






“Environmentally friendly transportation use in Vietnam: Behavioral and policy drivers”

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ENVIRONMENTALLY FRIENDLY TRANSPORTATION USE IN VIETNAM: BEHAVIORAL AND POLICY DRIVERS

Abstract

This study aims to investigate the behavioral and policy drivers of environmentally friendly transportation use in Vietnam by integrating environmental economics with behavioral theories of pro-environmental action. Primary data were collected through a structured online and in-person survey conducted across Vietnam's northern, central, and southern regions between March and December 2025. The survey targeted respondents with regular daily travel activities to ensure a relevant transportation experience, and 538 valid responses were retained after data screening for analysis. Data were analyzed using PLS-SEM with SmartPLS software. The results show that behavioral intention is the strongest direct predictor among the examined factors of environmentally friendly transportation use ($\beta = 0.472, p < 0.001$), followed by perceived behavioral control ($\beta = 0.283, p < 0.001$) and benefits awareness ($\beta = 0.108, p < 0.001$). Attitude, subjective norm, and personal norm also exert significant positive effects on behavioral intention. Government policies, environmental awareness, and awareness of consequences positively shape personal norms, with government policies exerting the strongest effect ($\beta = 0.450, p < 0.001$). In addition, service availability and willingness to pay enhance perceived behavioral control, while ease of use strengthens benefits awareness. These findings highlight that environmentally friendly transportation adoption in Vietnam depends on the joint effects of behavioral motivation, normative influence, and structural feasibility, suggesting that integrated policy approaches are essential for promoting sustainable mobility in developing economies.

Keywords

transportation, sustainability, behavioral intention,
policy, benefits awareness, Vietnam

JEL Classification

Q51, Q58, R41

INTRODUCTION

Transportation systems play a critical role in economic development by facilitating mobility, trade, and social interaction. At the same time, transportation activities are among the most significant sources of environmental degradation, greenhouse gas emissions, and urban air pollution worldwide. According to the International Energy Agency (2025), road transport accounts for the largest share of transport-related CO₂ emissions globally, highlighting the environmental costs associated with motorized mobility. In rapidly developing economies, rising incomes, rapid urbanization, and changing lifestyles often accelerate motorization and travel demand faster than the expansion of sustainable mobility infrastructure and environmental governance capacity, thereby deepening the tension between economic growth, social welfare, and environmental sustainability.

In this context, encouraging environmentally friendly transportation has emerged as an important policy objective aligned with the broader goals of sustainable development, encompassing environmental protection, economic efficiency, and social well-being. Environmentally friendly transportation, such as public transport, non-motorized trav-

el, and low-emission vehicles, not only reduces environmental externalities but also contributes to improvements in public health and long-term economic efficiency (OECD, 2021; WHO, 2022). Nevertheless, the effectiveness of such strategies depends fundamentally on individual transportation use behavior, rather than solely on technological availability, infrastructure investment, or system-level optimization, which have traditionally dominated transport policy interventions (Turan et al., 2024).

Environmental economics increasingly emphasizes the importance of behavioral factors in shaping environmentally relevant decisions, including transportation choices. Beyond traditional price-based instruments, individuals' attitudes, social norms, and perceived behavioral control significantly influence environmental behavior, including energy consumption, waste management, and transportation choices (Gifford & Nilsson, 2014; Steg, 2023). At the same time, public policies, service availability, and economic constraints, such as willingness to pay, interact with these behavioral drivers, either enabling or constraining the translation of environmental awareness into actual behavior, particularly in developing-country contexts.

Vietnam provides a compelling case for examining these issues. As one of Southeast Asia's fastest-growing economies, Vietnam faces mounting environmental pressures from rapid motorization, urban congestion, and deteriorating air quality, particularly in major cities such as Hanoi and Ho Chi Minh City (WHO, 2023; World Bank, 2022). While the government has introduced various policy initiatives to promote sustainable transportation and environmental protection, including public transport development and low-emission mobility strategies, the adoption and continued use of environmentally friendly transportation options remain limited and uneven across population groups (World Bank, 2024). This situation highlights the importance of gaining deeper insights into the behavioral and policy-related mechanisms shaping environmentally friendly transportation use in order to inform environmental and economic policymaking.

1. LITERATURE REVIEW AND HYPOTHESES

Existing studies have increasingly examined environmentally friendly transportation use through the lens of environmental economics and behavioral theories. Prior research highlights that transportation-related environmental behavior is shaped by a combination of psychological determinants, social influences, and contextual factors, rather than by technological or infrastructural conditions alone. Accordingly, the following review synthesizes key theoretical and empirical contributions related to behavioral determinants, policy influences, and economic constraints underlying environmentally friendly transportation use.

Personal norm represents an individual's internalized moral obligation to engage in a behavior, independent of external social pressure. This concept originates from the norm activation model (NAM) developed by Schwartz (1977), which has been widely applied to explain pro-environmental behaviors. In the context of environmentally

friendly transportation, personal norms reflect feelings of moral responsibility to reduce environmental impacts and contribute to sustainable mobility (Nordlund & Garvill, 2003). Empirical evidence shows that personal norms exert a significant influence on behavioral intention, complementing attitudinal and social determinants (Bamberg et al., 2007). Integrating the theory of planned behavior (TPB) and NAM perspectives, this study posits that individuals with stronger personal norms toward environmental protection are more likely to intend to use environmentally friendly transportation modes.

Attitude reflects an individual's overall positive or negative evaluation of performing a specific behavior and is a core determinant in the theory of planned behavior (Ajzen, 1991). Prior research consistently indicates that favorable attitudes toward sustainable transportation strengthen behavioral intention (Bamberg & Möser, 2007). From an environmental economics perspective, such attitudes reflect internalized environmental preferences that reduce the perceived disutility of

adopting environmentally friendly transportation alternatives, particularly in developing-country contexts (Gifford & Nilsson, 2014).

Subjective norm refers to perceived social pressure from significant others, such as family members, peers, or society at large, to perform or refrain from a particular behavior (Ajzen, 1991). In transportation behavior, subjective norms capture the extent to which individuals believe that environmentally friendly travel choices are socially expected or socially approved. Prior research indicates that subjective norms play an important role in shaping behavioral intention toward pro-environmental transportation, particularly in collectivist societies where social conformity and interpersonal influence are strong (Bamberg & Möser, 2007). Empirical evidence from Asian and emerging economies further suggests that individuals are more likely to intend to use public transport or low-emission vehicles when they perceive strong social endorsement of such behaviors (Heath & Gifford, 2002; Ng & Phung, 2021).

Behavioral intention reflects an individual's readiness or willingness to perform a given behavior and is widely recognized as the most immediate predictor of actual behavior (Ajzen, 1991). In transportation research, behavioral intention has consistently been shown to translate into actual travel choices, particularly when situational constraints are not prohibitive (Bamberg et al., 2003). Evidence from Vietnam and other emerging contexts further indicates that psychological readiness serves as a key mediating factor between cognitive evaluations and actual behavior (Bui et al., 2026). Accordingly, this study expects behavioral intention to directly influence environmentally friendly transportation use behavior, while acknowledging that structural and cognitive drivers may also exert direct effects on behavior.

Benefits awareness refers to individuals' recognition of the environmental, economic, and health benefits associated with environmentally friendly transportation. From an environmental economics perspective, benefits awareness facilitates the internalization of positive externalities that would otherwise be undervalued in private decision-making (Tietenberg & Lewis, 2018). Prior studies show that individuals who clearly perceive such benefits

are more likely to adopt sustainable transportation, even when facing certain costs or inconveniences (Rezvani et al., 2015). Unlike attitude, which reflects overall evaluative judgments, benefits awareness captures a more concrete and cognitive recognition of tangible outcomes, such as cost savings, health improvements, and environmental gains. In routine transportation decisions, particularly in developing-country contexts, salient perceived benefits may directly motivate actual behavior without necessarily strengthening behavioral intention. Accordingly, this study conceptualizes benefits awareness as a direct determinant of environmentally friendly transportation use behavior.

Perceived behavioral control (PBC) reflects individuals' perceptions of their ability to perform a behavior, taking into account available resources, opportunities, and constraints (Ajzen, 1991). In transportation contexts, PBC captures factors such as accessibility, affordability, time availability, and personal capability to use environmentally friendly transport modes. Empirical studies confirm that higher perceived behavioral control enhances actual sustainable transportation behavior, particularly when structural constraints are salient (Heath & Gifford, 2002). In developing-country contexts such as Vietnam, perceived behavioral control often reflects objective and structural constraints, including service availability, infrastructure quality, and financial affordability, rather than purely psychological readiness. Under such conditions, individuals may express a positive intention to use environmentally friendly transportation even when their perceived control is limited. However, actual adoption only occurs when enabling conditions are present. Recent empirical evidence from Vietnam indicates that perceptions of service quality, reliability, and structural feasibility exert a direct influence on actual behavior, even when favorable attitudes or behavioral intentions are already formed (Bui et al., 2026). Accordingly, the present study conceptualizes perceived behavioral control as a direct determinant of environmentally friendly transportation use behavior, emphasizing the role of structural feasibility in constrained mobility environments.

Government policies constitute an important external driver shaping pro-environmental norms and behaviors. Policy instruments such as regu-

lations, subsidies, information campaigns, and infrastructure investments can signal societal priorities and reinforce moral obligations toward environmental protection by strengthening personal and social norms (Klößner, 2013). Previous research further suggests that supportive government policies strengthen individuals' personal norms by legitimizing environmental goals and reducing moral ambiguity regarding sustainable behaviors (Zhang et al., 2013). Beyond their instrumental role in providing incentives or reducing practical barriers, government policies also function as moral and normative signals that define environmentally friendly transportation as a socially responsible and ethically desirable choice. By clearly articulating societal expectations and collective environmental commitments, such policies primarily reinforce individuals' internalized moral obligations rather than merely shaping attitudes or perceived behavioral control. Accordingly, policies promoting public transport, low-emission vehicles, and sustainable mobility can enhance individuals' moral commitment to environmentally friendly transportation use.

Awareness of consequences reflects individuals' understanding of the negative environmental and social impacts resulting from unsustainable transportation behaviors. According to NAM, awareness of consequences is a prerequisite for activating personal norms (Schwartz, 1977). Studies in environmental behavior literature show that individuals who recognize the adverse consequences of private car use, such as air pollution, congestion, and climate change, are more likely to feel morally obliged to adopt environmentally friendly transportation alternatives (Bamberg et al., 2007).

Environmental awareness refers to individuals' general knowledge and concern about environmental issues. Environmental awareness is a key antecedent of personal norms in the NAM framework, as it heightens individuals' sensitivity to environmental issues (Schwartz, 1977). Empirical evidence consistently indicates that individuals with higher environmental awareness are more likely to develop strong moral obligations to engage in pro-environmental behaviors, including sustainable transportation choices (Nordlund & Garvill, 2003).

Beyond normative and economic considerations, characteristics related to service design and usability also play an important role in shaping individuals' perceptions of the benefits associated with environmentally friendly transportation. Ease of use refers to the extent to which environmentally friendly transportation is perceived as simple, convenient, and effortless. Drawing from technology acceptance and consumer behavior theories, ease of use enhances perceived benefits by lowering cognitive and practical barriers (Davis, 1989). In transportation research, ease of use, such as simple ticketing systems, clear information, and user-friendly services, has been found to increase perceived benefits and positive evaluations of sustainable transport modes (Lai & Chen, 2011).

Willingness to pay reflects individuals' readiness to incur monetary costs for environmentally friendly transportation, such as higher fares or vehicle prices. From an environmental economics perspective, willingness to pay represents the monetization of environmental preferences and perceived benefits (Hanemann, 1991). Studies show that higher willingness to pay reduces perceived financial barriers and enhances perceived behavioral control, thereby increasing the likelihood of adopting sustainable transportation options (Rezvani et al., 2015).

Service availability reflects the extent to which environmentally friendly transportation options are accessible in terms of coverage, frequency, and reliability. Availability is a critical determinant of perceived behavioral control, particularly in urban transport systems (Redman et al., 2013). Empirical studies further indicate that improvements in service availability enhance individuals' perceived ability to use public or low-emission transport modes, thereby facilitating sustainable transportation behavior (Beirão & Sarsfield Cabral, 2007; Paulssen et al., 2014).

Integrating TPB and NAM, behavioral intention serves as a partial mediating mechanism through which attitudinal and normative factors influence actual behavior. Prior research confirms that intention mediates the effects of attitude, subjective norm, and personal norm on environmentally relevant behaviors, including transportation choices (Klößner, 2013). Building on this inte-

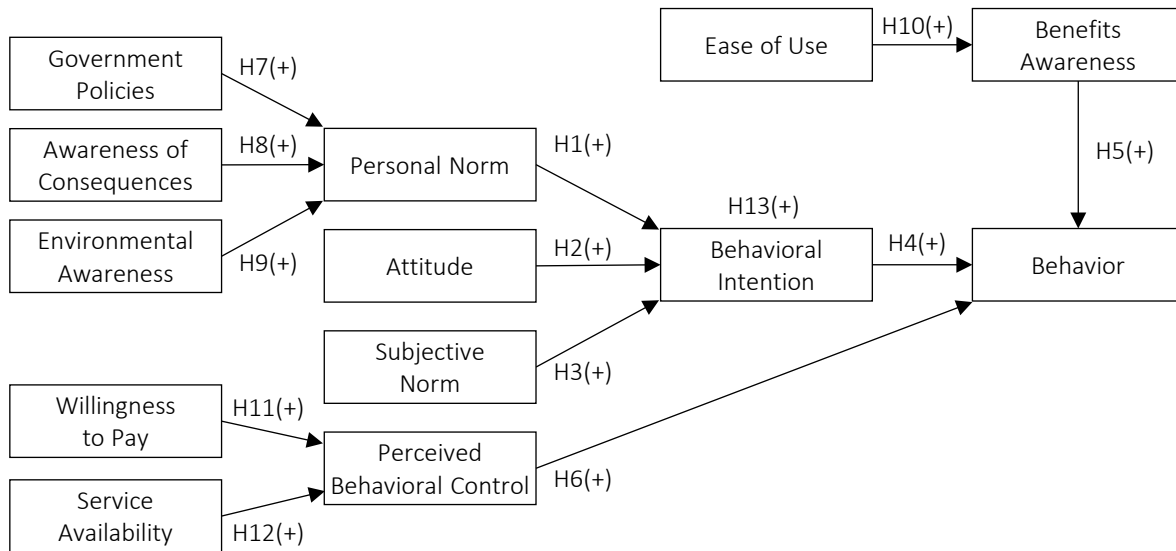


Figure 1. Proposed structural model

grated theoretical foundation, the present study proposes an extended framework that reflects the behavioral realities of environmentally friendly transportation use in a developing-country context such as Vietnam. Compared with the original TPB, perceived behavioral control is conceptualized as a direct determinant of behavior rather than intention, acknowledging the dominance of structural and infrastructural constraints that may prevent intentions from being translated into action. In addition, benefits awareness is incorporated as a distinct behavioral driver to capture the role of internalizing positive environmental, economic, and health externalities beyond general attitudinal evaluation. Government policies are further modeled as antecedents of personal norms, emphasizing their moral and normative signaling effects in legitimizing environmentally friendly transportation as a socially responsible choice. These theoretical adaptations enhance the contextual relevance and explanatory power of the proposed model.

The purpose of this study is to examine the behavioral and policy-related determinants of environmentally friendly transportation use in Vietnam by integrating environmental economics and behavioral theories. Accordingly, the study empirically assesses how attitudes, personal and social norms, perceived behavioral control, policy influences, and economic constraints jointly shape actual transportation use behavior (Figure 1). Drawing on environmental

economics and behavioral theories of pro-environmental action, this study develops a parsimonious set of hypotheses to explain environmentally friendly transportation use in Vietnam, as follows:

- H1: Personal norm positively affects behavioral intention to use environmentally friendly transportation.*
- H2: Attitude positively affects behavioral intention to use environmentally friendly transportation.*
- H3: Subjective norm positively affects behavioral intention to use environmentally friendly transportation.*
- H4: Behavioral intention positively affects environmentally friendly transportation use behavior.*
- H5: Benefits awareness positively affects environmentally friendly transportation use behavior.*
- H6: Perceived behavioral control positively affects environmentally friendly transportation use behavior.*
- H7: Government policies positively affect personal norms toward environmentally friendly transportation use.*

- H8: *Environmental awareness positively affects personal norm toward environmentally friendly transportation use.*
- H9: *Awareness of consequences positively affects personal norm toward environmentally friendly transportation use.*
- H10: *Ease of use positively affects benefits awareness of environmentally friendly transportation.*
- H11: *Willingness to pay positively affects perceived behavioral control.*
- H12: *Service availability positively affects perceived behavioral control.*
- H13: *Behavioral intention mediates the effects of personal norm, attitude, and subjective norm on environmentally friendly transportation use behavior.*

2. METHODOLOGY

This study employs a quantitative research design using a survey of individuals in Vietnam to examine the determinants of environmentally friendly transportation use. A survey-based approach is appropriate because the key constructs in the proposed model, including attitude (AT), personal norm (PN), subjective norm (SN), perceived behavioral control (PBC), benefits awareness (BA), behavioral intention (BI), and actual transportation behavior (USE), are latent and perceptual in nature. These behavioral and normative constructs cannot be directly observed through secondary data sources such as traffic statistics or administrative records, and therefore require standardized multi-item measurement scales for reliable empirical assessment.

The analytical framework integrates insights from environmental economics and behavioral research on pro-environmental action, drawing on intention-based mechanisms proposed by Ajzen (1991) and norm-oriented processes developed by Schwartz (1977). From an environmental economics perspective, environmentally friendly transportation use is conceptualized as an indi-

vidual decision involving trade-offs between private costs, perceived benefits, and the internalization of environmental externalities. Behavioral theories complement this perspective by explaining how attitudes, social expectations, moral obligations, and perceived feasibility influence transportation choices beyond purely price-based considerations. Consistent with this integrated framework, behavioral intention is modeled as a proximal determinant of actual behavior, while perceived behavioral control and benefits awareness are specified as direct behavioral drivers reflecting structural constraints and benefit salience in a developing-country context.

All constructs included in the questionnaire were operationalized through multiple indicators derived and refined from the existing literature on environmental behavior and sustainable transportation. A five-point Likert scale was used to capture respondents' evaluations for all measurement items, with response options ranging from 1 ("strongly disagree") to 5 ("strongly agree"). The target population consists of individuals who regularly engage in daily transportation activities, including commuting, education-related travel, and personal mobility. Data were collected in Vietnam through a structured questionnaire administered between March 2025 and December 2025. Questionnaires were distributed via both online and in-person channels to capture respondents from diverse regions and socioeconomic backgrounds. Respondents were recruited using a non-probability convenience sampling approach targeting individuals who regularly engage in daily mobility activities. Participation was voluntary, responses were anonymous, and informed consent was obtained from all participants prior to the survey. The dataset was utilized solely for academic research purposes. After screening for missing values and inconsistent responses, a total of 538 valid responses were retained for statistical analysis.

The final sample size of 538 observations exceeds the minimum sample size recommended for PLS-SEM analysis. Methodological studies indicate that PLS-SEM is well-suited for analyzing complex models with multiple constructs and mediation effects and can produce reliable results with relatively small samples compared to covariance-

Table 1. Characteristics of the survey respondents

Category	Sub_category	Frequency	Percent (%)
Gender	Male	237	44.1
	Female	301	55.9
Age	Under 25	147	27.3
	25–45	264	49.1
	Over 45	127	23.6
Education Level	Below high school	36	6.7
	High school	104	19.3
	Colleges and universities	249	46.3
	Postgraduate	149	27.7
Income (Million VND)	Under 10	165	30.7
	10–20	230	42.8
	20–30	106	19.7
	Over 30	37	6.9
Job	Business owner	59	11.0
	Private sector employee	189	35.1
	Public sector employee	95	17.7
	Public sector leader	58	10.8
	Student	101	18.8
	Housewife	30	5.6
	Other	6	1.1
Location	Northern	154	28.6
	Central	195	36.2
	Southern	189	35.1

Note: N = 538.

based SEM (Hair et al., 2017, 2021). Therefore, the sample size used in this study is considered sufficient to ensure reliable parameter estimation and hypothesis testing.

An analytical approach based on PLS-SEM was adopted, and the analyses were conducted using SmartPLS. Measurement quality was evaluated in terms of indicator reliability, internal consistency, and discriminant validity. Subsequent analyses examined structural relationships, explained variance, and the mediating role of behavioral intention, with the significance of direct and indirect effects assessed via bootstrapping.

Table 1 demonstrates substantial demographic and socioeconomic diversity of the study sample. Female respondents accounted for 55.9% of the sample, while males represented 44.1%. Respondents aged 25–45 constituted the largest age group (49.1%), followed by those aged under 25 (27.3%) and those aged 45 or older (23.6%). In terms of education level, 46.3% of the sample held college or university degrees, while 27.7% held postgraduate qualifications. Monthly income levels were concentrated in the 10–20 million VND

range (42.8%). The sample also includes a wide range of occupations, such as private- and public-sector employees, business owners, students, and other groups, reflecting diverse mobility needs. Geographically, respondents were relatively evenly distributed across northern (28.6%), central (36.2%), and southern (35.1%) regions of Vietnam, allowing for variation in transportation infrastructure and service conditions. This demographic diversity is consistent with the study's focus on individuals who regularly engage in daily mobility activities, ensuring the behavioral relevance of the sample for analyzing transportation use.

3. RESULTS

The reliability and convergent validity of the measurement model are reported in Table 2. All measurement items showed factor loadings above commonly accepted benchmarks, supporting the adequacy of indicator reliability. The Cronbach's alpha values range from 0.826 to 0.937, while composite reliability (CR) values range from 0.877 to 0.950, confirming strong internal consistency reliability across all constructs (Hair et al., 2017, 2021).

Moreover, the AVE values for all constructs indicate adequate convergent validity, ranging from 0.589 to 0.765. These results provide clear evidence of adequate convergent validity, indicating that each construct explains a substantial proportion of the variance in its corresponding indicators (Hair et al., 2017). Taken together, the results indicate that the measurement model exhibits acceptable levels of reliability and con-

vergent validity, providing a solid foundation for evaluating the structural relationships.

Discriminant validity was assessed using HTMT statistics, as reported in Table 3. The findings suggest that most construct pairs demonstrate adequate distinctiveness. Although three HTMT values slightly exceed the conservative threshold of 0.85, all values remain below the more liberal

Table 2. Summary of reliability and convergent validity results

Constructs	Code	Outer loadings	Cronbach's Alpha	CR	AVE
Personal Norm (PN)	PN1	0.807	0.826	0.877	0.589
	PN2	0.751			
	PN3	0.724			
	PN4	0.754			
	PN5	0.797			
Attitude (AT)	AT1	0.876	0.900	0.926	0.716
	AT2	0.825			
	AT3	0.839			
	AT4	0.880			
	AT5	0.807			
Subjective Norm (SN)	SN1	0.862	0.912	0.932	0.694
	SN2	0.828			
	SN3	0.833			
	SN4	0.854			
	SN5	0.776			
	SN6	0.843			
Behavioral Intention (BI)	BI1	0.803	0.833	0.889	0.667
	BI2	0.812			
	BI3	0.794			
	BI4	0.856			
Benefits Awareness (BA)	BA1	0.709	0.859	0.899	0.641
	BA2	0.804			
	BA3	0.830			
	BA4	0.824			
	BA5	0.828			
Perceived Behavioral Control (PBC)	PBC1	0.777	0.869	0.905	0.656
	PBC2	0.834			
	PBC3	0.789			
	PBC4	0.837			
	PBC5	0.811			
Government Policies (GP)	GP1	0.786	0.852	0.894	0.629
	GP2	0.776			
	GP3	0.779			
	GP4	0.828			
	GP5	0.795			
Awareness of Consequences (AC)	AC1	0.778	0.828	0.886	0.661
	AC2	0.861			
	AC3	0.762			
	AC4	0.845			
Environmental Awareness (EA)	EA1	0.825	0.886	0.916	0.687
	EA2	0.836			
	EA3	0.828			
	EA4	0.826			
	EA5	0.829			

Table 2 (cont.). Summary of reliability and convergent validity results

Constructs	Code	Outer loadings	Cronbach's Alpha	CR	AVE
Ease of Use (EU)	EU1	0.874	0.859	0.905	0.705
	EU2	0.851			
	EU3	0.752			
	EU4	0.874			
Willingness to Pay (WP)	WP1	0.869	0.898	0.929	0.765
	WP2	0.892			
	WP3	0.881			
	WP4	0.858			
Service Availability (SA)	SA1	0.867	0.937	0.950	0.761
	SA2	0.857			
	SA3	0.876			
	SA4	0.883			
	SA5	0.868			
	SA6	0.884			
Behavior (USE)	USE1	0.818	0.877	0.911	0.671
	USE2	0.830			
	USE3	0.803			
	USE4	0.819			
	USE5	0.823			

Note: CR = Composite reliability; AVE = Average variance extracted.

threshold of 0.90, which is commonly accepted for conceptually related constructs in behavioral research (Hair et al., 2017; Henseler et al., 2014). Given the close conceptual relationships among attitudinal, awareness-related, and behavioral constructs in models of environmentally friendly transportation use, these marginal exceedances do not indicate a lack of construct distinctiveness. Overall, the results provide sufficient evidence of discriminant validity for the measurement model, supporting subsequent structural model analysis.

Prior to hypothesis testing, collinearity among the predictor constructs was assessed using variance inflation factors (VIFs). The results indicate that all VIF values range from 1.000 to 3.046, which are well below the commonly recommended threshold of 5.0 (Hair et al., 2017). The highest VIF value is observed for subjective norm (VIF = 3.046), while most constructs exhibit VIF values below 2.5. The findings indicate that collinearity among the predictor constructs does not pose a substantive issue, thereby ensur-

Table 3. Discriminant validity of the measurement model (HTMT)

Variable	AC	AT	BA	BI	EA	EU	GP	PBC	PN	SA	SN	USE	WP
AC													
AT	0.592												
BA	0.837	0.717											
BI	0.612	0.870	0.691										
EA	0.851	0.597	0.788	0.632									
EU	0.710	0.656	0.825	0.639	0.636								
GP	0.749	0.758	0.769	0.761	0.693	0.783							
PBC	0.621	0.839	0.706	0.754	0.555	0.762	0.739						
PN	0.681	0.769	0.780	0.771	0.675	0.684	0.790	0.722					
SA	0.463	0.707	0.548	0.696	0.534	0.568	0.683	0.689	0.658				
SN	0.594	0.844	0.700	0.846	0.577	0.645	0.804	0.808	0.840	0.714			
USE	0.539	0.851	0.639	0.837	0.566	0.569	0.702	0.746	0.660	0.668	0.755		
WP	0.564	0.574	0.548	0.594	0.556	0.652	0.724	0.626	0.602	0.531	0.600	0.459	

Note: PN = Personal Norm; AT = Attitude; SN = Subjective Norm; BI = Behavioral Intention; BA = Benefits Awareness; PBC = Perceived Behavioral Control; GP = Government Policies; AC = Awareness of Consequences; EA = Environmental Awareness; EU = Ease of Use; WP = Willingness to Pay; SA = Service Availability; USE = Behavior.

Table 4. Summary of direct hypothesis testing results

Hypotheses	Structural paths	Path coefficient (β)	P Values	Conclusion
H1	PN \rightarrow BI	0.129	0.004	Supported
H2	AT \rightarrow BI	0.418	0.000	Supported
H3	SN \rightarrow BI	0.325	0.000	Supported
H4	BI \rightarrow USE	0.472	0.000	Supported
H5	BA \rightarrow USE	0.108	0.010	Supported
H6	PBC \rightarrow USE	0.283	0.000	Supported
H7	GP \rightarrow PN	0.450	0.000	Supported
H8	AC \rightarrow PN	0.125	0.039	Supported
H9	EA \rightarrow PN	0.224	0.000	Supported
H10	EU \rightarrow BA	0.714	0.000	Supported
H11	WP \rightarrow PBC	0.327	0.000	Supported
H12	SA \rightarrow PBC	0.464	0.000	Supported

Note: PN = Personal Norm; AT = Attitude; SN = Subjective Norm; BI = Behavioral Intention; BA = Benefits Awareness; PBC = Perceived Behavioral Control; GP = Government Policies; AC = Awareness of Consequences; EA = Environmental Awareness; EU = Ease of Use; WP = Willingness to Pay; SA = Service Availability; USE = Behavior.

ing the robustness of the estimated structural relationships.

The structural model was evaluated by examining the estimated path relationships, the model's explanatory power (R^2 and adjusted R^2), and the significance of direct and indirect effects derived from resampling. The results of the direct hypothesis tests are summarized in Table 4.

The results indicate that attitude (AT) exerts the strongest positive effect on behavioral intention (BI) ($\beta = 0.418$, $p < 0.001$), followed by subjective norm (SN) ($\beta = 0.325$, $p < 0.001$) and personal norm (PN) ($\beta = 0.129$, $p = 0.004$). In addition, government policies (GP) ($\beta = 0.450$, $p < 0.001$), environmental awareness (EA) ($\beta = 0.224$, $p < 0.001$), and awareness of consequences (AC) ($\beta = 0.125$, $p = 0.039$) have significant positive effects on personal norm.

Regarding environmentally friendly transportation use behavior (USE), behavioral intention shows the strongest direct influence ($\beta = 0.472$, $p < 0.001$), followed by perceived behavioral control (PBC) ($\beta = 0.283$, $p < 0.001$) and benefits awareness (BA) ($\beta = 0.108$, $p = 0.010$). Moreover, ease of use (EU) strongly enhances benefits awareness ($\beta = 0.714$, $p < 0.001$), while service availability (SA) ($\beta = 0.464$, $p < 0.001$) and willingness to pay (WP) ($\beta = 0.327$, $p < 0.001$) significantly improve perceived behavioral control. Overall, the structural model results provide empirical support for all proposed direct hypotheses, highlighting the important roles of attitudinal, normative, awareness-

related, and control-related factors in shaping behavioral intention and environmentally friendly transportation use behavior.

Table 5 reports the results of the indirect and mediation effects examined using a bootstrapping procedure. The majority of the proposed indirect pathways are statistically significant, with only two indirect effects found to be non-significant.

With respect to the indirect effects on behavioral intention, environmental awareness exerts a significant indirect effect through personal norm (EA \rightarrow PN \rightarrow BI; $\beta = 0.029$, $p = 0.024$), as does government policies (GP \rightarrow PN \rightarrow BI; $\beta = 0.058$, $p = 0.008$). In contrast, the indirect effect of awareness of consequences on behavioral intention via personal norm is not statistically significant (AC \rightarrow PN \rightarrow BI; $p = 0.100$).

Regarding environmentally friendly transportation use behavior, behavioral intention plays a significant mediating role. Specifically, behavioral intention significantly mediates the relationships between attitude and behavior (AT \rightarrow BI \rightarrow USE; $\beta = 0.197$, $p < 0.001$), personal norm and behavior (PN \rightarrow BI \rightarrow USE; $\beta = 0.061$, $p = 0.005$), and subjective norm and behavior (SN \rightarrow BI \rightarrow USE; $\beta = 0.153$, $p < 0.001$), thereby supporting Hypothesis H13.

In addition, environmental awareness (EA \rightarrow PN \rightarrow BI \rightarrow USE; $\beta = 0.014$, $p = 0.027$) and government policies (GP \rightarrow PN \rightarrow BI \rightarrow USE; $\beta = 0.027$, $p = 0.009$) exhibit significant indirect effects on behavior through the sequential pathway of personal norm

Table 5. Summary of indirect hypothesis testing results

Hypotheses	Structural paths	Path coefficient (β)	P Values	Conclusion
Not hypothesized	AC \rightarrow PN \rightarrow BI	0.016	0.100	Not supported
Not hypothesized	EA \rightarrow PN \rightarrow BI	0.029	0.024	Supported
Not hypothesized	GP \rightarrow PN \rightarrow BI	0.058	0.008	Supported
Not hypothesized	EU \rightarrow BA \rightarrow USE	0.077	0.010	Supported
H13	AT \rightarrow BI \rightarrow USE	0.197	0.000	Supported
Not hypothesized	AC \rightarrow PN \rightarrow BI \rightarrow USE	0.008	0.108	Not supported
Not hypothesized	EA \rightarrow PN \rightarrow BI \rightarrow USE	0.014	0.027	Supported
H13	PN \rightarrow BI \rightarrow USE	0.061	0.005	Supported
Not hypothesized	GP \rightarrow PN \rightarrow BI \rightarrow USE	0.027	0.009	Supported
H13	SN \rightarrow BI \rightarrow USE	0.153	0.000	Supported
Not hypothesized	SA \rightarrow PBC \rightarrow USE	0.131	0.000	Supported
Not hypothesized	WP \rightarrow PBC \rightarrow USE	0.093	0.000	Supported

Note: PN = Personal Norm; AT = Attitude; SN = Subjective Norm; BI = Behavioral Intention; BA = Benefits Awareness; PBC = Perceived Behavioral Control; GP = Government Policies; AC = Awareness of Consequences; EA = Environmental Awareness; EU = Ease of Use; WP = Willingness to Pay; SA = Service Availability; USE = Behavior.

and behavioral intention. By contrast, the sequential indirect effect of awareness of consequences through personal norm and behavioral intention is not supported (AC \rightarrow PN \rightarrow BI \rightarrow USE; $p = 0.108$).

Finally, the results confirm the mediating roles of benefits awareness and perceived behavioral control. Benefits awareness mediates the relationship between ease of use and behavior (EU \rightarrow BA \rightarrow USE; $\beta = 0.077$, $p = 0.010$), while perceived behavioral control mediates the effects of service availability (SA \rightarrow PBC \rightarrow USE; $\beta = 0.131$, $p < 0.001$) and willingness to pay (WP \rightarrow PBC \rightarrow USE; $\beta = 0.093$, $p < 0.001$) on environmentally friendly transportation use behavior. Overall, the indirect effect results demonstrate that most of the proposed mediation mechanisms are empirically supported, with only two indirect pathways involving awareness of consequences failing to reach statistical significance.

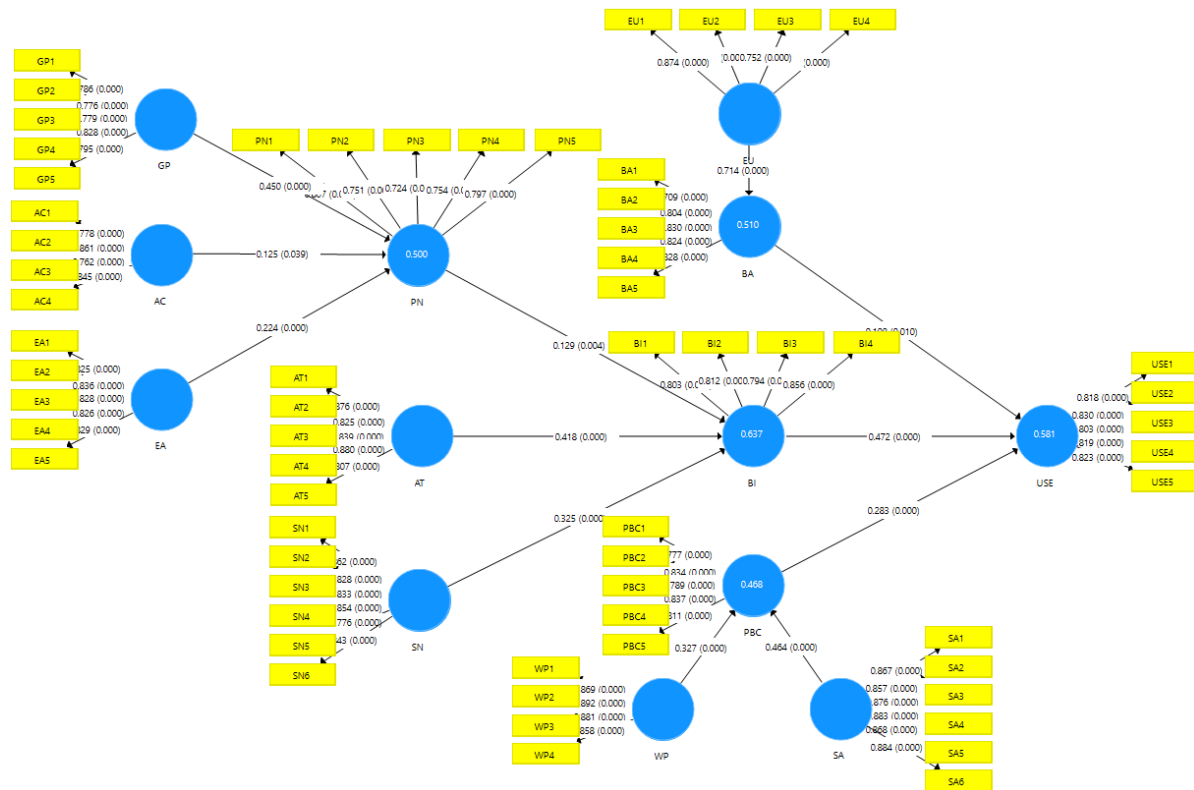
Table 6. Coefficients of determination

Construct	R ²	Adjusted R ²
Benefits Awareness (BA)	0.510	0.510
Behavioral Intention (BI)	0.639	0.637
Perceived Behavioral Control (PBC)	0.470	0.468
Personal Norm (PN)	0.503	0.500
Environmentally Friendly Transportation Use (USE)	0.583	0.581

Table 6 reports the coefficients of determination for the endogenous constructs in the structural model. The results show that the model explains a considerable share of variance in the key endogenous variables. Specifically, behavioral intention and environmentally friendly

transportation use behavior exhibit R² values of 0.639 and 0.583, respectively, indicating strong explanatory performance for the core behavioral outcomes. Furthermore, the antecedent constructs explain 51.0% of the variance in benefits awareness and 50.3% of the variance in personal norm, while 47.0% of the variance in perceived behavioral control is explained by service availability and willingness to pay. The close correspondence between R² and adjusted R² values suggests that the estimated relationships are stable and not unduly influenced by model complexity. Overall, the R² estimates confirm that the model captures a substantial proportion of variance in the endogenous constructs associated with environmentally friendly transportation use.

The empirical findings summarized in Figure 2 indicate that the proposed research framework is well supported by the data. The assessment of the measurement component confirms that the latent constructs are measured with adequate consistency and distinctiveness. The structural model results indicate that the specified predictors have statistically significant direct and indirect effects on behavioral intention and environmentally friendly transportation use behavior. In addition, the mediation analysis confirms the presence of multiple significant indirect pathways, while the coefficients of determination show that the model explains a substantial proportion of variance in the key endogenous constructs.



Note: PN = Personal Norm; AT = Attitude; SN = Subjective Norm; BI = Behavioral Intention; BA = Benefits Awareness; PBC = Perceived Behavioral Control; GP = Government Policies; AC = Awareness of Consequences; EA = Environmental Awareness; EU = Ease of Use; WP = Willingness to Pay; SA = Service Availability; USE = Behavior.

Figure 2. Confirmed research model

4. DISCUSSION

This study contributes to the environmental economics and sustainable mobility literature by empirically validating an integrated behavioral-policy framework explaining environmentally friendly transportation use in Vietnam. The proposed model explains 63.9% of the variance in behavioral intention and 58.3% of the variance in actual use behavior, indicating that motivational, normative, and feasibility-related factors jointly contribute to environmentally friendly transportation decisions in developing-country contexts.

Consistent with the theory of planned behavior, behavioral intention is the strongest direct predictor of environmentally friendly transportation use ($\beta = 0.472, p < 0.001$). This result aligns with prior evidence on transport behavior, indicating that intention is the most immediate determinant of actual mode choice when individuals face repeated daily travel decisions (Bamberg et al., 2003; Gardner & Abraham, 2008; Klöckner & Blöbaum, 2010). From an environmental economics perspec-

tive, intention can be interpreted as the individual's "readiness to internalize" the perceived social and environmental externalities associated with transport, translating preferences and norms into a behavioral plan. However, the presence of additional statistically significant direct behavioral drivers, particularly perceived behavioral control and benefits awareness, indicates that intention alone is insufficient when structural constraints and perceived payoffs remain salient.

Attitude exerts the strongest effect on intention ($\beta = 0.418, p < 0.001$), followed by subjective norm ($\beta = 0.325, p < 0.001$) and personal norm ($\beta = 0.129, p = 0.004$). The prominence of attitude is strongly consistent with TPB and meta-analytic findings in pro-environmental behavior and travel mode choice (Bamberg & Möser, 2007; Lanzini & Khan, 2017). In Vietnam, favorable evaluations of environmentally friendly modes likely reflect perceived co-benefits (reduced stress, cost savings, health, and environmental quality), which increase the utility of "green" choices beyond purely monetary considerations.

The relatively strong role of subjective norm is also consistent with evidence that social pressure and perceived approval can be particularly influential in collectivist or community-oriented settings (Heath & Gifford, 2002; Klöckner, 2013). Notably, the magnitude of the subjective norm effect in this study suggests that policy and communication strategies that leverage peer comparison, social endorsement, and community narratives (e.g., “responsible commuting”) may be effective complements to infrastructure-based interventions. This result is directionally consistent with prior Vietnamese evidence on public transport intention (Ng & Phung, 2021), reinforcing that social influence remains a critical lever for shifting mobility preferences.

Personal norm is statistically significant but weaker than attitude and subjective norm. This result suggests that although moral obligation toward environmental protection plays a role, day-to-day transport decisions are often habitual and strongly influenced by convenience. As a result, personal norms typically need to be reinforced by supportive contextual cues, such as clear policy signals, accessible services, and salient personal benefits, in order to translate into actual travel behavior.

Perceived behavioral control has a sizable direct effect on use behavior ($\beta = 0.283$, $p < 0.001$). This result supports the study’s contextual adaptation, indicating that in constrained mobility environments, feasibility conditions such as availability, affordability, and reliability shape behavior directly rather than operating solely through behavioral intention. This is consistent with transport research, which emphasizes that service quality and accessibility can attract (or deter) users regardless of pro-environmental attitudes (Beirão & Sarsfield Cabral, 2007; Redman et al., 2013). The significant mediated pathways further clarify how feasibility is formed, showing that service availability ($\beta = 0.464$, $p < 0.001$) and willingness to pay ($\beta = 0.327$, $p < 0.001$) significantly increase perceived behavioral control, and both have meaningful indirect effects on use via PBC (SA \rightarrow PBC \rightarrow USE; $\beta = 0.131$; WP \rightarrow PBC \rightarrow USE; $\beta = 0.093$; both $p < 0.001$). These results are particularly relevant to environmental economics, as they indicate that “soft” preference-based interventions (information, norm nudges) will have limited impact if the opportunity set re-

mains constrained (insufficient coverage, low reliability, or high perceived cost). Conversely, improving service supply and affordability can relax constraints, increasing the probability that intentions translate into repeated use.

Benefits awareness has a statistically significant direct effect on use behavior ($\beta = 0.108$, $p = 0.010$). Although this effect is smaller than those of behavioral intention and perceived behavioral control, it remains theoretically important. From an environmental economics perspective, the adoption of environmentally friendly options depends on individuals’ ability to recognize and internalize positive externalities, such as cleaner air, reduced congestion, and public health improvements, which are not fully reflected in private costs and benefits (Tietenberg & Lewis, 2018). This finding suggests that emphasizing concrete and personally relevant benefits, including health outcomes, time reliability, financial savings, and comfort, can encourage actual use even when general environmental concern is relatively diffuse.

Ease of use strongly predicts benefits awareness ($\beta = 0.714$, $p < 0.001$), and the mediated effect EU \rightarrow BA \rightarrow USE is significant ($\beta = 0.077$, $p = 0.010$). This aligns with the technology acceptance and service design literature, which suggests that lower cognitive and practical friction (simple ticketing, clear information, seamless interchanges) increases perceived value (Davis, 1989; Lai & Chen, 2011; Venkatesh et al., 2012). For Vietnam, where mixed-mode commuting is common and time costs are salient, usability improvements may be an efficient policy lever because they enhance perceived benefits without necessarily requiring large capital investment relative to major infrastructure expansion.

Government policies exert the strongest effect on personal norm ($\beta = 0.450$, $p < 0.001$), followed by environmental awareness ($\beta = 0.224$, $p < 0.001$) and awareness of consequences ($\beta = 0.125$, $p = 0.039$). This result supports the argument that policies do more than change prices or provide infrastructure. They also function as normative signals that legitimize environmentally friendly transportation as a morally appropriate and socially expected choice (Klöckner, 2013; Steg et al., 2014; Stern, 2000). Notably, environmental awareness and government policies have significant in-

direct effects on intention and behavior through personal norm and behavioral intention (e.g., GP \rightarrow PN \rightarrow BI; EA \rightarrow PN \rightarrow BI; and sequential pathways to USE), suggesting a coherent moral-intentional mechanism.

Results indicate that awareness of consequences does not exert a significant indirect influence on behavioral intention via personal norm (AC \rightarrow PN \rightarrow BI; $p = 0.100$), and the extended sequential pathway to use behavior is likewise non-significant (AC \rightarrow PN \rightarrow BI \rightarrow USE; $p = 0.108$). A plausible interpretation is that the consequences of conventional travel, such as air pollution, congestion, and climate risks, are widely recognized but psychologically normalized. As a result, they may raise moral concern without substantially strengthening behavioral intention beyond the effects of attitude and subjective norms. This pattern has been noted in broader pro-environmental behavior research where problem awareness alone is insufficient unless accompanied by efficacy, feasible alternatives, and salient personal relevance (De Groot & Steg, 2009; Steg & Vlek, 2009).

The mediation analysis confirms that behavioral intention significantly mediates the effects of attitude, subjective norm, and personal norm on use behavior, reinforcing the TPB logic while extending it with NAM-type moral pathways. At the same time, the direct roles of PBC and benefits awareness demonstrate that in Vietnam, structural feasibility and benefit salience are not merely background conditions but active determinants of adoption. This finding has a clear policy implication. Effective sustainable transport strategies should be designed as “behavior-constraint packages” that combine service availability and affordability, usability improvements, and norm-based policy communication.

In sum, the findings highlight that environmentally friendly transportation transitions in developing economies require simultaneously addressing preferences (attitude), social influence (subjective norms), moral motivation (personal norms shaped by policy signals), and constraints (perceived behavioral control shaped by service availability and willingness to pay).

CONCLUSION

The purpose of this study is to examine the behavioral and policy-related determinants of environmentally friendly transportation use in Vietnam. The findings highlight that environmentally friendly transportation adoption in Vietnam is shaped by the interaction between motivational, normative, and structural feasibility factors. While pro-environmental attitudes and internalized moral norms provide an important motivational foundation, actual behavior is strongly conditioned by whether individuals perceive environmentally friendly options as feasible and associated with salient perceived benefits in their daily mobility decisions.

These findings further suggest that sustainable transportation behavior cannot be explained solely by environmental concern or moral awareness. Perceived accessibility, affordability, and usability of transportation services, reflecting service availability, willingness to pay, and ease of use, play a decisive role in enabling individuals to translate pro-environmental intentions into actual behavior. In this respect, government policies contribute not only by improving infrastructure and service provision, but also by reinforcing personal norms through normative signaling and legitimizing environmentally responsible transportation choices.

Overall, the findings imply that effective sustainable transport policies should adopt an integrated approach that simultaneously addresses behavioral intention formation and perceived behavioral control. Investments in service availability and affordability should be combined with user-oriented design improvements and communication strategies that strengthen social norms, enhance benefits awareness, and signal a strong, consistent policy commitment to environmental goals.

This study relies on cross-sectional data, which constrains causal interpretation of the observed relationships. Employing longitudinal or experimental research designs would allow for a more robust ex-

amination of behavioral change over time. In addition, further studies may explore heterogeneity across income groups, urban-rural settings, or transport modes, as well as incorporate objective measures of service quality and environmental outcomes. These extensions would deepen understanding of sustainable mobility transitions and support more targeted policy design in emerging economies.

AUTHOR CONTRIBUTIONS

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