infrastructure governance mechanisms—particularly government policies and financial incentives—serving as pivotal drivers in fostering EV adoption (Zhang, Yang, Zhang, & Zhang, 2021). A critical examination of these policies and incentives underscores the strategic role of government-led initiatives in expanding the EV market. For instance, research by Liu, Chen, Liu, & Yan (2020) identifies those preferential policies, such as purchase subsidies and exemptions from license plate restrictions, significantly influence consumer behavior, increasing EV purchase rates across China. Complementing this, Wang et al. (2019) emphasize that urban infrastructure governance is instrumental for sustaining EV market growth and advocate for a well-rounded policy framework that effectively encourages EV adoption. These studies collectively underscore the necessity for carefully structured, targeted policies that motivate Hunan's consumers to consider EVs as a viable option for sustainable transportation. Further research indicates that promoting environmental compliance and fostering innovation among Chinese manufacturing sectors may also enhance EV adoption (Liu et al., 2021). By highlighting the environmental advantages of EVs and aligning these with corporate sustainability objectives, companies are increasingly encouraged to incorporate EVs into their operational fleets. To support this shift, the Chinese government has instituted clear policy targets, as demonstrated in directives such as the "Notice on Launching the First Batch of Pilots for the Full Electrification of Public Sector Vehicles." This policy encourages the transition of public sector fleets to electric power, aiming to reduce emissions and bolster environmental conservation efforts by advocating for sustainable transportation solutions within public sector enterprises.

Recent case studies within Hunan illustrate successful applications of urban infrastructure governance to bolster EV adoption. For example, Liu and Zhang (2021) discuss Yueyang's proactive approach, where local authorities enacted a comprehensive EV charging infrastructure plan developed through partnerships with government agencies, power utilities, and charging service providers, ensuring widespread charging availability. In Changde, Chen et al. (2021) report on the integration of renewable energy sources, including solar power, within EV charging infrastructure to support sustainable, low-carbon EV charging solutions. These case examples highlight various strategies within Hunan Province that reinforce EV adoption and emphasize the importance of public policy support, community engagement, and user feedback for the successful operation of charging infrastructure. Collectively, these cases yield critical insights and best practices that reinforce successful governance of EV infrastructure within urban settings in Hunan. A key takeaway is the essential role of multi-stakeholder collaboration—engaging government bodies, utility companies, charging service providers, and EV users—in the effective deployment, maintenance, and management of charging infrastructure. This collaborative approach not only enhances the functionality and accessibility of EV charging networks but also serves as a scalable model that could be adopted by other regions aiming to increase EV penetration within their transportation sectors.

2. Technical Factors and Electric Vehicle Adoption

In this study, technical factors encompass a comprehensive array of elements related to the technology and infrastructure vital for the effective implementation and sustained operation of electric vehicles (EVs). These factors are operationalized through three primary constructs: charging infrastructure (Bakker & Trip, 2013), vehicle performance (Wang, Zheng, & Han, 2018), and technical knowledge (Zhou, Wu, Wu, & Wang, 2020). Each construct serves as a critical pillar for evaluating the viability, operational efficiency, and overall impact of EV adoption in urban environments. The first construct, charging infrastructure, pertains to the network of charging stations and supportive facilities that are indispensable for ensuring widespread EV usability (Chawla, Mohnot, Mishra, Harsh, & Singh, 2023). This study assesses charging infrastructure through indicators such as

the availability, accessibility, and geographical distribution of public charging stations within India's urban areas. Key metrics include the density of charging stations and their operational efficiency, which are essential for supporting EV users' needs and fostering a reliable charging ecosystem. The infrastructure's robustness directly influences EV adoption by determining the practicality of EV usage for both short and long-distance travel.

The second construct, vehicle performance, focuses on the functional capabilities and dependability of EVs used in urban public transportation. This encompasses metrics such as range per charge, energy efficiency, reliability (e.g., frequency of mechanical breakdowns), and user satisfaction (Wang et al., 2018). Vehicle performance data can be gathered through transportation agency reports and user feedback surveys, offering insight into how well EVs meet operational demands within public transportation. The correlation between performance attributes and consumer satisfaction highlights the role of functional reliability and efficiency in fostering positive adoption attitudes among users. The third construct, technical knowledge, addresses the level of expertise and awareness among transportation operators, maintenance staff, and policymakers concerning EV technology. This knowledge is measured through surveys that assess familiarity with EV maintenance procedures, operational guidelines, troubleshooting skills, and a broader understanding of EV technology (Zhou et al., 2020). A robust knowledge base among stakeholders is instrumental for maintaining operational standards and minimizing technical barriers that may otherwise hinder EV adoption.

In addition to these constructs, recent literature emphasizes the significance of advancing EV charging infrastructure as a cornerstone for EV adoption (Zink, Valdes & Wuth, 2020). The availability and accessibility of charging stations are crucial factors influencing consumer decisions and adoption intentions. Technological advancements in fast charging, which allow substantial energy transfer in reduced timeframes, have considerably improved the practicality of EVs and positively affected consumer perceptions of convenience (Pang, Ye, & Zhang, 2023). Future developments in super-fast charging technology are anticipated to further expedite the charging process, enhancing user experience and potentially accelerating EV adoption rates (Rafiq, Parthiban, Rajkumari, Adil, Nasir, & Dogra, 2024). In support of these findings, Pandak, Piaralal, and Rethina (2024) emphasize that the availability of charging stations is critical for shaping adoption intentions. Research by Harahap et al. (2023) also identifies specific charging infrastructure features—such as affordable electricity tariffs, enhanced battery durability, and rapid or free charging options—that can incentivize EV adoption. Studies by Reiner, Beard, Park, and Kinnear (2020) underscore the necessity for accessible charging facilities near residential and work areas as well as the importance of a nationwide public charging infrastructure to support long-distance EV travel.

However, the literature presents mixed insights. Bhat et al. (2022) and Imran & Mohammad (2022) argue that certain facilitating conditions, like charging infrastructure, may negatively influence adoption intentions if perceived as inadequate. Conversely, Habich-Sobiegalla, Kostka, and Anzinger (2019) report that charging infrastructure alone may not drive consumer intentions to adopt EVs, suggesting that multiple interconnected factors are required. Additionally, Verma, Verma, & Khan (2020) highlight that inadequate physical infrastructure poses a considerable barrier to adoption. Nonetheless, studies by Zink, Valdes, and Wuth (2020) reveal that the impact of charging infrastructure varies depending on whether it is private, semi-public, or fully public. The impact of EV performance and user expectations is another critical area of focus. Wang, Ozden, and Tsang (2023) reveal that expectations regarding EV performance significantly influence adoption intentions, while Bhat et al. (2022) further substantiate a positive correlation between performance expectancy and adoption intentions. Interestingly, Peters, Van der Werff, and Steg (2018) observe that user motivations for adopting EVs differ, with technological factors appealing to some adopters more than others. Reiner et al. (2020) confirm that consumer perceptions of functional attributes, such as reliability and range, are central to adoption decisions. Di Foggia (2021) underscores the role of technical awareness in influencing EV fleet managers' procurement choices, emphasizing that comprehensive understanding of EV functionality significantly impacts adoption intentions.

Finally, technical knowledge is shown to be a pivotal factor influencing adoption decisions. Studies by Reiner et al. (2020) suggest that awareness and understanding of EV technology substantially impact adoption rates. A lack of education regarding EV functionality can deter potential adopters, as Gupta and Rhoads (2022) point out. Pan, Wang, Li, and Wu (2024) further indicate that both sustainability awareness and experiential knowledge are vital to EV repurchase intentions. Habich-Sobiegalla et al. (2019) identify technical readiness as a strong predictor of adoption intentions, while Pandak et al. (2024) affirm that knowledge of EV technology influences consumer adoption decisions. Based on the above narration, this study postulated that;

H_1: Charging infrastructure exerts significant effect on urban public electric vehicle adoption,

H_2: Electric vehicle performance exerts significant effect on urban public electric vehicle adoption.

H3: Technical knowledge exerts significant effect on urban public electric vehicle adoption.

In summary, EV performance—encompassing factors like range, dependability, and user satisfaction—directly correlates with adoption, as consumers' performance expectations significantly shape their intentions. However, some studies suggest that these functional attributes may not consistently drive adoption across all user groups. Similarly, technical knowledge profoundly impacts adoption intentions; familiarity with EV functionality, combined with knowledge of advancements, strengthens consumer acceptance. Conversely, knowledge gaps or insufficient awareness can act as barriers to adoption. These findings underscore the intricate and multifaceted role that technical factors play in shaping adoption decisions, ultimately highlighting the need for a holistic approach that addresses infrastructure, performance, and user awareness to effectively foster EV adoption.

2.3 Economic Factors and Electric Vehicle Adoption

In this study, economic factors encompass the financial and market-oriented elements that critically shape the feasibility, adoption, and long-term sustainability of electric vehicles (EVs) within public transportation systems (Chaturvedi, Kulshreshtha, Tripathi, & Agnihotri, 2023). These factors are instrumental in evaluating the cost-effectiveness, funding mechanisms, and broader economic impacts associated with transitioning to electric public transportation networks. To capture the influence of these economic constructs, they are operationalized through three primary indicators: vehicle cost, charging facilities, and economic benefits, collectively representing the second set of independent variables under investigation. The vehicle cost construct includes both the initial purchase price of EVs and the ongoing maintenance and operational expenses. In this study, vehicle cost is measured by comparing the total cost of ownership (TCO) of electric buses and taxis against that of their internal combustion engine (ICE) counterparts. TCO analysis integrates various expense components, such as purchase price, maintenance costs, fuel or charging expenses, and depreciation over time (Hawkins et al., 2020). This approach provides a comprehensive view of the long-term economic impact of EV adoption, underscoring how upfront and lifecycle costs influence decision-making for public transportation agencies.

The charging facilities cost construct relates to the infrastructure required to support EVs, specifically focusing on the types and availability of charging stations, including fast chargers and standard chargers, their power output, and the associated waiting times for charging. In this study, charging infrastructure is assessed based on the number, type, and utilization rates of charging facilities at key public transportation hubs, as these factors directly influence the operational efficiency and user convenience of electric vehicle fleets (Li, Song, Liu, & Xie, 2019). Robust charging infrastructure is essential for minimizing downtime and facilitating the seamless integration of EVs into urban transport. The third construct, economic benefits, pertains to the financial advantages realized by adopting EVs as compared to conventional vehicles. These benefits include reduced fuel expenses, lower maintenance costs, and potential government subsidies or financial incentives. Economic benefits are evaluated through cost-benefit analyses and financial performance assessments of public transportation fleets, providing insight into the tangible financial savings and profitability gains associated with EV implementation (Buhmann, Rialp-Criado, & Rialp-Criado, 2024). By highlighting the economic incentives linked to EV use, this construct illustrates the broader appeal of EVs from a financial perspective, thereby encouraging adoption.

Prior research corroborates the significance of these economic factors. Pandak et al. (2024) identify the purchase price as a major predictor of consumer intent to adopt EVs, with Di Foggia (2021) finding that access to clear financial information—particularly regarding TCO and payback periods—greatly influences fleet managers' decisions to invest in EV technology. Wang et al. (2023) report that price value positively correlates with EV adoption intention, while Li, Wang, and Xie (2020) demonstrate that purchase price significantly affects consumers' readiness to adopt EVs. Conversely, Gupta & Rhoads (2022) note that the high upfront costs of EVs remain a considerable barrier, especially for consumers in developing nations. Findings by Imran and Mohammad (2022) underscore the relationship between vehicle price and EV adoption, suggesting that cost is a priority factor for many consumers when making adoption decisions.

In terms of charging costs and operational expenses, Reiner et al. (2020) emphasize that the cost of charging significantly impacts EV adoption rates. Gupta and Rhoads (2022) argue that lower energy costs could facilitate broader adoption, while Kester et al. (2018) highlight that cost reduction strategies may accelerate EV uptake across various global regions. These insights align with the understanding that the economic feasibility of operating EVs is contingent upon the affordability of associated energy and maintenance costs. Study further highlights the role of perceived economic benefits in shaping adoption intentions. Bhat et al. (2022) observe that perceived advantages positively influence consumer intentions to transition to electric vehicles. Similarly,

Featherman, Jia, Califf, and Hajli (2021) report that perceived benefits influence EV purchasing behavior, while Li et al. (2020) note that higher perceived economic benefits facilitate consumers' willingness to adopt EVs. However, Deka (2022) suggests that the desire for personal financial gain does not have a direct effect on adoption intentions, indicating that individual motivation may not be the only driver behind these decisions. Sovacool et al. (2019) find that perceived benefits indeed shape consumers' willingness to adopt EVs, and Reiner et al. (2020) further underscore the importance of economic benefits in influencing consumer perceptions and adoption behaviors.

Additionally, research on the economic impacts of EV infrastructure development highlights broader socioeconomic advantages. Lin, Chen, and Xie (2018) demonstrate that expanding EV infrastructure in China has the potential to create substantial employment opportunities. Manufacturing, installation, and maintenance of EV charging stations, alongside the production of EV components, are shown to contribute to job creation and stimulate economic growth. Effective governance mechanisms supporting EV infrastructure can attract substantial investment and enhance revenue generation. A study by Zhang, Su, and Gao (2019) on the economic benefits of EV infrastructure development in China reveals that establishing charging stations not only supports the EV market but also generates revenue through charging, parking, and additional service fees. Furthermore, the transition to EVs—facilitated by strong governance in infrastructure management—can reduce fossil fuel dependency and lower operational costs, thereby delivering cost savings for both individual consumers and businesses (Ghosh & Dey, 2024). Based on the extant review of the past empirical studies, this study postulates that:

H_4: Vehicle cost exerts significant effect on urban public electric vehicle adoption.

H_5: Charging facility cost exerts significant effect on urban public electric vehicle adoption.

H_6: Economic Benefits exerts significant effect on urban electric vehicle adoption.

In summary, research indicates that vehicle purchase price significantly influences the intention of urban public transportation sectors to adopt EVs, with high initial costs posing a considerable barrier in developing countries. Perceived economic benefits generally have a positive effect on adoption intentions, although the desire for personal financial gain does not directly impact these intentions. Furthermore, EV infrastructure development can create job opportunities and stimulate economic growth, as evidenced by studies focusing on China. Effective governance mechanisms in EV infrastructure can additionally help reduce reliance on fossil fuels and lower operational expenses, ultimately leading to further savings for both consumers and enterprises. This body of evidence underscores the complex yet impactful role of economic factors in shaping the landscape of EV adoption, highlighting the importance of financial feasibility, infrastructure, and governance in fostering sustainable transitions to electric transportation.

2.4 Technical Factors and Infrastructure Governance Mechanisms

In the study by Li et al. (2020), technical factors are defined to include critical attributes such as the accessibility and quality of charging infrastructure or stations, the performance metrics of electric vehicles, and the technical knowledge of both providers and consumers. These elements, as established in various empirical studies, represent foundational determinants in the adoption of electric vehicles (EVs) across a range of customer segments and application domains (Wang et al., 2023). Specifically, Li et al. (2020) identifies charging station availability, vehicle performance, and technical familiarity as having a significant influence on consumers' willingness to adopt EV technology, underscoring the necessity of these technical enablers in supporting EV market growth. However, as asserted by Harahap et al. (2023), the influence of technical factors on EV adoption is further amplified by effective infrastructure governance mechanisms. Governance frameworks, including regulatory, economic, and social infrastructures, serve as a conduit through which technical factors like charging facilities, vehicle performance, and technical expertise can more effectively drive EV adoption. The literature highlights that governance mechanisms play a pivotal role by creating an environment in which technical components are maximized to accelerate EV uptake (Harahap et al., 2023). By establishing regulated standards and facilitating technical capacity-building, governance mechanisms are shown to strengthen the integration and performance of essential technical factors, fostering wider acceptance and practical feasibility of EVs.

Zhang et al. (2018) conducted a foundational study within this context, examining the potential of the rapidly expanding EV industry in China to generate employment. Their analysis revealed that growth in the electric vehicle sector has catalyzed job creation across several industries, including manufacturing, research and development, and the construction and maintenance of EV-related infrastructure. This indicates that the rise of the EV market can significantly contribute to employment in key industrial sectors, reinforcing the economic benefits of EV proliferation (Zhang et al., 2018). Complementing these findings, Li et al. (2017) report that

heightened demand for electric vehicles has spurred revenue growth within automotive manufacturing, battery production, and charging infrastructure development sectors, illustrating the multifaceted economic benefits associated with the expansion of the EV industry. In terms of broader economic development, several studies have explored the substantial impact of EV adoption on macroeconomic growth. Zhang et al. (2019), for instance, conducted an economic analysis of the potential outcomes associated with widespread EV adoption in China. Their findings suggest that increasing EV use can drive economic growth by attracting investment, enhancing productivity, and strengthening global competitiveness. This economic impact is realized through both direct revenue generation within EV-specific industries and spillover effects into associated sectors, further reinforcing the viability of EV adoption as an economic growth strategy.

Additional studies provide similar insights across different geographical contexts. For example, Chen et al. (2018) analyzed the economic repercussions of electric vehicle adoption in California, demonstrating that the transition to EVs could lead to numerous financial advantages, such as increased tax revenues, reductions in healthcare costs linked to improved air quality, and enhanced productivity. Similarly, Wang et al. (2016) in Europe and Han et al. (2015) in South Korea underscore the positive economic outcomes of EV adoption, identifying benefits such as job creation, income growth, and strengthened economic stability. Based on the extant literature, the study hypothesized that:

H_7: Charging infrastructure exerts significant effect on urban public sector infrastructure governance mechanisms,

H_8: Electric vehicle performance exerts significant effect on urban public sector infrastructure governance mechanisms, and;

H_9: Technical knowledge exerts significant effect on urban public sector infrastructure governance mechanisms.

In summary, an aggregate analysis of the impacts of EV adoption on employment, income generation, and economic growth emphasizes the significant economic advantages associated with sustainable transportation solutions. By stimulating job creation across various sectors, promoting revenue and income growth, and contributing to the overall economic advancement of regions like Hunan, the transition to electric vehicles stands as a substantial driver of economic prosperity. The implementation of comprehensive governance mechanisms, particularly within technical and infrastructure domains, is instrumental in harnessing these benefits, ensuring that EV adoption is both economically viable and beneficial for sustained regional growth.

2.5 Economic Factors and Infrastructure Governance Mechanisms

In the assessment by Li et al. (2020), economic factors are characterized by critical attributes such as the overall vehicle cost (encompassing purchase and associated financial outlays), the cost of charging (analogous to fueling expenses), and the perceived financial benefits of electric vehicles (EVs). These economic dimensions have been empirically validated as significant determinants in consumer adoption of EVs, particularly within various demographic and geographic market segments (Wang et al., 2023; Reiner et al., 2020). Specifically, Li et al. (2020) identified that the vehicle purchase price, ongoing power (charging) expenses, and a heightened perception of economic benefits positively influence consumers' willingness to embrace EV technology. This underscores the role of affordability, cost-efficiency, and financial incentives as foundational motivators in EV market adoption. Moreover, as Harahap et al. (2023) argue, infrastructure governance mechanisms provide a structured framework through which economic factors further accelerate EV adoption across diverse consumer groups. Governance structures that include economic, regulatory, and social infrastructures create an enabling environment that amplifies the impact of key economic factors—namely, vehicle cost, charging expenses, and perceived economic value—on the likelihood of EV adoption (Gupta, Bansal, & Bankoti, 2024). Effective governance not only addresses cost and financial benefits but also ensures that economic policies and infrastructure provisions align with broader EV adoption strategies, thus supporting a robust and accessible transition to electric mobility.

In addition, the expansion of EV infrastructure and the strategic shift towards electric mobility act as catalysts for innovation and technological progression, driving growth in the clean energy industry. Xu, Cheng, and Wang (2017) conducted a comprehensive study on China’s EV sector, which emphasized the sector’s potential for fostering technological innovation, creating job opportunities, and facilitating industrial upgrading. The economic advantages afforded by Hunan's adoption of effective urban infrastructure governance mechanisms for EVs are significant, extending beyond cost efficiencies to include workforce expansion, revenue generation, cost savings, and the enhancement of clean energy innovation. By establishing a comprehensive infrastructure governance framework, Hunan is well-positioned to leverage the economic opportunities intrinsic to the shift toward sustainable transport solutions, thereby promoting regional economic vitality, sustainable job creation,

and technological leadership within the clean energy sector. Based on the above critical narration, this study hypothetically establish that:

H_{10}: Vehicle cost exerts significant effect on urban public infrastructure governance mechanisms.

H_{112}: Charging Facility Cost exerts significant effect on urban public infrastructure governance mechanisms.

H_{12}: Economic Benefits exerts significant effect on urban public infrastructure governance mechanisms.

2.6 Infrastructure Governance Mechanisms and Electric Vehicle Adoption in Hunan Province

An evaluation of the current electric vehicle (EV) urban infrastructure governance mechanisms in Hunan is of paramount importance for determining the efficacy of existing practices and for pinpointing areas that necessitate enhancement. In the assessment of the governance framework governing EV infrastructure within Hunan, numerous studies have illuminated the pivotal factors that contribute to its overall effectiveness. Chen et al. (2017) emphasized the critical roles played by government support, financial incentives, and advancements in technology in propelling the growth of EV charging infrastructure across China. Their research underscored the necessity for proactive policy interventions aimed at encouraging private sector investment and facilitating the deployment of charging stations. This perspective is particularly relevant when considering Hunan's governance mechanisms, wherein the extent of support and financial incentives extended by the provincial government to various stakeholders can substantially influence the trajectory of infrastructure development.

Furthermore, Jiang et al. (2018) conducted a thorough investigation into the prevailing conditions and challenges confronting the establishment of electric vehicle charging infrastructure in China. Their findings identified several significant obstacles, including inadequate planning, a lack of coordinated development efforts, and insufficient investment, all of which serve to impede the efficacy of existing governance mechanisms. Similarly, research conducted by Liu et al. (2021) focused on the implications of urban EV infrastructure development on residents' vehicular travel patterns in Changsha, Hunan's capital. This study concluded that, while the expansion of charging infrastructure has enhanced the accessibility of electric vehicles, substantial challenges remain regarding the availability and equitable distribution of charging stations. Collectively, these studies underscore the urgent need for enhanced planning, improved coordination, and more robust investment strategies to address the deficiencies present in Hunan's current governance structures and processes.

In addition, a thorough examination of the coordination and collaboration among relevant governmental agencies and stakeholders is essential for accurately assessing the governance mechanisms governing Hunan's EV infrastructure. Li, Jiang, Shao, Zhao, and Luo (2019) undertook a regression analysis to explore the influence of government policies, the availability of charging infrastructure, and financial incentives on EV adoption within Hunan. Their research revealed a positive correlation between the presence of supportive policy frameworks, the accessibility of charging infrastructure, and increased rates of EV adoption. In a similar vein, Yang, Yang, Chen, and Yan (2020) employed various statistical techniques, including correlation analysis, to discern the factors that significantly influence EV adoption in Hunan. Their findings revealed that the accessibility and proximity of charging stations, as well as the availability of charging infrastructure within residential areas, play a critical role in facilitating EV adoption. This, study postulates that;

H_{13}: Infrastructure governance mechanisms exert significant effect on urban public electric vehicle adoption.

In summary, several scholarly investigations have identified key determinants that significantly influence the success of governance mechanisms associated with EV infrastructure in Hunan. Consequently, the assessment of these governance mechanisms is not only crucial for evaluating their current effectiveness but also for identifying specific areas that require strategic improvements and interventions to foster enhanced adoption of electric vehicles and the development of supportive infrastructure.

2.7 Mediating Effect of Infrastructure Governance Mechanisms

Harahap et al. (2023) identified that governance mechanisms, encompassing both economic and legal instruments, play a pivotal role in facilitating the adoption of electric vehicles (EVs). They specifically highlighted that the implementation of special electricity tariffs, discounted pricing models, and energy subsidies, combined with the allocation of dedicated parking spaces and charging stations, can significantly enhance public awareness and ensure effective policy oversight. This multifaceted approach can thus create a conducive environment for promoting the uptake of EVs. Grandi (2020) further elaborated on this theme by demonstrating that local policies and the establishment of charging infrastructure are crucial governance mechanisms that influence EV adoption. His research underscored the significance of purchase cost, revealing that government incentives can substantially impact consumers' decisions to adopt electric vehicles. Moreover, Woodley, Rossetti, and Nunes (2023) conducted an analysis that showed a variety of government policies have been instituted to

stimulate the adoption of electric vehicles, indicating a growing recognition of the need for supportive measures. Trencher, Taeihagh, and Yarime (2020) explored the governance strategies employed by governments to accelerate both the development and dissemination of electric vehicles. Their findings indicated that supply-side measures, particularly those focused on infrastructure development, are vital for enhancing the diffusion of EVs. Conversely, they noted that demand-side measures, which heavily depend on public subsidies, have a more limited influence on EV adoption, particularly highlighting that regulatory measures often fail to effectively stimulate consumer demand for electric vehicles.

In addition to these insights, Gupta and Rhoads (2022) asserted that advancements in technology and economies of scale within the electric vehicle industry are anticipated to result in lower vehicle costs, thereby making electric vehicles more financially accessible and appealing to consumers. This aligns with the research conducted by Kester et al. (2018), who found that policy mechanisms aimed at cost reduction, such as tax exemptions and infrastructure support for public and residential charging stations, are effective in accelerating the diffusion of electric vehicles. However, Grandi (2020) posited that certain governance mechanisms, including local installation policies, charging infrastructure, and incentives such as free ferry rides, do not significantly impact the adoption rates of electric cars. He elucidated that the involvement of governmental authorities in the provision of national incentives and efforts to raise public awareness are significantly correlated with the increase in electric vehicle adoption rates. Similarly, the study conducted by Ryghaug and Skjølsvold (2023) illustrated how various political and economic conditions can stimulate the diffusion of electric vehicles.

Consequently, this study posits that effective governance mechanisms, particularly those that encompass comprehensive policy frameworks and targeted incentives, are essential for fostering an environment conducive to the widespread adoption of electric vehicles:

H_{14}: Infrastructure governance mechanisms mediate the effect of charging infrastructure on urban public electric vehicle adoption,

H_{15}: Infrastructure governance mechanisms mediate the effect of electric vehicle performance on urban public electric vehicle adoption,

H_{16}: Infrastructure governance mechanisms mediate the effect of technical knowledge on urban public electric vehicle adoption,

H_{17}: Infrastructure governance mechanisms mediate the effect of vehicle cost on urban public electric vehicle adoption,

H_{18}: Infrastructure governance mechanisms mediate the effect of charging facility cost on urban public electric vehicle adoption, and;

H_{19}: Infrastructure governance mechanisms mediate the effect of economic benefits on urban public electric vehicle adoption.

2.7 Underpinning Theories

2.7.1 Social Technical System Theory (STS Theory)

A Social Technical System (STS) serves as an organizational framework that underscores the intricate interrelationship between social and technical dimensions within any given system. The STS Theory articulates the notion of interdependence between social elements—such as human interactions, organizational structures, and cultural influences—and technical components, which encompass technological innovations and infrastructural developments. This theoretical perspective asserts that the optimal performance and innovation within complex systems emerge from the co-evolution and alignment of both social and technical subsystems. Such a theoretical framework is particularly pertinent when examining systems characterized by intensive interactions between human and technological components, notably in the context of urban public sector transportation systems that are in the process of integrating electric vehicles (EVs). The adoption of electric vehicles within Hunan's urban public transportation system presents multifaceted challenges, including issues related to technological reliability, the development of necessary infrastructure, public acceptance, and overall economic viability.

The STS Theory accentuates the necessity of involving a diverse array of stakeholders in the decision-making processes associated with the adoption of electric vehicles. By engaging policymakers, public transportation operators, technical experts, and the public, it becomes possible to consider a wide range of perspectives, which ultimately leads to the formulation of more robust and widely accepted solutions. Utilizing STS Theory enables policymakers to devise and implement governance mechanisms that facilitate the co-evolution of social and

technical elements. The dynamic interplay of technical advancements and economic factors necessitates a governance approach that is both flexible and adaptive. The STS Theory thereby supports the establishment of systems that can effectively respond to technological innovations and evolving economic landscapes, ensuring their long-term sustainability.

In conclusion, the Social Technical System (STS) Theory proves to be a valuable framework for investigating the adoption of electric vehicles within Hunan's urban public sector transportation landscape. Through the implementation of effective governance mechanisms that harmonize technical advancements with economic incentives, Hunan can cultivate a sustainable and efficient urban transportation system that is increasingly powered by electric vehicles.

2.7.2 Extension of Technology Acceptance Model (TAM2)

An extension of the original Technology Acceptance Model (TAM), referred to as TAM2, was developed by Venkatesh and Davis to delineate the concepts of perceived usefulness and usage intentions in relation to social influence and cognitive instrumental processes. According to their findings, perceived usefulness serves as a pivotal construct that significantly influences usage intentions across numerous empirical studies employing the Technology Acceptance Model. Understanding the determinants that contribute to the perceived usefulness construct is crucial, as it not only drives individuals' intentions to use technology but also highlights how these determinants may evolve over time, particularly as system usage becomes more prevalent. The extended Technology Acceptance Model (TAM2) is particularly pertinent for analyzing the adoption of urban public electric vehicle (EV) transportation in Hunan, China. It provides a comprehensive framework for scrutinizing the various factors that affect the acceptance of new technologies by both individuals and organizations. Building upon the foundational principles of the original TAM, TAM2 integrates additional external variables, including social influence and cognitive instrumental processes, which are instrumental in shaping user perceptions and behaviors toward new technologies such as electric vehicles.

In the context of urban public EV transportation within Hunan, TAM2 serves as a valuable analytical tool to elucidate how diverse psychological and social factors contribute to the acceptance and adoption of electric vehicles by public transportation systems and their users. According to the framework posited by TAM2, perceived usefulness and perceived ease of use are recognized as central drivers of technology acceptance. For public transport operators in Hunan, the perceived usefulness of electric vehicles is likely to be influenced by several factors, including reduced operational costs, enhanced energy efficiency, and adherence to environmental regulations. Electric vehicles are increasingly perceived as viable alternatives to traditional gas-powered buses, as they promise long-term financial benefits through lower fuel and maintenance costs while simultaneously advancing the city's sustainability objectives by curtailing emissions and improving air quality.

Perceived ease of use represents another critical component within the TAM2 framework, reflecting the degree of effort required to adopt and integrate electric vehicles into pre-existing transportation systems. In Hunan, this notion encompasses various aspects, such as the availability of adequate charging infrastructure, the technological complexity associated with managing electric buses, and the requisite training for drivers and maintenance personnel. If public transport operators find that the integration of electric vehicles into their fleets can be accomplished with minimal disruption and without significant learning curves, their likelihood of adopting this technology is markedly enhanced. Furthermore, TAM2 introduces the concept of social influence, which encompasses factors such as subjective norms—indicating the pressure felt by individuals or organizations to embrace new technology based on the expectations of others. In the Hunan context, this could be reflected in the realm of governmental policies and public expectations, particularly as the initiative for sustainable urban development increasingly gains prominence within both local and national agendas. If public transportation authority's perceive that the adoption of electric vehicles aligns with societal norms and governmental objectives, such as the reduction of carbon emissions, they may feel a heightened obligation to transition towards electric buses.

Cognitive instrumental processes, another critical aspect of TAM2, pertain to how users assess the relevance of the technology to their operational goals. For public transportation authorities in Hunan, this evaluation may involve scrutinizing the compatibility of electric vehicles with existing public transportation objectives, including reliability, route efficiency, and passenger capacity. When electric vehicles demonstrate the capacity to meet these operational benchmarks, their likelihood of adoption significantly increases.

In summary, the constructs articulated within TAM2—namely perceived usefulness, perceived ease of use, social influence, and cognitive instrumental processes—are directly applicable to comprehending the approaches taken by public transportation authorities and stakeholders in Hunan regarding the adoption of electric vehicles. These

factors provide critical insights into both the technological and social dynamics that influence decision-making processes, thus helping to explain why certain technologies, such as electric vehicles, are increasingly embraced within urban transportation systems.

3. Study Framework

This study undertakes the adaptation of a well-established theoretical framework to investigate the adoption of electric vehicles (EVs) within the public transportation system of Hunan. By employing a validated framework as depicted in Figure 1, this study enhances its credibility and scholarly rigor, while simultaneously aligning with pertinent technical and economic factors that influence EV adoption. Furthermore, this methodological choice facilitates comparative analyses across different contexts, allowing for a nuanced understanding of EV adoption dynamics. The process of adapting this framework specifically to the unique context of Hunan is crucial in ensuring its relevance to local circumstances. This tailored approach not only acknowledges the distinct characteristics and challenges associated with Hunan's public transportation infrastructure but also provides a comprehensive and effective means of exploring the intricate dynamics surrounding EV adoption within the region's governance framework. By leveraging this robust methodological framework, the study aspires to yield insights that can inform policymakers, stakeholders, and researchers about the factors driving or hindering the transition to electric vehicles in Hunan's public transportation sector, ultimately contributing to the formulation of strategies that enhance the sustainability and efficiency of urban mobility solutions.

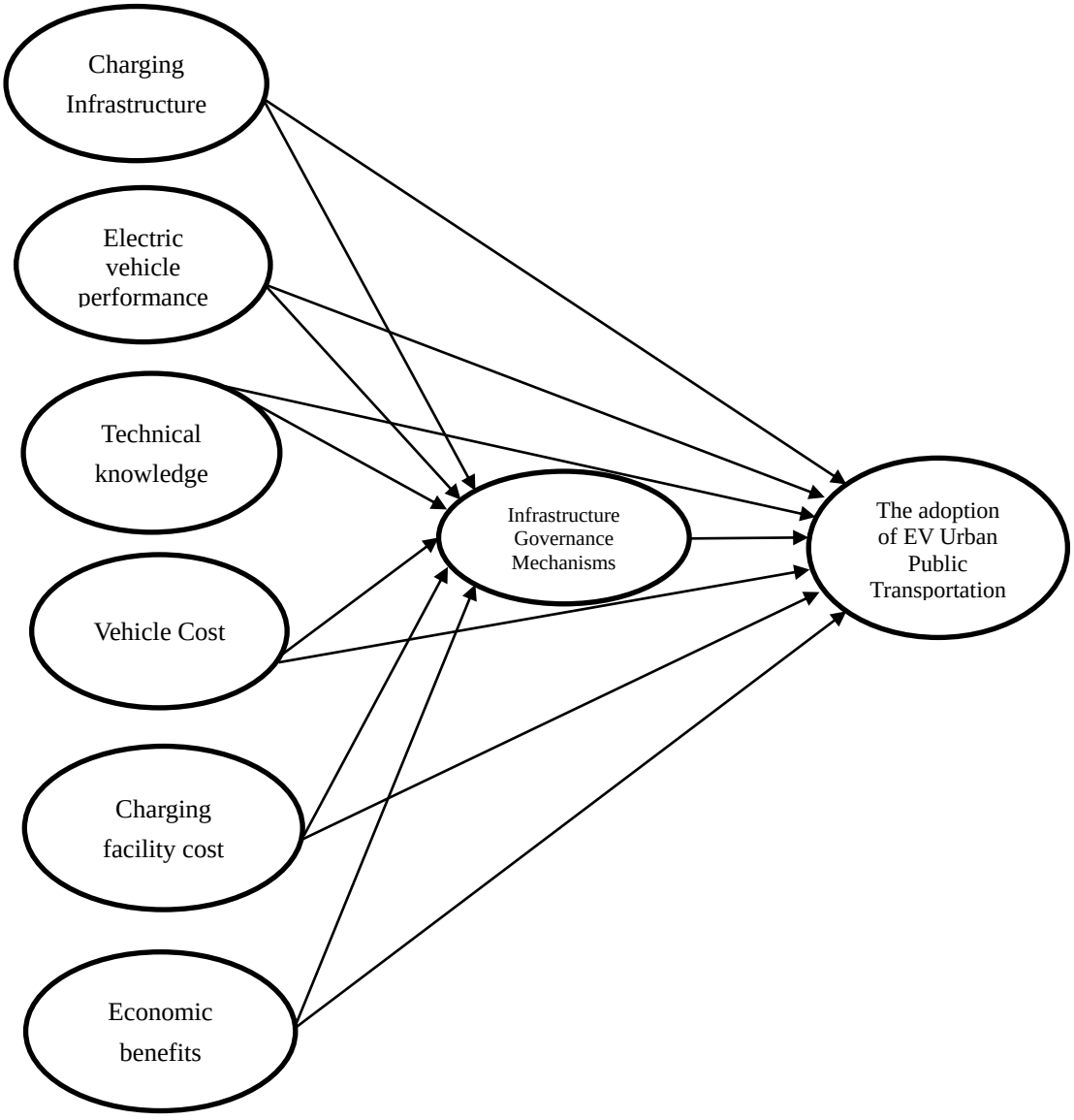

Figure 1. Research Framework & its Hypothesized Relationships

4. Implications for Future Research

The findings derived from this study carry several significant implications for future inquiries in the domain of electric vehicle (EV) infrastructure governance and adoption, particularly within the specific context of Hunan and analogous regions.

1. Longitudinal Studies on Policy Impact: Future research should prioritize longitudinal studies that investigate the long-term effects of government policies and financial incentives on the development and adoption of EV infrastructure. Such studies will provide critical insights into the sustainability and effectiveness of various governance strategies over extended periods, allowing for a more comprehensive understanding of their impact.

2. Comparative Analyses Across Regions: Conducting comparative analyses between Hunan and other provinces or countries characterized by different governance structures could yield valuable insights into best practices and effective strategies for overcoming prevalent challenges in EV infrastructure development. Such comparative studies would help identify context-specific factors that contribute to successful implementation, offering a richer understanding of how different governance frameworks influence outcomes.

3. Stakeholder Engagement Models: Future research should explore effective models for stakeholder engagement that emphasize how collaboration between government agencies, private investors, and local communities can enhance the deployment of EV infrastructure. A thorough examination of the dynamics within stakeholder relationships is essential, as it can lead to improved coordination, better resource allocation, and more successful infrastructure outcomes.

4. Technological Innovation Assessment: Investigating the role of technological innovations in EV infrastructure is critical, particularly in relation to smart charging solutions and the integration of renewable energy sources. Future studies could assess how these advanced technologies can enhance the efficiency and effectiveness of charging networks, ultimately improving user experiences and facilitating wider adoption.

5. Economic and Environmental Evaluations: Future studies should also focus on evaluating the economic and environmental impacts associated with the development of EV infrastructure. Conducting comprehensive cost-benefit analyses that account for both direct financial implications and broader societal benefits, such as reductions in greenhouse gas emissions and improvements in air quality, will enhance the overall understanding of the value of investing in EV infrastructure.

By addressing these areas, future research can significantly contribute to the advancement of more effective governance mechanisms for EV infrastructure, thereby facilitating the transition toward sustainable urban transportation systems that are essential for addressing contemporary environmental and mobility challenges.

References

Achıaw, Y. O., & Kanol, D. (2021). Explaining the adoption of EV policies in oil-rich countries. *LAÜ Sosyal Bilimler Dergisi, 12*(2), 144-162.

Anastasiou, A., Fuehres, H., & Sousa-Zomer, T. (2018). The role of charging infrastructure deployment in electric vehicle adoption: A case study of The Netherlands and Norway. *Transportation Study Part A: Policy and Practice, 107,* 113-126. https://doi.org/10.1016/j.tra.2018.05.014

Bakker, S., & Trip, J. J. (2013). Policy options to support the adoption of electric vehicles in the urban environment. *Transportation StudyPart D: Transport and Environment, 25,* 18-23. https://doi.org/10.1016/j.trd.2013.07.005

Bhat, F. A., Verma, M., & Verma, A. (2022). Measuring and modeling electric vehicle adoption of Indian consumers. *Transportation in Developing Economies, 8*(1), 6. https://doi.org/10.1007/s40890-021-00143-2

Buhmann, K. M., Rialp-Criado, J., & Rialp-Criado, A. (2024). Predicting consumer intention to adopt battery electric vehicles: Extending the theory of planned behavior. *Sustainability, 16*(3), 1284. https://doi.org/10.3390/su16031284

Carvalho, D. V., Delafave, A., & Balestieri, J. A. P. (2021). A dynamic simulation model for understanding the influence of socio-economic factors on the adoption of electric vehicles in Brazil. *Energy Policy, 148 (Part A),* 112027. https://doi.org/10.1016/j.enpol.2020.112027

Chaturvedi, P., Kulshreshtha, K., Tripathi, V., & Agnihotri, D. (2023). Exploring consumers' motives for electric vehicle adoption: Bridging the attitude-behavior gap. *Benchmarking, 30*(10), 4174-4192. https://doi.org/10.1108/BIJ-10-2021-0618

Chawla, U., Mohnot, R., Mishra, V., Harsh, V. S., & Singh, A. K. (2023). Factors influencing customer

preference and adoption of electric vehicles in India: A journey towards more sustainable transportation. *Sustainability, 15*(8), 7020. https://doi.org/10.3390/su15087020

Chen, H., Zeng, Y., & Tan, Z. (2021). Policy incentives and electric vehicle adoption: Evidence from China. *Energy Policy, 153*, 112281. https://doi.org/10.1016/j.enpol.2021.112281

Chen, L., Huang, H., Zhang, Y., & Hu, Q. (2017). Factors influencing the development of electric vehicle charging infrastructure in China. *Energy Policy, 110*, 51-61. https://doi.org/10.1016/j.enpol.2017.08.007

Chen, L., Wang, Y., Li, L., & Zhao, J. (2017). Coordinating charging for electric vehicles and energy storage systems in a parking lot with renewable energy integration. *Applied Energy, 208*, 961-971. https://doi.org/10.1016/j.apenergy.2017.09.036

China Association of Automobile Manufacturers (CAAM) (2021). *Sales of New Energy Vehicles.* Retrieved June 15, 2024, from http://en.caam.org.cn/Index/lists/catid/72.html

China Meteorological Administration (CMA) (2023). *2022 Blue Book on China's Ecological Environment.*

Di Foggia, G. (2021). Drivers and challenges of electric vehicles integration in corporate fleet: An empirical survey. *Study in Transportation Business & Management, 41*, 100627. https://doi.org/10.1016/j.rtbm.2021.100627

European Environment Agency (EEA) (2024). *Electric Vehicles.* Retrieved October 19, 2024, from https://www.eea.europa.eu/en/topics/in-depth/electric-vehicles

Featherman, M., Jia, S. J., Califf, C. B., & Hajli, N. (2021). The impact of new technologies on consumers beliefs: Reducing the perceived risks of electric vehicle adoption. *Technological Forecasting and Social Change, 169*, 120847. https://doi.org/10.1016/j.techfore.2021.120847

Fournel, J. F. (2022). *Essays on the Economics of Electric Vehicle Markets: Effect of Subsidies on Adoption, Infrastructure Development, and Environmental Outcomes.* McGill University (Canada).

Ghosh, A., & Dey, A. K. (2024). Electrifying customer satisfaction and loyalty: A structural equation modeling approach in the Indian four-wheeler electric vehicle industry. *Srusti Management Review, 17*(1), 24-37. Retrieved from http://eserv.uum.edu.my/scholarly-journals/electrifying-customer-satisfaction-loyalty/docview/3095235980/se-2

Gupta, A., & Rhoads, J. (2022). Barriers and drivers for electric vehicle adoption in developing countries. *International Journal of Social Analytics, 7*(12), 1-10.

Gupta, S., Bansal, R., & Bankoti, N. (2024). Factors affecting Consumer's intention to use electric vehicles: Mediating role of awareness and knowledge. *J Adv Transport.* https://doi.org/10.1155/2024/5922430

Habich-Sobiegalla, S., Kostka, G., & Anzinger, N. (2019). Citizens' electric vehicle purchase intentions in China: An analysis of micro-level and macro-level factors. *Transport Policy, 79*, 223-233. https://doi.org/10.1016/j.tranpol.2019.05.008

Han, S., Park, J., & Choi, I. (2015). Economic benefits of electric vehicles for reducing greenhouse gas emissions and oil consumption in South Korea. *Applied Energy, 143*, 311-322. https://doi.org/10.1016/j.apenergy.2015.01.029

Hao, W, & Lei, C. (2021). *The General Trend of Carbon Neutrality has been Set, and the Process of Electrification is Accelerating - A New Energy Vehicle Industry Strategy Report.* Retrieved from https://data.eastmoney.com/report/zw_industry.jsht ml?infocode=AP202105251493817139

Harahap, F., Mohammed, H., Henrysson, M., Franco, J., & Jenelius, E. (2023). *Policy Tools for Electric Vehicle Adoption in Curitiba City*. In SBEUT-Sustainable Built Environment and Urban Transition Conference.

Haustein, S., Jensen, A. F., & Cherchi, E. (2021). Battery electric vehicle adoption in Denmark and Sweden: Recent changes, related factors, and policy implications. *Energy Policy, 149*, Article 112096. https://doi.org/10.1016/j.enpol.2020.112096

Hawkins, T. R., Gausen, O. M., Meyer, N., & Schenker, U. (2020). The environmental impacts of battery electric vehicles: A review. *Journal of Cleaner Production, 256*, 120395. https://doi.org/10.1016/j.jclepro.2020.120395

Hildemann, L. M., Markowski, G. R., & Cass, G. R. (2015). Chemical composition of emissions from urban sources of fine organic aerosol. *Environmental Science and Technology, 25*(4), 744-759.

https://doi.org/10.1021/es00016a021

Huang, B., Tian, L., Lu, Z., & Li, W. (2017). Analysis of the development of electric vehicle charging infrastructure in Hunan Province. *China Electric Power, 50*(6), 76-81.

Hunan Provincial Electric Vehicle Industry Association. (2021). *Statistical Data on EV Registrations in Hunan.* Hunan, China.

Imran, A., & Mohammad, N. (2022). Insights on electric vehicle adoption: Does attitude play a mediating role? *Innovative Marketing, 18*(1), 104-116. https://doi.org/10.21511/im.18(1).2022.09

International Energy Agency [IEA]. (2022). *World Energy Outlook 2022*. Retrieved October 19, 2024, from https://www.iea.org/reports/world-energy-outlook-2022

International Energy Agency [IEA]. (2023). *Global EV Outlook 2022.* Retrieved October 22, 2024, from https://www.iea.org/reports/global-ev-outlook-2023/executive-summary

Jiang, Y., Zhu, Q., Zhao, H., & Zhou, N. (2018). Study on the current situation and problems of the construction of electric vehicle charging infrastructure in China. *Energy Procedia, 152,* 1192-1197.

Jing, R., Yuan, C., Rezaei, H., Qian, J., & Zhang, Z. (2020). Assessments on energy and greenhouse gas emissions of internal combustion engine automobiles and electric automobiles in the USA. *Journal of Environmental Science, 90,* 297-309. https://doi.org/10.1016/j.jes.2020.03.017

Kawamoto, R., Mochizuki, H., Moriguchi, Y., Nakano, T., Motohashi, M., Sakai, Y., & Inaba, A. (2019). Estimating CO_2 Emissions of Internal Combustion Engine Vehicle and Battery Electric Vehicle Using LCA. *Sustainability, 11*, 2690. https://doi.org/10.3390/su11092690

Kester, J., Noel, L., Zarazua de Rubens, G., & Sovacool, B. K. (2018). Policy mechanisms to accelerate electric vehicle adoption: A qualitative review from the Nordic region. *Renewable and Sustainable Energy Reviews, 94*, 719-731. https://doi.org/10.1016/j.rser.2018.05.067

Li, C., Song, Z., Liu, J., & Xie, J. (2019). Exploring the determinants of electric vehicle adoption: Evidence from Hunan, China. *Journal of Cleaner Production, 241,* 118258. https://doi.org/10.1016/j.jclepro.2019.118258

Li, H., Chen, J., & Hong, Y. (2016). The role of government subsidy in promoting China's new energy vehicle industry: A dynamic game approach. *Sustainability, 8*(10), 1056. https://doi.org/10.3390/su8101056.

Li, H., Xiong, K., & Wang, Y. (2020). An analysis of challenges faced by electric vehicle charging infrastructure in China. (10), 2454.

Li, J., Gu, B., & Ma, J. (2017). *Policy study on the development of new energy vehicles in Hunan Province.* In *Proceedings of the International Symposium on Computer Science and Intelligent Control* (pp. 389-396). Springer.

Li, J., Jiang, W., Shao, J., Zhao, H., & Luo, Y. (2019). An empirical analysis of the impact of government policy on electric vehicle industry development in China. *Energy Policy, 130*, 313-323. https://doi.org/10.1016/j.enpol.2019.04.029

Li, L., Wang, Z., & Xie, X. K. (2020). *From Government to Market? A Discrete Choice Analysis of Policy Instruments for Electric Vehicle Adoption* (CEIBS Working Paper, No. 039/2020/POM, 2020).

Liang, L., Zhang, W., & Huang, C. (2021). Design and evaluation of electric vehicle subsidy policies in China. *Transportation Study Part D: Transport and Environment, 94*, 102774. https://doi.org/10.1016/j.trd.2021.102774

Lin, B., Chen, Y., & Xie, C. (2018). Quantifying the Economic Benefits of Electric Vehicle Deployment in China. *Energies, 11*(3), 675. https://doi.org/10.3390/en11030675

Liu, C., & Zhang, T. (2021). Governance mechanism of electric vehicle charging infrastructure development: A case study of Yueyang, China. *Sustainability, 13*(5), 2854. https://doi.org/10.3390/su13052854

Liu, C., Chen, H., Liu, Y., & Yan, J. (2020). Accelerating the commercialization of electric vehicles: Policy incentives for the private sector in China. *Energy Policy, 137*, 111131. https://doi.org/10.1016/j.enpol.2019.111131

Liu, W., Wu, Y., Qian, H., Wu, Q., & Wang, M. (2021). Multi-stakeholder collaboration on electric vehicle integration in China: An analysis of barriers and potential solutions. *Energy Policy, 150,* 112146. https://doi.org/10.1016/j.enpol.2021.112146

Liu, Y., Sun, S., & Chen, Y. (2020). The profitability and influencing factors of electric vehicle charging station: Evidence from China. *Applied Energy, 268*, 114994. https://doi.org/10.1016/j.apenergy.2020.114994

Lu, C (2022). *Analysis of China's New Energy Vehicle Industry*. Proceedings of the 2022 7th International Conference on Financial Innovation and Economic Development (ICFIED 2022). Advances in Economics, Business, and Management Study, volume 211.

Luo, D., Li, Y., Xu, M., & Zhang, Z. (2018). Government-led public-private partnership in the development of electric vehicle charging infrastructure in China. *Energy Policy,* 122, 35-42. https://doi.org/10.1016/j.enpol.2018.07.020

Mumford, E. (2006). The story of socio-technical design: Reflections on its successes, failures, and potential. *Information Systems Journal, 16*(4), 317–342. https://doi.org/10.1111/j.1365-2575.2006.00221.x

Pan, D., Wang, B., Li, J., & Wu, F. (2024). Exploring the user adoption mechanism of green transportation services in the context of the electricity–carbon market synergy. *Energies, 17*(1), 274. https://doi.org/10.3390/en17010274

Pandak, I., Piaralal, S. K., & Rethina, V. S. (2024). Investigating the Moderating Role of Government Incentive Policy on Consumer Adoption of Battery Electric Vehicles (BEV) in Malaysia.

Pang, J., Ye, J., & Zhang, X. (2023). Factors influencing users' willingness to use new energy vehicles. *PLoS One. 18*(5). https://doi.org/10.1371/journal.pone.0285815

Peters, A. M., Van der Werff, E., & Steg, L. (2018). Beyond purchasing: Electric vehicle adoption motivation and consistent sustainable energy behavior in The Netherlands. *Energy Study & Social Science, 39*, 234-247. https://doi.org/10.1016/j.erss.2017.10.008

Rafiq, F., Parthiban, E. S., Rajkumari, Y., Adil, M., Nasir, M., & Dogra, N. (2024). From thinking green to riding green: A study on influencing factors in electric vehicle adoption. *Sustainability, 16*(1), 194. https://doi.org/10.3390/su16010194

Ramasamy, M., Qian, Y., Zhai, Q., & Liu, L. (2021). Examining the challenges of public electric vehicle charging infrastructure development in China. *Sustainable Cities and Society, 73,* 103062. https://doi.org/10.1016/j.scs.2021.103062

Reiner, C., Beard, G., Park, T., & Kinnear, N. (2020). *Driving and accelerating the adoption of electric vehicles in the UK*. The Behavioral Insights Team and TRL, Jul.

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the Technology Acceptance Model: Four longitudinal field studies. *Management Science, 46*(2), 186-204. https://doi.org/10.1287/mnsc.46.2.186.11926

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

Wang, D., Ozden, M., & Tsang, Y. P. (2023). The impact of facilitating conditions on electric vehicle adoption intention in China: An integrated unified theory of acceptance and use of technology model. *International Journal of Engineering Business Management, 15*, 18479790231224715. https://doi.org/10.1177/18479790231224715

Wang, D., Xu, L., Zhou, J., & Wang, S. (2019). Analysis of the factors influencing the development of electric vehicle charging infrastructure in China based on an integrated framework of geographic information systems and multiple criteria decision-making. *Energy Policy, 134*, 110951. https://doi.org/10.1016/j.enpol.2019.110951

Wang, H., Su, J., Zhang, M., & Zhou, D. (2016). Economic assessment of electric vehicles in Europe: A comprehensive sensitivity analysis. *Energy Policy, 98*, 183-194. https://doi.org/10.1016/j.enpol.2016.09.029

Wu, Y., Guo, Y., Zhang, R., & Zeng, W. (2018). Analysis of factors influencing the promotion of new energy vehicles in Hunan province. *Journal of Hunan University (Natural Sciences), 45*(11), 135-143. https://doi.org/10.13300/j.cnki.jhnu.2018.11.019

Xu, M., Cheng, S., & Wang, J. (2017). The economic impact of electric vehicles industry in China: A regional approach. *Sustainability, 9*(12), 2235. https://doi.org/10.3390/su9122235

Yang, S., Yang, L., Chen, L., & Yan, X. (2020). Analysis of influencing factors of electric vehicle penetration based on multi-level modeling in China. *Energy Policy, 141*, 111483.

https://doi.org/10.1016/j.enpol.2020.111483

Zhang, M., Su, J., & Gao, X. (2018). An economic analysis of job creation by electric vehicle industry in China. *Journal of Cleaner Production, 202*, 485-493. https://doi.org/10.1016/j.jclepro.2018.08.086

Zhang, M., Su, J., & Gao, X. (2019). Economic benefits of electric vehicle charging infrastructure: A case study in China. *Energy Policy, 126*, 228-237. https://doi.org/10.1016/j.enpol.2018.10.061

Zhang, M., Wang, W., Wang, L., & Bi, J. (2018). Comparative analysis of environmental impacts of electric vehicles based on life cycle assessment: A case study in Shanghai, China. *Energy, 109*, 473-484. https://doi.org/10.1016/j.energy.2016.05.086

Zhang, R., Li, S., & Wang, X. (2021). Governance mechanisms and electric vehicle adoption in Chinese cities: Empirical evidence from panel data analysis. *Journal of Cleaner Production, 311*, 127459. https://doi.org/10.1016/j.jclepro.2021.127459

Zhang, X., Yang, D., Zhang, T., & Zhang, Y. (2021). Comparative analysis of electric vehicle charging infrastructures based on accessibility and efficiency. *Sustainability, 13*(4), 2321. https://doi.org/10.3390/su13042321

Zhou, P., Wu, Y., Wu, J., & Wang, H. (2020). Economic and environmental benefits of electric vehicles: A case study in China. *Journal of Cleaner Production, 267*, 122062. https://doi.org/10.1016/j.jclepro.2020.122062

Zink, R., Valdes, J., & Wuth, J. (2020). Prioritizing the chicken or egg? Electric vehicle purchase and charging infrastructure subsidies in Germany. *Politics and Governance*, *8*(3), 185-198. https://doi.org/10.17645/pag.v8i3.3025

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