



## Willingness to switch to EV passenger transport services in Vietnam: Insights for sustainable mobility in developing economies

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### ABSTRACT

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Environmental pollution, energy scarcity, and advancements in electric vehicle (EV) technology are critical global issues. Combining these factors offers a promising solution for sustainable transportation development, particularly for emerging economies like Vietnam, through the implementation of green mobility solutions via EV passenger transport services (EVPTS). This study investigates the motivations behind the willingness to switch from internal combustion engine vehicles to EVPTS. It focuses on factors related to the perceived benefits of EVs and individual pro-environmental characteristics. Data were collected from a survey of 352 individuals in Hanoi, Vietnam, and analyzed using SmartPLS 4.0 software. The findings revealed a significant positive correlation among environmental concerns, environmental personal norms, perceived inconvenience of private vehicles, and the perceived usefulness of EVPTS. Moreover, excluding the factor of environmental concerns, willingness to switch to EVPTS was positively correlated with perceived usefulness of EV ( $\beta=0.380$ ), perceived inconvenience ( $\beta=0.318$ ), and environmental personal norms ( $\beta=0.251$ ). The major contribution of this study is twofold: First, by selectively combining elements of the Technology Acceptance Model (TAM) and the Norm Activation Model (NAM) and adding the concept of "Perceived inconvenience," our study develops a more comprehensive framework for understanding this behavioral shift. Second, this study demonstrates how perceived benefit attributes (encompassing the benefits of EVPTS and the inconvenience of personal transport), as well as individuals' pro-environmental characteristics, influence their willingness to switch to EVPTS within the context of a developing country. These findings further provide a foundation for suggesting managerial implications to foster the shift to EVPTS in Vietnam.

**Contribution/Originality:** This study contributes to the existing literature by developing a comprehensive TAM-NAM framework, including perceived inconvenience, to examine EVPTS switching intentions. Results characterize users as pro-environmental individuals aware of EVPTS benefits and private transport inconveniences. Such findings provide essential implications for promoting sustainable mobility in developing economies like Vietnam.

## 1. INTRODUCTION

The world is grappling with significant environmental challenges, including energy scarcity, air pollution, and greenhouse gas emissions. A primary contributor to these issues is the excessive use of personal gasoline-powered vehicles, which produce substantial carbon emissions (Adnan, Nordin, Rahman, & Rasli, 2017). Consequently, mitigating the detrimental impacts of personal vehicle usage and establishing a sustainable transportation system have become pressing concerns and priorities on the agendas of many countries (Jakovcevic & Steg, 2013).

As an emerging economy, Vietnam faces significant challenges due to its large population and rapid urbanization, which have led to an overburdened national transportation system. Personal vehicles powered by internal combustion engines, such as motorbikes and cars, dominate Vietnam's transportation landscape (Ninh, 2021), resulting in severe air pollution and traffic congestion. According to IQAir's 2023 annual survey, Vietnam ranked second in air pollution within the ASEAN region and 22nd globally, with Hanoi identified as the eighth most polluted city in the world (Pratt, Khalidi, & Flowers, 2024).

The Vietnamese government is advised to adopt several solutions that have proven effective in other cities and countries: reducing the number of private vehicles on the road, accelerating the electrification of public transport, and encouraging the transition to EVs (Pratt et al., 2024). These three solutions can be implemented simultaneously and are likely to complement each other. By fully electrifying the public transport system and fostering the development of the EV industry, the government can incentivize the public to switch to EVs and/or utilize EVPTS (such as electric buses, taxis, and motorbike taxis), thereby reducing the overall number of vehicles on the road. Moreover, the adoption of EVs is considered an essential trend for the sustainable development of nations, offering benefits such as improved air quality, reduced reliance on non-renewable fossil fuels (e.g., oil, natural gas, coal), and enhanced national economic stability (Nguyen-Phuoc, Nguyen, Tran, Pham, & Oviedo-Trespacios, 2023).

Owning an electric car is an ideal aspiration; however, in a developing country like Vietnam, with an average annual GDP per capita of \$4,284.5 (General Statistics Office, 2023), not every individual can afford an EV. Additionally, if promoting EVs leads to a decrease in active mobility and public transportation use, the positive impact of EVs on the sustainability of the urban transport system could be compromised. Therefore, alongside encouraging the purchase of personal EVs, promoting EVPTS is considered essential. These dual strategies are seen as effective solutions to promote a comprehensive transformation of the Vietnamese transport system, aligning with the government's commitment to reaching net-zero emissions by 2050, as pledged at the United Nations Climate Change Conference (COP 26) (Prime Minister, 2022).

In the context of developing sustainable transport systems, current literature indicates that the green transition, especially behavior related to EV usage, has attracted significant scholarly attention worldwide. Research has mainly focused on adoption intentions (Deka, Dutta, Yazdanpanah, & Komendantova, 2023; Lee, Kim, & Roh, 2023; Ninh, 2021; Tran, Hoang, & Nguyen-Phuoc, 2023), intentions to use electric car-sharing services (Curtale, Liao, & Van Der Waerden, 2021), and intentions to rent electric cars (Gulzari, Wang, & Prybutok, 2022). A common theme in these studies is their focus on electric vehicles and behaviors associated with their personal use, whether through purchasing, renting, or sharing, with little exploration of the transition mechanisms toward using EVPTS. Indeed, starting in 2023, Isa, Laila, Dani, Sulthan, and Jiann (2023) conducted an initial investigation into public perceptions regarding the feasibility of integrating EVs, specifically electric buses, into Brunei's public transport network. Brunei, a high-income Southeast Asian country characterized by a relatively small population (about 430,000 in 2021), high private car ownership rates, abundant oil and gas resources, and government subsidies for fuel, presents a unique context in the region. Unsurprisingly, the study found that the integration of EVs into the existing public transport system was not seen as a priority by respondents. In contrast, in other Southeast Asian countries with very different conditions, lower per capita income, larger populations, severe traffic congestion and environmental issues, and no fuel subsidies the integration of EVs into public transport systems is increasingly viewed as essential for maintaining sustainable urban mobility and broader economic stability. Since the transport sector in Southeast Asia has long been

one of the largest sources of carbon emissions, the policies adopted by governments (e.g., in Brunei, Thailand, Indonesia, Malaysia, the Philippines, Singapore, and most recently Vietnam) to promote EV deployment demonstrate a clear political commitment to electrifying road transport and pursuing sustainable development goals (Kresnawan, Yurnaidi, Bilqis, Wijaya, & Suryadi, 2022). However, empirical research on the factors influencing shifts in user behavior from reliance on gasoline-powered private vehicles to EVPTS in Southeast Asia remains limited. This may create a gap in understanding why people choose to switch to EVPTS instead of their own EV. Knowing the true reasons behind this decision is vital for policymakers and service providers aiming to promote green mobility and develop sustainable transportation. Our study seeks to fill this research gap. The significance of this study lies in its applicability to the context of developing countries like Vietnam, which face significant challenges such as large populations, environmental pollution, traffic congestion, and low GDP per capita, making the widespread purchase of electric cars less feasible.

Our research model on the motivations behind the willingness to switch to EVPTS integrates two primary approaches: (1) the perceived functional and utility attributes of EVs, and (2) individuals' pro-environmental characteristics. The model focuses on the relationships among environmental concern, environmental personal norms, perceived inconvenience, perceived usefulness, and willingness to switch. The novelty of this research lies in the development of two additional hypotheses regarding the influence of pro-environmental personal norms and perceived inconvenience on the perceived usefulness of EVPTS. The results of the hypothesis testing further validate the relevance of our research, emphasizing the potential of EVPTS as an optimal solution for sustainable transportation development in a developing country. Consequently, some managerial implications for vendors and policymakers are suggested to reinforce the switch to EVPTS and move toward establishing thus fulfilling the emission reduction target to reach zero by 2050 of the Vietnamese Government.

The remainder of this paper is structured as follows: Section 2 provides a theoretical overview and the development of research hypotheses. Section 3 outlines the methods used in this study. Section 4 presents interpretations of the research model testing results. Section 5 offers discussions and recommendations based on the research findings. Finally, Section 6 addresses limitations and suggests directions for future research.

## **2. LITERATURE FRAMEWORKS**

### *2.1. EVPTS and Sustainability*

EVs are often regarded as innovative, technology-based products that offer green mobility options. They address environmental issues linked to personal transportation by providing significant benefits over gasoline-powered vehicles, such as improved energy efficiency and reduced maintenance requirements (Kosmidis, Müller-Eie, & Delbosc, 2023).

Recent global studies have increasingly focused on promoting the use of personal EVs (Lee et al., 2023; Ng, Law, & Zhang, 2018; Ninh, 2021; Rehman, Bresciani, Yahiaoui, & Kliestik, 2024). However, the market share of EVs in many countries remains limited (Kosmidis et al., 2023; Ninh, 2021). Barriers to EV adoption include concerns about long charging times and the potential for being stranded midway through a journey (Adu-Gyamfi et al., 2022) as well as the high costs associated with batteries (purchasing, renting, replacing, etc.) (Rehman et al., 2024). Furthermore, in densely populated areas, the widespread use of personal vehicles, whether electric or gasoline-powered, exacerbates issues of traffic congestion and parking (Curtale et al., 2021; Rehman et al., 2024). Thus, while the increased use of EVs addresses emission reduction, it does not resolve traffic congestion. Building a sustainable transportation system requires not only reducing emissions from personal vehicles but also decreasing the overall number of personal vehicles on the road. Addressing both aspects, the use of EVPTS emerges as an optimal solution. It mitigates the limitations of personal vehicle use, meets users' environmental protection needs, and contributes to a more sustainable urban transport system.

## 2.2. Conceptual Model

This study examines the factors influencing the willingness to switch to EVPTS. According to Wang et al. (2024), most studies on individuals' EV behavior are based on two perspectives: (1) the perceived functional or instrumental attributes of EVs and (2) individuals' pro-environmental characteristics. Researchers (Chen, 2016; Deka et al., 2023; Shanmugavel & Balakrishnan, 2023; Vafaei-Zadeh, Wong, Hanifah, Teoh, & Nawaser, 2022) have employed various theoretical foundations to predict this behavior, including the Technology Acceptance Model (TAM) (Davis, 1989) and the Norm Activation Model (NAM) (Schwartz, 1977). TAM suggests that behavioral intentions are shaped by people's expectations, particularly their perceptions of efficiency benefits (Curtale et al., 2021). In contrast, NAM (and its variants) has been successfully applied to predict prosocial intentions and behaviors, including environmental behaviors such as EV adoption (Asadi et al., 2021). These theoretical models have many advantages due to their flexibility in incorporating additional factors or integrating with related theories in the context of EV adoption (Asadi et al., 2021; Vafaei-Zadeh et al., 2022).

In this study, we incorporate fundamental elements from the theoretical models, such as environmental concern, environmental personal norms, and perceived usefulness. Additionally, we introduce the variable "perceived inconvenience" for the following reasons: First, although rarely considered in studies on EV usage behavior, this factor has been shown to positively impact the willingness to switch to green transportation (Wang, Wang, & Yang, 2020). Second, this factor aligns with the context and objectives of this study, particularly in examining the motivation to transition from personal transportation to EVPTS in a developing country like Vietnam, where the transportation system is burdened by excessive personal vehicle use. The attributes of the variables in the proposed research model are presented below.

- (1) Environmental concern (EC) is understood as an individual's awareness of and willingness to address environmental issues (Rehman et al., 2024). Individuals with a high level of environmental concern tend to be more conscious of environmental quality and view environmental protection as their personal responsibility. Consequently, they are more likely to engage in behaviors and adopt measures aimed at protecting the environment (Rehman et al., 2024).
- (2) Environmental personal norms (EPN): refer to an individual's self-expectations for specific behaviors that stem from the norms and values associated with those behaviors (Park & Ha, 2014). When activated, personal norms are experienced as a sense of moral obligation (Schwartz, 1977) and a reflection of conscience (Shanmugavel & Balakrishnan, 2023), thereby serving as a guiding principle for behavior (Park & Ha, 2014).
- (3) Perceived usefulness (PU) refers to the extent to which consumers believe that EVs can enhance their lives, particularly in terms of environmental performance (Vafaei-Zadeh et al., 2022). In the context of pro-environmental behavior, PU pertains to the consumption of environmentally friendly products that offer greater environmental benefits compared to traditional alternatives (Vafaei-Zadeh et al., 2022). For EVPTS, PU encompasses several aspects, such as reducing air pollution, traffic congestion, and parking shortages (Curtale et al., 2021), as well as improving personal travel efficiency (Vafaei-Zadeh et al., 2022).
- (4) Perceived inconvenience (PIN) refers to the extent to which an individual feels inconvenienced when traveling by personal vehicle (Wang, Wang, Yang, Li, & Song, 2020). This inconvenience can stem from various factors, such as complicated road conditions, difficulties in finding parking, particularly in countries with large populations and overburdened transportation systems and the financial burden associated with vehicle maintenance.
- (5) Willingness to switch (WIS) refers to the extent to which an individual is willing to embrace the opportunity to engage in a particular behavior under favorable conditions (Jun & Arendt, 2016). A high level of willingness increases the likelihood that the individual will perform the behavior (Wang, Wang, & Yang, 2020).

Figure 1 presents the proposed research model.

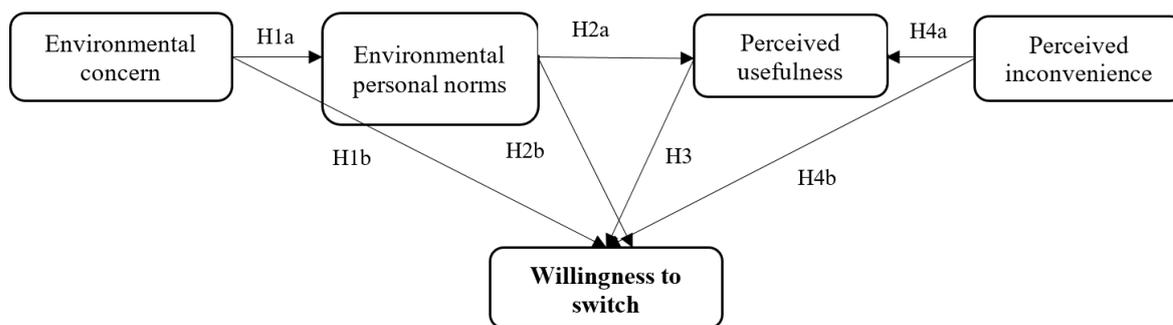


Figure 1. Proposed research model.

### 3. RESEARCH HYPOTHESES

#### 3.1. Environmental Concern, Environmental Personal Norms and Willingness to Switch to EVPTS

As environmental pollution has become an increasingly serious issue in developing countries in recent years, consumers' environmental concerns have grown accordingly (Nguyen, Pham, Nguyen, Do, & Ngo, 2021; Shanmugavel & Balakrishnan, 2023). These concerns are regarded as one of the key factors driving consumers toward sustainable transportation options (Jakovcevic & Steg, 2013; Lee et al., 2023).

Existing literature has established a relationship between EC and pro-environmental behavior, highlighting the significance of EC in predicting such behavior. Empirical studies by Wang, Fan, Zhao, Yang, and Fu (2016); Mohamed, Higgins, Ferguson, and Réquia (2018), and Shanmugavel and Balakrishnan (2023) have identified a bidirectional and positive relationship between EC and EPN. Furthermore, EC is recognized as a crucial determinant of individuals' willingness to switch from current behaviors to more environmentally friendly practices (Wang et al., 2016). For instance, Ng et al. (2018) found that environmentally conscious consumers are willing to pay a premium for EVs. Similarly, Adnan et al. (2017) demonstrated that EC moderates the relationship between intention and actual EV purchase behavior. However, studies conducted in Vietnam, a developing country, have shown that EC does not directly impact the willingness to switch to electric motorbikes (Nguyen-Phuoc et al., 2023) or the willingness to pay for electric cars (Ninh, 2021). Nguyen-Phuoc et al. (2023) attributed this lack of direct impact to consumer concerns about potential battery issues with electric motorbikes. In the case of electric cars, the high-cost relative to the average per capita income in developing countries like Vietnam means that many consumers, despite their EC, may lack the economic means to afford an EV. Consequently, with the use of EVPTS, it is anticipated that concerns about battery issues and personal costs will be mitigated, allowing environmentally conscious individuals to develop strong motivations to switch to EVPTS. Therefore, the first two hypotheses are.

*H<sub>1a</sub>: Environmental concern positively influences environmental personal norms.*

*H<sub>1b</sub>: Environmental concern positively influences willingness to switch to EVPTS.*

#### 3.2. Environmental Personal Norms, Perceived Usefulness and Willingness to Switch to EVPTS

EPN are defined as a sense of moral obligation to act in ways that benefit the environment (Hiratsuka, Perlaviciute, & Steg, 2018). These norms encourage individuals to act conscientiously to promote a sustainable environment essential for future generations (Shanmugavel & Balakrishnan, 2023). Consequently, EPN, as a manifestation of individual social responsibility, can serve as a catalyst for environmentally conscious behaviors (Nishma, Sia, Roy, & Wilson, 2023).

In this study, we hypothesize a positive relationship between EPN, PU, and the WIS to EVPTS. Individuals with strong EPN are likely to have a heightened perception of the usefulness of EVPTS due to their increased concern for environmental issues (Shanmugavel & Balakrishnan, 2023). While no previous studies have explicitly linked these two factors, we anticipate a positive relationship. Additionally, the role of PU has been well documented in literature as a significant predictor of the intention to use technology (Nguyen, Nguyen, Huynh, Vrontis, & Ahmed, 2024),

including EVs. According to a report by Deloitte (2022), the primary motivations for Europeans to purchase EVs include reducing fuel costs, protecting the environment, and promoting personal health. Lee et al. (2023) found that Chinese consumers are primarily motivated to purchase electric cars due to their environmental benefits, particularly their role in reducing greenhouse gas emissions, which outweighs the influence of subsidies designed to promote pro-social consumption. PU is also identified as a major driver of the intention to use electric motorbikes in Vietnam (Tran et al., 2023). Moreover, existing studies have shown that stronger EPN are associated with higher intentions to adopt EVs (Ninh, 2021; Shanmugavel & Balakrishnan, 2023; S. Wang et al., 2016) or to rent EVs (Gulzari et al., 2022). Based on these observations, we propose the following hypotheses.

*H<sub>2a</sub>: Environmental personal norms positively influence perceived usefulness of EVPTS.*

*H<sub>2b</sub>: Environmental personal norms positively influence willingness to switch to EVPTS.*

*H<sub>3</sub>: Perceived usefulness of EVPTS positively influences willingness to switch to EVPTS.*

### 3.3. Perceived Inconvenience, Perceived Usefulness and Willingness to Switch to EVPTS

The use of personal transportation can present users with various inconveniences, such as complicated road conditions, limited parking spaces, and car maintenance costs (Curtale et al., 2021; Gulzari et al., 2022). These inconveniences may reduce users' willingness to purchase or use personal vehicles, but can also positively motivate individuals to choose green transportation when they perceive its usefulness. Previous studies, such as those by Wang, Wang, Yang, et al. (2020) and Chowdhury and Ceder (2013), have demonstrated that perceived inconvenience negatively impacts users' willingness to use private cars. Furthermore, Wang, Wang, and Yang (2020) found that the inconvenience of traveling by private car may influence individuals' willingness to switch to green transportation.

In many developing countries, the rapid expansion of urban areas combined with large populations has led to severe air pollution and congestion, primarily due to the high number of private vehicles on the road (Deka et al., 2023; Nguyen-Phuoc et al., 2023). Consequently, the use of EVPTS is considered a highly competitive alternative as it addresses urban mobility issues such as air pollution, traffic congestion, and parking shortages (Curtale et al., 2021) while also alleviating concerns about vehicle repair and maintenance costs for users (Gulzari et al., 2022). Notably, no study has yet examined the relationship between the PIN of using personal vehicles and the PU of EVPTS. However, based on considerations, we hypothesize that when users perceive the inconvenience of using personal vehicles, they will also perceive greater usefulness in EVPTS, thereby increasing their willingness to switch to this type of green transport service. Therefore, the following hypotheses are proposed.

*H<sub>4a</sub>: Perceived inconvenience positively influences perceived usefulness of EVPTS.*

*H<sub>4b</sub>: Perceived inconvenience positively influences willingness to switch to EVPTS.*

## 4. RESEARCH METHODOLOGY

**Measurements and Questionnaire:** The measurement scales for the variables in the research model are derived from previous related studies (Table 2 Appendix 1) 4 items of "Environmental Concern" were adopted from S. Wang et al. (2016). 3 items of "Environmental Personal Norms" were inherited from Deka et al. (2023). The variable "Perceived Usefulness" consists of 3 items, adapted from Chen (2016) and Vafaei-Zadeh et al. (2022). 3 items of "Perceived Inconvenience" were adapted from Wang, Wang, and Yang (2020). Finally, the variable "Willingness to Shift" includes 3 items inherited from Wang, Wang, and Yang (2020). All scales utilize a 5-point Likert scale, ranging from "1-Strongly Disagree" to "5-Strongly Agree".

Based on the initial scales, a questionnaire was developed. A pre-test was then conducted with 25 experts, including 3 scientists specializing in Management/Marketing at universities, 3 EV drivers, and 19 individuals who regularly use EV services such as electric taxis, electric motorbike taxis, and electric buses. This pre-test aimed to gather feedback on the questionnaire's content and the validity of the scales. Based on the feedback received, a finalized questionnaire was established. To ensure the confidentiality of personal information, the survey was designed to be

anonymous. Additionally, the questions were phrased concisely and clearly to ensure that respondents could easily understand and provide accurate answers.

**Research population and sample:** The survey targeted individuals across different age groups, categorized into three main cohorts: Generation Z (1996-2009), Generation Y (1980-1995), and Generation X (1965-1979), as recommended by Bencsik, Horváth-Csikós, and Juhász (2016). Data collection was conducted in Hanoi for several reasons: Hanoi is the economic, political, and cultural center of Vietnam, and has the second-largest population in the country, with 8.44 million people in 2022 (General Statistics Office, 2023). Additionally, the city government is committed to promoting the greening of public passenger transport, and Hanoi serves as a pioneering market for EV services (Son, 2023). This study examines the readiness to switch from traditional gasoline-powered passenger transport services to EV services. Only two-wheeled EVs (electric motorbikes) and four-wheeled EVs (electric taxis, electric buses) are considered.

Data collection employed a non-probability sampling method using convenience sampling. An online survey was disseminated via Facebook to gather data. The survey form was created with Google Docs and distributed on Facebook and through a network of collaborators to reach potential respondents. The survey was conducted from December 2023 to January 2024, receiving 415 responses. After excluding 63 invalid forms, 352 valid responses were retained, resulting in a response rate of 84.8%. Table 1 presents the characteristics of the survey sample.

**Table 1.** Demographics of respondents.

Characteristics	Demographic features	Frequency (N=352)	Percent
Gender	Female	212	60.2
	Male	137	38.9
	Other	3	0.9
Age	Gen Z (1996-2009)	206	58.5
	Gen Y (1980-1995)	120	34.1
	Gen X (1965-1979)	26	7.4
Education Level	High School	144	40.9
	College/University	179	50.9
	Graduate School	29	8.2
Occupation	Student	115	32.7
	Administrator	56	15.9
	Housewife	14	4.0
	Officer	69	19.6
	Business	80	22.7
	Retired	11	3.1
	Other	7	2
Income per Month (VND)	≤10.000.000	175	49.7
	11.000.000- 20.000.000	58	16.5
	21.000.000- 30.000.000	43	12.2
	31.000.000- 40.000.000	42	11.9
	>40.000.000	34	9.7

**Data Analysis:** This study applied the PLS-SEM (Hair, Hult, Ringle, & Sarstedt, 2017; Hair et al., 2019) to analyze the data in two stages. First, the measurement model analysis will be evaluated to examine the relationships between latent variables and to determine the reliability, validity, and discriminant validity of the scales (Hair et al., 2017). Second, the structural model analysis will be conducted to test the relationships between variables and to test the hypotheses proposed in the research model.

## 5. RESULTS

### 5.1. Measurement Model

The convergent validity and internal consistency reliability of the measurement model are evaluated using the coefficients of outer loadings, the average variance extracted (AVE), composite reliability (CR), and Cronbach's alpha

(Fornell & Larcker, 1981; Hair et al., 2019). As demonstrated in Table 2 and Table 3, the outer loading values of the scales are all greater than 0.7, the Cronbach's alpha coefficients for the variables range from 0.791 to 0.894, the composite reliability of the constructs ranges from 0.799 to 0.896, and the AVE values range from 0.705 to 0.808. These indicators are compliant with the thresholds proposed by Hair et al. (2019), thereby confirming that the measurement scales in the research model ensure reliability and convergence.

**Table 2.** Results of reliability and validity.

Variables & items	Outer loadings	Cronbach alpha	CR	AVE
Environmental personal norms (EPN)		0.791	0.799	0.705
EPN1	0.848			
EPN2	0.873			
EPN3	0.796			
Perceived usefulness (PU)		0.881	0.883	0.808
PU1	0.899			
PU2	0.872			
PU3	0.925			
Perceived inconvenience (PIN)		0.844	0.845	0.762
PIN1	0.870			
PIN2	0.874			
PIN3	0.875			
Environmental concern (EC)		0.894	0.898	0.760
EC1	0.897			
EC2	0.893			
EC3	0.805			
EC4	0.888			
Willingness to switch (WIS)		0.861	0.867	0.782
WIS1	0.906			
WIS2	0.867			
WIS3	0.879			

**Note:** CR (rho\_a): Composite reliability; AVE: Average variance extracted.

To ensure discriminant validity, the HTMT ratio is applied, adhering to the recommendation by Henseler, Ringle, and Sarstedt (2015), which specifies a threshold of less than 0.85. The results presented in Table 3 indicate that the discriminant validity of the constructs in the model is robustly established, as they meet the criteria set forth by Henseler et al. (2015).

**Table 3.** HTMT Ratio.

	EPN	PIN	PU	EC	WIS
EPN					
PIN	0.569				
PU	0.762	0.581			
EC	0.714	0.491	0.703		
WIS	0.748	0.709	0.770	0.549	

**Note:** EPN: Environmental Personal Norms; PIN: Perceived Inconvenience; PU: Perceived Usefulness; EC: Environmental Concern; WIS: Willingness to switch.

## 5.2. Structural Model

The first step in evaluating the structural model is the multicollinearity test (VIF). The results shown in Table 4 indicate that there was no multicollinearity issue in this study, as all VIF values for the variables were below 2.2. Additionally, the  $R^2$  value, which represents the variance explained by the exogenous constructs collectively, was used to evaluate the goodness of fit of the regression model (Hair et al., 2017). The  $R^2$  values for EPN, PU, and WIS

were 0.368, 0.460, and 0.578, respectively. This indicates that EC could explain 36.8% of the variance in EPN; while EPN and PIN together explained 46% of the variance in PU; and the three factors (EPN, PIN, and PU) together explained 57.8% of the variance in WIS. Furthermore, the  $Q^2$  value was incorporated in this study to assess the predictive relevance of the structural model, following the guidelines of Hair et al. (2019). The findings revealed that the  $Q^2$  values of 0.366, 0.414, and 0.412 for EPN, PU, and WIS respectively, confirm the substantial predictive relevance of the structural model for these variables (Hair et al., 2019).

Table 4. VIF and  $R^2$ .

Constructs	VIF	$R^2$	$R^2$ adjusted
EPN -> PU	1.275		
EPN -> WIS	1.982		
PIN -> PU	1.275		
PIN -> WIS	1.416		
PU -> WIS	2.121		
EC -> EPN	1.000		
EC -> WIS	1.888		
EPN		0.370	0.368
PU		0.463	0.460
WIS		0.583	0.578

Note: EPN: Environmental personal norms; PIN: Perceived inconvenience; PU: Perceived usefulness; EC: Environmental concern; WIS: Willingness to switch.

To evaluate the structural model and validate the research hypotheses, this study utilized indexes such as path coefficients ( $\beta$ ), effect size ( $f^2$ ), t-value, and p-value (Hair et al., 2017; Hair et al., 2019). The results of testing the research hypotheses are presented in Table 5 and Figure 2.

The findings indicate that EC significantly impacts EPN ( $H_{1a}$ ,  $\beta=0.608$ ,  $t=13.668$ ,  $p=0.000$ ), whereas EC is not a significant predictor of WIS ( $H_{1b}$ ,  $\beta=-0.042$ ,  $t=0.826$ ,  $p=0.409$ ). Furthermore, hypotheses  $H_{2a}$  and  $H_{2b}$ , positing the effect of EPN on PU and WIS, were supported ( $H_{2a}$ :  $\beta=0.519$ ,  $t=11.820$ ,  $p=0.000$ ;  $H_{2b}$ :  $\beta=0.251$ ,  $t=4.725$ ,  $p=0.000$ ). Likewise, hypotheses regarding the effect of PU on WIS ( $H_3$ ), and the impact of PIN on PU ( $H_{4a}$ ) and WIS ( $H_{4b}$ ) were also confirmed with t-values of 6.162, 5.298, and 6.428, respectively, all exhibiting a p-value of 0.000.

Regarding the effect sizes of the constructs,  $f^2$  values greater than 0.02, 0.15, and 0.35 indicate small, medium, and large effect sizes, respectively, as recommended by Chin (1998).

Results from Table 5 show that EPN has the strongest effect, significantly influencing PU with  $f^2$  values of 0.588 and 0.393. The effect sizes of PIN and EPN on WIS are medium ( $f^2=0.100$ ) and small ( $f^2=0.077$ ), respectively.

Table 5. Hypothesis testing.

Hypothesis	$\beta$	$f^2$ value	t-value	p-value	Results
$H_{1a}$ : EC -> EPN	0.608	0.588	13.668	0.000	Supported
$H_{1b}$ : EC -> WIS	-0.042	0.002	0.826	0.409	Rejected
$H_{2a}$ : EPN -> PU	0.519	0.393	11.820	0.000	Supported
$H_{2b}$ : EPN -> WIS	0.251	0.077	4.725	0.000	Supported
$H_3$ : PU -> WIS	0.380	0.163	6.162	0.000	Supported
$H_{4a}$ : PIN -> PU	0.261	0.100	5.298	0.000	Supported
$H_{4b}$ : PIN -> WIS	0.318	0.171	6.428	0.000	Supported

Note: EPN: Environmental personal norms; PIN: Perceived inconvenience; PU: Perceived usefulness; EC: Environmental concern; WIS: Willingness to switch

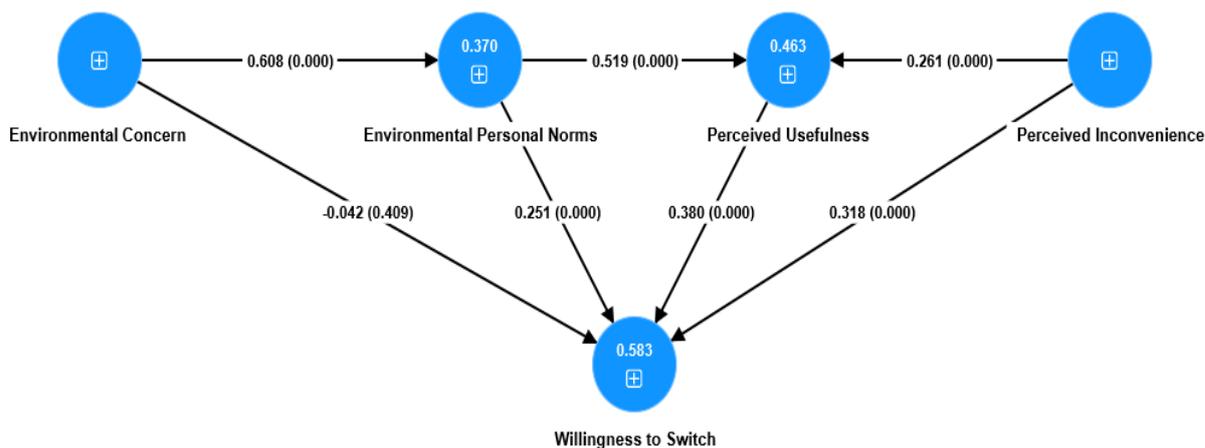


Figure 2. Evaluation of structural model (path coefficient and p-value).

## 6. DISCUSSIONS AND IMPLICATIONS

### 6.1. Discussions

This study aims to investigate the motivations driving users' willingness to switch to EVPTS in Vietnam. By integrating two approaches (1) examining the functional attributes and perceived benefits of EVPTS, and (2) considering personal pro-environmental characteristics, we develop hypotheses regarding the causal relationships between these factors and their influence on users' willingness to switch from personal transport to EVPTS. The results indicate that:

Environmental concern exerts a significant positive influence on environmental personal norms. Additionally, these norms directly and positively impact the willingness to switch to EVPTS. This result aligns with the findings of Mohamed et al. (2018), Wang et al. (2016), Shanmugavel and Balakrishnan (2023), and Ninh (2021) but contrasts with the results reported by Deka et al. (2023). Contrary to initial expectations, environmental concern does not directly affect the willingness to switch to EVPTS. This outcome is consistent with the findings of Ninh (2021) and Nguyen-Phuoc et al. (2023) within the Vietnamese context but opposes the results of Ng et al. (2018). According to Adnan et al. (2017), pro-environmental behaviors can be influenced by individuals' specific environmental concerns. Indeed, individuals who exhibit a strong commitment to environmental issues may simultaneously develop perceptions of factors that dissuade them from considering EVs as a viable alternative to conventional gasoline-powered vehicles (Nguyen-Phuoc et al., 2023). This dynamic may help explain the finding that individuals with heightened environmental concern tend to engage in a more comprehensive evaluation of potential barriers prior to adopting EVPTS. Such barriers include apprehensions regarding battery safety (Nguyen-Phuoc et al., 2023) as well as the overexploitation of non-renewable natural resources associated with EV battery production (Kosmidis et al., 2023). Only after rigorously assessing the actual environmental performance of EVs are these individuals likely to perceive EVPTS as contributing meaningfully to the cultivation of environmental ethics, which in turn encourages practical environmental protection behaviors, such as adopting EVPTS. This interpretation is supported by prior studies suggesting that environmental concern influences specific environmentally friendly behaviors indirectly through variables such as norms, beliefs, and attitudes (Mohamed et al., 2018; Nguyen-Phuoc et al., 2023; Wang et al., 2016).

Our other expectation was confirmed when this study demonstrated, for the first time, that environmental personal norms and perceived inconvenience are two strong drivers of the perceived usefulness of EVPTS. This finding implies that EVPTS is particularly suitable for individuals who are significantly inconvenienced by personal transport and possess high environmental personal norms. These individuals recognize the benefits of EV services, such as improved travel efficiency and enhanced quality of life (due to the elimination of parking issues on crowded roads), reduced vehicle maintenance burdens, and contributions to improved urban traffic quality and air pollution reduction.

Additionally, perceived inconvenience and perceived usefulness positively impact the willingness to switch to EVPTS. These results align with previous studies by Wang, Wang, and Yang (2020) and Tran et al. (2023) but contrasts with the findings of Vafaei-Zadeh et al. (2022), which found that perceived usefulness did not affect the intention to purchase EVs. The discrepancy can be attributed to the focus of Vafaei-Zadeh et al. (2022) on individuals' intentions to purchase EVs, where usefulness may not be a direct predictor due to other potential hindrances such as perceived price value and perceived risk. In this study, the transition to using EVPTS likely mitigates or eliminates these hindrances, thereby confirming the relationship between perceived usefulness, perceived inconvenience, environmental personal norms, and the willingness to switch.

### *6.2. Theoretical Implications*

This research offers several important theoretical contributions. Firstly, it addresses a significant gap in the existing literature by exploring the factors that drive the shift from private vehicles to EVPTS. Based on the approach of perceived functional/beneficial attributes of EVPTS and individuals' pro-environmental characteristics, we have combined TAM and NAM models and added other variables to contribute to the theory of consumer behavior. Unlike previous studies on pro-environmental behavior, this study selectively adapts the TPB-NAM model and adds the variable of "Perceived inconvenience" to propose a more tailored research model for understanding the shift towards EVPTS. Our findings confirm how the perceived attributes of benefits (including both advantages of EVPTS and disadvantages of personal conveyance) as well as individuals' pro-environmental characteristics affect Vietnamese people's willingness to switch to EVPTS. The results of this research offer valuable insights into the mindset of potential customers for EVPTS. These individuals prioritize environmental protection as a core life principle and are cognizant of the drawbacks associated with personal vehicle use. Consequently, they recognize the significant benefits of EVPTS (such as electric buses, electric taxis, and electric motorbike taxis), which address both their personal needs and broader societal and environmental benefits.

Lastly, our study further reveals the crucial role of environmental personal norms and perceived inconvenience of private transportation in fostering individuals' perceptions of the usefulness of EVPTS and, subsequently, their intention to switch. These findings contribute to our understanding of how perceived benefits of EV and individuals' pro-environmental characteristics influence the adoption of sustainable transportation. Furthermore, they offer practical implications for vendors and policymakers in promoting green mobility and developing sustainable urban transportation systems.

### *6.3. Policy Implications*

Vietnam currently holds strong commitments to combating climate change and striving to achieve Sustainable Development Goal (SDG) 11: "Sustainable Cities and Communities," which includes guaranteeing affordable housing, sustainable transport systems, protecting cultural heritage, reducing pollution and environmental impact, and developing safe, accessible public green spaces (United Nation, 2015). Thus, the findings of this research hold a pivotal role for policymakers and vendors to inform a holistic transport system transformation strategy and drive sustainable development in Vietnam toward achieving SDG 11. Our proposed solutions focus on two main aspects.

First, the government should enhance public awareness regarding traffic and environmental pollution issues. Given that environmental concerns significantly influence the development of pro-environmental norms, it is essential for the government and stakeholders to address the adverse effects of excessive emissions from personal vehicles, including their contributions to traffic congestion, atmospheric pollution, human health issues, and overall economic performance. Additionally, public awareness campaigns should highlight the benefits of electric public transport in addressing both environmental and social challenges, as well as the specific advantages it offers to individual transportation users.

Second, a fundamental solution is to ensure that EVs offer clear advantages over gasoline-powered personal vehicles. Initially, EV manufacturers and suppliers must address inherent issues related to batteries, such as lifespan, charging time, and range per charge, to enhance the economic viability for electric passenger transport service providers. Additionally, advancements should continue in fuel-saving technology and efforts to reduce harmful particulate matter emissions, which can be generated by tire friction and braking (Kosmidis et al., 2023).

Third, the government plays an indispensable role in translating citizens' intentions into actual behavioral change through the implementation of targeted policies and programs. In 2022, the Vietnamese government established a national action roadmap for the transition to green energy and the reduction of carbon and methane emissions within the transport sector. As part of this roadmap, urban transport is expected to achieve full electrification of buses and taxis by 2050, while the modal share of public passenger transport is projected to reach at least 40% in special urban areas and 10% in class I urban areas (Prime Minister, 2022). However, with the rapid advancement of the EV industry (Nguyen et al., 2024) and the accelerating development of supporting infrastructure, major cities such as Hanoi are already pursuing more ambitious targets. Hanoi is actively developing a fully electric, door-to-door public transport system that integrates various EV-based modes - including urban railways, electric taxis, electric motorbikes, and electric buses - into a cohesive network (Hieu, 2025). This model demonstrates strong potential for replication in other Class I cities across Vietnam, suggesting that the national electrification timeline for urban transport could be expedited well ahead of the 2050 target. To facilitate this acceleration, however, the government must clearly define specific objectives and implementation plans for developing electric public transport systems in urban areas. This includes identifying priority modes of electric public transport (such as electric buses, taxis, motorbikes, and railways) based on local contexts and needs, as well as introducing both financial and non-financial incentive mechanisms to support EVPTS adoption among service providers and passengers.

Fourth, to enable the accelerated electrification of urban transport and advance broader sustainable development objectives, it is critical to address the primary barriers to EV adoption in general and EVPTS in particular. First, collaboration among government authorities, relevant agencies, and the private sector is essential to establish a comprehensive urban green transport infrastructure. This effort should encompass the development and deployment of fast-charging technologies to minimize waiting times for EV users, as well as the improvement of charging stations, bus stops, and parking facilities in urban areas. Establishing efficient and accessible networks for public EVs, including fast-charging stations, dedicated bus stops, and parking infrastructure, will be foundational to supporting widespread adoption. In addition, the government must ensure the adequacy and sustainability of the power supply required to operate the national EV system. If the domestic electricity mix remains heavily reliant on fossil fuels, concerns about the environmental performance and "cleanliness" of EVs will persist. Therefore, it is imperative to accelerate the expansion of renewable energy sources, particularly solar energy, to replace fossil fuels and provide a genuinely clean electricity supply for the electric public transport sector.

Finally, to create a truly sustainable green transport system, the government must balance the growth of the EV industry with responsible management of non-renewable natural resources used in battery production, such as nickel, lithium, graphite, cobalt, copper, aluminum, and steel (Kosmidis et al., 2023), aligning with the country's sustainable development strategy.

## **7. LIMITATIONS AND FUTURE COPEs**

This study has noteworthy limitations. First, it employed cross-sectional data collected at a single point in time, which limits the ability to assess changes or shifts in respondents' perspectives. Future research could utilize longitudinal data to improve the reliability of the causal relationships identified in our research model. Second, the study's survey was conducted in a single location, the capital city of Hanoi, and future research could be extended to other small urban areas. Third, the focus of this study was primarily on two key drivers of the willingness to switch to EVPTS: personal characteristics (environmental concern, environmental personal norms) and perceived benefits

(perceived usefulness, perceived inconvenience). However, other factors such as government policies, green transport infrastructure, and social influence may also affect the willingness to switch and the behavior of using EVPTS. Future research should consider exploring these additional factors.

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**Transparency:** The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.

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Appendix 1 illustrates the measurement items in proposed research model.

**Appendix 1. Measurement items.**

Variables & items	Source
<b>Environmental Personal Norms (EPN)</b>	
EPN1. I have the obligation to reduce my CO <sub>2</sub> emissions from using petrol/Diesel vehicles.	
EPN2. Adopting EVs and reducing CO <sub>2</sub> emissions is consistent with my moral principles.	
EPN3. I would feel guilty if I do not adopt EV and try to mitigate climate change from my side.	Deka et al. (2023)
<b>Perceived Usefulness (PU):</b>	
PU1. I believe that EVPTS can improve traffic quality.	
PU2. I believe that the quality of the living environment improves after using EVPTS.	
PU3. EVPTS can improve my travel efficiency and improve my living quality.	Chen (2016) and Vafaei-Zadeh et al. (2022)
<b>Perceived Inconvenience (PIN):</b>	
PIN1. I feel inconvenient to drive my vehicle since the road conditions are complex	
PIN2. I feel inconvenient to look for a place to park.	
PIN3. I feel inconvenient to maintain my vehicle.	Wang, Wang, Yang, et al. (2020)
<b>Environmental Concern (EC):</b>	
EC1. I think environmental problems are becoming more serious in recent years.	
EC2. I think human beings should live in harmony with nature to achieve sustainable development.	
EC3. I think we are not doing enough to save scarce natural resources from being used up.	
EC4. I think individuals have the responsibility to protect the environment.	Wang et al. (2016)
<b>Willingness to Switch (WIS):</b>	
WIS1. I am willing to shift to EVPTS for traveling to work/Study.	
WIS2. I am willing to shift to EVPTS to shopping.	
WIS3. I am willing to shift to EVPTS for other purposes to alleviate environmental problems.	Wang, Wang, and Yang (2020)

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