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THE MODERATING EFFECT OF TRUST ON THE ADOPTION OF ELECTRIC MOTORCYCLES AMONG ROAD USERS

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Abstract. Motorcycles with internal combustion engines fueled by fossil fuels dominate the traffic flow in major Asian cities, contributing significantly to air and noise pollution compared to other transport modes like walking, cycling, and public transport. To address this issue, many Asian countries are promoting the adoption of electric motorcycles to reduce air pollution and reliance on non-renewable energy sources. However, the adoption of electric motorcycles faces various challenges. This study investigates factors influencing the adoption of electric motorcycles in Vietnam. Structural equation model (PLS-SEM) software was used to analyze data gathered from 751 valid responses. The findings reveal that perceived usefulness has the most significant positive impact on the adoption of electric motorcycles, while perceived risk acts as a barrier to the adoption intention. Additionally, age moderates the relationship between perceived ease of use and adoption intention, and income level influences the correlation between perceived risk and the adoption of electric motorcycles. The study also discusses the policy implications, focusing on how motorbike manufacturers can further promote the adoption of electric motorbikes (EMs).

Keywords: Electric motorcycles, developing countries, energy, environment, Vietnam

1. INTRODUCTION

Air pollution and greenhouse gas emissions (GHGs) from transportation are the primary causes of climate change and global warming [1]. To address the challenges of air pollution and reduce greenhouse gas emissions from transportation, many countries globally have advocated for the shift towards eco-friendly and energy-efficient transportation methods instead of conventional internal combustion engine vehicles. High-income nations, particularly in Europe, have introduced diverse incentives such as complimentary parking, buyer subsidies, and exemptions from sales taxes to promote the extensive adoption of electric vehicles (EVs) or transport systems fueled by renewable energy sources [2]. To encourage the use of electric vehicles (EVs), China has introduced many incentives to motivate electric vehicle users. As a result, the number of electric vehicles sold in China has increased rapidly from 5,209 units in 2009 to 1.367 million units in 2020, surpassing Germany, the world's second best-selling country, by more than 970,000 units [3].

Two-wheelers have become the primary means of transportation in low- and middle-income countries due to their user-friendly nature, surpassing other modes of transport, particularly in densely populated areas. For example, the number of motorbike users in Asian countries is the largest in the world (200 million people) and namely accounts for nearly 85% of world motorbike sales [4]. The high number of motorcycles in Asia significantly contributes to elevated levels of air pollution [5]. A study in Iran indicates that motorcycles are the second-largest contributor to traffic-related pollution [6]. The transition from gasoline-powered motorcycles to electric motorcycles (EMs) is expected to improve local air quality [7]. According to the 2018 Environmental Performance Index, Vietnam ranks 161st out of 180 countries in the category of air pollution [8]. In urban areas of Vietnam, motorized vehicles are identified as a significant source of air pollution, with motorcycles, in particular, being the primary contributors to air pollution [9]. Although government efforts to provide incentives, such as bus subsidies or bus rapid transit, are aimed at promoting the use of public transport and reducing pollution. However, the results were not as expected. Furthermore, the transportation network in Vietnam consists of many narrow roads, leading many people to prefer using motorcycles as their primary means of transportation. Therefore, opting for electric motorcycles instead of internal combustion engine motorcycles is considered a way to reduce transportation emissions into the environment and save fossil fuels [10].

In recent years, electric motorbikes, introduced to users in Vietnam, have been praised by businesses and consumers thanks to effectively replacing conventional motorbikes. Recently, there have been several empirical studies on the potential of the application of electric motorcycles in Vietnam as an alternative to motorcycles with internal combustion engines [11]. However, previous studies have predominantly relied on the TAM theory to examine factors influencing the intention to use electric motorcycles. These studies either do not consider perceived risk or focus solely on specific factors within perceived risk without clearly analyzing which factors within perceived risk negatively impact usage intention. Additionally, these studies have not fully explored the effect of trust on the intention to use electric motorcycles. Therefore, in this study, we integrated the TAM theory, perceived risk, and trust models to explore the factors that promote or hinder the intention to use electric motorcycles.

In this paper, we investigated the factors influencing the adoption of electric motorcycles in two major cities, Ho Chi Minh City and Da Nang. A paper-based questionnaire was proposed. Through data analysis based on established measurement standards, we identified positive and negative factors affecting the use of electric motorcycles. The study concludes by providing

recommendations and solutions for enterprises to stimulate the electric motorcycle market in Vietnam.

2. BACKGROUND AND HYPOTHESIS DEVELOPMENT

2.1 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM), which was introduced by Davis [12] based on the Theory of Reasoned Action (TRA), is a detailed psychological theory encompassing key factors to understand and predict the acceptance of novel technologies. Similar to TRA, TAM assumes attitude towards behavior (ATT) determines the behavioral intention. The TAM theory is a widely used theoretical framework in research. It is employed to illuminate and predict how users perceive and adopt new technologies [13]. The TAM theory encompasses two key factors: Perceived Ease of Use (PEU) and Perceived Usefulness (PUS). When users perceive both PEU and PUS, they are more likely to have a positive intention to use them [14]. Van der Heijden [15] posits that PUS is the extent to which an individual believes that using a specific system will enhance their job performance, while PEU is the extent to which an individual believes that using a specific system will require little effort [15]. TAM has been applied and extended in various research contexts [16]. Some studies have also applied TAM to electric motorcycles [11, 17].

Therefore, this study will apply the TAM model to explore which factors significantly influence the intention to adopt electric motorcycles (EMs). The aim is to formulate appropriate policies to promote the usage of EMs.

2.2 Perceived risk theory

Perceived risk introduced by Bauer [18] in 1960 is a psychological concept within consumer behavior. Bauer posited that consumers face uncertainty when making purchase decisions, unable to accurately predict or confirm the correctness of their choices and whether undesirable outcomes may arise. This uncertainty forms the foundation of the perceived risk concept. Cox, Rich [19] claimed that research on perceived risk operates under the assumption that specific goals drive consumer purchasing behavior. Consumers set anticipated purchase objectives and make decisions based on product attributes such as performance, style, brand, and color. Perceived risk arises when consumers encounter challenges in determining the combination that aligns with their goals. Building on this, Jacoby, Kaplan [20] identified six dimensions of perceived risk through their research: functional risk, physical risk, social risk, time risk, financial risk, and psychological risk.

In the context of transportation, travelers' risk perception can significantly influence their travel behavior and choice of transport modes or services [21, 22]. For EMs, many types of risks have been found in previous studies. Typical risks include purchasing incomplete or defective electric vehicle products (limited range or product malfunction), poor performance, privacy, and financial drawbacks [23, 24]. Ngoc, Nishiuchi, Nhu [25] show psychological factors such as perceived risk may affect the intention of transport companies to use electric motorbikes in Vietnamese cities. These risks are considered barriers that have negative effects on the intention to adopt EMs. This study will explore the dimensions of perceived risk that influence the intention to adopt EMs.

2.3. Hypothesis development

Perceived usefulness (PUS)

Davis [12] states that perceived usefulness is the degree to which people believe that using a particular system will enhance their job performance. PUS was found to be directly related to both attitudes and behavioral intentions to adopt new technology [12]. According to Author Shaikh, et al. [17], research results show that perceived usefulness is positively related to behavioral intention to apply EMs in Pakistan. Adapted to this study, perceived usefulness is the benefit of using the adoption of electric motorcycles. Agreeing with the literature, we hypothesized that there appears to be a positive association between PUS and the adoption of electric motorcycles. Based on the findings of prior research, we posit the hypothesis that:

H_1: Perceived usefulness positively affects users' adoption of EMs.

Perceived ease of use (PEU)

Perceived ease of use (PEU) defined by Davis [12] is considered the degree to which a person believes that using a particular system will be effortless. Previous studies have found that PEU influences PUS and the impact of PEU on users' attitudes toward technology [26]. Therefore, the adoption of new technology is strongly influenced by PEU [12]. Ngoc, et al. [25] studies on the intention to use electric motorcycles indicated that the perceived ease of use could be linked to the perceived usefulness and the adoption of electric motorcycles. This is also consistent with the research conducted by Shaikh, et al. [17], where perceived ease of use positively influences the intention to use electric motorcycles, and perceived ease of use plays a mediated role through perceived usefulness. In this study, we employ a similar hypothesis to that of earlier researchers, suggesting a positive correlation between perceived ease of use and the adoption of electric motorcycles.

H_2: Perceived ease of use positively affects users' adoption of EMs.

H_3: Perceived ease of use positively affects perceived usefulness.

Perceived risk

Perceived risk is considered a factor that negatively affects the intention to use transportation services [21, 22]. The adoption of innovations, including emerging technologies (EMs), can be considered a form of risk-taking behavior. Therefore, consumers' evaluations of potential drawbacks and their severity, stemming from perceived risks, harm the intention to adopt [23]. For example, the technical challenges on top of the lack of critical infrastructure, greatly hinder the adoption process of hydrogen-powered vehicles [23]. The intention to adopt electric vehicles (EVs) is negatively influenced by perceived risks, encompassing concerns associated with performance, physical attributes, financial aspects, time, and psychological factors [27]. Ngoc, et al. [25] have identified that factors such as safety risk, performance risk, and time risk negatively affect intentions of using electric vehicles (EVs). Choi, Ji [28] showed that perceived risk indicators (PRI), particularly concerns related to range anxiety, explosion, and fire, act as significant barriers influencing the intention to use electric motorcycles (EMs). Previous studies on electric motorbikes show that factors in perceived risk affect the intention to use electric motorbikes. So, we make the following hypothesis:

H_4: Perceived risk negatively affects users' adoption of EMs.

The role of trust (TRU)

The trust (TRU) is found to influence the relationship between PEU and the adoption of EMs (ADO). The significance of perceived usefulness (PEU) in fostering trust has been emphasized in numerous studies in electronic commerce, leading to trust and intention to use

[29]. However, very few such studies have been conducted in the context of transportation. Dikmen, Burns [30] discovered a positive correlation between the initial trust in the Tesla Autopilot system and perceived usefulness (PUS). Similar to the aforementioned study, Zhang et al [22] research revealed that perceived usefulness (PUS) was a crucial factor influencing initial trust, attitude toward using, and behavioral intention to use automated vehicles.

H5: Trust positively moderates the relationship between PEU and ADO

In the context of electronic commerce research, the authors identified that consumer trust was influenced by PEU and vice versa [29]. In the context of transportation, the relationship between trust and PEU is found to be relatively scarce. Research on automated vehicles indicates that users' trust in automated vehicles is positively influenced by Perceived Ease of Use (PEU) [22].

H6: Trust positively moderates the relationship between PUS and ADO

Additionally, trust is considered to have a relationship with perceived risk. Some authors discover that trust is related to the level of risk and suggest that higher levels of trust reduce the level of perceived risk over time [31]. Zhang, et al. [22] suggest that perceived risk does not directly determine users' attitudes toward autonomous vehicles but rather influences them indirectly by affecting users' levels of trust in autonomous vehicles. In this study, we also incorporate some additional elements into perceived risk and the relationship between trust and perceived risk.

H7: Trust negatively moderates the relationship between PRI and ADO

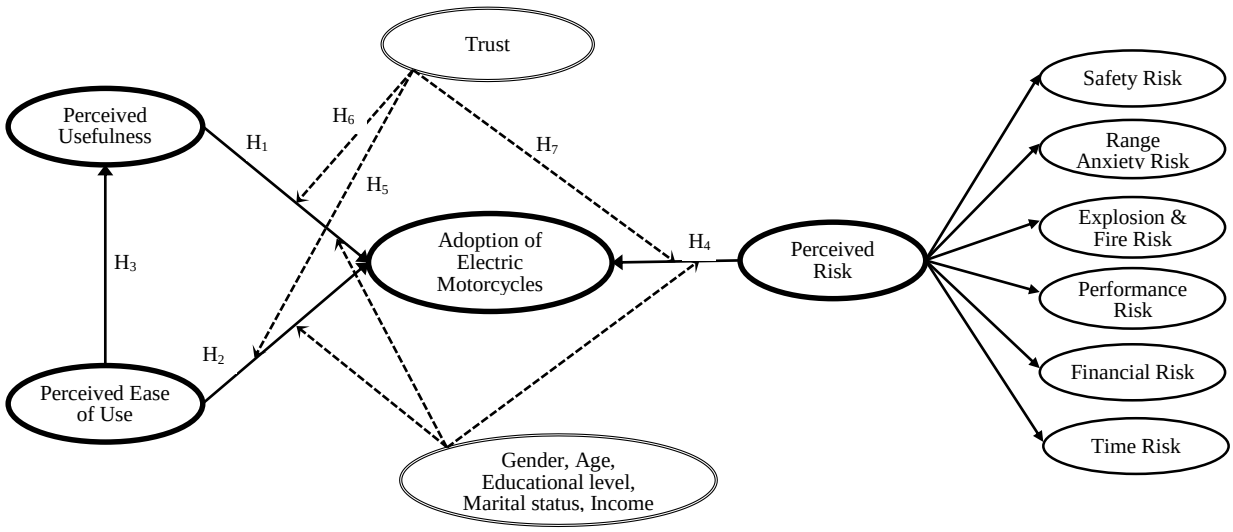


Figure 1. The developed model.

Control variables

Demographics is one of the crucial factors influencing the usage of electric vehicles [32]. A study conducted in Macau yielded results indicating that male motorcyclists do not show a greater preference for electric motorcycles compared to their female counterparts. This trend emerges when male riders perceive electric motorcycles as lacking satisfactory driving performance [33]. However, research conducted in Austria reveals that a significant proportion of early adopters of e-bikes are older individuals with lower levels of education and household income when compared to the overall population [34]. Therefore, in this study, we will explore

demographic factors to examine which ones influence the intention to use electric motorcycles.

3. METHODOLOGY

3.1 Questionnaire development

The questionnaire was developed to gather essential data for the study and structured into three distinct parts. The first part introduces the purpose of the research, objectives, and participant rights. The second part is a self-report instrument specifically designed to measure the gauge of constructs. These measures were designed based on reference to validated literature from previous studies. A 7-point Likert scale, with responses ranging from "strongly disagree" (1) to "strongly agree" (7), was employed in designing all measures for the latent variables, including perceived usefulness, perceived ease of use, and perceived risk. The last part of the questionnaire inquired about individual and demographic variables (e.g., age, gender, income).

The initial questionnaire draft underwent a comprehensive evaluation by five transport experts to assess the relevance of its measurement items. After meticulously addressing the concerns raised by the experts, the authors proceeded to implement the pilot survey with a sample of 30 students. Subsequently, the feedback, such as the clarity of language, question content, average completion time, and identification of any spelling errors, was carefully tackled. The final version, after undergoing refinements, was willing for the main survey.

3.2 Data collection and descriptive statistics of participants

The cross-section survey was conducted in Ho Chi Minh City and Da Nang City in 2022. In order to receive representative data, the data collection team employed a random sampling strategy, approaching individuals in diverse public settings such as supermarkets, malls, and hospitals. The team underscored the importance of adhering to existing data protection laws and assured participants that the collected information would solely be utilized for statistical and research purposes. This clarification was provided to participants before the commencement of the survey. To minimize the effect of some potential bias related to self-reported data, the importance of answering all the questions honestly was highlighted, along with the non-existence of wrong or right answers. Upon agreement to participate in the survey, individuals were handed a paper-based questionnaire, requested to complete it promptly. After receiving the completed questionnaires, each form underwent a thorough check for completeness, and respondents were prompted to address any unfinished items. Throughout the survey process, research assistants actively encouraged participants to seek clarification for any inquiries they might have. The research assistants remained readily available to explain any misunderstandings related to the questions, ensuring that participants could proceed with confidence and clarity. A total of 1.000 questionnaires were distributed, and over 900 responses were received. Following a meticulous review that involved eliminating responses with missing data or redundant answers across most questions, 751 questionnaires were deemed valid for analysis, with 380 from HCM and 371 from DN. Subsequently, we use Statistical Product and Service Solutions (SPSS) to input, manage, and analyze data.

Figure 2 compares the response characteristics of demographic variables, including gender, age, education level, marital status, occupation, and monthly income. The participants had a mean age of 34.78 years (SD = 14.13 years), with a relatively equal representation of females (52.5%) and males (47.5%). Marital status was evenly distributed between single (51%) and married (49%) individuals. Notably, 49.3% of participants had a university graduate-level

education, and the majority were engaged in full-time employment (48.7%). The highest percentage of participants reported a monthly income in the range of 5-10 million (37.3%).

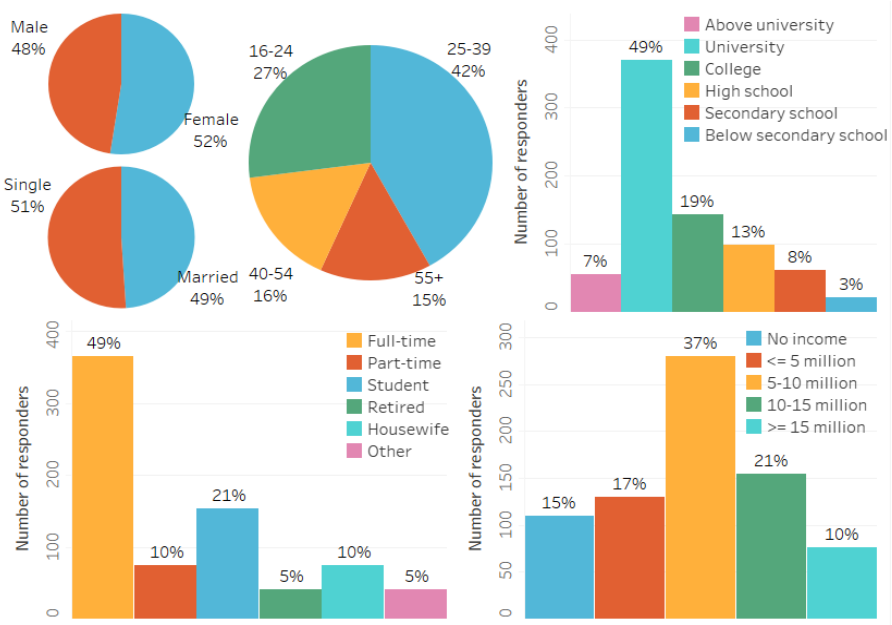


Figure 2. Survey respondent characteristics.

4. DATA ANALYSIS AND FINDINGS

4.1 First-order measurement model evaluation

Three criteria, including internal consistency reliability, convergent validity, and discriminant validity, were used to evaluate the reliability test of the first-order measurement model. The findings of Table 1 revealed that Cronbach's Alpha (CA) and Composite Reliability (CR) for all latent variables, ranging from 0.739 to 0.970, were higher than the recommended threshold of 0.7 [35], indicating that the internal reliability of the measurement scales was verified. Simultaneously, Convergent validity, evaluated through Factor loadings and Average Variance Extracted (AVE), indicated favorable results. The majority of factor loadings exceeded the cut-off value of 0.7 (Hair et al., 2010), and AVE values for all constructs were above the suggested point of 0.5 [35]. Thus, the data confirmed good convergence. Henseler, Ringle, Sarstedt [36] introduced a novel method for evaluating discriminant validity: the Heterotrait-Monotrait ratio of correlations (HTMT). The findings revealed that all constructs satisfied the criteria for discriminant validity, as evidenced by HTMT values below the recommended threshold of 0.85 (Table 2).

Table 1. First-order measurement model evaluation.

Constructs	Items	Loadings	CA	CR	AVE
Safety Risk (SAR)			0.875	0.934	0.877
	SAR1	0.894			
	SAR2	0.977			
Range Anxiety Risk (RAR)			0.832	0.889	0.729
	RAR1	0.736			
	RAR2	0.883			
	RAR3	0.930			
Explosion & Fire Risk (EFR)			0.867	0.937	0.882

	EFR1	0.947			
	EFR2	0.931			
Financial Risk (FIR)			0.864	0.899	0.750
	FIR1	0.787			
	FIR2	0.977			
	FIR3	0.822			
Time Risk (TIR)			0.739	0.822	0.609
	TIR1	0.780			
	TIR2	0.673			
	TIR3	0.874			
Performance Risk (PER)			0.740	0.879	0.785
	PER1	0.939			
	PER2	0.830			
Perceived Usefulness (PUS)			0.871	0.911	0.720
	PUS1	0.831			
	PUS2	0.859			
	PUS3	0.859			
	PUS4	0.844			
Perceived Ease of Use (PEU)			0.875	0.914	0.727
	PEU1	0.869			
	PEU2	0.873			
	PEU3	0.798			
	PEU4	0.869			
Adoption of Electric Motorcycles (ADO)			0.953	0.970	0.915
	ADO1	0.953			
	ADO2	0.957			
	ADO3	0.959			

Table 2. The heterotrait-monotrait ratio of correlations of the first-order factor model.

Constructs	ADO	EFR	FIR	PEU	PUS	PER	RAR	SAR	TIR
ADO									
EFR	0.136								
FIR	0.044	0.511							
PEU	0.327	0.031	0.072						
PUS	0.460	0.144	0.161	0.602					
PER	0.066	0.600	0.517	0.087	0.185				
RAR	0.074	0.450	0.424	0.286	0.133	0.400			
SAR	0.046	0.575	0.409	0.043	0.232	0.489	0.352		
TIR	0.123	0.562	0.844	0.149	0.219	0.565	0.482	0.490	

In summary, all measurement scales used in the proposed first-order measurement model achieved the requirement due to the above three criteria.

4.2 Second-order measurement model evaluation

Table 3 displays the second-order measurement model of the PRI variable. In this analysis, Time Risk (TIR) was excluded from the measurement model due to outer loadings being less than 0.6 [37]. After removing TIR, the results indicated an absence of multicollinearity among the five remaining components-SAR, RAR, EFR, PER, and FIR—as their Variance Inflation Factors were less than the proposed value of 5 (Table 4) [37], indicating that the proposed

second-order measurement model satisfied. Notably, the effect of EFR on PRI was the highest ($t = 13.430$; $p < 0.001$). This indicated that the road rider's concern was the risk of fire and explosion when using electric motorcycles.

Table 3. Second-order measurement model evaluation.

Second-order/ First-order constructs	AVE	VIF	Outer loadings	SD	t-value	p-value
Perceived Risk (PRI)	0.509					
Safety Risk (SAR)		1.402	0.647***	0.114	5.682	<0.001
Range Anxiety Risk (RAR)		1.266	0.668***	0.094	7.086	<0.001
Explosion & Fire Risk (EFR)		1.715	0.869***	0.065	13.430	<0.001
Performance Risk (PER)		1.410	0.676***	0.111	6.068	<0.001
Financial Risk (FIR)		1.432	0.685***	0.110	6.243	<0.001
Time Risk		-	-	-	-	-

4.3 Structural model results

Figure 3 presents the results of the direct effect through the path coefficients of the proposed structural model. Notably, the correlation between PEU and PUS emerged as the most substantial ($\beta = 0.536$). As detailed in Table 4, both PEU and PUS had positively significant direct correlations with ADO. Particularly, PUS had the most influential role ($\beta_{PUS \rightarrow ADO} = 4.06$, $t = 11.369$, $p < 0.001$). On the contrary, the direct effect of PRI on ADO was negatively significant ($\beta_{PRI \rightarrow ADO} = -0.192$, $t = 5.519$, $p < 0.001$).

Table 4. Direct, indirect, and total effect.

Path	Effect	Coefficient	SD	t-value	p-value
PEU → ADO	Direct effect	0.099***	0.035	2.856	0.004
	Indirect effect	0.217***	0.024	8.908	<0.001
	Total effect	0.316***	0.033	9.733	<0.001
PUS → ADO	Direct effect	0.406***	0.036	11.369	<0.001
	Indirect effect	-	-	-	-
	Total effect	0.406***	0.036	11.369	<0.01
PRI → ADO	Direct effect	-0.192***	0.035	5.519	<0.001
	Indirect effect	-	-	-	-
	Total effect	-0.192***	0.035	5.519	<0.001

Notes: ***p < 0.01, **p < 0.05, *p < 0.1, ns non significant

Moreover, no indirect effects of both PUS and PRI on ADO were exhibited in the structural equation model, making their direct effects equal to the total effect. The proposed structural model assessed the indirect effect of PEU on ADO via PUS. The result showed that its indirect effect was larger than the direct effect ($ß_{PEU \rightarrow ADO} = 0.217$, $t = 8.908$, $p < 0.001$). In the same result, the total effect of PUS on ADO was strongest. Finally, all paths were empirically supported with significance levels at $t = 2.57$ and $p = 0.01$.

4.4 Moderation effect

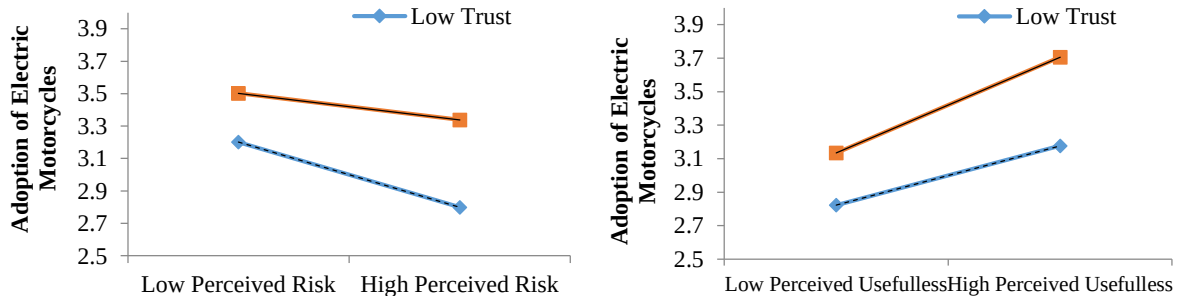
In this study, the model examined the moderating role of trust (TRU) in EMs and the influence of trust on the link between PEU, PUS, PRI, and ADO. The results reveal a significant

negative moderating impact of TRU on the correlation between PRI and ADO (β = -0.103, t = 2.760, p < 0.05), supporting hypothesis H7 (Table 5). Also, the relationship between PUS and ADO was positively significant by the moderating of TRU (β = 0.109, t = 2.843, p <0.05), supporting hypothesis H6. On the other hand, the positive relationship between PEU and ADO is insignificant, with a low level of TRU (p > 0.5).

To depict the interaction effect between PRI and ADO, and PUS and ADO at both high and low levels, a simple slope analysis was displayed. Specifically, the interaction plot in Figure 3a illustrates that the strength of the negative relationship between PRI and ADO decreases when TRU is higher (simple slope = -0.082) compared to when it is lower (simple slope = -0.201). On the contrary, Figure 3b depicts interaction reveals that a higher level of TRU (simple slope = 0.286) with the positive relationship between PUS and ADO is stronger in comparison to a lower level of TRU (simple slope = 0.177). Additionally, the outcomes indicated the impact sizes of moderation. The f2 values of 0.021 and 0.028 validate the presence of a moderate and large moderation effect of TRU on the relationships between PUS and ADO, and PRI and ADO, respectively.

Table 5. Results of direct and moderating effects of trust.

Path	Coefficient (ß)	*t*-value	*p*-value	f^2	Low trust		High trust	
					Slope	*p*-value	Slope	*p*-value
H_5: (PEU* TRU) → ADO	-0.103***	2.760	0.006	0.015	-0.017	0.704	-0.120	0.274
H_6: (PUS* TRU) → ADO	0.109***	2.843	0.004	0.021	0.177	0.000	0.286	0.009
*H_7: (PRI** TRU) → ADO	0.119***	3.320	0.001	0.028	-0.201	0.000	-0.082	0.454



a) PRI to ADO b) PUS to ADO

Figure 3. Moderating effect of trust.

4.5 Multigroup analysis

Table 6 shows the correlation between the two groups according to three characteristics of the participants, including gender (group 1 - Male and group 2 - Female), age (group 1 - Young and group 2 - Old), education (group 1 – Low education and group 2 – High education), Marital status (group 1 - Single and group 2 - Married), and monthly income (group 1 - Low-Middle and group 2 – High) through the path of the PEU, PUS, and PRI variables on the ADO. The difference between the two groups was defined based on the p-value of Henseler's approach. The results indicated that the relationship between PEU and ADO was significantly influenced by age, education, and marital status. Similarly, marital status and monthly income significantly influenced the relationship between PRI and ADO.

Table 6. Multigroup analysis results.

Group	Path	Coefficient Group 1	Coefficient Group 2	Coefficient Difference	*p*-value Difference (Two-Tailed)	Supported
Male (1) vs Female (2)	PEU → ADO	0.064^{ns}	0.102**	0.038	0.698	No/No
	PUS → ADO	0.436***	0.385***	0.051	0.237	No/No
	PRI → ADO	-0.182**	-0.217***	0.036	0.398	No/No
Young <30 (1) vs Old >=30 (2)	PEU → ADO	0.051^{ns}	0.161***	0.110	0.936*	***Yes/Yes***
	PUS → ADO	0.409***	0.380***	0.028	0.351	No/No
	PRI → ADO	-0.157^{ns}	-0.230***	0.072	0.312	No/No
Low education (1) vs High education (2)	PEU → ADO	0.169***	0.019^{ns}	0.150	0.000*	***Yes/Yes***
	PUS → ADO	0.407***	0.386***	0.022	0.616	No/No
	PRI → ADO	-0.284***	0.046^{ns}	0.330	0.980*	***Yes/Yes***
Single vs Married	PEU → ADO	-0.006^{ns}	0.222***	0.228	0.001*	***Yes/Yes***
	PUS → ADO	0.447^{ns}	0.342^{ns}	0.105	0.926	No/No
	PRI → ADO	-0.166^{ns}	-0.219***	0.053	0.590	No/No
Low-Middle income (1) vs High income (2)	PEU → ADO	0.090**	0.074^{ns}	0.017	0.419	No/No
	PUS → ADO	0.418***	0.383***	0.035	0.318	No/No
	PRI → ADO	-0.222***	0.047^{ns}	0.269	0.990*	***Yes/Yes***

Note: For coefficient: ** significant at 95%, *** significant at 99%; For coefficient difference: * significant at 90%
Low-Middle income: <10 million VND/month; High income >= 10 million VND/month

5. DISCUSSION

This study aims to investigate potential customers' intention to use electric motorbikes (EMs) in Vietnam (a low- and middle-income country), to enrich existing knowledge about EMs. The research is grounded in the Perceived Risk theory (PRT) and Technology Acceptance theory (TAM). It evaluates the adoption intention of EMs based on three factors: perceived usefulness, perceived ease of use, and perceived risk. Furthermore, the examination of perceived risk delves into various dimensions. Additionally, the study introduces customer trust in EMs as a moderating factor. As a result, the findings contribute to both theoretical understanding and practical implications in the field of EMs. The subsequent paragraphs will discuss significant contributions from both theoretical and practical perspectives.

Firstly, this study contributes to the existing knowledge of EMs by conducting a detailed examination of perceived risk. Building upon perceived risk research studies investigating perceived risk, including those conducted by Nguyen-Phuoc, et al. [38], our findings align with the previous research that perceived risk negatively influences intention towards EMs. Particularly, this research explicitly identifies components shaping perceived risk, delineating six components: safety risk, range anxiety risk, explosion and fire risk, performance risk, financial risk, and time risk. Relating to the findings of the second-order measurement model, the results indicate that explosion and fire risk exert the most significant impact, while time risk does not affect overall perceived risk. Safety risk, range anxiety risk, performance risk, and financial risk exhibit similar influence levels, underscoring customers' substantial apprehension regarding the potential for fire and explosion-associated EMs. Consequently, we propose perceived risk prioritizing the development of targeted communication campaigns to improve customers' perception, particularly focusing on explosion and fire risk, and emphasizing safety measures in EMs. This approach aims to enhance the safety image of EMs in customer

awareness. Additionally, our study underscores the necessity of providing solutions related to manufacturers' risk commitment to the product, warranty, and repair measures, emphasizing the shared responsibility of both manufacturers and users in the preservation and maintenance of EMs to prevent adverse situations. Beyond communication measures, our findings advocate for manufacturers to enhance the quality of EMs to minimize the risk of explosion and fire to the lowest possible level. This comprehensive analysis contributes to advancing the understanding of perceived risk in the EM sector while also highlighting the positive impact of interventions on perceived risk.

Secondly, the findings reveal that perceived usefulness exerts the highest positive influence on intention, followed by perceived ease of use and perceived risk. These correlations align with previous studies conducted by Nguyen-Phuoc, et al. [38]. However, the impact of perceived usefulness on intention is notably much stronger than reported by Nguyen-Phuoc, et al. [38] and closely aligns with findings from [28]. This underscores that customers will use EMs when they perceive EMs as useful. Additionally, the results confirm the positive correlation between perceived ease of use and the formation of perceived usefulness, as demonstrated in earlier studies [28]. This implies that perceived usefulness is influenced by their perceived ease of use, suggesting that the likelihood of EM usage increases when customers feel comfortable using them. This outcome reinforces the predictive capability of the TAM in understanding new technology adoption behavior. Furthermore, this research contributes to the current understanding of EMs by integrating a model that combines PRT and TAM. As a practical implication, managers and manufacturers can understand the perceived risk among users. This involves communication policies to enhance users' comprehension of the benefits of EMs. Subsequently, facilitating hands-on experiences for customers is crucial for a better understanding of EMs functionality. Perceived ease of use is contingent on actual experiences, necessitating educational sessions and product trial opportunities. Lastly, communication campaigns are vital to mitigate perceived risk toward EMs.

The third contribution of this research lies in elucidating the moderating role of trust towards EMs. Diverging from previous studies conducted by Choi, Ji [28], this study uniquely positions customer trust not as a primary factor but as a moderating factor. Aligned with previous studies in other domains such as e-wallets and e-commerce [39], trust has been acknowledged as a moderating factor; this research reveals that trust positively moderates the relationships between perceived risk and adoption intention as well as perceived usefulness and adoption intention. High-trusted customers, cognizant of the numerous benefits of EMs, exhibit a greater likelihood of usage compared to their low-trusted customers. Correspondingly, similar to perceived risk, customers lacking confidence in EMs are prone to discontinuing their usage when faced with heightened perceived risk. This underscores that customers with low trust are less inclined to adopt EMs compared to those with high trust, aligning with the findings of Senali, et al. [39]. The primary significance of this result lies in highlighting the moderating role of trust in shaping customer behavior. Recognizing the moderating influence of customer trust offers a pragmatic avenue for fostering and sustaining trust in EMs, thereby influencing future adoption rates. This study suggests that manufacturers and managers should engage in brand promotion activities, emphasizing the functions and missions associated with EMs to leverage the role of trust. Furthermore, manufacturers must prioritize delivering top-notch products, services, and experiences. Additionally, clear commitments between sellers and buyers become crucial, especially when significant issues arise with EMs.

In addition to its theoretical and practical contributions, this research has several limitations. Firstly, it is important to acknowledge the contextual specificity of the study, which

is situated in Vietnam, where EM technology is not widely adopted. Future investigations could extend their scope to a timeframe when EM technology has gained more popularity in Vietnam. Secondly, it would be beneficial for subsequent studies to adopt a more expansive approach, conducting simultaneous research on a broader scale to obtain multidimensional perspectives on customer behavior. For instance, data collection could be carried out concurrently in major cities like Hanoi, Da Nang, and Ho Chi Minh City, and comparative analyses could include countries with a significant proportion of motorcycles in their traffic flow, such as Malaysia, Thailand, Laos, and Cambodia. Thirdly, the current research model has certain limitations, and future studies could explore opportunities for improvement. Combining different theories, such as Behavioral Reasoning Theory (BRT), Unified Theory of Acceptance and Use of Technology (UTAUT) could enhance the accuracy in predicting adoption behavior.

6. CONCLUSION

This study examines the factors affecting the adoption of electric motorcycles by traffic users in two big cities in Vietnam. An integrated structural model between first-order and second-order constructs is developed based on the TAM model. The findings show that the risk of fire and explosion when using electric motorcycles is the biggest concern of road users. In terms of the total effect, perceived ease of use has the most significant and positive influence on the behavior of using electric motorcycles. Regarding the moderating effect of demographic variables, age differences influence the correlation between PEU and ADO. Meanwhile, monthly income affects the correlation between PRI and ADO. These findings are very useful for electric motorbike manufacturers and businesses in Vietnam in proposing solutions to improve the quality of electric motorbikes, aiming to increase the adoption of EMs in the future.

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