

Article

Driving the Mass Market: How Infrastructure Readiness and User Experience Shape Consumer Valuation of Electric Vehicles in Thailand

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Abstract

Electric vehicles (EVs) are increasingly recognized as a sustainable transportation solution; however, mass-market adoption in Thailand remains limited due to infrastructure constraints, technological complexity, and evolving consumer perceptions. This study examines the effects of charging infrastructure accessibility, perceived ease of use, and psychological driving experience on consumers' willingness to pay (WTP) for EVs. A quantitative approach was employed using survey data collected from 400 EV users and analyzed through Structural Equation Modeling (SEM). Grounded in the Technology Acceptance Model (TAM) and the Theory of Consumption Values (TCV), the study reveals that charging infrastructure accessibility significantly enhances perceived ease of use, driving experience, and WTP. In addition, perceived ease of use and driving experience positively influence consumers' financial commitment toward EV adoption and partially mediate the relationship between infrastructure accessibility and WTP. The findings indicate that EV consumer valuation is shaped by both functional infrastructure readiness and psychological user experience. The study contributes to EV consumer behavior literature by integrating cognitive and experiential perspectives and provides practical implications for policymakers and industry stakeholders seeking to accelerate EV adoption in Thailand.

Keywords: electric vehicle adoption; charging infrastructure accessibility; perceived ease of use; driving experience; willingness to pay



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1. Introduction

The global transition toward sustainable mobility has accelerated rapidly over the past decade, with electric vehicles (EVs) emerging as a central solution to mitigate climate change, reduce urban air pollution, and enhance energy security. Governments worldwide, including Thailand, have introduced policy incentives, infrastructure investments, and regulatory frameworks to promote EV adoption. Financial incentives continue to represent the most influential factor shaping adoption among early majority consumers. In the Thai context, the EV 3.5 policy package (2024–2027), which offers subsidies of up to 100,000 THB for passenger vehicles, has played a pivotal role in accelerating market uptake, as reflected in the 46% year-on-year growth in xEV registrations observed in 2024 [1]. Despite these efforts, consumer adoption of EVs has not yet reached mass-market penetration levels, particularly in emerging economies where infrastructural, technological, and behavioural uncertainties persist. Recent behavioural models published in February 2026, grounded in

an extended Technology Acceptance Model (TAM), indicate a notable shift in consumer priorities. Specifically, factors related to “technology consideration” including charging duration and the complexity of maintenance have emerged as more influential barriers to adoption among urban consumers than the traditionally emphasized concern of range anxiety [2]. This raises a critical question: what factors truly drive consumers’ willingness to adopt and pay for electric vehicles in contexts where both technological systems and user experiences are still evolving?

Recent advances in EV research have increasingly shifted from macro-level policy and environmental perspectives toward micro-level analyses of consumer behavior. Traditional models, such as the Technology Acceptance Model (TAM) and diffusion of innovation theory, have been widely applied to explain EV adoption by focusing on perceived usefulness, perceived ease of use, and social influence. More recent studies have expanded this perspective by incorporating experiential and contextual variables, including driving performance, environmental consciousness, and perceived economic benefits. In parallel, infrastructure-related studies have emphasized the importance of charging availability, accessibility, and technological compatibility as critical enablers of EV adoption. Environmental awareness and knowledge have evolved beyond peripheral considerations to become central determinants that play a pivotal role in reducing individuals’ perceived risks associated with the adoption of emerging technologies [3]. These developments reflect a growing recognition that EV adoption is not solely a technological or economic decision but a complex interplay between system readiness and user perception.

Within the Thai context, the evolution of EV adoption has been particularly dynamic. Government initiatives, such as tax incentives and the expansion of public charging networks, have contributed to increased market awareness and interest. This research advances the electric vehicle (EV) adoption literature by highlighting the substantial variation in adoption determinants across vehicle segments within emerging markets, thereby questioning the effectiveness of uniform policy approaches to EV promotion [4]. However, challenges remain regarding infrastructure reliability, spatial distribution of charging stations, and integration with digital platforms. For instance, consumers’ perception of charging infrastructure accessibility encompasses not only the physical presence of charging stations but also their spatial density along daily routes, technical compatibility with different vehicle models, ease of information access through mobile applications, and functional reliability in terms of uptime and maintenance. These multidimensional aspects suggest that infrastructure is experienced not merely as a physical system but as a service ecosystem that directly shapes consumer confidence and perceived value.

Simultaneously, user experience has emerged as a critical determinant of EV adoption. Perceived ease of use, including the ability to learn vehicle operations, manage charging processes, and interact with digital interfaces, significantly influences consumer attitudes toward EVs. In Thailand, where digital literacy and mobile application usage are relatively high, the integration of user-friendly interfaces in EV ecosystems (e.g., charging apps and vehicle management systems) plays an essential role in reducing perceived complexity. consumers’ perceptions of the simplicity of operating electric vehicles (EVs), together with their intuitive and user-oriented features, play a pivotal role in facilitating adoption among Thai users. In this context, digital interfaces—such as applications supporting navigation, payment systems, and battery management—function as critical interaction points that mitigate perceived complexity and enhance overall user acceptance [5]. Moreover, the psychological dimension of driving experience such as sensory comfort, performance satisfaction, environmental consciousness, and perceived innovativeness has been identified as a key factor shaping consumer preferences. EVs offer unique experiential benefits,

including quiet operation, instant torque, and a sense of contributing to environmental sustainability, which collectively enhance the perceived value of the technology.

Despite these advances, a significant gap remains in understanding how infrastructure readiness and user experience jointly influence consumers' willingness to pay (WTP) for EVs. While prior studies have examined these factors independently, limited research has integrated them into a comprehensive framework that captures both functional and experiential dimensions of consumer valuation. This gap is particularly critical in emerging markets like Thailand, where consumers often face trade-offs between higher upfront costs and uncertain long-term benefits. Willingness to pay is not merely a function of economic rationality but is shaped by perceptions of value-for-money, budget prioritization, and long-term commitment to EV ownership. For example, consumers' acceptance of a price premium, belief in long-term cost savings, and intention to purchase EVs even in the absence of subsidies reflect deeper psychological and contextual evaluations of value [6].

Another critical limitation in the current body of knowledge is the lack of context-specific empirical evidence. Much of the existing research has been conducted in developed countries with mature EV ecosystems, where infrastructure and user familiarity are relatively advanced. In contrast, emerging markets like Thailand present unique challenges and opportunities, including varying levels of infrastructure development, diverse consumer segments, and distinct cultural attitudes toward technology and environmental sustainability. In the context of Thailand, the adoption of autonomous vehicles is influenced by key determinants, including performance expectancy, effort expectancy, facilitating conditions, perceived environmental benefits, and financial incentives such as purchase subsidies [7]. Therefore, there is a pressing need for research that captures the nuanced interplay of factors influencing EV adoption within this specific context.

Addressing these gaps is not only academically important but also practically significant. As Thailand aims to position itself as a regional hub for EV production and adoption, understanding the determinants of consumer willingness to pay becomes critical for achieving policy targets and market growth. Insights into how infrastructure and user experience shape consumer valuation can inform the design of more effective interventions, such as targeted infrastructure investments, user-centric technology design, and tailored marketing strategies. Moreover, such understanding can help bridge the gap between early adopters and the mass market, facilitating a more inclusive and sustainable transition to electric mobility.

Although previous studies have extensively applied the Technology Acceptance Model (TAM) and the Theory of Consumption Values (TCV) to explain electric vehicle adoption, most investigations have focused primarily on adoption intention, purchase intention, or technology acceptance outcomes. Comparatively limited attention has been devoted to understanding how technological perceptions and consumption values interact to shape consumers' financial valuation of electric vehicles.

The present study addresses this gap by developing an integrated framework that links infrastructure-related perceptions, user experience, and consumer valuation. Specifically, the study conceptualizes charging infrastructure accessibility as a critical external condition that influences both perceived ease of use and driving experience, which subsequently affect consumers' willingness to pay. By examining the mechanisms through which technological and experiential evaluations are translated into economic valuation, the study extends existing EV adoption research beyond behavioral intention and contributes to a more comprehensive understanding of consumer decision-making in emerging electric mobility markets.

In light of the above discussion, this study seeks to develop an integrated framework that examines the combined effects of charging infrastructure accessibility, perceived ease

of use, and driving experience on consumers' willingness to pay for electric vehicles in Thailand. Specifically, the study addresses the following research questions: (1) How does charging infrastructure accessibility influence consumers' willingness to pay for EVs? (2) To what extent does perceived ease of use shape consumer valuation of EVs? (3) How does the psychological driving experience contribute to willingness to pay? (4) How do these factors interact to influence consumer decision-making in the Thai EV market?

2. Literature Review

This study adopts the Technology Acceptance Model (TAM) and the Theory of Consumption Values (TCV) to provide a comprehensive explanation of electric vehicle (EV) consumer behavior. TAM is employed to capture the role of perceived ease of use in reducing technological complexity and enhancing user acceptance. Meanwhile, TCV explains how consumers evaluate EVs through multidimensional value perceptions, including functional, emotional, and economic benefits. The integration of these theories is essential, as it links technological interaction with value-based decision-making, thereby offering a holistic understanding of consumers' willingness to pay in the context of evolving infrastructure and user experience.

2.1. Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) is widely recognized as a foundational framework in information systems research for explaining and predicting individuals' adoption of new technologies. Originally proposed by Fred D. Davis, the model posits that users' behavioral intentions are primarily shaped by two key perceptions: Perceived Usefulness (PU), which reflects the extent to which a technology is believed to enhance performance, and Perceived Ease of Use (PEOU), which refers to the degree to which using the technology is considered effortless. Together, these factors play a central role in influencing users' decisions to adopt a system [8].

In the EV context, this construct extends beyond basic driving functionality to include users' ability to comprehend system features, efficiently manage battery charging processes, and interact with digital interfaces such as mobile applications and integrated charging infrastructures. These dimensions are especially critical within technology-intensive mobility ecosystems, where intuitive and seamless user interaction can enhance acceptance while mitigating perceived complexity.

2.2. Theory of Consumption Values (TCV)

The Theory of Consumption Values, proposed by Jagdish N. Sheth and colleagues, offers a comprehensive lens for examining consumers' willingness to pay for electric vehicles (EVs). The framework suggests that purchasing decisions are influenced by multiple dimensions of value, notably functional, emotional, and economic factors. Economic value, in turn, relates to consumers' perceptions of long-term financial benefits and the justification of purchase costs. Accordingly, the Theory of Consumption Values is highly pertinent for explaining how the integration of diverse value perceptions informs consumer evaluation and ultimately shapes purchase intentions [9].

Within the context of electric vehicle (EV) adoption, functional value is demonstrated through the accessibility and reliability of charging infrastructure, including its compatibility with users' needs. Epistemic value pertains to consumers' perceptions of innovation and technological advancement associated with EVs. Emotional value is derived from the driving experience, encompassing both comfort and a sense of environmental responsibility. Conditional value reflects the impact of situational factors, such as government incentives and the availability of supporting infrastructure. Economic value relates to consumers'

assessment of price premiums in relation to anticipated long-term cost savings. Taken together, these value dimensions illustrate how consumers evaluate EVs as an integrated set of benefits, ultimately shaping their overall perceptions and purchase intentions.

2.3. Research Hypothesis

2.3.1. The Relationship Between Charging Infrastructure Accessibility Factor and Driving Experience (Psychological) Factor

Environmental consciousness, cost competitiveness relative to fossil fuels, and the accessibility of charging infrastructure act as key motivators, with many users demonstrating a willingness to pay a premium for stations powered by renewable energy. Nevertheless, adoption remains impeded by concerns such as range anxiety, dissatisfaction with charging durations, inconsistent pricing structures, high installation expenses, regulatory complexities, and disparities in access for tenants and lower-income groups. In addition, technical and infrastructural limitations particularly constrained grid capacity and inadequate parking availability pose significant challenges, although the development of smart grid systems presents a promising avenue for addressing these barriers [10]. The availability of electric vehicle (EV) charging infrastructure has been shown to be positively associated with EV sales. Existing studies typically operationalize charging availability using indicators such as station density or the ratio of EVs to charging facilities (e.g., number of stations or chargers). While these metrics are intuitive and easy to apply, they often overlook the spatial accessibility of charging infrastructure, including its distribution and configuration. To address this limitation, this study develops a set of indicators that capture charging availability from a spatial accessibility perspective [11]. Actual ownership levels remained relatively low, primarily due to concerns regarding affordability, insufficient charging infrastructure, and range anxiety. The qualitative findings offered further insight by demonstrating how individual experiences and perceptions shaped attitudes toward electric vehicles. Demographic characteristics including age, educational attainment, income level, and housing status were identified as significant predictors of favorable adoption attitudes. Younger individuals, those with higher levels of education and income, and residents of owner-occupied housing exhibited a stronger willingness to transition to electric vehicles. Participants also underscored the critical role of robust government support, particularly in the form of financial incentives and expanded infrastructure, in promoting wider adoption [12]. Accessibility to charging infrastructure exerts a positive influence on the psychological dimensions of the driving experience by alleviating range anxiety, strengthening perceived behavioral control, and enhancing convenience. Collectively, these effects contribute to higher levels of user satisfaction and greater confidence in the use of electric vehicles.

Hypothesis 1. *The charging infrastructure accessibility factor has a significant and positive relationship with driving experience (Psychological) factor.*

2.3.2. The Relationship Between Charging Infrastructure Accessibility Factor and Perceived Ease of Use Factor

Perceived quality and price value exert a significant influence on attitudes, whereas the availability of charging infrastructure and expected resale value directly shape adoption intentions. Notably, attitude, subjective norms, and perceived behavioral control do not emerge as significant predictors. These results indicate that, within emerging markets, pragmatic and economic considerations take precedence over psychological or affective drivers [13]. Trust is identified as a central mediating factor that links technical, economic, and social determinants to consumers' intentions to adopt electric vehicles (EVs). The literature emphasizes that enhancing infrastructure reliability, ensuring policy transparency, and maintaining consistent service quality are essential strategies for strengthening consumer

trust and promoting wider EV adoption [14]. Although charging infrastructure is gradually expanding, it remains underdeveloped and unevenly distributed across Slovakia. The scarcity of fast-charging stations especially along highways and in rural regions leads to congestion and exacerbates range anxiety among prospective battery electric vehicle (BEV) users. This infrastructural limitation continues to persist despite recent initiatives and investments aimed at enhancing the availability of public charging networks [15]. Morocco's electric vehicle (EV) ecosystem is characterized by an interplay of structural constraints and behavioral barriers. Key challenges are predominantly structural, including the high cost of EVs, limited consumer trust, and underdeveloped charging infrastructure. By contrast, in industrialized countries, adoption is more often impeded by the inertia of established legacy systems. Although environmental awareness is relatively strong, it has not yet translated into widespread adoption, particularly among younger cohorts. Consistent with prior literature, consumer behavior is largely driven by considerations of cost-effectiveness and convenience, which frequently override pro-environmental intentions [16]. Drawing on the literature, the accessibility of charging infrastructure is found to positively affect perceived ease of use by lowering operational complexity, improving convenience, and strengthening users' sense of control over charging processes.

Hypothesis 2. *The charging infrastructure accessibility factor has a significant and positive relationship with perceived ease of use factor.*

2.3.3. The Relationship Between Charging Infrastructure Accessibility Factor and Willingness-to-Pay Factor

Enhancing users' willingness to pay (WTP) for EV charging requires strategic investments in fast-charging technologies, the upgrading of charging station amenities, and the promotion of environmental awareness. Policymakers and charging service providers can further stimulate user engagement by introducing differentiated pricing schemes such as premium fees for faster charging and by developing integrated, hybrid spatial infrastructures [17]. Drivers of battery electric vehicles (BEVs) with extended driving ranges demonstrate a greater willingness to pay for faster charging speeds or higher-power charging infrastructure. Additionally, Tesla users exhibit higher sensitivity to charging duration compared to drivers of other brands. The provision of complementary amenities such as restrooms, cafés, and outdoor recreational spaces can partially mitigate the perceived inconvenience of longer charging times and enhance consumers' willingness to pay [18]. Attitudes and perceived behavioral control emerge as the most influential determinants of individuals' intentions to use EV services, whereas perceived risk exerts a significant negative effect. In contrast, environmental concern and personal norms do not significantly influence usage intention; however, they demonstrate a direct and positive effect on willingness to pay [19]. Prioritizing investment in advanced grid technologies and energy storage systems is essential to enhance the stability and reliability of the power network, particularly in response to the increasing electricity demand from EV charging infrastructure and the integration of renewable energy sources [20]. Greater accessibility to charging infrastructure enhances consumers' willingness to pay by improving perceived convenience, minimizing uncertainty and time-related costs, and strengthening the overall perceived value of electric vehicle ownership and associated charging services.

Hypothesis 3. *The charging infrastructure accessibility factor has a significant and positive relationship with willingness-to-pay factor.*

2.3.4. The Relationship Between Perceived Ease of Use Factor and Willingness to Pay Factor

Electric vehicle (EV) adoption intentions are chiefly influenced by perceived cost implications, knowledge of EVs, and the accessibility of charging infrastructure, each demonstrating markedly stronger effects than driver behavior. Exploratory findings further suggest that aggressive driving is associated with lower awareness of fuel efficiency, whereas maintenance-oriented practices and eco-driving behaviors are linked to higher levels of such awareness [21]. Perceived value exerts a significant positive influence on the intention to adopt electric vehicles and serves as a mediating factor in the relationship between willingness to pay and environmental cognition. Overall, the findings indicate that both willingness to pay and environmental awareness, as strengthened through perceived value, play critical roles in enhancing Indonesians' intentions to adopt electric vehicles [22]. Purchase intention exerts a significant positive influence on both electronic word-of-mouth (e-WOM) and willingness to pay (WTP), underscoring its pivotal role within the adoption ecosystem. The findings indicate that the uptake of used electric vehicles in Indonesia is primarily shaped by rational economic considerations and confidence in technical performance, rather than by environmental motivations. From a managerial perspective, the results emphasize the importance of implementing standardized battery health certification to strengthen consumers' perceived behavioral control (PBC) [23]. Based on the literature review, it can be concluded that perceived ease of use has a positive effect on willingness to pay, as it lowers cognitive and operational effort, enhances perceived usefulness and value, and strengthens consumer confidence in the use of electric vehicles.

Hypothesis 4. *The perceived ease of use factor has a significant and positive relationship with willingness-to-pay factor.*

2.3.5. The Relationship Between Driving Experience (Psychological) Factor and Willingness-to-Pay Factor

The literature suggests that incremental improvements in driving range and acceleration yield limited additional consumer value once key performance thresholds are reached. Instead, advanced technologies particularly Level 3 autonomous driving play a more influential role in shaping consumer preferences and design priorities. Moreover, consumers tend to favor functional enhancements over luxury-oriented interior features, indicating a stronger emphasis on practicality and value in vehicle design decisions [24]. Recent studies on environmental policy emphasize the role of government incentives in promoting the adoption of low-carbon technologies, particularly electric vehicles (EVs) and residential solar panels (PVs). The literature highlights the importance of understanding the relationship between these technologies, as their complementarity or substitutability has significant implications for policy efficiency in addressing environmental externalities. Empirical evidence based on household-level data suggests that EVs and PVs are generally complementary goods, with the strength of this relationship influenced by factors such as income and vehicle characteristics. Moreover, analytical findings indicate that such complementarity increases the likelihood of joint adoption, thereby enhancing the overall effectiveness of integrated policy interventions [25]. The willingness to pay for reductions in charging time and emissions is notably higher in strategic purchase contexts than in tactical charging decisions. Furthermore, the estimated scale parameter for the charging location experiment was consistently below one, suggesting increased randomness and heterogeneity in tactical choices, as opposed to the more structured and consistent evaluations observed in strategic decision-making contexts [26]. Drawing on the literature, it can be concluded that driving experience, as a psychological factor, exerts a positive influence

on willingness to pay by increasing emotional satisfaction, strengthening perceived value, and enhancing users' confidence in electric vehicle usage.

Hypothesis 5. *The driving experience (Psychological) factor has a significant and positive relationship with willingness-to-pay factor.*

2.3.6. The Relationship Between Driving Experience (Psychological) Factor and Perceived Ease of Use Factor

The key service quality dimensions, including accessibility, pricing transparency, and system usability, as critical determinants of user experience. Empirical studies employing quantitative methods, such as regression analysis, demonstrate that factors such as station layout, ease of use, pricing, and environmental conditions (e.g., lighting) significantly influence satisfaction levels, with pricing often identified as the most influential variable. However, much of the existing research remains largely descriptive and fragmented, lacking integrative frameworks that capture both behavioral and spatial aspects of user experience. To address this gap, recent studies propose more comprehensive models, such as the QUESS-PAC framework, which integrates quantitative user experience metrics with behavioral and spatial dimensions, thereby enabling a more systematic and holistic assessment of EV charging service quality [27]. The consumers' perceived value plays a crucial role in shaping both sustainability perception and purchase intention. Higher perceived value enhances consumers' evaluation of sustainability, which in turn strongly drives their intention to purchase electric vehicles. Household income further strengthens the influence of perceived value on purchase decisions, suggesting that economic capacity remains an important contextual factor [28]. The multiple antecedents significantly influence perceived trust and perceived risk, which in turn mediate their effects on users' adoption intentions. The strength of these relationships varies across income levels and usage-frequency groups, highlighting user heterogeneity. Drawing on Sociotechnical Systems (STS) theory, the literature explains how digitally mediated battery-swapping infrastructure shapes adoption behavior through trust and risk perceptions [29]. Based on the literature review, it can be inferred that driving experience, as a psychological factor, exerts a positive influence on perceived ease of use by lowering perceived effort, fostering familiarity, and strengthening users' confidence in operating electric vehicles.

Hypothesis 6. *The driving experience (Psychological) factor has a significant and positive relationship with perceived ease of use factor.*

2.3.7. The Relationship Between Charging Infrastructure Accessibility Factor and Willingness-to-Pay Factor as Perceived Ease of Use as a Mediator Factor

The willingness to pay (WTP) and environmental awareness (EA) as key antecedents of perceived value (PV), which serves as a central mechanism driving consumers' intention to adopt electric vehicles (EVs). Higher perceived value strengthens purchase intention, highlighting the importance of both economic and environmental considerations in shaping consumer evaluations. Conversely, perceived product-related risks (PR) act as barriers that can reduce purchase intention; however, their negative influence is moderated when consumers perceive strong overall value. Importantly, prior studies also underscore a critical gap between favorable consumer attitudes toward EVs and limitations in existing infrastructure, suggesting that enhancing charging accessibility and support systems is essential to translate positive perceptions into actual adoption [30]. The consumers demonstrate a positive willingness to pay a premium for higher levels of vehicle automation, reflecting perceived value and anticipated benefits. Although gender does not appear to significantly influence this willingness, age emerges as an important determinant, with

younger individuals showing greater acceptance and readiness to adopt such technologies. Furthermore, the study highlights the interconnected roles of information type, willingness to ride, and demographic factors such as gender and nationality in shaping consumer attitudes. These findings suggest that manufacturers should not only focus on advancing automated vehicle technologies but also invest in effective communication strategies to enhance public awareness, build trust, and foster broader acceptance [31]. A review of the extant literature indicates that the accessibility of charging infrastructure plays a pivotal role in shaping consumers' willingness to pay for electric vehicles, with perceived ease of use functioning as a key mediating variable within the Technology Acceptance Model framework.

Hypothesis 7. *The charging infrastructure accessibility factor has a significant and positive relationship with willingness-to-pay factor as perceived ease of use as a mediator factor.*

2.3.8. The Relationship Between Charging Infrastructure Accessibility Factor and Willingness-to-Pay Factor as Driving Experience (Psychological) as a Mediator Factor

The availability of charging infrastructure plays a pivotal role in enhancing the overall driving experience of electric vehicles (EVs). An improved driving experience, in turn, significantly influences consumers' behavioral intentions toward EV adoption. These positive behavioral intentions are further associated with a greater willingness to pay, reflecting the perceived value and practicality of EV usage. Moreover, existing studies highlight a sequential mechanism in which driving experience and behavioral intentions jointly mediate the relationship between infrastructure availability and willingness to pay. However, the mediation effect is often partial, suggesting that additional contextual and psychological factors may also contribute to consumers' valuation and adoption decisions [32]. User satisfaction and perceived ease of use are pivotal in alleviating range anxiety among electric vehicle users. Both external factors (e.g., satisfaction and perceived ease of use) and internal factors (e.g., range anxiety, charging habits, and risk-averse attitudes) jointly influence individuals' willingness to pay (WTP) for charging services. Notably, enhancements in user satisfaction demonstrate the strongest effect, significantly reducing range anxiety while simultaneously increasing WTP for charging [33]. The behavioral intention toward electric vehicles (EVs) as a function of both cognitive and social determinants. Environmental knowledge and performance expectancy emerge as key positive drivers, reflecting consumers' awareness of sustainability benefits and anticipated functional advantages. Similarly, subjective norms play a significant role, indicating the influence of social pressure and normative beliefs on adoption decisions. Conversely, information overload is shown to hinder behavioral intention by creating cognitive burden and decision fatigue. Interestingly, perceived risk is also found to have a significant positive association with behavioral intention, suggesting that risk awareness may heighten consumer engagement or perceived value considerations. Ultimately, behavioral intention serves as a critical antecedent to willingness to pay (WTP), reinforcing its central role in shaping consumers' valuation and adoption of EVs [34]. Drawing on the literature, it can be inferred that the accessibility of charging infrastructure plays a significant role in increasing consumers' willingness to pay for electric vehicles. Moreover, driving experience encompassing psychological dimensions such as perceived comfort, range confidence, and emotional satisfaction functions as a crucial mediating factor in this relationship.

Hypothesis 8. *The charging infrastructure accessibility factor has a significant and positive relationship with willingness-to-pay factor as driving experience (Psychological) as a mediator factor.*

This literature review provides a structured and comprehensive analysis of the principal factors influencing consumers' willingness to pay for electric vehicles. It highlights charging infrastructure accessibility, perceived ease of use, and psychological aspects of driving experience as key determinants shaping this willingness. Furthermore, the review emphasizes the mediating roles of perceived ease of use and driving-related psychological experiences, through which these determinants exert their effects on consumers' valuation and payment intentions for electric vehicles.

Structural equation modeling (SEM) represents a sophisticated and methodologically robust statistical technique for evaluating complex theoretical models. It allows researchers to concurrently assess interrelationships among multiple variables by integrating observed measures with latent constructs that reflect underlying, unobservable concepts. Through this comprehensive capability, SEM is extensively utilized to examine and validate hypothesized causal linkages involving both manifest and latent variables within a single, cohesive analytical framework [35]. This methodological approach has proven highly effective in addressing challenges associated with the specification and evaluation of theoretical models. In comparison with traditional multivariate techniques such as multiple regression, path analysis, and factor analysis structural equation modeling (SEM) provides several distinct advantages. In particular, SEM facilitates the explicit estimation of interaction effects between independent and dependent variables, relationships that are often neglected or insufficiently captured by conventional analytical approaches [36].

Structural equation modeling (SEM) classifies variables into two principal categories: endogenous and exogenous. Endogenous variables, comparable to dependent variables in traditional regression analysis, may also act as predictors when they are influenced by other constructs within the model. Conversely, exogenous variables function exclusively as independent variables and are not accounted for by other variables in the system. SEM formally defines the structural relationships among these constructs, enabling the examination of both the direct effects of exogenous variables on endogenous outcomes and the interrelationships among endogenous variables [37].

2.4. Endogenous and Exogenous Variables in Structural Equation Modeling of Electric Vehicle Willingness to Pay

Figure 1 illustrates a model comprising three endogenous latent constructs. The first construct, perceived ease of use (PEU), encompasses dimensions such as ease of learning (PEU1), skill acquisition (PEU2), interface simplicity (PEU3), and effortless interaction (PEU4). The second construct, driving experience (psychological) (DEX), integrates aspects including sensory comfort (DEX1), performance satisfaction (DEX2), psychological well-being (DEX3), and perceived innovation (DEX4). The third construct, willingness to pay (WTP), is operationalized through indicators such as acceptance of a price premium (WTP1), perceived value for money (WTP2), budget prioritization (WTP3), and purchase commitment (WTP4).

The construct of charging infrastructure accessibility was conceptualized as a reflective latent variable in the present study. This specification was adopted because the research focuses on consumers' perceived accessibility of EV charging infrastructure rather than objective infrastructure characteristics. From a consumer perception perspective, charging infrastructure accessibility represents an underlying psychological evaluation that manifests through several observable dimensions, including perceived spatial availability, technical compatibility, information connectivity, and functional reliability.

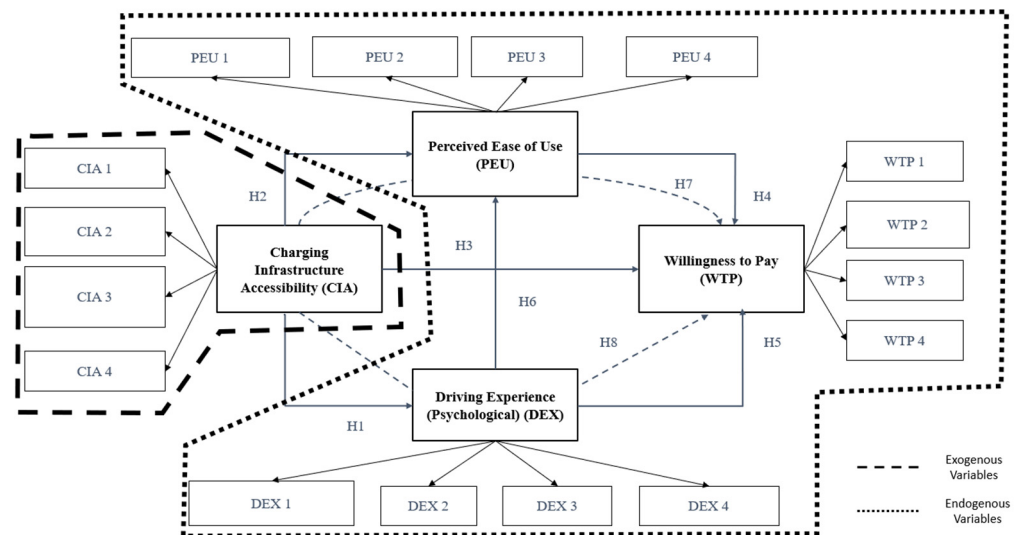


Figure 1. Structural Equation Model Illustrating Endogenous and Exogenous Variables Influencing Electric Vehicle Willingness to Pay.

Under a reflective measurement framework, variations in the latent construct are expected to influence respondents' evaluations across all indicators simultaneously. Consequently, individuals who perceive charging infrastructure to be highly accessible are likely to report favorable assessments of multiple accessibility-related attributes. This assumption is consistent with the theoretical foundations of consumer behavior and technology acceptance research, where latent perceptions are typically represented through correlated observable indicators.

Based on Figure 1, the exogenous and endogenous variables were identified. Accordingly, the structural equation model illustrating the relationships and pathways among the exogenous and endogenous variables is presented below.

Structural Equation for Path Coefficient

$$\begin{bmatrix} \eta_{PEU} \\ \eta_{DEX} \\ \eta_{WTP} \end{bmatrix} = \begin{bmatrix} 0 & \beta_1 & 0 \\ 0 & 0 & 0 \\ \beta_2 & \beta_3 & 0 \end{bmatrix} \begin{bmatrix} \eta_{PEU} \\ \eta_{DEX} \\ \eta_{WTP} \end{bmatrix} + \begin{bmatrix} \gamma_1 \\ \gamma_2 \\ \gamma_3 \end{bmatrix} \begin{bmatrix} \xi_{CIA} \end{bmatrix} + \begin{bmatrix} \zeta_1 \\ \zeta_2 \\ \zeta_3 \end{bmatrix}$$

Structural Equation for Endogenous Variables

$$y = \Lambda_y \eta + \varepsilon$$

$$\begin{bmatrix} y_{PEU1} \\ y_{PEU2} \\ y_{PEU3} \\ y_{PEU4} \\ y_{DEX1} \\ y_{DEX2} \\ y_{DEX3} \\ y_{DEX4} \\ y_{WTP1} \\ y_{WTP2} \\ y_{WTP3} \\ y_{WTP4} \end{bmatrix} = \begin{bmatrix} \lambda_{PEU1}^y & 0 & 0 \\ \lambda_{PEU2}^y & 0 & 0 \\ \lambda_{PEU3}^y & 0 & 0 \\ \lambda_{PEU4}^y & 0 & 0 \\ 0 & \lambda_{DEX1}^y & 0 \\ 0 & \lambda_{DEX2}^y & 0 \\ 0 & \lambda_{DEX3}^y & 0 \\ 0 & \lambda_{DEX4}^y & 0 \\ 0 & 0 & \lambda_{WTP1}^y \\ 0 & 0 & \lambda_{WTP2}^y \\ 0 & 0 & \lambda_{WTP3}^y \\ 0 & 0 & \lambda_{WTP4}^y \end{bmatrix} \begin{bmatrix} \eta_{PEU} \\ \eta_{DEX} \\ \eta_{WTP} \end{bmatrix} + \begin{bmatrix} \varepsilon_{PEU1} \\ \varepsilon_{PEU2} \\ \varepsilon_{PEU3} \\ \varepsilon_{PEU4} \\ \varepsilon_{DEX1} \\ \varepsilon_{DEX2} \\ \varepsilon_{DEX3} \\ \varepsilon_{DEX4} \\ \varepsilon_{WTP1} \\ \varepsilon_{WTP2} \\ \varepsilon_{WTP3} \\ \varepsilon_{WTP4} \end{bmatrix}$$

Structural Equation for Exogenous Variables

$$x = \Lambda_x \xi + \delta$$

$$\begin{bmatrix} x_{CIA1} \\ x_{CIA2} \\ x_{CIA3} \\ x_{CIA4} \end{bmatrix} = \begin{bmatrix} \lambda_{CIA1}^x \\ \lambda_{CIA2}^x \\ \lambda_{CIA3}^x \\ \lambda_{CIA4}^x \end{bmatrix} \begin{bmatrix} \xi_{CIA} \end{bmatrix} + \begin{bmatrix} \delta_{CIA1} \\ \delta_{CIA2} \\ \delta_{CIA3} \\ \delta_{CIA4} \end{bmatrix}$$

3. Research Methodology

3.1. Research Design

This study adopted a quantitative cross-sectional survey design to investigate the relationships among charging infrastructure accessibility, perceived ease of use, psychological driving experience, and willingness to pay for electric vehicles (EVs) in Thailand. Data were collected from a structured, onsite questionnaire administered to drivers with prior experience in operating EVs. The onsite data collection approach was intentionally employed to ensure that participants possessed adequate familiarity with EV usage and charging conditions, thereby enhancing the relevance and reliability of the responses.

Participants were selected through a probability-based simple random sampling technique. Initially, 412 questionnaires were obtained. Following data cleaning procedures, incomplete responses were removed and multivariate outliers were identified using Mahalanobis distance ($p < 0.001$), resulting in the exclusion of 12 cases. Consequently, a final sample of 400 valid responses was retained for subsequent Structural Equation Modeling (SEM) analysis.

The present study employed covariance-based Structural Equation Modeling (SEM) to evaluate the proposed theoretical relationships among latent constructs. The analytical focus was placed on assessing measurement validity, reliability, structural path coefficients, and mediation effects based on observed survey responses. Accordingly, the objective of the analysis was explanatory and theory-driven rather than simulation-based. As a result, the study did not incorporate global sensitivity analysis techniques, such as Sobol decomposition or Morris screening, which are typically applied to computational models involving explicit parameter uncertainty and scenario variation.

The present study focused primarily on the theoretical relationships among charging infrastructure accessibility, perceived ease of use, driving experience, and willingness to pay. Although demographic and contextual characteristics were collected to describe the sample, variables such as household income, vehicle ownership status, geographic location, charging access conditions, driving experience, vehicle type, and eligibility for government incentives were not explicitly incorporated as control variables in the structural model. This decision was made to maintain a parsimonious model structure and to emphasize the examination of the core theoretical constructs derived from the Technology Acceptance Model and the Theory of Consumption Values.

The sample exhibited a relatively balanced gender composition and was largely composed of middle-aged individuals with moderate income levels. In terms of travel behavior, the majority of respondents indicated predominantly urban or combined urban–intercity mobility patterns, which is consistent with the current stage of electric vehicle infrastructure development in Thailand. Comprehensive socio-demographic details of the participants are presented in Table 1.

Table 1. Demographic information of 400 samples who responded to the questionnaires.

Category	Items	Details	Frequency	Percentage
Demographic Characteristics	Residential types	Landed house	152	38.0
		High-rise condominium	248	62.0
	Geographic location	Bangkok Metropolitan Region	287	71.8
		Upcountry provinces	113	28.2
		Less than 428	32	8.0
Travel and EV Usage Characteristics	Monthly household income (USD)	429–714	78	19.5
		715–1000	283	70.8
		More than 1001	7	1.8
		Route Regularity and Predictability	192	48.0
	Ability to Manage Charging Procedures		184	46.0
		Appreciation of Quietness and Smoothness of EV Driving	24	6.0
Vehicle Ownership Characteristics	Current vehicle ownership	Internal Combustion Engine Vehicle (ICE)	123	30.8
		Electric vehicle car	174	43.5
		Hybrid electric vehicle car	103	25.7
	Gender	Male	178	44.5
		Female	222	55.5
	Age	20–29 years	35	8.8
		30–39 years	40	10.0
		40–49 years	275	68.8
		More than 49 years	50	12.5

Willingness to pay (WTP) in this study is conceptualized as a latent behavioral valuation construct that reflects consumers' readiness to incur additional financial commitment for electric vehicle adoption. Rather than measuring a specific monetary amount, the construct captures consumers' acceptance of a price premium, perceptions of value for money, prioritization of EV expenditure within personal budgets, and commitment to purchase. This operationalization is consistent with prior consumer behavior research that examines valuation intentions and financial commitment as antecedents of purchase behavior. Consequently, the construct should be interpreted as behavioral willingness to pay rather than an explicit monetary willingness-to-pay estimate.

Participant eligibility was determined based on direct experience with electric vehicle (EV) operation rather than vehicle ownership status. To qualify for inclusion in the study, respondents were required to have previously driven, operated, or regularly used an EV and to possess sufficient familiarity with EV charging processes and vehicle functionality. Such experience could be acquired through personal ownership, household access, company-provided vehicles, vehicle-sharing services, rental programs, or participation in test-drive activities. Consequently, EV ownership was not a mandatory requirement for participation. This criterion was adopted to ensure that respondents were capable of providing informed evaluations of charging infrastructure accessibility, perceived ease of use, driving experience, and financial valuation related to EV adoption.

Questionnaire Development and Validation

The questionnaire was developed based on established constructs and measurement scales identified in the literature on technology acceptance, consumer valuation, and electric vehicle adoption. All measurement items were adapted from previously validated studies and modified to reflect the context of electric vehicle usage in Thailand. The questionnaire

consisted of four principal constructs: charging infrastructure accessibility, perceived ease of use, driving experience, and willingness to pay.

To ensure linguistic and conceptual equivalence, the questionnaire was initially developed in English and subsequently translated into Thai by a bilingual researcher. A back-translation procedure was then conducted by an independent bilingual expert to verify consistency between the original and translated versions. Any discrepancies identified during this process were discussed and resolved through consensus among the research team.

Prior to the main survey, a pilot study was conducted with a small group of respondents who possessed prior experience with electric vehicles. The pilot test was undertaken to assess question clarity, item relevance, wording appropriateness, and completion time. Based on participant feedback, minor revisions were made to improve the readability and comprehensibility of several items.

The content validity of the instrument was further evaluated through expert review. A panel of specialists with expertise in electric vehicle adoption, consumer behavior, and survey methodology examined the questionnaire to assess item relevance, construct representativeness, and contextual suitability. Their recommendations were incorporated into the final version of the questionnaire prior to data collection.

3.2. Data Collection Process

This study adopted a quantitative research design, utilizing a structured questionnaire as the primary instrument for data collection. The questionnaire comprised two main sections. The first section captured the demographic characteristics of electric vehicle (EV) drivers, while the second examined the relationships among perceived ease of use, psychological driving experience, and charging infrastructure accessibility, as well as their effects on consumers' willingness to pay. Consumer perceptions were measured using a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree), covering all key constructs: perceived ease of use, psychological driving experience, charging infrastructure accessibility, and willingness to pay. The collected data were subsequently analyzed using appropriate statistical techniques to derive meaningful insights and support the study's findings.

The sampling strategy employed a probability-based design to improve the representativeness of the study. Data collection was conducted through onsite surveys at public EV charging stations and designated EV service areas, where active electric vehicle users are frequently present. At each site, a systematic random intercept technique was implemented by approaching every *n*th eligible driver with prior EV experience. This approach ensured that all potential participants had a known and non-zero probability of selection, while simultaneously minimizing the risk of interviewer bias.

The sample was collected using a stratified sampling approach to ensure close alignment with the demographic composition of the Thai population. Stratification criteria included key variables such as age, educational attainment, and income level. This procedure enhanced the representativeness of the sample across critical socio-demographic dimensions, thereby strengthening the generalizability of the study's findings. Furthermore, post-survey weighting adjustments were implemented to address any residual imbalances between the sample and the overall population.

The target population of this study consisted of individuals with direct experience in using electric vehicles and related charging infrastructure. Data collection was conducted at public EV charging stations and designated EV service areas to ensure that respondents possessed sufficient familiarity with EV ownership and operation. While this sampling approach enhanced the relevance and accuracy of responses concerning charging accessibility,

driving experience, and perceived ease of use, it also resulted in a sample predominantly composed of urban and experienced EV users. Therefore, the findings should be interpreted within the context of current EV users rather than as representative of the entire Thai vehicle-buying population.

Prior to questionnaire administration, respondents were screened to confirm that they had prior experience using or operating an electric vehicle. Screening questions were employed to verify familiarity with key aspects of EV usage, including vehicle operation, charging procedures, and interactions with charging infrastructure. Individuals without any direct EV experience were excluded from participation. This screening process ensured that all respondents possessed sufficient experiential knowledge to evaluate the constructs examined in the study, irrespective of whether they personally owned an EV.

3.3. Data Screening and Preliminary Analysis

Prior to model estimation, the dataset was screened for missing values and multivariate outliers. Using the Mahalanobis distance criterion ($p < 0.001$), 12 observations were identified as multivariate outliers and subsequently removed. Consequently, the final dataset comprised 400 valid cases, which were retained for the structural equation modeling (SEM) analysis.

Structural equation modeling (SEM) was conducted using AMOS with maximum likelihood estimation to examine the proposed relationships. In accordance with the two-step analytical procedure, confirmatory factor analysis (CFA) was initially applied to validate the measurement model, followed by an assessment of the structural model to test the hypothesized paths.

3.4. Measurement Model Assessment

The measurement model was assessed through confirmatory factor analysis (CFA) using AMOS. Reliability and convergent validity were evaluated based on factor loadings, composite reliability (CR), and average variance extracted (AVE). Discriminant validity was determined by comparing the square root of the AVE for each construct with the corresponding inter-construct correlations.

The structural model was assessed only after confirming that the measurement model demonstrated satisfactory psychometric properties. Adopting this two-step procedure strengthens the rigor of structural equation modeling (SEM) analysis and mitigates the likelihood of biased parameter estimates.

Measurement adequacy was examined in accordance with established methodological standards. Convergent validity was evaluated by analyzing standardized factor loadings, composite reliability (CR), and average variance extracted (AVE). In addition, internal consistency reliability was assessed using Cronbach's alpha coefficient.

Discriminant validity was assessed by examining whether the square root of the average variance extracted (AVE) for each construct exceeded its corresponding inter-construct correlations. The results indicate that all constructs met the established criteria, thereby confirming the robustness of the measurement model and its suitability for subsequent structural analysis.

3.5. Structural Model Evaluation

Structural equation modeling (SEM) with maximum likelihood estimation, implemented in AMOS, was applied to examine the proposed hypotheses. The adequacy of the model was evaluated using widely recognized goodness-of-fit indices, namely the chi-square to degrees of freedom ratio (χ^2/df), comparative fit index (CFI), Tucker-Lewis index (TLI), goodness-of-fit index (GFI), and root mean square error of approximation (RMSEA).

Both direct and indirect effects were analyzed to assess the mediating roles of perceived value and perceived risk in the relationship between ecosystem and policy support and adoption intention. The statistical significance of these relationships was evaluated using standardized path coefficients alongside their corresponding p -values.

A non-significant chi-square statistic ($p > 0.05$) is generally preferred, and the relative chi-square (CMIN/DF) should be less than 2, suggesting an adequate fit between the proposed model and the observed data. Incremental fit measures such as the GFI, NFI, TLI, and CFI are recommended to exceed the threshold of 0.95 to indicate strong model performance. Furthermore, residual-based indices, including the RMSEA and RMR, should fall below 0.05, demonstrating both a good fit and model parsimony [38].

4. Results

Table 1 presents the demographic and behavioral profile of the 400 respondents, revealing several important patterns relevant to electric vehicle (EV) consumer behavior.

The sample is predominantly composed of individuals living in high-rise condominiums (62.0%), suggesting an urban lifestyle that may influence dependence on public charging infrastructure rather than private home charging. This is further supported by the geographic distribution, where a substantial majority (71.8%) reside in the Bangkok Metropolitan Region, indicating that the findings largely reflect urban EV user experiences characterized by higher infrastructure availability and policy exposure.

It is important to distinguish between vehicle ownership and electric vehicle experience. While 43.5% of respondents reported owning an EV, the remaining participants consisted of hybrid vehicle owners and internal combustion engine vehicle owners who had previously operated or regularly used electric vehicles through alternative arrangements, including family ownership, organizational fleets, rental services, and test-drive programs. Therefore, all respondents met the study's eligibility requirement of possessing prior EV experience, despite differences in current vehicle ownership status.

In terms of economic status, most respondents fall within the middle-income group (70.8% earning USD 715–1000), highlighting that EV adoption in Thailand is currently concentrated among financially stable consumers who are capable of absorbing initial investment costs. Lower and higher income groups are comparatively underrepresented, suggesting a potential affordability threshold in EV adoption.

Behaviorally, nearly half of the respondents (48.0%) report regular and predictable travel routes, which aligns with conditions favorable for EV usage due to easier planning of charging routines. Additionally, 46.0% indicate the ability to manage charging procedures, reflecting a relatively high level of user familiarity and technological adaptation.

Regarding vehicle ownership, EVs account for the largest share (43.5%), followed by hybrid vehicles (25.7%) and internal combustion engine vehicles (30.8%). This distribution indicates a transitional market structure in which electrified mobility is gaining prominence but still coexists with conventional technologies.

Table 2 presents the assessment of the measurement model, focusing on convergent validity, internal consistency reliability, and discriminant validity of the constructs.

Overall, all constructs demonstrate satisfactory measurement properties. Factor loadings for all indicators exceed the recommended threshold of 0.60, indicating that each observed variable adequately represents its underlying latent construct. For the construct of Charging Infrastructure Accessibility (CIA), loadings range from 0.727 to 0.771, confirming that dimensions such as spatial density, technical compatibility, information connectivity, and functional reliability consistently capture infrastructure accessibility.

Table 2. Convergent validity, discriminant validity, and reliability results.

Construct	Variables	Factor Loading	CR	AVE	Cronbach's Alpha	MSV	ASV
Charging Infrastructure Accessibility (CIA)	Spatial Density	0.727	0.854	0.573	0.824	0.479	0.421
	Technical Compatibility	0.753					
	Information Connectivity	0.747					
	Functional Reliability	0.771					
Perceived Ease of Use (PEU)	Ease of Learning	0.643	0.833	0.542	0.845		
	Skill Acquisition	0.792					
	Interface Simplicity	0.877					
	Effortless Interaction	0.671					
Driving Experience (Psychological) (DEX)	Sensory Comfort	0.746	0.871	0.527	0.853		
	Performance Satisfaction	0.721					
	Psychological Well-being	0.730					
	Perceived Innovation	0.671					
Willingness to Pay (WTP)	Price Premium Acceptance	0.624	0.845	0.613	0.844		
	Value-for-Money Perception	0.812					
	Budgetary Priority	0.687					
	Purchase Commitment	0.780					

Similarly, the Perceived Ease of Use (PEU) construct shows strong indicator reliability, with loadings between 0.643 and 0.877. The relatively high loading of interface simplicity (0.877) suggests that ease of interaction plays a particularly critical role in shaping user perceptions. The Driving Experience (DEX) construct also demonstrates acceptable loadings (0.671–0.746), indicating that sensory comfort, performance satisfaction, psychological well-being, and perceived innovation collectively reflect the experiential dimension of EV usage.

For Willingness to Pay (WTP), factor loadings range from 0.624 to 0.812, with value-for-money perception emerging as the strongest indicator. This suggests that economic evaluation remains central in consumers' payment intentions.

In terms of reliability, all constructs exceed the recommended composite reliability ($CR > 0.70$) and Cronbach's alpha ($\alpha > 0.70$) thresholds, confirming strong internal consistency. Convergent validity is further supported by average variance extracted (AVE) values above 0.50 for all constructs, indicating that each construct explains more than half of the variance in its indicators.

Discriminant validity is also established, as the maximum shared variance (MSV) and average shared variance (ASV) values are lower than the AVE for the constructs, suggesting that each construct is empirically distinct from others within the model.

The structural equation model explains the causal relationships among Charging Infrastructure Accessibility (CIA), Perceived Ease of Use (PEU), Driving Experience (DEX), and Willingness to Pay (WTP) for electric vehicles. The path coefficient equation demon-

states that PEU is positively influenced by both DEX and CIA. Specifically, a positive driving experience significantly enhances consumers' perceptions of ease of use ($\beta = 0.762$), while greater charging infrastructure accessibility also improves ease of use perceptions ($\beta = 0.791$). These findings indicate that both psychological driving satisfaction and infrastructure readiness reduce technological complexity and strengthen consumers' confidence in operating electric vehicles.

The equation for DEX further reveals that charging infrastructure accessibility exerts a strong positive effect on driving experience ($\beta = 0.720$). This suggests that reliable, accessible, and compatible charging systems contribute substantially to consumers' psychological comfort, perceived convenience, and overall satisfaction with EV usage.

In addition, the structural equation for WTP demonstrates that consumers' willingness to pay is simultaneously influenced by PEU, DEX, and CIA. Perceived ease of use positively affects WTP ($\beta = 0.581$), indicating that consumers are more willing to financially commit to EV adoption when the technology is perceived as simple and user-friendly. Similarly, driving experience positively contributes to WTP ($\beta = 0.523$), highlighting the importance of emotional and experiential value in consumer decision-making. Charging infrastructure accessibility also has a direct positive effect on WTP ($\beta = 0.738$), emphasizing that infrastructure readiness remains a critical determinant of EV valuation.

Structural Equation for Path Coefficient

$$\eta = \beta\eta + \Gamma\xi + \zeta$$

$$\begin{bmatrix} \eta_{PEU} \\ \eta_{DEX} \\ \eta_{WTP} \end{bmatrix} = \begin{bmatrix} 0 & 0.762 & 0 \\ 0 & 0 & 0 \\ 0.581 & 0.523 & 0 \end{bmatrix} \begin{bmatrix} \eta_{PEU} \\ \eta_{DEX} \\ \eta_{WTP} \end{bmatrix} + \begin{bmatrix} 0.791 \\ 0.720 \\ 0.738 \end{bmatrix} \begin{bmatrix} \xi_{CIA} \end{bmatrix} + \begin{bmatrix} 0.377 \\ 0.558 \\ 0.373 \end{bmatrix}$$

$$\eta_{PEU} = 0.762\eta_{DEX} + 0.791\xi_{CIA} + 0.377$$

$$\eta_{DEX} = 0.720\xi_{CIA} + 0.558$$

$$\eta_{WTP} = 0.581\eta_{PEU} + 0.523\eta_{DEX} + 0.738\xi_{CIA} + 0.373$$

Structural Equation for Endogenous Variables

$$y = \Lambda_y\eta + \varepsilon$$

$$\begin{bmatrix} y_{PEU1} \\ y_{PEU2} \\ y_{PEU3} \\ y_{PEU4} \\ y_{DEX1} \\ y_{DEX2} \\ y_{DEX3} \\ y_{DEX4} \\ y_{WTP1} \\ y_{WTP2} \\ y_{WTP3} \\ y_{WTP4} \end{bmatrix} = \begin{bmatrix} 0.610 & 0 & 0 \\ 0.717 & 0 & 0 \\ 0.770 & 0 & 0 \\ 0.782 & 0 & 0 \\ 0 & 0.972 & 0 \\ 0 & 0.701 & 0 \\ 0 & 0.702 & 0 \\ 0 & 0.641 & 0 \\ 0 & 0 & 0.807 \\ 0 & 0 & 0.824 \\ 0 & 0 & 0.825 \\ 0 & 0 & 0.724 \end{bmatrix} \begin{bmatrix} \eta_{PEU} \\ \eta_{DEX} \\ \eta_{WTP} \end{bmatrix} + \begin{bmatrix} 0.395 \\ 0.259 \\ 0.143 \\ 0.320 \\ 0.287 \\ 0.258 \\ 0.157 \\ 0.350 \\ 0.400 \\ 0.276 \\ 0.344 \\ 0.375 \end{bmatrix}$$

Structural Equation for Exogenous Variables

$$x = \Lambda_x\tilde{\xi} + \delta$$

$$\begin{bmatrix} x_{CIA1} \\ x_{CIA2} \\ x_{CIA3} \\ x_{CIA4} \end{bmatrix} = \begin{bmatrix} 0.620 \\ 0.811 \\ 0.625 \\ 0.761 \end{bmatrix} [\xi_{CIA}] + \begin{bmatrix} 0.472 \\ 0.443 \\ 0.465 \\ 0.364 \end{bmatrix}$$

Table 3 presents the results of the structural model and hypothesis testing. Consistent with the order of the hypotheses, the findings indicate that Charging Infrastructure Accessibility (CIA) has a significant positive effect on Driving Experience (DEX) ($\beta = 0.791$, $p < 0.01$), supporting H1. Likewise, CIA significantly influences Perceived Ease of Use (PEU) ($\beta = 0.720$, $p < 0.001$), supporting H2. The direct effect of CIA on Willingness to Pay (WTP) is also positive and significant ($\beta = 0.738$, $p = 0.005$), confirming H3. Furthermore, Perceived Ease of Use positively affects WTP ($\beta = 0.581$, $p < 0.001$), supporting H4. Driving Experience also exerts a significant positive influence on WTP ($\beta = 0.523$, $p = 0.006$), supporting H5. Finally, Driving Experience significantly enhances Perceived Ease of Use ($\beta = 0.762$, $p = 0.05$), providing support for H6. Overall, the results confirm that charging infrastructure accessibility serves as a key antecedent of both cognitive and experiential evaluations, which subsequently contribute to consumers' willingness to pay for electric vehicles. Hypothesis 6 was supported. The results indicate that Driving Experience (DEX) exerts a positive effect on Perceived Ease of Use (PEU) ($\beta = 0.762$, $p = 0.05$). The relationship is statistically significant at the 5% level, suggesting that consumers who report more favorable psychological driving experiences tend to perceive electric vehicles as easier to use. This finding implies that positive experiences related to comfort, performance satisfaction, psychological well-being, and perceived innovation enhance users' confidence and familiarity with EV technology, thereby reducing perceived operational complexity.

Table 3. The hypothesis testing.

Hypothesis	Paths	Path Coefficient	<i>p</i> -Value	Relationship
H1	CIA → DEX	0.791 **	<0.01	Supported
H2	CIA → PEU	0.720 ***	<0.001	Supported
H3	CIA → WTP	0.738 *	0.005	Supported
H4	PEU → WTP	0.581 ***	<0.001	Supported
H5	DEX → WTP	0.523 **	0.006	Supported
H6	DEX → PEU	0.762 *	0.05	Supported

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Source: Author.

In summary, the results confirm that charging infrastructure accessibility is a key antecedent influencing both perceived ease of use and driving experience, which in turn drive willingness to pay. The findings emphasize that EV adoption is not solely determined by economic considerations but is strongly mediated by experiential and usability perceptions.

Table 4 presents the mediation analysis, examining the indirect effects of charging infrastructure accessibility (CIA) on willingness to pay (WTP) through perceived ease of use (PEU) and driving experience (DEX).

Table 4. Mediation analysis.

Hypothesis	Paths	Direct Effect	Indirect Effect	<i>p</i> -Value	Mediation	Relationship
H7	CIA → WTP	0.521 ***	0.041 *	<0.001	Partial	Supported
	CIA → PEU → WTP			0.045		Supported
H8	CIA → WTP	0.428 **	0.051 *	0.01	Partial	Supported
	CIA → DEX → WTP			0.031		Supported

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Source: Author.

The results indicate that both PEU and DEX serve as significant partial mediators in the relationship between CIA and WTP. First, the direct effect of CIA on WTP remains strong and statistically significant ($\beta = 0.521, p < 0.001$), confirming that infrastructure accessibility independently enhances consumers' willingness to pay. In addition, the indirect pathway through PEU (CIA $\rightarrow$ PEU $\rightarrow$ WTP) is also significant (indirect effect = 0.041, $p = 0.045$). This finding suggests that improved charging infrastructure increases consumers' perception of ease of use, which subsequently strengthens their financial commitment toward EV adoption.

Similarly, the second mediation pathway through driving experience (CIA $\rightarrow$ DEX $\rightarrow$ WTP) is statistically significant (indirect effect = 0.051, $p = 0.031$), while the direct effect of CIA on WTP remains significant ($\beta = 0.428, p = 0.01$). This confirms that DEX also partially mediates the relationship, indicating that enhanced infrastructure contributes to more positive psychological and experiential perceptions, which in turn increase willingness to pay.

The presence of partial mediation in both pathways implies that CIA influences WTP through both direct and indirect mechanisms. While infrastructure accessibility directly improves consumers' economic readiness, it simultaneously shapes cognitive (ease of use) and experiential (driving experience) evaluations that further reinforce adoption intention.

Overall, these findings highlight that the impact of charging infrastructure is not purely functional but operates through perceptual and experiential channels, emphasizing the importance of user-centered infrastructure development in promoting electric vehicle adoption.

5. Conclusions

The present study provides a comprehensive examination of the factors influencing consumers' willingness to pay (WTP) for electric vehicles (EVs) in Thailand by integrating charging infrastructure accessibility, perceived ease of use, and psychological driving experience within a unified structural framework. The findings offer both theoretical and practical insights into the evolving dynamics of EV adoption in an emerging market context.

The results confirm that charging infrastructure accessibility is a fundamental driver of consumer valuation. It exerts strong direct effects on WTP while simultaneously shaping key perceptual constructs, namely perceived ease of use and driving experience. This highlights that infrastructure is not merely a physical provision but a critical component of the user experience ecosystem. Accessibility, reliability, and compatibility of charging systems significantly enhance consumers' confidence, reduce uncertainty, and improve the perceived practicality of EV ownership.

Furthermore, the study demonstrates that perceived ease of use plays a crucial role in influencing WTP. When consumers perceive EV systems as simple to operate, easy to learn, and well-integrated with digital platforms, their cognitive burden decreases, leading to higher acceptance and financial commitment. This finding reinforces the relevance of the Technology Acceptance Model (TAM) in explaining EV adoption behavior, particularly in technology-intensive environments.

Equally important is the role of psychological driving experience. The results reveal that experiential factors such as comfort, performance satisfaction, and perceived innovation significantly enhance consumers' willingness to pay. This suggests that EV adoption is not solely driven by economic or functional considerations but is also strongly influenced by emotional and experiential value, consistent with the Theory of Consumption Values (TCV).

The mediation analysis further strengthens these conclusions by demonstrating that both perceived ease of use and driving experience partially mediate the relationship be-

tween infrastructure accessibility and WTP. This indicates that infrastructure influences consumer decisions not only directly but also indirectly through cognitive and experiential pathways. Such findings underscore the importance of adopting a holistic approach to EV ecosystem development, where infrastructure, technology design, and user experience are closely integrated.

From a theoretical perspective, this study contributes to the literature by bridging TAM and TCV, offering a more comprehensive understanding of EV consumer behavior. It moves beyond traditional models that focus primarily on economic or environmental factors and highlights the importance of perception-based mechanisms in shaping consumer valuation.

From a practical standpoint, the findings provide valuable implications for policymakers, manufacturers, and service providers. Investments in charging infrastructure should prioritize not only expansion but also reliability, accessibility, and user convenience. At the same time, enhancing user interfaces, simplifying charging processes, and improving overall driving experience can significantly increase consumers' willingness to adopt and pay for EVs.

Although the structural equation model demonstrated satisfactory reliability, validity, and explanatory power, the findings should be interpreted within the assumptions of the specified measurement and structural framework. The study focused primarily on testing theoretical relationships among latent constructs and did not explicitly evaluate the sensitivity of the results to alternative parameter specifications or measurement assumptions. Future research could complement SEM-based analyses by incorporating global sensitivity assessment techniques, such as Sobol indices or Morris screening methods, to investigate the relative importance of model inputs and to evaluate the robustness of willingness-to-pay outcomes under varying analytical conditions. Such approaches may provide additional insights into the stability of consumer valuation estimates and the extent to which model conclusions are influenced by underlying assumptions.

In conclusion, the transition toward mass-market EV adoption in Thailand depends on the synergistic development of infrastructure readiness and user-centered experience. By aligning functional, cognitive, and experiential dimensions, stakeholders can effectively bridge the gap between early adoption and widespread market acceptance, thereby accelerating the shift toward sustainable mobility.

Although the findings provide valuable insights into the factors influencing willingness to pay for electric vehicles among experienced EV users, they should not be interpreted as fully representative of the Thai mass-market population. The study primarily reflects the perceptions of consumers who have already engaged with EV technology and charging infrastructure. Future research should extend the investigation to prospective adopters and consumers with limited EV experience to better understand the determinants of mass-market adoption and consumer valuation across diverse segments of Thai society.

6. Research Limitations

Several limitations should be acknowledged when interpreting the findings of this study. First, willingness to pay was measured as a behavioral valuation construct rather than as a direct monetary amount. Although this approach is suitable for examining psychological and attitudinal determinants within a structural equation modeling framework, it does not provide an estimate of the maximum price premium consumers are willing to pay for electric vehicles. Consequently, the results should be interpreted as reflecting consumers' financial commitment and valuation intentions rather than actual monetary willingness to pay. Future research could strengthen the measurement of willingness to pay by employing contingent valuation techniques, discrete choice experiments, conjoint

analysis, or direct price-premium elicitation methods to capture consumers' monetary valuations more accurately.

This study is subject to several limitations related to sample representativeness. The respondents were recruited primarily from EV charging stations and service locations, which led to the overrepresentation of individuals who already own or regularly use electric vehicles. In addition, a substantial proportion of participants resided in urban areas, particularly within the Bangkok Metropolitan Region, where charging infrastructure and EV-related services are more developed than in other parts of the country. As a result, the sample may not fully capture the perspectives of non-EV users, rural residents, or consumers with limited exposure to electric mobility technologies. Consequently, caution should be exercised when generalizing the findings to the broader Thai mass market. Future studies are encouraged to employ nationally representative sampling frameworks that include diverse geographic regions, demographic segments, and potential EV adopters to enhance the external validity and generalizability of the results.

A limitation of the present study is that it did not explicitly assess parameter uncertainty through global sensitivity analysis. While the structural equation modeling approach provides robust estimates of the relationships among latent variables, the potential effects of alternative measurement specifications, sampling variability, and structural assumptions were not systematically examined. Future studies may extend the current framework by integrating uncertainty analysis techniques, including Sobol sensitivity indices, Morris screening procedures, Monte Carlo simulations, or Bayesian SEM approaches. Such methods would enable researchers to identify the variables exerting the greatest influence on willingness-to-pay outcomes and to evaluate the robustness of model conclusions under different assumptions and scenarios.

This study contributes to the electric vehicle literature in three important ways. First, it extends the application of the Technology Acceptance Model by demonstrating that perceived ease of use functions not only as an antecedent of technology acceptance but also as a determinant of consumers' financial valuation of electric vehicles. Second, it enriches the Theory of Consumption Values by incorporating infrastructure accessibility and driving experience as mechanisms through which consumers form value perceptions associated with EV ownership. Third, the study proposes and empirically validates a process-oriented framework linking infrastructure readiness, user experience, and willingness to pay. This framework provides a more integrated explanation of how technological, functional, and experiential considerations jointly influence consumer valuation decisions.

Unlike many previous studies that focus primarily on adoption intention, the present research emphasizes willingness to pay as a valuation-based outcome, thereby offering additional insight into the economic commitment underlying EV adoption decisions. The findings suggest that consumers evaluate electric vehicles not only as technological innovations but also as experiential and value-generating products whose attractiveness depends on both infrastructure readiness and user experience.

Research Workflow

To enhance the transparency and comprehensibility of the research process, a structured workflow was developed to illustrate the sequential stages undertaken in this study. The research commenced with an extensive review of the literature on electric vehicle adoption, drawing upon the Technology Acceptance Model (TAM) and the Theory of Consumption Values (TCV) to establish the theoretical foundation. Based on the identified research gaps and theoretical insights, the conceptual framework and research hypotheses were formulated.

Subsequently, a structured questionnaire was designed to operationalize the study constructs, including charging infrastructure accessibility, perceived ease of use, driving experience, and willingness to pay. Following instrument development, data were collected from electric vehicle users in Thailand using a probability-based sampling approach. The collected responses were then subjected to data screening procedures, including the assessment of missing values and the identification of multivariate outliers.

The analytical phase consisted of two stages. First, confirmatory factor analysis (CFA) was conducted to evaluate the reliability and validity of the measurement model. Second, structural equation modeling (SEM) was employed to test the hypothesized relationships among the constructs. Mediation analyses were subsequently performed to examine the indirect effects of perceived ease of use and driving experience on the relationship between charging infrastructure accessibility and willingness to pay.

Finally, the results were interpreted in relation to the proposed theoretical framework, leading to the development of practical implications and recommendations for policy-makers, industry practitioners, and future researchers. This systematic workflow ensures methodological rigor and facilitates a clearer understanding of the study's research process.

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Informed Consent Statement: The informed consent was obtained from all participants by using the Information Sheet for Research Participant which approved by the Human Research Ethics Committee Suranaree University of Technology and the participants have the legal protection. The participants will sign the Informed Consent Form before the interview was done. If the participants do not feel comfortable with the interview, they can withdraw anytime.

Data Availability Statement: Data available on request.

Conflicts of Interest: The authors declare no conflicts of interest.

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