

# EXTENDING THE THEORY OF PLANNED BEHAVIOR TO EXPLORE THE INTENT TO USE ELECTRIC MOTORCYCLES IN DA NANG

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**Abstract** - The continuous increase in the demand for personal vehicles, particularly fossil-fuel-powered two-wheeler, has become one of the main causes of air pollution. However, in recent years, electric motorcycle have gradually attracted consumer attention. Researching consumer intentions to use electric motorcycle plays a crucial role in understanding their needs, thereby proposing more effective measures to encourage the use of electric motorcycle in the future to reduce emissions contributing to environmental pollution. To achieve this, it is essential to analyze in depth the factors influencing the intention to use electric motorcycle. This study is based on an extended Theory of Planned Behavior (TPB) model, aiming to examine and evaluate the impact of perceived value and perceived cost on the behavior of using electric motorcycle. The PLS-SEM model was tested with data collected from 286 non-users of electric motorcycle in Da Nang City, Vietnam. Based on these analyses and findings, the study can help support the Government and manufacturers in devising specific solutions and comprehensive strategies to shift mindsets and attract consumers toward the intention to use electric motorcycle.

**Key words** - Electric motorbikes; developing country; PLS-SEM; intention to use electric motorcycle; Da Nang.

## 1. Introduction

The rapid increase in personal vehicles, especially in large urban areas, has led to many issues such as traffic congestion, traffic accidents, and environmental pollution, which have become increasingly serious and difficult to control [1]. In low- and middle-income countries, the growing number of motorcycles remains a major concern for authorities. Especially in Asian countries, the total number of motorcycles registered in 2019 was 106 million in Indonesia, 62 million in Vietnam, and 21 million in Thailand. Transitioning from motorcycles with internal combustion engines to electric motorcycles will improve local air quality and reduce the environmental impact of these vehicles [2]. In addition, electric motorcycles need to be regularly charged from the power grid, which can contribute to efforts to eliminate fossil fuels as non-renewable energy sources such as oil, coal, and natural gas. Transitioning to electric motorcycles (EMs) also contributes to economic stability due to political instability arising from fluctuating prices of fossil fuels and their increasingly volatile imports [3]. In countries like Vietnam, many national and local-level solutions have been implemented to encourage the use of electric motorcycles. However, these initiatives have not yet achieved outstanding success, as the adoption rate of electric motorcycles remains relatively low. The use of electric motorcycles heavily depends on consumer awareness of

them [4]. Therefore, conducting in-depth research to understand the factors influencing the use of electric motorcycles is absolutely necessary. This research will significantly contribute to supporting government and manufacturers' policies to promote the use of this environmentally friendly transportation method through specific research evidence.

Research on the intention to use electric motorcycles is receiving a lot of attention from researchers in the field of traffic behavior [5]. However, research on the intention to use electric motorcycles in the context of countries with middle-income and low incomes is still relatively scarce. Previous research has employed various methods such as linear regression and multiple regression to explore the factors influencing the intention to use electric motorcycles [2, 6]. Author Jones, et al. [6] conducted research presenting the impact of economic and technological factors on the use of electric motorcycles in Vietnam. The results obtained using the logit model showed that technological improvements and economic incentives significantly impact the choice to use EMs. There has also been research on the application of electric motorcycles by consumers and the analysis of their environmental benefits [7, 8]. Additionally, perceived risk factors associated with the use of electric motorcycles have been analyzed and evaluated in previous research [9, 10]. The use of Structural Equation Modeling (SEM) in the field of research on EMs choice behavior is still very limited [11]. Some notable studies, such as the one conducted by Yuniaristanto in 2022 in Indonesia, used the SEM model to explore the intention to purchase EMs. According to that research, barriers related to infrastructure, charging stations, tax policies, and the characteristics of electric motorcycles (such as charging time and battery life) are factors that make consumers hesitant to use EMs. However, individuals with broad social networks and concerns about environmental issues are willing to pay to own and use EMs for transportation. EMs are known as a new technological model with features such as energy efficiency, reduced air emissions, and quieter operation compared to conventional motorcycles. Therefore, some researchers have used the Technology Acceptance Model (TAM) in their studies [12]. Other research has used the Theory of Planned Behavior (TPB) to explore behaviors and factors influencing the intention to use electric motorcycles, such as attitude, perceived behavioral control, and subjective norms [13, 14]. In the context of Vietnam, several studies have examined the intention to use electric

motorcycles. Nguyen-Phuoc, et al. [3] combined the TPB model to clarify the factors influencing motivation and barriers to transitioning to electric motorcycles. Additionally, some studies have applied the Technology Acceptance Model (TAM) and the Diffusion of Innovation Theory (DIT) to assess the role of technology, innovation, and attitudes toward adopting electric motorcycles [15]. Furthermore, research by Nguyen-Phuoc, et al. [13] integrated both the TAM and TPB models to further understand the process of accepting electric motorcycles. Văn [16] applied the TAM, combined with data analysis using SPSS and AMOS, to identify factors influencing the intention to use electric motorcycles among consumers in the Da Nang market. Similarly, research by Thao and Linh [17] also used the TPB model along with SPSS analysis in Ho Chi Minh City to evaluate the factors influencing the intention to switch to electric motorcycles.

Previous research has successfully combined the Theory of Planned Behavior (TPB) model with other frameworks like the TAM and DIT. However, there hasn't been any research that extends the TPB to incorporate perceived factors such as perceived cost and perceived value. Therefore, this research is groundbreaking as it broadens the TPB by integrating these factors, allowing for a deeper exploration of consumer perceptions regarding electric motorcycle use. By applying Partial Least Squares Structural Equation Modeling (PLS-SEM), we analyze data collected from residents of Da Nang City, Vietnam. The research focuses on clarifying the roles of perceived value and perceived cost while also examining the impact of demographic factors on the intention to use electric motorcycles. The results of this research not only contribute to theory but also provide important practical insights for strategies to encourage the transition to electric motorcycles in the future.

## 2. Theoretical background and research hypotheses

### 2.1. Theory of Planned Behavior (TPB)

Theory of Planned Behavior (TPB) developed by Ajzen [18] is a psychological and social model with significant influence, designed to explain and predict human behavior. The TPB focuses on understanding how factors like attitudes, subjective norms, and perceived behavioral control affect people's intentions and actual behaviors in various contexts. Through this, the theory clarifies why a person decides to carry out or refrain from a specific action. The key components of the model include attitude, subjective norms, and perceived behavioral control, which are used to directly predict the intention to perform a behavior. Attitude (AT) reflects an individual's willingness to engage in or decline a specific behavior. Subjective norms (SN) indicate the social pressure an individual feels to perform a behavior. Perceived behavioral control (PB) relates to an individual's perception of the existence or non-existence of risks when performing a particular behavior [18].

The TBP is the most widely used theory to explain green behavior. In previous research, the TPB has successfully predicted consumer preferences for using

electric motorcycles [13, 19]. Moreover, some other studies have expanded the TPB by adding standard structures to better explain the factors influencing consumers' personal intentions [20]. Therefore, this research aims to identify the factors that directly impact consumers' intentions to use electric motorcycles while also providing recommendations to improve consumer behavior.

### 2.2. Research hypotheses

The conceptual section explains the related structures of the TPB, which includes three key components: attitude toward the behavior, subjective norms, and perceived behavioral control. These are used to predict interest in using electric motorcycles. The first factor that determines interest in using electric vehicles is attitude. The theoretical concept of this factor suggests that the more positive the evaluation of a product or service, the stronger the urge to take certain actions that lead to the adoption of that product or service [18]. Research on the adoption of electric motorcycles also shows that attitude is a factor that positively influences customers' intentions [20]. The second factor considered to affect interest in using electric motorcycles is subjective norms, which are tied to the presence of social pressure when carrying out a specific behavior [18]. According to the research of Gunawan, et al. [10], the intention to use electric motorcycles is influenced by subjective norms. The third factor of the TPB model is perceived behavioral control, which affects interest in adopting electric vehicles. This theoretical concept evaluates individuals' perceptions of how difficult or easy they think it is, reflecting their past experiences with using technology, products, or services [21]. This indicates that individuals' confidence in controlling certain situations is supported by available resources, and the greater the opportunities, the higher the awareness of their ability to manage those behaviors. Related research has shown that cognitive behavioral control positively contributes to the intention to use electric motorcycles [10, 20]. Therefore, in this research, we will use all three factors in the TPB to examine their influence on the intention to use electric motorcycles. We present the following hypotheses:

*H1: Subjective norms positively influence the intention to use electric motorcycles.*

*H2: Attitude positive impacts the intention to use electric motorcycles.*

*H3: Perceived behavioral control positively influences the intention to use electric motorbikes.*

*H4: Perceived value has a positive impact on customers' attitudes.*

*H5: Perceived value positively impacts the intention to use electric motorcycles.*

*H6: Perceived cost has a positive impact on customer attitude.*

*H7: Perceived cost positively impact the intention to use electric motorcycles.*

Perceived value is defined as the overall evaluation of a customer regarding the usefulness of a product or service

based on their perception of what they receive (benefits) and what they give up (sacrifices) [22]. Perceived value includes functional value, emotional value, social value, and knowledge value. Perceived value impacts purchasing decisions, customer satisfaction, and behavioral intentions during the post-purchase evaluation stage [23]. Additionally, perceived value is a factor that influences customer attitudes [24].

Perceived cost is the costs imposed on customers in manufacturing or service companies, whether monetary or non-monetary (time and effort) [25]. Perceived cost in this research is defined as the extent to which an individual believes they will incur costs when using a system [26]. It is argued that costs have a negative impact on an individual's attitude towards using the system. Furthermore, perceived cost negatively affects customer intentions.

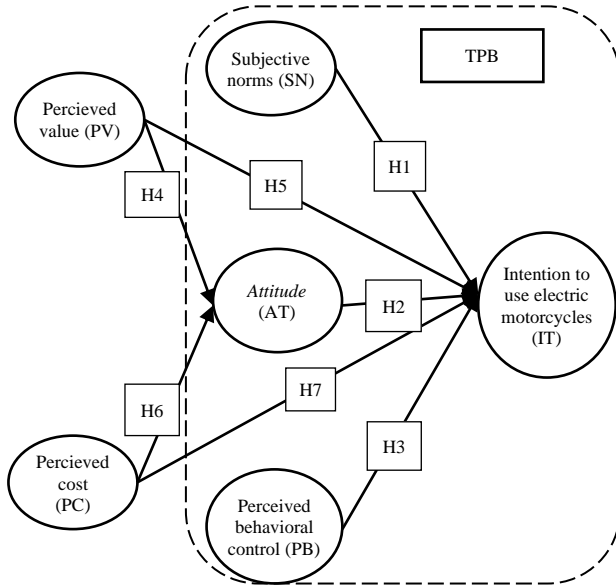


Figure 1. Research model

### 3. Research methodology

#### 3.1. Survey design

A survey questionnaire has been designed to gather the necessary data for the research, consisting of three main parts. The first part provides an overview of the goals and objectives of the study, as well as the benefits for participants. The second part, the main section of the questionnaire, focuses on the measurements of the constructs in the conceptual model, developed based on verified literature. All latent variables are measured using a 7-point Likert scale, ranging from "strongly disagree" (1) to "strongly agree" (7). The final part of the questionnaire collects demographic information such as the participant's gender, age, income, and residence. To ensure the content of the measurement items is appropriate, the initial draft of the questionnaire was reviewed and evaluated by five experts in the field of transportation. After that, the questionnaire was edited and translated into Vietnamese. A group of 30 students from the University of Da Nang, Vietnam was selected to participate in a pilot survey. Their feedback provided comments on the clarity of the language, the content of the questions, the average

completion time, and any spelling errors. The final version is to be used for data collection in the city of Da Nang from August 2024 to September 2024.

#### 3.2. Data analysis

Structural Equation Modeling (SEM) is commonly used to examine the relationships among factors in data and their associated effects. There are two types of SEM models corresponding to two estimation methods in SEM: Covariance-based SEM (CB-SEM) and Partial Least Squares SEM (PLS-SEM). PLS-SEM is recommended for studies involving multiple structures and aimed at explaining the increasing complexity due to theoretical expansion [27].

With the goal to explore and examining the complex relationship between the factors influencing the intention to use electric motorcycles, as well as the predictive ability of these factors, the PLS-SEM method was used to analyze the observational data. The analysis results provide estimates of the path model, showing each factor's impact on the intention to use and offering metrics to assess the theoretical model's fit.

### 4. Result

#### 4.1. Descriptive statistics

In total, 286 valid data samples were analyzed, collected in Da Nang. Among these, men accounted for 57.35% and women for 42.65%. Regarding marital status, those who are married make up 52.10%, while the remaining 47.90% are single. 55.95% of survey participants have an education level of college or higher. The majority of respondents were students (25.15%), followed by office workers (12.24%) and freelancers (11.54%). The average income range of 10 to 20 million VND received the highest response rate at 33.22%.

#### 4.2. Measurement model evaluation

This research tested the reliability of the latent variables in the proposed model through confirmatory factor analysis (CFA). To evaluate the reliability of the measurement model, three main criteria were used: internal consistency reliability (CR), convergent validity, and discriminant validity [28]. According to the analysis results, the loading coefficients, Cronbach's Alpha (CA), and CR of all latent variables ranged from 0.715 to 0.853, exceeding the recommended value of 0.7 [29]. This indicates that the measurement scales exhibit internal reliability. Convergent validity was assessed based on the loading coefficients and average variance extracted (AVE). The loading coefficients of the factors in most items exceeded the threshold of 0.7. Meanwhile, the AVE values of all constructs ranged from 0.548 to 0.770, all above the recommended level of 0.5 [29]. This indicates that the questionnaire has good convergent validity. A new method introduced by Henseler, et al. [30] to evaluate discriminant validity is the Heterotrait-Monotrait (HTMT) ratio and the Fornell-Larcker criterion. For the HTMT ratio, the results show that the discriminant validity of all constructs meets the requirements, with all HTMT values ranging from 0.076

to 0.694, which is lower than the recommended threshold of 0.85. Thus, all measures in the first-order model meet the criteria for internal consistency, convergent validity, and discriminant validity.

**4.3. Structural model evaluation**

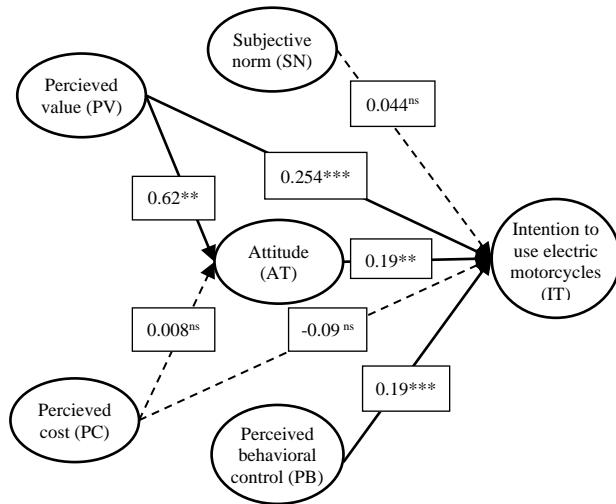
**4.3.1. Direct effects**

The relationship between the variables in the proposed research model is shown through the path coefficients and their significance levels. These path coefficients and their significance are evaluated based on the t-value, with corresponding thresholds of 1.65, 1.96, and 2.57, which correspond to significance levels of 10%, 5%, and 1%, respectively [27]. In cases where multiple research variables have the same path coefficient, the importance of each variable will be determined based on the significance level of the path coefficient. Specifically, the research variable with a higher t-value will have a higher significance level and importance in the research model.

toward the intention to use electric motorcycles (IT). Among these, PV has the most substantial influence ( $\beta_{PV \rightarrow IT} = 0.254, t = 3.050, p = 0.002$ ). Additionally, perceived value positively impacts attitude ( $\beta_{PV \rightarrow AT} = 0.62, t = 13.846, p = 0.000$ ). However, there is no effect of perceived cost (PC) and subjective norm (SN) on the intention to use electric motorcycles.

**4.3.2. Indirect effects**

The bootstrapping test used in SmartPLS by Zhao, et al. [31] was employed to explore the mediating role of PC and PV on IT through AT. Table 2 presents the results of two indirect paths, revealing one statistically significant relationship between PV and IT at a significance level below 5%. Specifically, AT acts as a mediating factor in the relationship between PV and IT ( $\beta_{PV \rightarrow AT \rightarrow IT} = 0.118, t = 2.162, p = 0.031$ ). These results indicate that both direct and indirect effects are aligned. This indicates that the effects of the mediating factor complement each other [31].



**Figure 2. Results of PLS-SEM**

**Table 1. Direct effects**

Path relationship	Coefficient	Standard deviation	t-values	p-values
Perceived cost (PC) -> Attitude (AT)	0.008 <sup>ns</sup>	0.056	0.148	0.882
Perceived cost (PC) -> Intention to use electric motorcycles (IT)	-0.090 <sup>ns</sup>	0.085	1.055	0.292
Subjective norm (SN) -> Intention to use electric motorcycles (IT)	0.044 <sup>ns</sup>	0.066	0.666	0.505
Perceived value (PV) -> Attitude (AT)	0.62 <sup>***</sup>	0.045	13.846	0.000
Perceived value (PV) -> Intention to use electric motorcycles (IT)	0.254 <sup>***</sup>	0.083	3.050	0.002
Perceived behavioral control (PB) -> Intention to use electric motorcycles (IT)	0.190 <sup>***</sup>	0.068	2.794	0.005
Attitude (AT) -> Intention to use electric motorcycles (IT)	0.190 <sup>**</sup>	0.083	2.292	0.022

Note:\*\*\* p <0.01; \*\* p <0.05; \* p <0.1; <sup>ns</sup> non-significant

The results from Table 1 indicate that there is a significant positive correlation between perceived value (PV), perceived behavioral control (PB), and attitude (AT)

**Table 2. Indirect effects**

Indirect path	Coefficient	Standard deviation	t-values	p-values
PC -> AT -> IT	0.002 <sup>ns</sup>	0.012	0.132	0.895
PV -> AT -> IT	0.118 <sup>**</sup>	0.054	2.162	0.031

Note:\*\*\* p <0.01; \*\* p <0.05; \* p <0.1; <sup>ns</sup> non-significant

**4.3.3. Total effect**

Table 3 presents the overall impact of the latent variables on the intention to use electric motorcycles (IT) in the researched model. Perceived value (PV) has the strongest influence on the intention to use electric motorcycles (IT) ( $\beta_{PV \rightarrow IT} = 0.372, t = 4.852, p = 0.000$ ), followed by perceived behavioral control (PB) and attitude (AT), both with a coefficient of  $\beta = 0.190$  ( $t = 2.794, p = 0.005$  và  $t = 2.292, p = 0.022$ ).

**Table 3. Total effect**

Total impact	Coefficient	Standard deviation	t-values	p-values
PC -> IT	-0.088 <sup>ns</sup>	0.081	1.084	0.279
SN -> IT	0.044 <sup>ns</sup>	0.066	0.666	0.505
PV -> IT	0.372 <sup>***</sup>	0.077	4.852	0.000
PB -> IT	0.190 <sup>***</sup>	0.068	2.794	0.005
AT -> IT	0.190 <sup>**</sup>	0.083	2.292	0.022

Note:\*\*\* p <0.01; \*\* p <0.05; \* p <0.1; <sup>ns</sup> non-significant

**4.4. Multi-group analysis**

Table 4 illustrates the relationships between two groups based on three characteristics of the participants, including gender (Group 1 - Male, Group 2 - Female), age (Group 1 - Young, Group 2 - Older), and monthly income (Group 1 - Average - Low, Group 2 - High). These relationships are analyzed through the variables PV, PC, PB, SN, and AT in relation to IT. The differences between the two groups are determined through the p-value. The results indicate that age significantly impacts the relationship between PB and IT. Specifically, the effect of PB on IT is smaller for younger individuals compared to those over 30. Similarly, monthly income also significantly affects the relationship

between PB and IT. Individuals with a monthly income above 10 million VND have a greater influence on the relationship between PB and IT compared to those earning below 10 million VND.

**Table 4.** Multi-group analysis results

Group	Impact	Coefficient Group 1	Coefficient Group 2	P-values Group 1	P-values Group 2	Supports
Men (1) compared to Women (2)	PC -> IT	-0.142 <sup>ns</sup>	-0.223 <sup>ns</sup>	0.060	0.304	No / No
	SN -> IT	-0.043 <sup>ns</sup>	0.187 <sup>ns</sup>	0.597	0.051	No / No
	PV -> IT	0.231 <sup>**</sup>	0.260 <sup>ns</sup>	0.029	0.056	Yes / No
	PB -> IT	0.348 <sup>***</sup>	0.024 <sup>ns</sup>	0.000	0.795	Yes / No
	AT -> IT	0.223 <sup>**</sup>	0.114 <sup>ns</sup>	0.023	0.380	Yes / No
Young (1) compared to Older (2)	PC -> IT	0.157 <sup>ns</sup>	-0.301 <sup>***</sup>	0.128	0.000	Yes / No
	SN -> IT	0.034 <sup>ns</sup>	0.067 <sup>ns</sup>	0.645	0.505	No / No
	PV -> IT	0.212 <sup>ns</sup>	0.288 <sup>**</sup>	0.056	0.016	Yes / No
	<b>PB -&gt; IT</b>	<b>0.207<sup>**</sup></b>	<b>0.240<sup>**</sup></b>	<b>0.014</b>	<b>0.018</b>	<b>Yes / Yes</b>
	AT -> IT	0.235 <sup>**</sup>	0.129 <sup>ns</sup>	0.031	0.234	No / Yes
Low average income (1) compared to High income (2)	PC -> IT	-0.226 <sup>**</sup>	0.092 <sup>ns</sup>	0.014	0.351	Yes / No
	SN -> IT	0.052 <sup>ns</sup>	0.008 <sup>ns</sup>	0.498	0.940	No / No
	PV -> IT	0.240 <sup>**</sup>	0.242 <sup>ns</sup>	0.035	0.056	Yes / No
	<b>PB -&gt; IT</b>	<b>0.161<sup>**</sup></b>	<b>0.290<sup>**</sup></b>	<b>0.035</b>	<b>0.029</b>	<b>Yes / Yes</b>
	AT -> IT	0.168 <sup>**</sup>	0.205 <sup>ns</sup>	0.080	0.184	Yes / No

Note: For the coefficient: \*\* considerable at level 95%. \*\*\* considerable at level 99%. For the coefficient difference: \* considerable at level 90%

## 5. Discussion

Based on their smooth operation, energy efficiency, and eco-friendly, electric motorcycles are gradually becoming an ideal alternative to fossil fuel-powered vehicles. As a result, more researchers are turning their attention to electric motorcycles. However, research exploring their use remains limited in developing countries, where motorcycles are the primary mode of transportation. Therefore, this study aims to investigate the factors influencing the intention to use electric motorcycles in developing countries, specifically Vietnam, by expanding the Theory of Planned Behavior (TPB) to include the factors of perceived value (PV) and perceived cost (PC). The initial analysis results show that both attitude (AT) and perceived behavioral control (PB) positively impact intention (IT), aligning with previous research on the intention to use electric vehicles based on the TPB model [7, 10]. In this context, consumers' PB has been identified as the most important factor influencing the intention to use electric motorcycles. Consumers who can effectively manage their perceptions, have sufficient economic resources, and are confident in their abilities are more likely to choose electric motorcycles in the future. This finding is consistent with previous research, highlighting the importance of PB in the decision to adopt electric motorcycles [32]. Consumer AT also plays an important role; the research results indicate that individuals with a positive attitude towards electric motorcycles are more likely to accept and use this mode of transport. This affirms that attitudes are a strong driver for technology adoption, and they should be regarded as a primary target in intervention strategies aimed at promoting this

technology [19]. However, research also shows that the subjective norm (SN) factor, while positively influencing IT in some studies [3, 10] is not statistically significant in this model.

Additionally, PV has been identified as positively impacting IT, demonstrating its importance in consumer decision-making, as shown in previous research [12]. Furthermore, AT was found to mediate the relationship between PV and IT, suggesting that consumers are more likely to use electric motorcycles if they perceive the value these vehicles bring to themselves and the environment, leading to a positive attitude and subsequently increasing IT. This finding is consistent with previous studies that identified AT as a mediating factor influencing IT [33, 34]. In contrast, PC does not significantly impact IT. Multi-group analysis shows a significant difference in the impact of PB on IT between two age groups: under 30 and 30 and older. Specifically, for middle-aged and older individuals, cognitive behavioral control has a stronger impact than for the younger group. The results also reveal that PB has a more significant impact on IT in the high-income group compared to those with medium to low income.

## 6. Conclusion

This research analyzed the factors influencing IT of traffic participants in Da Nang city, Vietnam by developing a structural equation modeling (SEM) framework based on an extended Theory of Planned Behavior (TPB) model. From the analysis, several important conclusions can be drawn:

- AT and PB are identified as two significant factors influencing consumer's IT. This highlights the importance of fostering positive awareness and self-control to encourage individuals to adopt this environmentally friendly mode of transportation.

- PV plays a crucial role in influencing both AT and IT. Consumers who view electric motorcycles as offering significant environmental benefits are likely to develop a more positive attitude and a stronger intention to use them.

- Regarding the moderating effects of demographic variables, the study reveals that age influences the relationship between PB and IT. Additionally, monthly income affects the relationship between PB and AT.

The findings from this research provide valuable insights for businesses and electric motorcycle manufacturers in Vietnam to develop effective strategies and policies that encourage electric motorcycle usage. By focusing on factors such as attitude (AT), perceived behavioral control (PB), and perceived value (PV), while also considering the moderating effects of demographic variables, companies can create strategies that better align with consumers' needs and desires.

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