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FROM GREEN MOTIVATION TO SAFETY CONSIDERATIONS: ANALYZING FIRE RISK PERCEPTIONS AND CHARGING INFRASTRUCTURE IN ELECTRIC MOTORBIKE ADOPTION

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ABSTRACT

Air pollution caused by gasoline-powered motorcycles in Vietnam's urban areas has become a pressing environmental concern, making the transition to green transportation increasingly important. This study investigates the factors influencing consumers' purchase intention toward electric motorbikes in Vietnam during the 2025-2030 period. Addressing the limited research on electric two-wheelers in Southeast Asia, where motorcycles remain the dominant mode of transport, the study integrates the Theory of Planned Behavior (TPB) and the Technology Acceptance Model (TAM). In addition to traditional determinants such as attitude, subjective norms, and perceived behavioral control, the research incorporates contemporary factors including environmental awareness, perceived safety risk, government incentives, key opinion leader (KOL) influence, and charging infrastructure perceptions. A quantitative approach was employed using a structured questionnaire with a five-point Likert scale, and the data were analyzed using structural equation modeling (SEM). The findings reveal that attitude, perceived behavioral control, and KOL influence significantly enhance consumers' intention to adopt electric motorbikes, whereas perceived safety risk acts as a significant barrier. In contrast, environmental awareness and government incentives do not demonstrate statistically significant effects in the proposed model. The effect of charging infrastructure could not be tested because the construct did not meet the required measurement reliability and validity criteria. These results suggest that practical considerations, personal control, and safety concerns currently play a more influential role than environmental or policy-related motivations in shaping adoption intentions. By focusing on the Vietnamese context, this study contributes to the growing literature on sustainable transportation and provides practical implications for policymakers and manufacturers seeking to accelerate the adoption of electric motorbikes and promote a more sustainable mobility ecosystem.

Keywords: Electric motorbikes, purchase intention, Vietnam, environmental awareness, perceived safety risk, government incentives, KOL influence.

1. INTRODUCTION

Over the past decades, the rapid growth of private transportation has become a major contributor to greenhouse gas emissions, urban air pollution, and public health problems worldwide [1], [2]. In Vietnam, where motorcycles remain the dominant mode of personal transportation, vehicle-related emissions have become a growing environmental challenge, particularly in large urban centers such as Ho Chi Minh City and Hanoi [3], [4]. As countries pursue sustainable development goals and carbon-reduction strategies, electric vehicles (EVs),

including electric motorbikes, have been promoted as a cleaner mobility solution because of their zero tailpipe emissions, higher energy efficiency, and lower operating costs [2], [5]. Nevertheless, despite increasing environmental awareness and government support, the adoption of electric motorbikes remains relatively limited compared with conventional gasoline-powered motorcycles [6], [7].

Previous studies have identified various determinants of EV adoption, including attitude, subjective norms, perceived behavioral control, policy incentives, environmental concern, and perceived risk [8]-[10]. Recent evidence further suggests that consumers' decisions are increasingly influenced by emerging factors such as social media communication and Key Opinion Leaders (KOLs), whose credibility and attractiveness can significantly shape purchase intentions toward electric vehicles [11]. At the same time, concerns regarding battery safety, fire risks, and charging convenience continue to represent important psychological barriers that may discourage consumers from adopting electric mobility solutions [12]-[14].

Although a growing body of literature has examined electric vehicle adoption, most existing studies focus on electric cars in developed economies, while empirical evidence on electric motorbikes in Southeast Asia, particularly Vietnam, remains limited [5], [7]. Furthermore, few studies have simultaneously examined the effects of environmental concern, perceived safety risk, policy incentives, charging infrastructure, and KOL influence within a single integrated framework [3], [11]. To address this gap, the present study develops an extended Theory of Planned Behavior (TPB) model to investigate the factors affecting electric motorbike adoption intention among Vietnamese consumers. Specifically, the study evaluates the influences of attitude, perceived behavioral control, environmental concern, policy incentives, charging infrastructure, KOL influence, and perceived battery fire risk on electric motorbike adoption intention. The findings are expected to enrich the literature on sustainable mobility and provide practical implications for policymakers and manufacturers seeking to accelerate the transition toward green transportation in Vietnam.

2. THEORETICAL BACKGROUND

2.1. Literature review

2.1.1. Theoretical study

The decision to purchase an electric vehicle (EV) is rarely impulsive; rather, it typically reflects a rational decision-making process that involves careful deliberation [15]. The Theory of Planned Behavior (TPB), developed by Ajzen in 1991, is widely regarded as one of the most robust psychological frameworks for explaining this mechanism, emphasizing that behavioral intention is the most immediate antecedent of actual behavior [8], [9]. TPB offers a comprehensive explanatory structure built on three core pillars: Attitude (ATT) - an individual's evaluation of perceived benefits; Subjective Norm (SN) - perceived social pressure; and Perceived Behavioral Control (PBC) - beliefs about one's own capabilities and available resources [16].

This theory is particularly well suited to the EV context because it enables researchers to capture not only personal motivation but also external constraints that shape consumers' decisions. A substantial body of empirical research has confirmed TPB's strong explanatory power for pro-environmental behaviors, including the adoption and use of green transportation modes [8], [16].

2.1.2. Empirical study

Recent studies on electric vehicle (EV) adoption increasingly highlight that consumer intention is shaped not only by functional/technical evaluations but also by social influence,

perceived risks, and contextual uncertainties. In social commerce and short-video ecosystems, for example, the persuasive capacity of opinion leaders can outweigh purely technical appeals. In 2025, Zhu and Ra`tasuk demonstrated that, on Douyin (TikTok) in Nanjing, KOL credibility and attractiveness exert the strongest effects on users' EV purchase intentions, surpassing the role of technical expertise. This suggests that EV-related decision-making - particularly in media-rich environments - may be strongly driven by heuristic cues (e.g., trust and interpersonal appeal) rather than by analytic processing of product attributes alone [11]. Extending beyond social influence, health-related risk perceptions have also emerged as a salient motivational pathway. Hartmann et al. show that among individuals with a strong health orientation in the United States, concerns about respiratory diseases attributable to gasoline vehicles can be a more powerful driver of EV purchase than climate-change concern. Collectively, these findings indicate that EV adoption intentions are embedded in broader psychosocial mechanisms where social persuasion and health risk appraisal can dominate traditional "technology-only" narratives [1], [11].

In parallel, a second stream of evidence underscores the importance of policy environments and macro-level market volatility in shaping perceived value and adoption readiness. Using data from China's tier-one cities, Chen et al report that monetary and non-monetary incentives strongly enhance perceived usefulness, implying that policy design directly influences the utilitarian appraisal that precedes intention formation. Notably, by introducing oil price volatility (MOPV) as a moderator, the study further shows that instability in fossil-fuel prices strengthens consumers' intentions to switch to EVs, positioning energy-price uncertainty as a contextual catalyst that can amplify the attractiveness of electrification [12]. When juxtaposed with evidence on social and health mechanisms, this policy–market perspective suggests that EV adoption is best understood as a function of both micro-level psychological drivers and macro-level structural conditions [1], [12].

Vietnamese evidence aligns with these international insights while also revealing context-specific determinants and barriers that remain under-explored. Applying and extending the Norm Activation Model (NAM) across five major cities, [3] finds that Awareness of Consequences (AOC) and Ascription of Responsibility (AOR) not only directly predict intention but also reinforce Personal Norms (PN), thereby supporting a moral–normative pathway to EV adoption. Importantly, in 2025 Duong identifies environmental knowledge and concern as critical antecedents that activate these cognitive mechanisms, suggesting that informational and attitudinal readiness may be prerequisites for norm-driven adoption [3]. At a more product- and locale-specific level, [6] show that for VinFast electric motorbikes in Ho Chi Minh City, attitude is the strongest positive predictor, whereas the attractiveness of conventional gasoline motorcycles constitutes the most substantial barrier to switching. Taken together, Vietnamese studies imply that both pro-environmental normative activation and competitive pull from incumbent technologies shape adoption, but they do so via potentially distinct psychological routes—moral obligation and favorable attitude formation versus inertia and perceived desirability of existing options [3], [6].

Across contexts, the literature converges on a multi-mechanism view of EV adoption intention: (i) social influence cues (credibility/attractiveness of communicators), (ii) risk–benefit appraisals grounded in health concerns, (iii) policy-enabled usefulness perceptions, and (iv) normative activation processes that translate environmental awareness into moral obligation [3], [11]. However, an integrative understanding remains limited in at least two ways. First, existing studies often examine these pathways in isolation (e.g., KOL effects vs. NAM mechanisms vs. policy and market volatility), leaving unclear how social persuasion, normative motives, and contextual uncertainty may jointly shape intention in emerging markets [3], [5], [12]. Second, Vietnamese evidence suggests that the appeal of conventional vehicles can act as a strong switching barrier, yet it is seldom modeled alongside normative

and contextual drivers [3], [6]. Addressing these gaps would enable a more comprehensive account of EV adoption-particularly in Vietnam-by clarifying the relative and interactive roles of persuasion-based mechanisms, moral norms, and structural conditions.

Therefore, this study develops an extended Theory of Planned Behavior (TPB) framework to explain e-motorbike adoption in Vietnam. While TPB posits that adoption-relevant behavior is primarily driven by behavioral intention and perceived behavioral control, and that intention is shaped by attitude, subjective norm, and perceived behavioral control [17], recent evidence in the electrification domain suggests that these relationships are meaningfully conditioned by normative–moral motives and switching barriers associated with incumbent technologies [3], [6]. In particular, studies on electric mobility indicate that beyond utilitarian/technical considerations, adoption can be influenced by social persuasion and value-laden motivations (e.g., credibility- and attractiveness-based influence in short-video platforms), health-related risk appraisals, and contextual uncertainties [11], [12].

Building on this stream, the present study extends TPB by incorporating context-relevant determinants for electric motorbike adoption in Vietnam, including perceived safety risk, policy incentives, charging infrastructure, KOL influence, and environmental concern, alongside core TPB constructs.

2.2. Hypothesis Development

2.2.1. Attitude

According to the Theory of Planned Behavior (TPB), behavioral intention is substantially influenced by attitude [9], [15], [16]. Attitude is defined as the degree to which an individual holds a favorable or unfavorable evaluation of performing a particular behavior [10], [4]. Based on the expectancy–value model, attitude toward a behavior is determined by a set of behavioral beliefs that link the behavior to various outcomes and by the individual's evaluation of those outcomes [4], [6].

A substantial body of empirical research has consistently confirmed attitude as one of the strongest and most stable predictors of electric vehicle purchase intention. In Beijing, China, attitude was found to exert the strongest positive effect on purchase intention [9]. In Pakistan, attitude emerged as a significant determinant of purchase intention [8]. Similarly, a study conducted in Texas, United States, revealed that attitude exhibited the highest path coefficient and played a central role in promoting electric vehicle adoption [10]. In Vietnam, research focusing on VinFast electric motorbikes in Ho Chi Minh City showed that attitude had the second-largest positive effect within the proposed model [6].

Despite the well-established role of attitude, a notable geographical bias persists, as most existing studies predominantly focus on electric cars in developed countries [5], [7]. With respect to electric motorbikes - which represent the dominant mode of personal transportation, accounting for up to 80% of the total vehicle fleet in Asia - empirical studies on consumer adoption remain relatively scarce compared to those on electric cars [5]. Moreover, technological advancements, particularly the transition toward lithium-ion battery systems, have substantially altered the competitiveness, performance, and safety of electric vehicles [4]. These changes necessitate an updated assessment for the period leading up to 2025 in order to accurately capture how users form attitudes under evolving technological and policy conditions [18].

Hypothesis H1: Attitude (ATT) has a positive effect on the adoption of electric motorcycles (EVA).

2.2.2. Perceived safety risks

Perceived risk is defined as an individual's sense of uncertainty or concern regarding the potential negative consequences that may arise after performing a purchase behavior [19]. According to behavioral psychology, consumers do not merely seek to maximize benefits but also endeavor to minimize risk; consequently, purchasing behavior can be understood as an inherent process of risk acceptance [19], [20]. Within extended models of the Theory of Planned Behavior (TPB) and the Technology Acceptance Model (TAM), perceived risk constitutes a critical psychological barrier that weakens behavioral intention [19]. Among its dimensions, physical or safety risk represents a core component, reflecting concerns about direct threats to users' health and personal safety stemming from technical failures of the product [13], [19].

Empirical studies on electric vehicles worldwide consistently indicate that safety is a primary concern among consumers [5]. In China, skepticism toward the reliability of electric vehicles is often associated with battery fire and explosion risks occurring during accidents or charging processes [12], [14]. Empirical evidence from Taiwan confirms that perceived risk exerts a direct and significant negative effect on electric motorbike purchase intention [13]. Similarly, research conducted in India demonstrates that concerns over technical safety issues—such as electrical short circuits and lithium battery durability—constitute the most salient situational barrier preventing consumers from switching from gasoline-powered motorbikes to electric alternatives [12], [14]. Even in Vietnam, the attractiveness of conventional gasoline motorbikes (as a counterbalancing factor) partly stems from the perception that they are "time-tested" in terms of durability, in contrast to relatively novel electric motorbikes [6]. Moreover, technical problems associated with early generations of electric vehicles (e.g., lead-acid battery leakage) have left a lasting negative psychological imprint, heightening user sensitivity to reports of fires and explosions [21].

Although perceived risk has been widely examined in the literature, most existing studies focus primarily on electric cars in the United States and Europe, where safety standards and charging infrastructures are relatively mature [5], [20]. In contrast, for electric motorbikes—the dominant mode of transportation in high-density urban contexts such as Hanoi and Ho Chi Minh City—the risk profile differs substantially due to prevalent home-charging practices in confined spaces (e.g., narrow alleys and apartment basements), where fire and electrical hazards may lead to more severe consequences [5], [6]. Furthermore, the technological transition from lead-acid batteries to lithium-ion batteries has delivered superior performance but has also introduced new concerns related to chemical risks, about which consumers' current knowledge remains limited [6], [21], [22]. Accordingly, assessing the impact of perceived safety risk within Vietnam's specific context for the 2025–2030 period is both timely and essential.

Hypothesis H2: Perceived safety risks related to electric motorcycle battery fires (RISK) negatively impact the adoption of electric motorcycles (EVA).

2.2.3. KOL Influence

This hypothesis is grounded in Source Credibility Theory, which posits that the effectiveness of persuasive communication depends largely on the degree of credibility that message recipients attribute to the source [11]. In the digital era, Key Opinion Leaders (KOLs) are regarded as a salient reference group, possessing the capacity to shape consumer behavior through four core attributes: expertise, trustworthiness, attractiveness, and reputation [11]. Under the extended logic of the Theory of Planned Behavior (TPB), KOL influence is directly linked to subjective norm (SN), as KOLs function as "new reference groups" or "opinion leaders" who generate social pressure and help construct contemporary consumption norms—particularly for high-technology and symbolic products such as electric motorbikes [6].

Recent studies have demonstrated the strong role of KOLs in stimulating electric vehicle purchase intention. In Nanjing, China, empirical research conducted on the Douyin (TikTok) platform indicates that KOL trustworthiness and attractiveness are the most influential factors in enhancing EV purchase intention [11]. Structural equation modeling (SEM) results further confirm that all four KOL attributes exert positive effects on purchase intention, with path coefficients ranging from 0.098 to 0.286 [11]. In Vietnam, a study on VinFast electric motorbikes in Ho Chi Minh City reveals that collaborations with KOLs (e.g., pop singer Sơn Tùng M-TP) have been highly effective in reaching Generation Z consumers, with the mean score for celebrity influence reaching 3.50, thereby underscoring the role of KOLs in reducing psychological barriers and building brand trust [6]. In addition, review studies document that social media and influencers are capable of reshaping consumers' perceptions of what is considered "trendy" and "environmentally responsible" [23].

Although the role of KOLs has been extensively examined in industries such as fashion and cosmetics, their application in the electric motorbike sector—a high-involvement and technologically complex product category—remains limited [11]. Most prior EV studies (e.g., those conducted in Pakistan or Beijing) tend to focus on policy interventions and product attributes, while overlooking modern social-media-driven communication mechanisms [9], [10]. Particularly in the Vietnamese market, the rapid proliferation of social media has created distinct information-processing dynamics, calling for focused investigation into whether KOL credibility can effectively overcome technological risk perceptions (e.g., concerns over lithium battery safety) and thereby promote electric motorbike purchase intention in the lead-up to 2025 [6], [11].

Hypothesis H3: KOL influence (KOL) positively impacts the adoption of electric motorcycles (EVA).

2.2.4. Policy Incentives

Policy incentives are widely regarded as an important exogenous instrument through which governments intervene in consumers' decision-making processes [3], [10]. Under the extended logic of the Theory of Planned Behavior (TPB), such policies provide additional tangible benefits that strengthen behavioral beliefs and foster positive rational evaluations toward purchasing electric vehicles [15]. From a psychological perspective, incentives function as a form of extrinsic motivation, reducing individuals' "inertia threshold" by intervening in the overall cost of vehicle ownership and use [24]. When consumers perceive policy support, their perceived behavioral control (PBC) increases as financial and infrastructural barriers are mitigated [10], [12]. A growing body of international research provides consistent evidence of the positive impact of policy incentives on electric vehicle purchase intention [2], [14]. In Pakistan, both monetary policies (e.g., subsidies and tax reductions) and non-monetary measures (e.g., fast-charging stations and dedicated lanes) have been shown to exert significant effects on purchase intention [8]. Studies conducted in Beijing and Shenzhen (China) indicate that policies such as purchase tax exemptions and preferential license-plate allocation constitute core drivers of market expansion [18]. In Norway, a global frontrunner in electric mobility, more than 80% of buyers report that tax incentives are the primary reason for choosing electric vehicles [2], [24]. Nevertheless, empirical findings are not entirely convergent: while studies from Texas (United States) and Beijing suggest that only monetary incentives have a statistically significant influence, other review-based analyses argue that convenience-oriented policies (e.g., preferential parking) play a more critical role in the long run [10], [25]. Although the importance of policy incentives has been widely acknowledged, many prior studies tend to aggregate different forms of incentives or focus predominantly on financial aspects, thereby overlooking the distinct mechanisms through which non-monetary policies operate [8], [10]. In developing markets such as Vietnam, studies

on electric motorbikes have yet to sufficiently assess the interaction between newly introduced government policy packages and consumers' perceived risk concerns [4], [5]. Moreover, policy effectiveness may be undermined when public trust in governmental implementation is weak, creating a substantial gap between intention and actual behavior [7]. This underscores the need for context-specific empirical validation to determine whether policy incentives can indeed serve as an effective lever for electric motorbike adoption in the 2025 period [10], [12].

Hypothesis H4: Government policy incentives (PI) have a positive effect on electric motorbike adoption (EVA).

2.2.5. Charging Infrastructure (CI)

Within the framework of the Theory of Planned Behavior (TPB), charging infrastructure is regarded as a critical component of perceived behavioral control (PBC), representing the external resources and opportunities required to perform a given behavior [2], [10]. In the UTAUT2 model, this factor is conceptualized as facilitating conditions, which reflect individuals' perceptions of the availability of technical and infrastructural support necessary for using a new technology [2]. From a psychological perspective, the presence of adequate charging infrastructure helps alleviate range anxiety - the fear of being stranded due to battery depletion without access to charging facilities, thereby enhancing users' confidence in the product's real-world operational feasibility [1], [7].

Empirical studies worldwide consistently confirm that charging infrastructure is among the most decisive determinants of electric vehicle purchase intention. In Beijing and Shenzhen (China), the availability and density of charging stations exert a significant positive effect on purchase intention; consumers are more inclined to choose electric vehicles when they perceive charging to be as convenient as refueling gasoline [7], [9]. In India, survey evidence indicates that insufficient charging infrastructure constitutes the largest barrier (accounting for approximately 30% of opposing views), preventing consumers from transitioning from gasoline motorbikes to electric alternatives [7]. A comprehensive global review likewise identifies the "lack of charging stations" as the most frequently cited contextual barrier in electric vehicle adoption studies [7]. In Vietnam, preliminary research shows that 17.5% of young users consider electric motorbikes inconvenient due to the shortage of public charging infrastructure, and that improving this factor could serve as a critical lever for expanding the electric motorbike market [4].

Despite widespread recognition of the importance of charging infrastructure, most existing studies focus on electric cars (four-wheel vehicles) in developed countries, where charging networks tend to be centrally planned and well established. In contrast, electric motorbikes in Southeast Asia present distinct infrastructural needs, such as home charging in narrow residential alleys or the use of battery-swapping stations, which remain underexplored in traditional purchase intention models [2], [5]. Moreover, in the Vietnamese market toward 2025, the rapid emergence of both private and public charging networks is reshaping user perceptions, necessitating an updated assessment to determine whether current infrastructure availability is sufficient to overcome consumers' "hesitation threshold" [12].

Hypothesis H5: The availability and convenience of charging infrastructure (CI) have a positive effect on electric motorbike adoption (EVA).

2.2.6. Perceived Behavioral Control (PBC)

According to the Theory of Planned Behavior (TPB), Perceived Behavioral Control (PBC) represents an individual's perception of the ease or difficulty associated with performing a specific behavior [9], [10]. PBC reflects both internal factors (such as skills and self-confidence) and external constraints (such as financial resources, time availability, and convenience) [2], [10]. From a psychological perspective, when individuals focus more on

available opportunities and resources rather than on potential obstacles, their perceived level of behavioral control is strengthened [10]. Within the TPB framework, PBC functions as a critical direct antecedent; the higher the level of perceived control, the stronger the intention to perform the behavior [6], [9], [16].

The positive role of PBC in shaping electric vehicle purchase intention has been consistently confirmed across numerous empirical studies worldwide. In Beijing, China, PBC exerts a significant positive effect, indicating that consumers are more willing to purchase electric vehicles when they feel confident in their ability to do so [9]. In Pakistan, PBC has been identified as one of the strongest determinants of purchase intention [8]. In Vietnam, evidence from studies focusing on electric motorbikes further supports this relationship: research on VinFast electric motorbikes in Ho Chi Minh City demonstrates that PBC significantly influences purchase decisions, as users place high value on perceived ease of use and their own financial capability [6]. Similarly, a study among students in Hanoi confirms that PBC is one of the key factors shaping the intention to adopt electric two-wheelers [4].

Although the importance of PBC has been well established, comparative studies suggest that its influence varies substantially depending on urban characteristics (e.g., differences between Shenzhen and Yangjiang) [18]. Most existing research continues to focus on electric cars in developed countries, leaving a notable gap in in-depth studies on electric motorbikes in developing markets such as Vietnam [5], [7]. In the context of rapid technological change toward 2025, emerging elements such as battery-swapping systems and smart charging networks are redefining users' perceptions of "convenience" and "control" [5], [18]. Accordingly, an updated assessment is required to determine how PBC influences electric motorbike adoption intention as infrastructural and technological barriers are progressively reduced [6], [18].

Hypothesis H6: Perceived Behavioral Control (PBC) has a positive effect on electric motorbike adoption (EVA).

2.2.7. Environmental Concern (EC)

Environmental concern (EC) is defined as the extent to which individuals recognize environmental problems, as manifested through emotional responses such as worry or dissatisfaction with ecosystem degradation, and their willingness to make personal contributions to addressing these issues [2], [3], [26]. According to the Value–Belief–Norm (VBN) theory and extended TPB-based frameworks, such concern represents altruistic motives that function as key antecedents driving green consumption behaviors [1], [2]. From a psychological perspective, individuals with a high level of environmental concern are more likely to develop positive attitudes toward sustainable products and to feel a moral responsibility to change mobility practices that contribute to environmental pollution [1], [15].

The facilitating role of environmental concern in shaping electric vehicle purchase intention has been strongly supported by numerous empirical studies worldwide [1], [2], [27]. In China, EC has been identified as the most powerful predictor of motivation to purchase electric vehicles, surpassing both price-related factors and social influence [2], [28]. Comparative studies conducted in Spain and India reveal that EC exerts a positive and consistent effect on electric vehicle adoption intention in both countries [2]. In the Pakistani market, environmental concern has likewise been shown to significantly influence intention to adopt new transportation technologies [8]. Notably, recent evidence from Vietnam in 2025 indicates that EC not only has a direct impact on adoption intention but also reinforces Awareness of Consequences (AOC), thereby guiding individuals toward electric vehicle purchase intentions as a means to mitigate air pollution and climate change [3].

Although environmental concern is widely recognized as a common motivational driver, most existing studies continue to focus on electric cars in developed economies, where consumers possess the financial capacity to prioritize ethical and environmental values [5], [7]. In contrast, for electric motorbikes - which account for up to 80% of the vehicle fleet in Asia - empirical research on the role of EC remains relatively limited [5]. Furthermore, mixed evidence persists, as some consumers with high environmental concern still delay electric vehicle adoption due to skepticism regarding the actual environmental benefits of batteries (e.g., pollution generated during production and recycling processes) or because electricity supply remains heavily coal-dependent [2], [14], [25]. In Vietnam, where awareness of "green living" is rapidly increasing, re-examining the role of environmental concern in the context of electric motorbikes during the 2025 period is necessary to determine whether environmental motivations can indeed overcome barriers related to cost and charging infrastructure.

Hypothesis H7: Environmental concern (EC) has a positive effect on electric motorbike adoption (EVA).

Based on the theoretical foundations and prior empirical studies, this study proposes a conceptual framework examining the effects of attitude (ATT), perceived safety risk (RISK), KOL influence (KOL), policy incentives (PI), charging infrastructure (CI), perceived behavioral control (PBC), and environmental concern (EC) on electric motorbike adoption intention (EVA).

Accordingly, the research model presented in Figure 1 summarizes the hypothesized relationships and serves as the foundation for the subsequent empirical analysis.

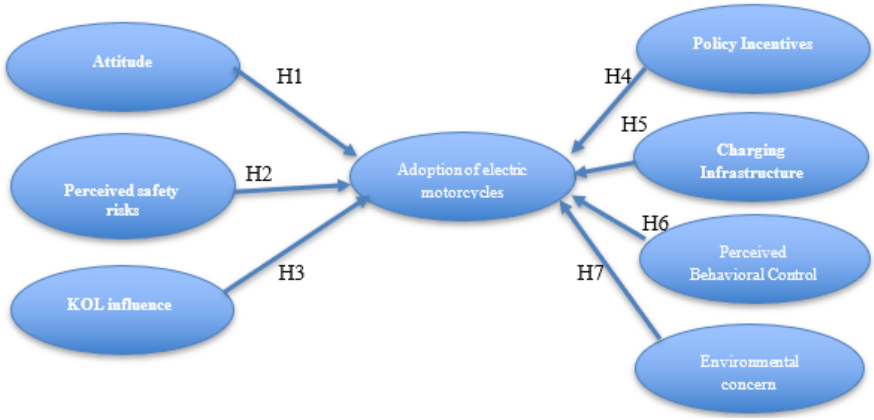

Fig. 1. Research model. Source: Developed by the author based on the literature review.

3. METHODOLOGY

3.1. Research Design

A quantitative research approach was employed to test the hypotheses concerning the causal relationships among barriers, motivational factors, and the adoption of electric motorbikes. This design was selected because it enables the quantification of complex psychological constructs and provides robust empirical evidence through statistical modeling techniques.

The research procedure was implemented in two main stages:

1. Preliminary study (Pilot test): A small-scale pilot survey (approximately 60 respondents) was conducted to evaluate the clarity of wording, terminology, and questionnaire

completion time. This step allowed for refinement of the measurement scales prior to the full-scale survey, thereby ensuring cultural relevance and contextual appropriateness.

2. Main study: After finalizing the questionnaire, large-scale data collection was carried out to support structural model analysis.

3.2. Sampling and Data Collection

- Target population: Young urban consumers (predominantly Gen Z) in Ho Chi Minh City (HCMC). This area is characterized by rapid urbanization, a high density of personal vehicles, and the active implementation of electric vehicle incentive policies.
- Sampling method: Convenience sampling was adopted by distributing a Google Forms survey link to social media groups on the Zalo platform. This approach facilitated rapid access to young, technology-oriented consumers who exhibit interest in green mobility solutions.
- Sample size: To ensure representativeness and meet the requirements of Structural Equation Modeling (SEM), the minimum sample size was determined using the 5:1 rule (at least five observations per observed variable). Given the multi-factor extended model, a large sample (typically >300 respondents) was targeted to enhance the precision of statistical estimates.

3.3. Measurement Scales

The study employed a five-point Likert scale, ranging from 1 (*Strongly disagree*) to 5 (*Strongly agree*).

Measurement items were adapted and refined from established studies:

- The KOL construct was developed based on Source Credibility Theory, encompassing expertise, trustworthiness, and attractiveness.
- Perceived battery fire risk and charging infrastructure constructs were derived from global studies on electric vehicle adoption barriers, with a focus on battery safety concerns and trust in charging systems.
- The questionnaire underwent back-translation to ensure semantic equivalence and avoid meaning distortion.

3.4. Data Analysis Techniques

Collected data were processed using standard analytical procedures:

- Descriptive statistics: Applied to profile the sample's demographic characteristics (e.g., gender, age, income), thereby providing context for subsequent analyses.
- Reliability and validity assessment: Internal consistency was evaluated using Cronbach's alpha (threshold >0.7). Subsequently, Confirmatory Factor Analysis (CFA) was conducted to establish convergent and discriminant validity of the measurement scales.
- Structural Equation Modeling (SEM): SEM served as the core analytical technique, enabling simultaneous testing of the entire network of relationships among latent variables. SEM was chosen for its capacity to account for measurement error and to provide comprehensive model-fit indices (e.g., CFI, RMSEA, GFI).

4. RESULTS

4.1. Descriptive Statistics

The final sample comprised 329 respondents. As shown in the descriptive statistics, the sample was predominantly female, with women accounting for 77.5% of respondents (n = 255), while males represented 21.9% (n = 72), and 0.6% identified as other genders (n = 2).

In terms of age, the sample was highly concentrated in younger cohorts, with 93.3% of respondents being under 29 years old (n = 307). Participants aged between 30 and 49 years accounted for 6.1% (n = 20), while those over 60 years old constituted a marginal 0.6% (n = 2). This age distribution indicates a strong representation of younger consumers, particularly Generation Z.

Regarding educational attainment, the majority of respondents held a bachelor's degree (89.1%, n = 293), followed by those with a master's degree (10.3%, n = 34). Only 0.3% of respondents completed high school (n = 1), and 0.3% reported other educational qualifications (n = 1), suggesting a highly educated sample overall.

With respect to monthly income, most respondents reported earnings in the range of VND 5,000,000–10,000,000, accounting for 89.4% of the sample (n = 294). Higher income brackets were less represented, including VND 10,000,000–18,000,000 (5.2%, n = 17), VND 18,000,000–32,000,000 (4.0%, n = 13), and VND 32,000,000–52,000,000 (1.5%, n = 5). This distribution reflects the income structure commonly observed among young urban consumers in Vietnam.

Overall, the demographic profile indicates that the study primarily captures the perceptions of young, well-educated, and lower- to middle-income consumers, who represent a key target segment for electric motorbike adoption in urban Vietnam.

Table 1. Demographic characteristics of the research sample

Demographic characteristic		Frequency	Percent
Gender	Female	255	77.5
	Male	72	21.9
	Other	2	0.6
Age	Less than 29	307	93.3
	30 – 49 years old	20	6.1
	Over 60 years old	2	0.6
Education	High school	1	0.3
	Bachelor	293	89.1
	Master	34	10.3
	Other	1	0.3
Income	5,000,000 – 10,000,000 VND	294	89.4
	10,000,000 – 18,000,000 VND	17	5.2
	18,000,000 – 32,000,000 VND	13	4.0
	32,000,000 – 52,000,000 VND	5	1.5

Note: n=329. Source: Author's analysis based on the survey data.

4.2. Reliability and Validity

The reliability and validity of the measurement scales were first assessed using survey data. Reliability analysis was conducted to ensure the consistency of the constructs, while data validity was examined using SPSS 27.0.

The initial measurement model was evaluated through confirmatory factor analysis (CFA), revealing that some constructs did not meet the required validity thresholds. In particular, the CI construct showed low reliability and convergent validity, and item RISK10 had a low factor loading. These were therefore removed from the model.

The revised measurement model demonstrated satisfactory reliability and validity and was retained for further structural analysis. CFA was conducted using STATA 17 to assess structural validity, including both convergent and discriminant validity. (Table 2),

The results indicate that all constructs achieved satisfactory reliability and validity. Factor loadings exceeded 0.5, composite reliability (CR) values were above 0.7, and average variance extracted (AVE) exceeded 0.5, (Table 2), confirming convergent validity [31]. Fig. 2 shows the measurement model. Discriminant validity was also established, as the square root of AVE for each construct was greater than its correlations with other constructs [32].

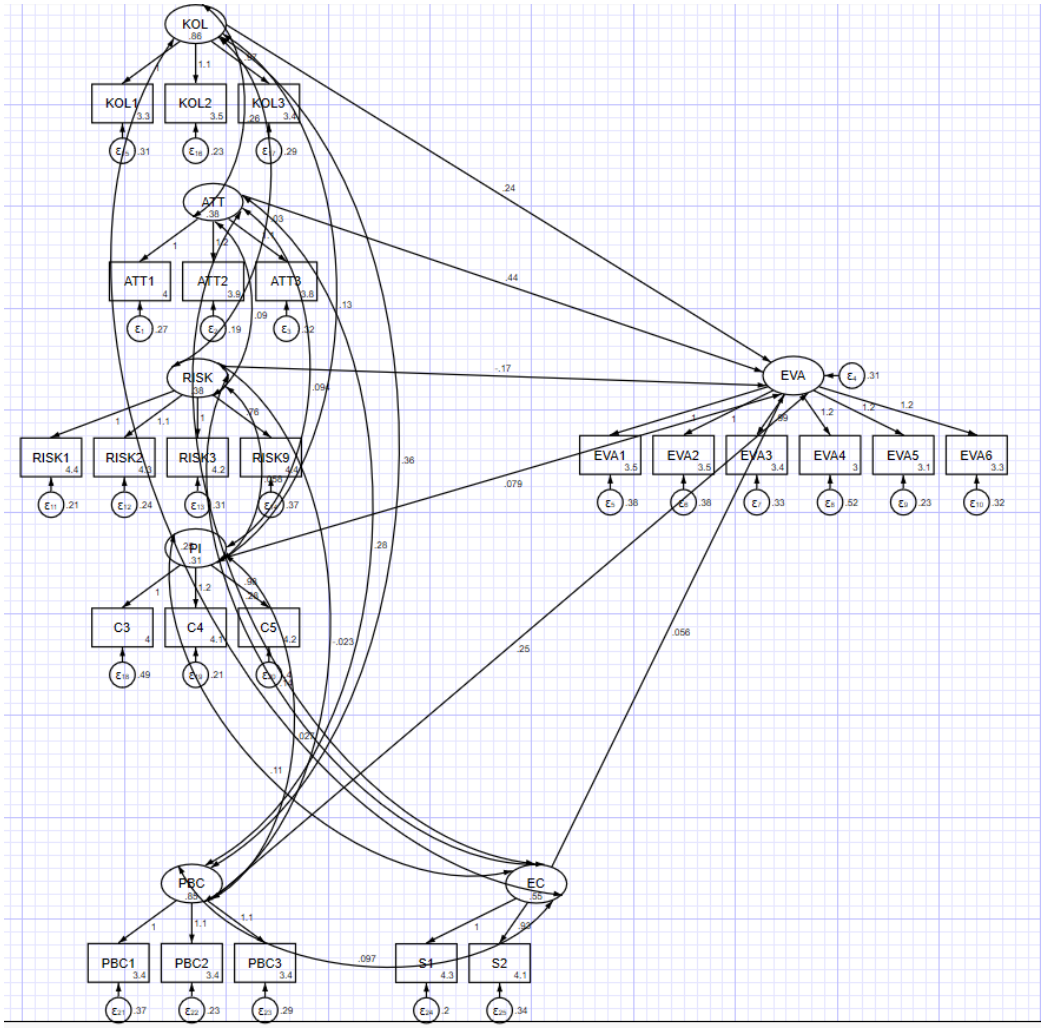

Fig. 2. Measurement model. Source: Author's analysis based on the survey data using STATA 17.

Table 2. Reliability and validity.

Constructs	Items	Factors loadings	CR	AVE	Cronbach's Alpha
ATT	ATT1	0.7682828	0.845	0.645	0.842
	ATT2	0.8608095			
	ATT3	0.7786125			
RISK	RISK1	0.8060671	0.828	0.560	0.826
	RISK2	0.8118171			

	RISK3	0.741755			
	RISK9	0.6109645			
KOL	KOL1	0.8551051	0.904	0.758	0.904
	KOL2	0.898414			
	KOL3	0.8575994			
PI	C3	0.6261968	0.751	0.505	0.733
	C4	0.8331508			
	C5	0.6551559			
PBC	PBC1	0.8347398	0.907	0.765	0.906
	PBC2	0.8988047			
	PBC3	0.8884566			
EC	S1	0.856683	0.791	0.656	0.790
	S2	0.7631919			
EVA	EVA1	0.8010229	0.931	0.693	0.929
	EVA2	0.8072296			
	EVA3	0.8202455			
	EVA4	0.7975791			
	EVA5	0.895012			
	EVA6	0.869689			

Source: Author's analysis based on the survey data.

Discriminant validity was evaluated using the Fornell–Larcker criterion. The results indicate that the square root of the Average Variance Extracted (AVE) for each construct exceeds its correlations with other constructs, confirming adequate discriminant validity. Table 3 presents the detailed results. According to [35], excessively high inter-construct correlations may indicate a lack of discriminant validity. In this study, all correlation coefficients remain within acceptable thresholds, while the square root of AVE is consistently greater than the corresponding inter-construct correlations [32]. Overall, the measurement model demonstrates satisfactory reliability as well as convergent and discriminant validity.

Table 3. Discriminant validity.

Latent Variable	ATT	RISK	KOL	PI	PBC	EC	EVA
ATT	0.804						
RISK	0.234	0.724					
KOL	0.460	.0512	0.880				
PI	0.272	.1682	.2458	0.505			
PBC	0.499	-.0397	.4173	.0527	0.876		
EC	0.614	.3074	.369181	.255	.1421	0.812	
EVA	0.330	-0.130	0.267	0.054	0.279	0.050	0.827

Source: Author's analysis based on the survey data.

4.3. Model fit test

The structural equation model demonstrates a good overall fit to the data. The Chi-square statistic is significant, $\chi^2(231) = 455.717$, $p < 0.001$ [34]. However, this result is

expected given the sensitivity of the Chi-square test to sample size. Therefore, additional fit indices were considered.

The RMSEA value is 0.054, indicating a good fit (< 0.08), with a 90% confidence interval ranging from 0.047 to 0.062. The p-close value of 0.156 (> 0.05) further supports the conclusion that the model fits the population well. Incremental fit indices also confirm the adequacy of the model, with CFI = 0.953 and TLI = 0.944, both exceeding the recommended threshold of 0.90.

In addition, the coefficient of determination (CD) indicates a very high level of explained variance, suggesting that the model explains a substantial proportion of variance in the endogenous constructs. The SRMR index was not reported due to missing values in the dataset.

4.4. Factors affecting EV adoption

The results of the structural equation modeling (SEM) analysis are presented in Table 4. The findings indicate that several hypothesized relationships are statistically significant. Specifically, ATT, KOL, and PBC exhibit positive and significant effects on EVA, while RISK shows a significant negative impact. In contrast, PI and EC do not demonstrate statistically significant relationships with EVA at the 5% significance level. The hypothesis related to CI was not tested because the construct was excluded from the final model due to inadequate reliability and convergent validity.

Among the significant predictors, PBC and ATT show relatively strong effects, followed by KOL. Meanwhile, RISK negatively influences EVA, suggesting that higher perceived risk reduces consumer evaluation. Overall, the results partially support the proposed hypotheses, indicating that not all theoretical relationships are confirmed in the Vietnamese context.

4.4.1. Electric motorbike adoption (EVA) with attitude (ATT)

According to Table 4, attitudes significantly and positively influence Electric motorbike adoption (β=0.329, $p<0.001$). According to the results, consumers who hold a favorable evaluation and perceive electric motorbikes as a "good idea" for a green future are more likely to purchase them. The findings of the extended TPB model show that ATT is the strongest positive predictor for EVA in the Vietnamese context. These results are consistent with previous research that demonstrated attitude is a reliable and significant predictor for consumer purchase intent [33] and studies in Beijing where attitude also exerted the strongest influence [9].

4.4.2. Electric motorbike adoption (EVA) with Perceived Risk (RISK)

According to Table 4, Perceived Risk significantly and negatively influences Electric motorbike adoption (β=−0.130, $p=0.008$). According to the results, higher levels of uncertainty regarding battery safety, specifically concerns over fire and explosion risks, act as a substantial psychological barrier. This confirms that even if consumers are environmentally conscious, technological anxiety can diminish their adoption intent. These results are consistent with previous research in Taiwan and India, which identified technical safety concerns as a critical negative determinant of green purchase intention [12], [13].

4.4.3. Electric motorbike adoption (EVA) with KOL Influence (KOL)

According to Table 4, KOL Influence significantly and positively influences Electric motorbike adoption (β=0.267, $p<0.001$). According to the results, consumers who perceive Key Opinion Leaders as credible, trustworthy, and attractive sources of information - especially on digital platforms - are more likely to purchase electric motorbikes. The findings of the extended TPB model show that KOLs act as a "new reference group" that helps reduce technological skepticism and shapes modern consumption norms for the Gen Z generation in Vietnam. These results are consistent with previous research that demonstrated KOL

characteristics are reliable and powerful predictors of consumer purchase intent in social-media-rich environments [11].

4.4.4. Electric motorbike adoption (EVA) with Policy Incentives (PI)

According to Table 4, Policy Incentives do not significantly influence Electric motorbike adoption (β=0.054, p=0.293). According to the results, while government support is theoretically a motivator, it does not currently act as a primary driver for Vietnamese consumers, possibly due to a lack of awareness or confidence in the implementation of these measures. These results contrast with previous research in Pakistan and China, where both monetary and non-monetary policies were found to be reliable and significant predictors of consumer intent [8], [12].

4.4.5. Electric motorbike adoption (EVA) with Charging Infrastructure (CI)

According to Table 4, the charging Infrastructure (CI) construct was excluded from the final model because it did not meet the required reliability and convergent validity criteria, possibly due to the limited variability in respondents' responses. The CI construct was excluded because it did not meet the required reliability and convergent validity criteria. Limited response variability may be one possible explanation; however, this interpretation requires further empirical verification. The findings indicate that while charging stations are a situational prerequisite, their widespread availability in major Vietnamese cities reduces their role as a primary driver of adoption intention compared to other psychological factors. These results contrast with previous research in other developing markets such as India, where the lack of adequate charging facilities remains the most significant barrier to adoption [7], and Beijing, where satisfaction with charging infrastructure is a strong positive predictor of purchase intent [9].

In the Vietnamese context, the rapid expansion of electric vehicle charging infrastructure—largely driven by VinFast—has positioned Việt Nam among the leading countries in Southeast Asia in terms of charging network coverage [31], [34]. This widespread availability of charging stations reduces consumers' concerns regarding accessibility and convenience. As a result, charging infrastructure is increasingly perceived as a given rather than a differentiating factor in consumers' decision-making process. Consequently, the CI construct exhibits limited variability and fails to significantly influence consumer evaluation in this study.

4.4.6. Electric motorbike adoption (EVA) with Perceived Behavioral Control (PBC)

According to Table 4, Perceived Behavioral Control (PBC) significantly and positively influences Electric motorbike adoption (β=0.279, p<0.001). According to the results, consumers are more willing to buy EVs when they feel they have the necessary financial resources, skills, and opportunities to operate the vehicle comfortably. These results are consistent with previous research which demonstrated that PBC is a critical precursor to purchase intention for green products [33] and studies in Ho Chi Minh City showing its significant impact on VinFast purchases [6].

4.4.7. Electric motorbike adoption (EVA) with Environmental Concern (EC)

According to Table 4, Environmental Concern (EC) does not significantly influence Electric motorbike adoption (β=0.050, p=0.484). According to the results, while consumers value environmental harmony, these altruistic motives do not directly translate into adoption intent, suggesting a "green attitude-behavior gap" where safety and technical risks take precedence. These results contrast with previous research in China and Spain, where environmental concern was identified as a primary significant predictor for EV adoption [2], [28].

Table 4. Results of the structural equation model and Hypothesis results.

Hypothesis	Path	Estimate	SE	P-value	Result
H1	EVA<— ATT	0.329	0.079	0.000	Supported
H2	EVA<— RISK	-0.130	0.049	0.008	Supported
H3	EVA<— KOL	0.267	0.054	0.000	Supported
H4	EVA<— PI	0.054	0.051	0.293	Not supported
H5	EVA<— CI	-	-	-	Not tested
H6	EVA<— PBC	0.279	0.058	0.000	Supported
H7	EVA<— EC	0.050	0.071	0.484	Not supported

Source: Author's analysis based on the survey data.

5. CONCLUSION

This study not only contributes to the theoretical body of knowledge on consumer behavior but also offers important practical implications for Vietnamese manufacturers and government agencies in fostering a sustainable e-motorbike ecosystem.

5.1. Theoretical Contributions

The study confirms the explanatory utility of an extended Theory of Planned Behavior (TPB) framework in accounting for e-motorbike adoption intention in the Vietnamese market over the 2025–2030 period. Its key academic contribution lies in successfully integrating contemporary determinants - most notably perceived safety risk (i.e., concerns over battery fires/explosions) and Key Opinion Leader (KOL) influence - into the conventional TPB structure. The results indicate that perceived risk constitutes a potent negative barrier, capable of effectively "crowding out" pro-environmental motivations when technological trust has not been adequately established. At the same time, the findings elucidate the role of KOLs in the digital era as a "new reference group" that helps shape consumption norms and attenuate technology-related skepticism among younger consumers.

5.2. Managerial Implications

To expand market share, e-motorbike manufacturers (e.g., VinFast) should consider the following strategies:

- To expand market share and strengthen consumer confidence, e-motorbike manufacturers such as VinFast should adopt a comprehensive strategy that simultaneously addresses perceived risk, product performance, and communication effectiveness. First, firms should strengthen technical trust and safety transparency by publicly disclosing battery safety standards, independent testing certifications, and clear "battery safety certification" labels. Transparent communication materials, including videos demonstrating thermal management systems and thermal runaway prevention processes, may help reduce consumer uncertainty and reinforce trust. In addition, manufacturers should establish clear incident-response protocols, such as dedicated hotlines, rapid battery replacement services, and transparent investigation procedures, to improve trust recovery when safety-related incidents occur. Companies may also collaborate with banks and insurance providers to offer bundled battery insurance and fire-risk protection packages, thereby lowering consumers' financial and psychological anxiety associated with electric vehicle usage.

- Second, manufacturers should continue enhancing product performance by improving driving range, reducing charging time, and expanding fast battery-swapping infrastructure to alleviate consumers' range anxiety and increase perceived convenience. Finally, firms should

implement a multi-dimensional marketing strategy by prioritizing collaborations with technically credible KOLs, engineers, battery specialists, and fire safety experts rather than entertainment celebrities. Such expert endorsements can strengthen communication credibility and reduce perceived risk perceptions. Marketing messages should also emphasize not only environmental benefits but also personal health benefits, such as reducing exposure to urban air pollution and respiratory risks, in order to attract health-conscious consumer segments.

5.3. Policy Implications

In a context where economic growth is closely linked to social welfare, the Government should play a leading role through:

- Maintaining and diversifying financial incentives: Continuing measures such as registration-fee exemptions, direct subsidies, or preferential low-interest loans can reduce price sensitivity during the market's early expansion phase.
- Developing and standardizing charging infrastructure: A coordinated national plan is needed for public charging networks and residential charging provisions (e.g., in apartment complexes). Making charging availability a "taken-for-granted utility" can strengthen citizens' perceived behavioral control (PBC) and, in turn, facilitate adoption.
- Implementing counterbalancing regulatory measures: Lessons from China suggest that restricting gasoline vehicles (e.g., banning gasoline motorbikes in urban cores or enforcing stringent emissions controls) can be a more effective lever than relying on subsidies alone.
- Public communication focused on social welfare and public health: Strengthening education and outreach on the harmful health effects of gasoline vehicles can activate personal norms and moral responsibility, thereby encouraging citizens to shift toward greener mobility options.

5.4. Limitations

This study relies on convenience sampling in Ho Chi Minh City, resulting in a sample that is heavily skewed toward young, well-educated respondents (predominantly under 29 years old). Future research should employ probability-based sampling and extend data collection to other Vietnamese cities and age groups to improve generalizability. In addition, the dependent construct captures adoption intention rather than actual purchase or usage behavior; longitudinal designs would be useful to examine intention–behavior consistency over time.

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