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Investigation of Influential Factors of Intention to Adopt Electric Vehicles for Motorcyclists in Vietnam

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Abstract: (1) Background and aims: The exploration of the intention to adopt electric vehicles has been intensively studied in developed countries where passenger cars are the most common private motorized vehicle. However, the same is not true for motorcycle-dependent countries such as Vietnam. This study aimed to advance our understanding of the determinants of motorcyclists' intention to use electric vehicles (i.e., electric passenger cars) in settings where the motorcycle is the dominant mode. (2) Data and methods: The partial least squares structural equation modeling (PLS-SEM) and the data from 330 motorcycle owners in Hanoi, Vietnam, were utilized to empirically test a research framework formulated based on the push–pull–mooring migration model. (3) Results: The results indicated that the push factor was formulated by safety concerns and environmental concerns while the pull factor was established by perceived usefulness, perceived ease of use, and financial incentive policy. Both the push factor and the pull factor significantly contributed to the adoption intention but the effect of the latter was stronger. Knowledge did not affect the intention; however, it moderated the link between the pull factor and the intention. For the respondents with a higher level of knowledge, the positive impact of the pull factor on the intention was lower (compared to those with a lower level of knowledge). (4) Conclusions: Based on the findings of the associated factors, policy implications were suggested to increase the prevalence of electric vehicles. Although the theoretical and practical contributions of this study may be significant to the literature regarding developing countries, more research is needed to validate and extend them.

Keywords: electric vehicles; motorcycles; electric passenger cars; Vietnam; pull–pull–mooring; knowledge

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1. Introduction

Vietnam is a typical motorcycle-dependent country in the Global South [1–3] with over 80% of the total daily trips performed by this motorized two-wheeled vehicle. In Vietnamese megacities, such as the capital Hanoi, the number of motorcycles has kept rising at a pace of over 9% per year during the period from 2010 to 2019 [4]. The steady growth in motorcycle ownership is attributable to economic, utilitarian, and emotional factors [5–8]. To be specific, the purchasing and operational cost (for fuel, maintenance, insurance, and parking) of a motorcycle is reasonable for Vietnamese citizens [5]. A new motorcycles costs from USD 900 to USD 2250, while the average annual income of a Vietnamese person is approximately USD 3300 [9]. In addition, people are offered many types of motorcycles at different prices by famous enterprises such as Honda, Yamaha, Piaggio, and SYM. Additionally, buying an old motorcycle is a favorite choice for those with a limited budget [10]. Besides the financial advantages, the functional merits of the motorcycle are notable. Learning to operate a motorcycle is straightforward for most people [7]. More importantly, it is easy to navigate a motorcycle that is able to accelerate faster than passenger cars in urban conditions. This point is perceived as highly valued during rush hours when motorcycles can weave in between stationary buses and passenger cars to arrive at their destinations more quickly [8]. The motorcycle is also suitable for

both long-distance trips and short trips for recreational or working purposes within cities. Unlike drivers, motorcyclists often face little difficulty in finding parking space [11]. Riding a motorcycle can bring about a strong sense of community because of the large motorcyclist population in Vietnam [5]. Moreover, travelling by motorcycle can be pleasurable since it enables one to enjoy the open space. However, the boom in motorcycles has resulted in severe environmental issues, i.e., noise and air pollution [12,13]. Vietnam is ranked in the top 30 most polluted countries while Hanoi was the most polluted city in Vietnam in 2022 [14]. The environmental challenges are expected to increase because of the rapid proliferation of passenger cars [15]. Hanoi had 328,000 registered passenger cars in 2019 while the figure for 2015 was only 226,000. The 2015–2019 period witnessed an average annual growth rate in passenger cars of approximately 110% [4]. According to the latest statistics from the Department of Hanoi Transportation, the capital had over 1 million passenger cars (including commercial vehicles such as taxis and (electronic) contract-based ones) in 2023, from which we can determine that, on average, one in every eight persons has a passenger car [16]. To lessen the disastrous impacts of the use of private motorized vehicles, the government made some attempts to develop a subsidized public transport system with the operation of over 110 conventional bus routes, 10 e-bus routes, 1 BRT corridor, and 1 sky-train line. Unfortunately, public transport systems have failed to attract people away from private motorized vehicles [17–19]. Consequently, transport authorities and planners have emphasized the use of electric private vehicles. Until 2022, Vietnam had approximately 4000 electric passenger cars and is projected to have 1 million units by 2028. The introduction of new electric passenger car types by VinFast (e.g., VF e34, VF 8) is expected to considerably promote the prevalence of electric passenger cars in 2023 and later [20]. In some cities and provinces (e.g., Lamdong and Hanoi), electric passenger cars have been utilized as taxis since March 2023. Recently, the charging system has been provided at a larger scale in department stores in Hanoi and Ho Chi Minh City. Some plans to equip charging points at fuel stations have been proposed but no acceptances have been made to date. To encourage the use of electric passenger cars (instead of ordinary ones), an extensive understanding of the factors associated with the acceptance of electric passenger car especially critical. Moreover, where the motorcycle is the dominant mode (e.g., Vietnam, Thailand, Indonesia, Malaysia, the Philippines, and Taiwan), most future owners of electric passenger cars are estimated to be current motorcyclists [21,22]. Accordingly, knowledge of what factors determine motorcyclists' intention to use electric passenger cars is needed in order to establish the sustainable development of urban transportation [23].

The exploration of the intention to adopt electric vehicles has been intensively studied in developed countries where passenger cars are the most common private motorized vehicle. However, the same is not true for motorcycle-dependent countries [24–26]. This study aimed to advance our understanding of the determinants of motorcyclists' intention to use electric passenger cars (hereafter referred to as 'electric vehicles' or 'EVs') by using the partial least squares structural equation modeling (PLS-SEM) and the data from 330 motorcycle owners in Hanoi, Vietnam, to empirically test a research framework formulated based on the push–pull–mooring migration model.

The current research's contributions to the literature are three-fold. This is among the first investigations of the factors associated with the intention to adopt EVs in motorcycle-dependent countries. Second, this study proposes a new conceptual framework of modeling the intention to accept EVs, which is an extension of the push–pull–mooring model. Third, the effects of influencing factors and policy implications proposed in this study could be informative for a number of countries with similar transportation conditions in Asia.

This paper continues with a review of studies on the intention to adopt EVs and an establishment of the research model. Then, data collection and analytical methods are presented in Section 3. Subsequently, Section 4 provides the discussions of the results. Finally, Section 5 indicates theoretical and practical contributions together with future research directions.

2. Literature Review and Foundation of the Research Model

2.1. Earlier Research on EVs' Adoption Intention

EVs—including battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), and hybrid electric vehicles (HEVs) [24,26]—have been extensively researched in the last decade as a result of the urgent need to mitigate the disastrous consequences of emissions from road transportation. Existing studies have covered a range of dimensions of EVs, such as charging systems, promotion incentives, safety, and environmental and social impacts [27–32]. For example, a denser network of charging stations—particularly free ones whose energy is generated by photovoltaic panels or wind turbines—means a higher prevalence of EVs [24]. However, as a new technological product, the success or failure of the EV market largely depends on people's acceptance, which can be measured through the adoption intention. Therefore, increasing scientific efforts have been invested into investigating the drivers of and impediments to the intention to use EVs, mirrored by the publication of review papers in the journals of *Transportation*, *Sustainability*, and *Energy* [24,26,33–35]. However, the literature on EV acceptance has been limited in terms of methods and geographical coverage.

According to the in-depth synthesis by Singh et al. [33], the adoption intention is determined by the four factor groups, including (1) the demographics of the individual and the household; (2) situational factors such as environmental and technological situations; (3) contextual factors such as governmental policies; and (4) psychological factors such as attitudes, perceived risk, and emotions. Among the four categories of predictors, the fourth group is the most important, and is considered in traditional behavioral theories, including the theory of planned behavior, diffusion innovation, normative theories, and the theory of reasoned action. Nevertheless, in order to achieve more knowledge on usage intention, the adoption of other well-established theories (e.g., the push–pull–mooring migration model) is critical [35].

The development of the literature on EV adoption is geographically in line with the major areas of this mode's growth. The vast majority of prior analyses have been conducted in developed countries, particularly in Europe, Canada, the US, and several Asian countries [24,26,33–36]. However, little research has focused on developing contexts. The study by Adnan et al. [37] analyzed the purchase intention of EVs based on the responses of 391 Malaysian respondents and an extension of the theory of planned behavior. Another study set in Malaysia [38] predicted the adoption intention of generation Y using a conceptual framework formed from the theory of planned behavior and the technology acceptance model. A recent work conducted in India explored the acceptance of EVs by utilizing the technology acceptance model and the social comparison theory [39]. Obviously, evidence from Malaysia and India has been insufficient to generalize to a large number of emerging countries. As such, more findings from the Global South are desirable.

2.2. Push, Pull, and Mooring Constructs

The push–pull–mooring (PPM) migration model was initially developed for research on human migration to account for why people change their residential locations to another over a particular period [40,41]. Theoretically, a PPM structure encompasses three factor groups (i.e., push factors, pull factors, and mooring factors). Push factors involve the elements that drive a person away from an original location while pull factors involve the elements that attract a migrant towards a specific place. Mooring factors refer to the supplementary components that either facilitate or hinder decision making among migration owing to individual, social, or environmental factors [41,42]. The PPM model has been deployed to predict the intention of switching or discontinuance in a range of sectors, such as commercial information technology services, social media, marketing, e-commerce, and consumer behaviors [42–49].

Several previous studies have looked at the intentions of employing green transportation from the perspective of PPM [50–52]. Notwithstanding, to the best of our knowledge, there has not been any research on the antecedents of the intention to shift from motorcycles

to EVs in a developing country. The use of the PPM framework is appropriate for this study's context because it allows one to simultaneously consider both the disadvantages of the motorcycle (current mode) and the advantages of the EV (future mode).

2.2.1. Push Factors

Environmental Concerns

The increase in significant concerns about pollution, waste disposal, climate change, and the greenhouse effect has pushed the practice of environmental protection at different levels (i.e., government, enterprises, and individuals) with the aim of forming a balance between environmental and human needs [53]. Actually, environmental challenges have become one among the most important social issues of the current time [54]. Therefore, the concept of environmental concerns has been increasingly used to predict the abandoning of polluting behaviors and the adoption of green alternatives [55–58]. Specifically, environmental concerns in this study refer to the public awareness and consideration of environmental problems, particularly in relation to the use of conventional motorcycles [37,59]. Many studies have demonstrated that environmental concerns have a significant positive association with the intention of purchasing new energy vehicles, such as autonomous electric vehicles or EVs [37,60,61]. In a motorcycle-dependent country, the motorcycle is expected to be the main source of emissions. Therefore, environmental concerns related to this mode may push riders away from it to shift to an electric alternative [53].

Safety Concerns

These are formulated based on the consideration and awareness of the danger and risks involved in using certain modes of transportation, such as the motorcycle [62,63]. Concrete evidence has suggested that concerns about traffic safety are a (negative) predictor of mode choices [64–66]. A study set in the US found that safety concerns inhibit public inclination towards shared autonomous vehicles [62]. A research based in Vietnam reported that, due to the fear of a collision risk, parents do not permit their children to ride a motorcycle [7]. It is important to note that the motorcycle is notoriously risky with fatality rates being 20–30 times higher than those for passenger car users per traveled distance [67]. Therefore, the current study assumes that safety concerns regarding motorcycle usage lead motorcyclists to shift to another move of transportation, such as EVs.

2.2.2. Pull Factors

Perceived Usefulness

Perceived usefulness is concerned with the utilitarian benefits of EVs that motorcyclists can achieve if they shift to this mode. Specifically, the construct is conceptualized as the extent to which a motorcyclist believes that employing an EV can improve their professional commitments and meet their travel demand [68]. Perceived usefulness, which is a core construct in the technology acceptance model, has been consistently found to be a strong facilitator of the adoption of environmentally friendly transportation modes [65,69–71]. However, several studies have also presented the insignificant impacts of perceived usefulness on the intention to use electric vehicles [38].

Perceived Ease of Use

Similarly to perceived usefulness, the perceived ease of use is a main construct in the technology acceptance model. It refers to the perception of EVs being free from physical and mental efforts [68,72]. The perceive ease of use has been hypothesized and demonstrated to exert positive direct effects on behavioral intention [73]. In travel behavior analysis, the perceived ease of use usually has no direct effects on the behavioral intention to use commercial services such as ride-hailing, possibly because accessing and using such services is generally not complex thanks to the support of technological advancements in booking and paying. However, when people have to select a mode and navigate it by

themselves, they usually pay more attention to how to operate it [7]. As such, the intention to adopt EVs is posited to be facilitated by the perceived ease of use.

Financial Incentive Policy

One of the largest obstacles to purchasing EVs consists in their high prices compared to those of conventional gasoline vehicles [74,75]. Although the operational price of electric vehicles can be considered one of their advantages during periods of energy crisis when the cost of gasoline is significantly increased, the higher purchasing cost and the inconsistent strategies of battery hiring or replacement prevent the acceptance of electric vehicles. In a survey conducted in the US, more than half of the participants indicated the purchase price as a prime impediment [76]. To lessen the purchase price and thus promote the adoption of electric vehicles, issuing financial incentive policies such as purchasing subsidies have been implemented and proved to be effective in many parts of the world [29,30]. A number of prior studies have analyzed the influences of financial incentive policies on EVs sales and adoption [77,78]. Evidence from the Netherlands recommends that financial support is useful for attracting consumers [79]. Another international study based on data from 14 regions reported a positive association between incentive policies and sales [80]. Accordingly, the intention to adopt EVs for motorcyclists is expected to be boosted by a financial incentive policy.

2.2.3. Mooring Factors

Knowledge

This can be defined as the degree to which a motorcyclist technically understands EVs, which can be measured through how much they believe that they know about this mode [81]. Kaplan emphasizes that knowledge plays a critical role in helping customers make decisions [82]. Much earlier research showed that a person's knowledge of a green product significantly and positively affects their buying intentions towards the product [83,84]. Interestingly, previous studies have suggested that, in Vietnam, people with less knowledge are a hindrance to sustainable consumption [85]. In fact, technical knowledge of EVs such as the range, battery capacity, charging system, and duration, varies across vehicle types and is also limited in developed countries [26,86]. Krause et al. [87], based on an analysis of 21 US cities, stressed that about two-thirds of over 2300 respondents gave the wrong answers to basic questions on electric vehicles and over-look the advantages of this mode. Due to the failure of having a sound understanding of the characteristics of EVs, people tend to over-estimate their shortcomings and over-estimate their merits, leading to the deterioration of the adoption intention. Additionally, the lack of knowledge may influence personal beliefs, such as the perceived ease of use or perceived usefulness; hence, knowledge may have moderating effects on the links between antecedents and behavioral intentions [88].

2.3. Research Hypotheses

The current research applies the method of [89,90], wherein the push and pull factors are formulated as second-order constructs by (first-order) sub-constructs. Specifically, the push factor is formatively created by environmental concerns and safety concerns; meanwhile, the pull factor is formatively formed by the financial incentive policy, perceived ease of use, and perceived usefulness. The application of a high-order research model has received more attention in recent years as it can generate an abstract model with more robust findings in terms of statistics. This approach enables one to better measure the overall factor (i.e., the second-order construct) that is directly measured by its sub-construct (rather than transferring the effects of sub-factors to the target variable (i.e., behavioral intention) in a one-order model) [91].

Based on the aforementioned discussions on the considered sub-factors (Section 2.2) and the relationships among the push, pull, and mooring factors in previous studies [51,89,90], five hypotheses are suggested (Figure 1) as follows:

H1. *The push factor facilitates the intention to adopt EVs.*

H2. *The pull factor facilitates the intention to adopt EVs.*

H3a. *The mooring factor facilitates the intention to adopt EVs.*

H3b. *The mooring factor moderates the effect of the push factor on the intention to adopt EVs.*

H3c. *The mooring factor moderates the effect of the pull factor on the intention to adopt EVs.*

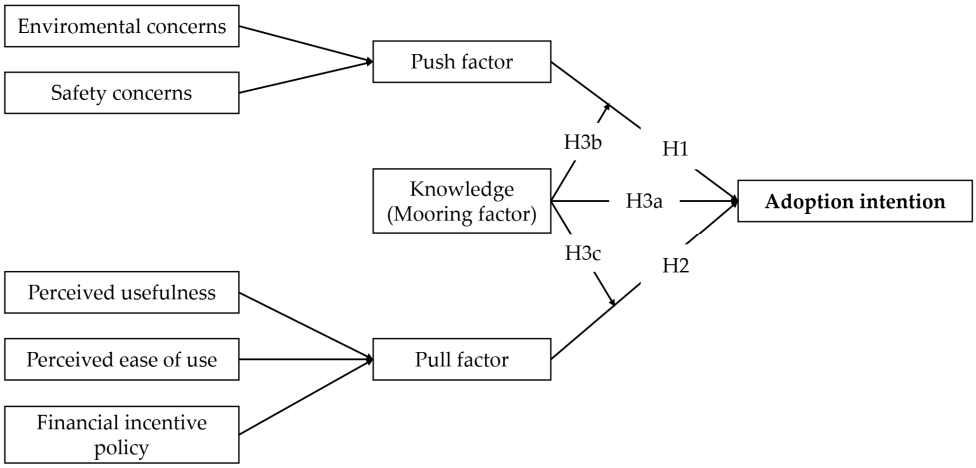

Figure 1. Proposed research framework adapted from the PPM model.

3. Data and Method

3.1. Questionnaire and Data Collection

To gather the data, a questionnaire was designed based on the proposed research framework. It included three sections. The first is a cover letter, which declares the research scope and objectives. It emphasizes that only the current motorcyclists should continue the survey. The second asks for the basic demographics of the respondents, including gender, age, income, and residential location. The third comprises a series of attitudinal statements adopted to measure the latent constructs of the theoretical framework. The responses to the items were based on a 5-point Likert scale ranging from "strongly disagree" to "strongly agree" (see Table 1). The questionnaire was initially prepared in English before being converted into Vietnamese. Due to potential inaccuracies arising the translation process, the Vietnamese version was reviewed by three transportation experts whose feedback was taken into consideration to improve the questionnaire. Subsequently, the questionnaire was utilized to undertake some pilot surveys with five motorcyclists in Hanoi before being revised to adopt the final form used for the large-scale survey.

Table 1. Measurement items.

Code	Constructs/Indicators	Supporting Studies
PU	Perceived usefulness	[92,93]
PU_1	I can easily reach common destinations by EV.	
PU_2	With an EV, I can save time and reduce fatigue due to travelling (compared to a motorcycle)	
PU_3	An EV helps me to be less subject to the fluctuations of energy price	
PU_4	An EV's characteristics are useful for my everyday mobility	
PEU	Perceived ease of use	[92,93]
PEU_1	Learning how to ride an EV is not a difficult task	
PEU_2	It is easy for me to become skilful with an EV	
PEU_3	For me, the functionality and usage of an EV are simple	
FIP	Financial incentive policy	[77]
FIP_1	From my point of view, the subsidy policies for EV in Vietnam is sufficient	
FIP_2	From my point of view, the subsidy policies for EV in Vietnam is durable	
FIP_3	From my point of view, subsidy policies are important when adopting an EV	

Table 1. *Cont.*

Code	Constructs/Indicators	Supporting Studies
EC	Environmental concerns	[37]
EC_1	The heavy use of motorcycles results in air and noise pollution	
EC_2	I think environmental problems are incresingly serious in recent years	
EC_3	I think people should change their behaviours to lessen climate change and protect our ecology	
SC	Safety concerns	[10,62]
SC_1	Motorcycles have too few functions and equipment to protect motorcyclists' health when a crash occurs	
SC_2	Lack of adherence to the road rules is common among motorcyclists, leading to a high risk of traffic crash	
SC_3	Generally, the risk of collisions for motorcyclists is high in Hanoi	
SC_4	Generally, the risk of collisions for motorcyclists in Hanoi is increasing	
K	Knowledge	[77]
K_1	I am accustomed to the performance of an EV, such as charging time and driving range	
K_2	I am aware of the purchase and usage cost of an EV	
K_3	I am aware of advantages of an EV over a conventional one	
AI	Adoption intention	[77,90]
AI_1	I am willing to use an EV	
AI_2	Soon I will consider buying an EV	
AI_3	I would like to recommend my friends to buy an EV	

Data collection was carried out in Hanoi from 6 to 12 March 2023. To gain a sample with a balanced distribution in terms of gender and residential locations, the surveys were undertaken in both urban and non-urban districts. During each survey, only one surveyor worked in one district and tried to obtain the equal number of men and women respondents. Face-to-face interviews were applied because this method enabled the staff to quickly approach potential respondents and support them during the survey procedure. To increase the response rate and survey quality, VND 20,000 (approximately USD 1) were given to each participant as compensation for contributing their time.

After one week of the survey, we collected 345 responses. However, 15 were removed due to being unreliable and lacking the answers to some questions. The removal led to an eligible sample comprising 330 responses.

The breakdown of the sample shows that the sample was nearly balanced in terms of gender (51% of the respondents were men) and residential location (52% of the respondents living in urban areas). More respondents (56%) were younger than 30 years old and 61% of the participants came from households with a monthly income of less than VND 15 million VND (USD 680).

3.2. Method

The structural equation modeling (SEM) technique is widely used to empirically investigate theoretical frameworks that are based on traditional theories and include various complex relationships, such as the PPM model. Two types of SEM utilized in parallel are covariance-based SEM (CB-SEM) and partial least squares SEM (PLS-SEM). The former is more common and even frequently indicated (misleadingly) as the only representation of SEM in many previous studies [94,95]. The latter is an emerging alternative to the former in various fields, such as marketing, e-commerce, education, safety research, and transportation [96–101]. The debate on the pros and cons of the two methods is ongoing and contested [95,102].

The current research utilized PLS-SEM to explore the proposed PPM-based research model because many recent travel behavior analyses deployed this method [37,98,100,103]. PLS-SEM was found to provide robust and consistent estimates of the inter-relationships among the constructs in complex theoretical frameworks [104,105], even for the estimation of second-order constructs [99,106,107]. The approach is recommended when it comes to testing the extensions of well-established theories [108]. Moreover, it does not set strict requirements for the sample, such as the size and the normal distribution [96].

The professional software SmartPLS version 3.3.5 was employed to run PLS-SEM. According to [108], the results of PLS-SEM are subject to two evaluation steps: (1) the

evaluation of the measurement models; and (2) the evaluation of a structural model. In the next section, evaluation results are provided and discussed.

4. Results and Discussions

4.1. Evaluation of First-Order Measurement Models

The measurement models were assessed through three criteria, as follows.

4.1.1. Internal Consistency Reliability

The reliability was measured with Cronbach's alpha (CA) values and the composite reliability (CR) values with the minimum levels of 0.7 [109]. The results shown in Table 2 indicate that all values of CA and CR for all constructs were over 0.7. As such, the criterion of the internal consistency reliability was satisfied.

Table 2. Assessment of measurement models.

Construct	Factor Loading	Cronbach Alpha	Composite Reliability	Average Variance Extracted
Dimension of pull factor: financial incentive policy				
FIP_1	0.891			
FIP_2	0.845	0.799	0.882	0.715
FIP_3	0.797			
Dimension of pull factor: perceived ease of use				
PEU_1	0.875			
PEU_2	0.832	0.795	0.880	0.713
PEU_3	0.826			
Dimension of pull factor: perceived usefulness				
PU_1	0.731			
PU_2	0.874	0.785	0.861	0.610
PU_3	0.790			
PU_4	0.719			
Dimension of push factor: environmental concerns				
EC_1	0.883			
EC_2	0.887	0.873	0.922	0.797
EC_3	0.909			
Dimension of push factor: safety concerns				
SC_1	0.893			
SC_2	0.893	0.891	0.925	0.755
SC_3	0.844			
SC_4	0.843			
Knowledge				
K_1	0.898			
K_2	0.874	0.862	0.916	0.784
K_3	0.884			
Adoption intention				
AI_1	0.921			
AI_2	0.899	0.891	0.932	0.821
AI_3	0.898			

4.1.2. Convergent Validity

Convergent validity was assessed through factor loadings and the average variance extracted (AVE) of indicators. Hair et al. [108] recommended the thresholds of 0.708 for factor loadings and 0.5 for AVE. All of the estimated values of AVE and factor loadings fell in the acceptable ranges; thus, the criterion of the convergent validity was met.

4.1.3. Discriminant Validity

Discriminant validity was evaluated through the heterotrait–monotrait (HTMT) criterion [108]. Specifically, the values of HTMT should not be over 0.85. Since all of the

estimated HTMT values are lower than the benchmark value (Table 3), discriminant validity was confirmed.

Table 3. The result of checking the HTMT criterion.

	Adoption Intention	Environmental Concerns	Financial Incentive Policy	Knowledge	Perceived Ease of Use	Perceived Usefulness	Safety Concerns
Adoption intention							
Environmental concerns	0.684						
Financial incentive policy	0.556	0.499					
Knowledge	0.404	0.297	0.317				
Perceived ease of use	0.534	0.317	0.584	0.162			
Perceived usefulness	0.496	0.37	0.805	0.357	0.663		
Safety concerns	0.642	0.848	0.591	0.343	0.339	0.414	

4.2. Evaluation of Second-Order Measurement Models

The satisfactory results of evaluating the first-order measurement models enabled the evaluation of the second-order measurement models. In the current study, there were the measurement models wherein (1) the push factor was formatively formed by environmental concerns and safety concerns; and (2) pull factors were formatively formed by perceived usefulness, perceived ease of use, and financial incentive policy. The multi-collinearity risk was insignificant because the values of the variance inflation factor (VIF) for all dimensions were lower than 3 [96]. As can be seen in Table 4, the weights of all dimensions were statistically significant (i.e., $p < 0.05$) and sufficiently larger (i.e., weight > 0.1) [110]. The strongest contributor to the push factor was that of safety concerns while the counterpart to the pull factor was perceived usefulness.

Table 4. Evaluation of second-order measurement model.

Second-Order Constructs	Outer Weights	Standard Deviation	*p*-Value	VIF
Dimensions of pull factors				
Financial incentive policy	0.386 **	0.004	0.005	2.187
Perceived ease of use	0.205 *	0.011	0.014	1.417
Perceived usefulness	0.451 ***	0.000	0.000	2.383
Dimensions of push factors				
Environmental concerns	0.461 ***	0.006	0.000	2.329
Safety concerns	0.582 ***	0.007	0.000	2.529

Note: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

4.3. Evaluation of Structural Model

4.3.1. Evaluation of Predictive Capacity and Model Fit

The predictive capacity of the structural model was assessed through the coefficient of determination (R^2) and the cross-validated redundancy measure (Q^2), which was estimated by the blindfolding procedure [96]. The R^2 and Q^2 values of adoption intention were higher than 0—the cut-off value. In more detail, the R^2 of 0.362 was considered moderate and the Q^2 of 0.286 was considered a medium predictive ability [96].

The model fit was measured through the normed fit index (NFI) and standardized root mean square residual (SRMR). The results suggest that the NFI value of 0.895 was higher than the minimum threshold of 0.8, while the SRMR value of 0.045 was lower than the maximum cut-off of 0.08 [108,111]. Accordingly, the structural model fitted the data.

4.3.2. Hypothesis Testing

Table 5 and Figure 2 indicate the results of path analysis. Both the push factor ($\beta = 0.200$) and the pull factor ($\beta = 0.255$) positively affect the adoption intention with the impact of the former being smaller, implying the validation of H1 and H2. Hypothesis H3a was not accepted since knowledge was found to insignificantly facilitate the adoption

intention. The results also show that knowledge did not moderate the effect of the push factor on the adoption intention, whereas it negatively moderated the impact of the pull factor on the adoption intention. As such, for the respondents with a higher level of knowledge, the positive impact of the pull factor on the intention was lower (compared to those with a lower level of knowledge) (Figure 3).

Table 5. The results of hypothesis testing.

Path	β	SD	*p*-Value	Hypothesis	Decision
Push factor → adoption intention	0.200 **	0.070	0.002	H2	Accept
Pull factor → adoption intention	0.255 ***	0.052	0.000	H1	Accept
Knowledge → adoption intention	0.054	0.064	0.285	H3a	Reject
Push factor × knowledge → adoption intention	0.046	0.054	0.386	H3b	Reject
Pull factor × knowledge → adoption intention	−0.127 *	0.053	0.019	H3c	Accept

Note: SD—standard deviation; *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

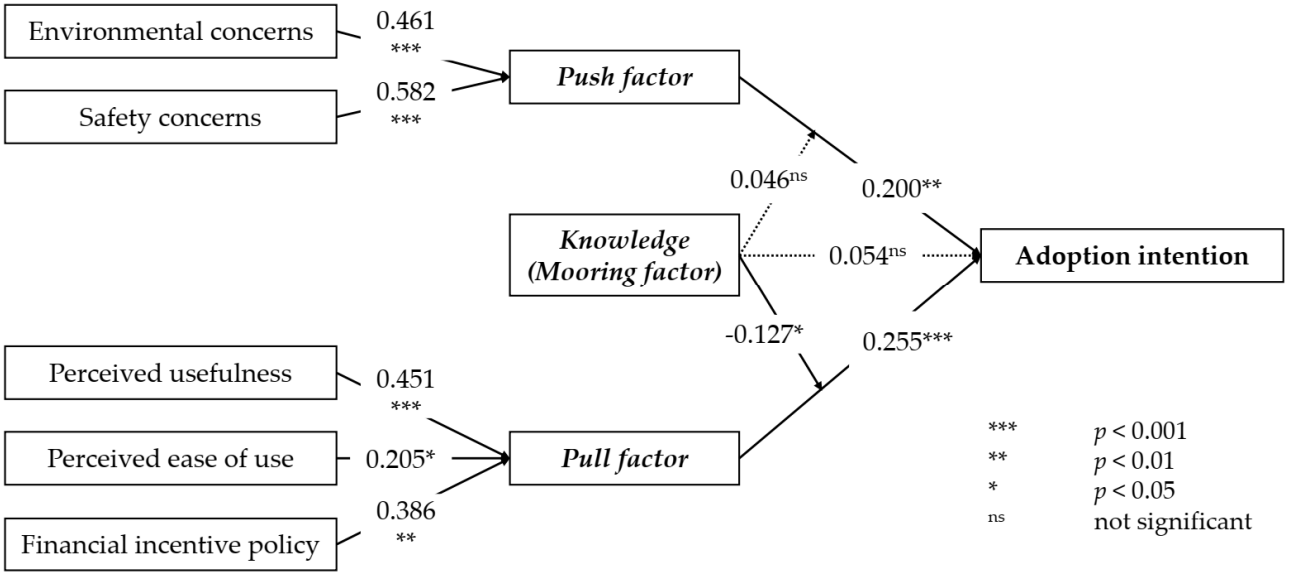

Figure 2. Graphical results of the effects.

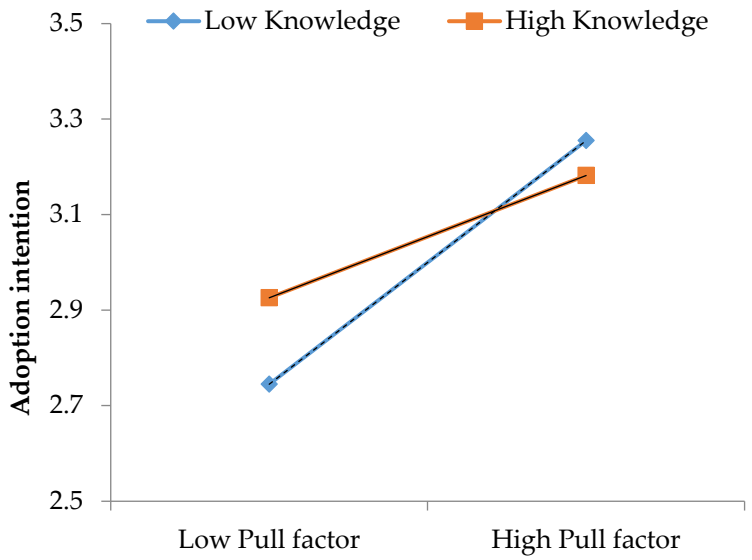

Figure 3. Result of the moderating effect of knowledge.

4.4. Result and Discussions

The push factor was formulated by both environmental concerns and safety concerns. The larger contribution of safety concerns to the push factor was understandable because 63.5% of crashes occurring between 2015 and 2020 involved motorcycles (while the percentage of collisions related to passenger cars was 30.2%) [4]. Meanwhile, the pull factor was formed by all of three considered constructs, including perceived usefulness, perceived ease of use, and financial incentive policy. Unsurprisingly, perceived usefulness was the strongest facilitator (in terms of pull factor) because of the clear advantage of an EV compared with a gasoline-based vehicle (i.e., being less oil-reliant) or motorcycle (i.e., travelling to most places with a high level of comfort). Interestingly, the weight of the financial incentive policy was higher than that of the perceived ease of use. It can be explained that the respondents paid more attention to the governmental policies, which are currently relatively limited and expected to be expanded in the short/medium-term [112,113]. The higher the financial assistance from the government and companies, the lower the cost users have to pay. An additional explanation may be the significant worry about the uncertainty of EV-related policies in a new market [114], whereas the navigation and operation of EVs are nearly similar to those of conventional ones; thus, the perceived ease of use did not strongly affect the formulation of the pull factor.

The statistical results suggest that the adoption intention was significantly contributed by the push factor, pull factor, and mooring factor. In line with previous studies [89], the current research found that the characteristics of the destination (i.e., an EV) were the prime ration behind the intention. A relatively large effect of the pull factor on the intention indicated that people acknowledged issues of motorcycle use, leading to them thinking about a coping strategy based on purchasing passenger cars. Of course, this is not good news for urban planning but this is an emerging trend in the urban areas of developing countries such as Vietnam [53]. In opposition to the results in [77], better knowledge did not result in a higher intention in this study.

The present study found an insignificant moderating impact of knowledge on the path from the push factor to intention; however, the effect of the pull factor on the adoption intention was significantly smaller for those with better knowledge. This contradicted previous findings [57,84,88] because the lack of knowledge of electric vehicles usually results in the over-estimation of these disadvantages and the under-estimation of these advantages. For the case of Vietnam, the provision of EVs is mainly the responsibility of a Vietnamese enterprise named VinFast, whose marketing strategies have been successful in promoting a very bright and impressive picture of EVs—which has been described as a symbol of Vietnamese automobile manufacturing and a critical path to the development of a green and modern society. As such, the insufficient understandings of EVs' shortcomings (i.e., poor knowledge) can become a good attitude and higher intention can result from the strong impact of marketing policies. However, for those with better knowledge, they do understand the limitations of EVs, and thus become less intent on adopting this mode.

5. Conclusions

5.1. Theoretical Contributions

The current paper has offered a number of theoretical insights, as follows. First, this is among the first studies to investigate the intention to adopt EVs in a motorcycle-dependent context, thus enriching the literature on the factors associated with the acceptance of this mode. Secondly, this study has proposed a new conceptual framework adapted from the PPM framework. In contrast with many other studies that have modeled constructs separately, this analysis has considered a range of factors as the sub-constructs of two second-order constructs (the push and pull factors). The proposed model has passed all statistical tests and explained quite well the adoption intention; thus, it deserves to be considered as a potential model for predicting the prevalence of different electric vehicle kinds in different contexts. Third, the current paper found that the main reason for the acceptance intention of EVs is the perceptions of this mode rather than those of the current

mode (i.e., the motorcycle) which, however, does play a role. Fourth, a better understanding of EVs may lead to the less prevalence of EVs. This is typically true for cases where the marketing strategies are strong and effective and the development of EVs is in its infancy.

5.2. Managerial Contributions

Some managerial implications derived from the current study in order to encourage the acceptance of EVs are as follows. The potential customers are more inclined to be affected by the advantageous attributes of EVs. The (utilitarian) benefits of EVs need to be persuasively demonstrated, including comfort, wide-range travel, safety, health, and free from the energy crisis due to the shortage of oil. Financial assistance from the government and manufacturers should be conducted consistently and informed when changes are made in a timely. Another way to encourage the adoption of EVs is to highlight the safety and environmental concerns stemming from riding a motorcycle through the introduction of statistical figures from governmental bodies. When formulating marketing strategies and solutions, it is essential to consider the knowledge of the target subject on EVs.

5.3. Research Limitations

Despite being carefully designed and carried out, the current paper has several limitations which need to be considered when using its findings. The collected sample was not necessarily representative of the motorcyclist population in Hanoi because only gender and residential locations were considered during the survey phase. In addition, the present research neglected a number of possible predictors of EV use intention, such as the perceived risk and norms related to this mode. Finally, the results from Hanoi, Vietnam, may be informative but cannot be completely applied to other contexts due to the unique transportation context of the capital. As such, more studies should be implemented with a better sampling strategy to deepen the knowledge of the antecedents of intentions to adopt EVs. Future authors may consider various rider groups instead of only focusing on motorcyclists. Additionally, another possible switch from conventional motorcycle riders is that to electric motorcycles; hence, an exploration of the intention to adopt e-motorcycles would result in valuable contributions to seek the path towards relieving the environmental repercussions of the domination of motorcycles in developing countries.

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