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# The Role of Market Insights in Shaping Sustainable Mobility in Fast Developing Countries: The Case of Vietnam

**Pietro Lanzini *, Tra Thu Nguyen and Debora Slanzi**

Department of Management, Venice School of Management, Ca' Foscari University of Venice, Cannaregio 873, 30121 Venice, Italy; thutra.nguyen@unive.it (T.T.N.); debora.slanzi@unive.it (D.S.)
* Correspondence: pietro.lanzini@unive.it

**Abstract:** Individual mobility represents one of the main contributors of air quality degradation in urban areas, with detrimental social and environmental impacts as well as economic loss. Mobility policies hence represent a key public instrument to curb congestion, pollution and health-related problems. In order to be effective, they need to rely on an adequate knowledge of demand, in terms of commuters' attitudes, habit strength and perceived priorities. While most studies on the determinants of modal choice are rooted in Western countries or in developed economies little evidence is available for fast-developing countries, whose urban areas suffer from severe congestion and bad air quality. We test a comprehensive model to predict mobility behaviors in Vietnam, by means of an empirical investigation, with data from 898 participants (N = 898) collected via an online self-administered questionnaire. We discuss the implications for policy of the research findings, which provide an informational background representing a necessary prerequisite for the implementation of sound policies for the shift to more sustainable paradigms.

**Keywords:** structural equation modeling; sustainable mobility; travel mode choice



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## 1. Introduction

Transport sector is one of the main contributors to climate change, accounting for 23% of total global $CO_2$ emission [1], almost half of which produced by road vehicles including two wheelers (2 Ws) and light duty vehicles. Numerous actors and stakeholders play a role in the shift toward more sustainable mobility paradigms [2], ranging from the automotive industry and private actors (e.g., enhancing the fuel-efficiency of conventional engines, engineering new electric vehicles (EVs), or investing in the recently trending mobility sharing services), to local authorities promoting sustainable mobility in urban areas (e.g., through new infrastructures, improved public transportation (PT) systems, or economic measures such as congestion charges), or even policy makers at national and international level (by means of taxes, standards and regulations). Specifically, citizens play a key role, since "the sustainability of transport systems is significantly affected by people's travel behaviour and transport mode choice" [3] (p. 11). We argue that, while individual attitudes and habits are essential elements for the success of any sustainable mobility policy or commercial strategy [4], policy makers and businesses often lack adequate interest in analyzing in depth the real motives underpinning modal choices, with most surveys focusing merely on actual behaviors (so as to provide a snapshot of what commuters already do) or generic levels of satisfaction for existing services (PT systems, availability of parking spaces, and so on).

It is, on the contrary, crucial to shed light on citizens' psychological determinants of travel mode choice: shifting the focus from investigating the what (actual behaviors and satisfaction) to analyzing the why, as only the latter approach holds significant potential to provide an adequate understanding of which levers to act in order to change individual behaviors and make them consistent with envisaged goals. Indeed, psychological aspects

proved to be more effective than infrastructural changes in predicting transport mode choice [5], so that they should be increasingly leveraged by policy makers in devising pro-environmental strategies.

Although there is a growing body of literature on the psychological factors affecting transport mode choice, a shortcoming of the available evidence is represented by the fact that most existing research has been conducted in Western countries [6] or developed economies such as Japan [7], while little has been investigated in developing countries, where most of the world population lives. Indeed, with the exception of China, which was put under the spotlight by recent research [8–11], other smaller yet fast-developing nations have been left mostly unexplored.

Fast-developing countries will play an ever-increasing role on the international stage, with higher shares of global GDP mainly at the expense of Western countries [12]. From a sustainability perspective, it is worth stressing how, along with economic development and an increasing middle class enjoying unprecedented standards of living, also come relevant environmental and health-related consequences of such a rapid development, often coupled with high levels of urbanization [13] leading to the disordered growth of urban areas, the congestion of roads, and the degradation of air quality. Developing countries are, indeed, "expected to experience an economic growth over the next years and decades which is likely to increase the footprint of communities living in the area, given more affluent production and consumption patterns" [14] (p. 271).

In urban areas, these effects are going to strike the hardest, as the combination of fast urbanization and (among other factors) the subsequent increase in the circulating fleet pose serious problems not only to the environment at large, but also to human health.

Fast-developing countries present strikingly different characteristics when compared to their developed counterparts, such as a lack of adequate infrastructure supporting sustainable means of transport: lower quality and availability of PT systems, fewer designated bike lanes or sidewalks, fewer or no mobility-sharing services (e.g., bike-sharing, scooter-sharing), and so on. Further, most of the time, they lack those environmental standards that are typical of developed countries and that might limit the polluting effects of fast development and motorization. Not only institutions, but also citizens (facing serious issues such as poverty eradication or adequate healthcare provision) tend to pay less attention to climate change and sustainability issues, which are often perceived as distant and not impellent problems.

Indeed, while the concern for environmental degradation and its consequences is slowly becoming a global phenomenon that now permeates different societies and cultures around the globe, and different views emerged on the relationship between economic development and environmental awareness [15], most literature suggests that the latter is more salient in affluent societies and developed countries [16,17]: this is consistent with well-established theoretical frameworks, such as the Theory of Postmaterialism [18] or the so-called Affluence Hypothesis [19], assuming a direct link between affluence and environmental concern and awareness. The empirical evidence backing the assumption that economic development triggers environmental concern and awareness is robust, and corroborated by cross-national studies based on ad hoc-indexes, such as for instance the Environmental Awareness Index, or EAI [20]. The work is based on a survey on sustainability-related attitudes and willingness to act distributed in 57 countries, and confirms the strong correlation between environmental awareness of citizens and national wealth. Likewise, the Peoples' Climate Vote [21] (the largest survey on public opinion on sustainability and climate change, with 1.2 million respondents from 50 countries) confirms that Western countries and developed economies show greater awareness for the problems connected with sustainability, compared to developing countries.

This is further demonstrated by looking at the UN's funding allocations towards each sustainable development goal (SDG) in developing nations, as in Vietnam, climate change related goals (e.g., climate action, sustainable cities and communities, responsible

consumption and production) receive much less attention and funding than good health and well-being, gender equality, and no poverty [22].

Overall, the vast differences between developed and developing world, together with the rapidly increasing private vehicle ownership in the latter, given their rising middle class, demonstrate the need for further research on factors behind individuals' transport mode choice in such national and cultural contexts.

The paper thus contributes to the existing literature by examining the determinants of transport mode choice in Vietnam (one of the fastest-growing developing economies in Asia), prerequisite for the implementation of effective commercial strategies and sound mobility policies [23]. To this aim, the paper is structured as follows: Section 2 reviews extant literatures and theoretical frameworks on psychological determinants of transport mode choice; Section 3 focuses on mobility in Vietnam, providing the rationale for the choice of the study's empirical setting; Section 4 describes the methodology; Section 5 illustrates and discusses the main results of the analysis; Section 6 illustrates the policy implications that might derive from the emerging evidence; Section 7 concludes the paper by illustrating some of the limitations of the study, along with avenues for future research.

## 2. Theoretical Frameworks on Travel Mode Choice

Several theoretical frameworks have been adopted to investigate transport mode choice, with various degrees of complexity and predictive capability. Among them, three main streams of research can be observed, focusing on egoistic drivers, altruistic drivers, and habits, respectively [24].

The first stream of research originates from the Theory of Planned Behavior (TPB) [25], which eventually experienced further refinements and integrations so as to increase its predictive capability. TPB holds that attitudes, subjective norms and perceived behavioral control (PBC) are antecedents of behavioral intentions which, in turn, mediate their impacts and are the best predictors of actual behaviors. Attitudes represent the (positive or negative) predisposition of individuals towards a specific behavior or, in other words, the personal desirability of it. Subjective norms, on the other hand, reflect social pressure—what people believe their referent individuals or social groups expect them to do. Thirdly, since often behaviors are not under volitional control, PBC reflects the perception of how difficult or easy it is to perform a specific behavior [25].

TPB has been widely applied to analyze the determinants of travel mode choice [24] and, to enhance its explanatory power, several authors attempted to integrate into the original model other variables such as personal norms [26], descriptive norms [27], or environmental concerns [28].

The second stream of research focuses on the feelings of moral obligation and their impacts on behaviors. The Norm-Activation Model (NAM) [29] states that behaviors are driven by personal norms, which are the "feelings of moral obligation to perform or retain from specific actions" [30] (p. 191). Personal norms are activated by situational variables consisting of problem awareness (also known as awareness of consequences) and ascription of responsibility. While the former measures the extent to which a person is aware of the adverse consequences of not acting virtuously, the latter represents personal feelings of responsibility and accountability for such negative outcomes. The Value-Belief-Norm Theory (VBN) [31,32] represents an extension of NAM and proposes that behaviors are driven by five variables linked by a causal chain: values, beliefs, awareness of consequences, ascription of responsibility, and personal norms. "Each variable in the chain directly affects the next; each may also directly affect variables farther down the chain" [32] (p. 86).

While NAM and VBN theories have been extensively adopted in empirical investigations on travel mode choice, they appear to be less effective compared to TPB [24,33]. According to Lanzini and Khan, while environmental variables (i.e., awareness of consequences, problem awareness, ascription of responsibility, environmental concern, and environmental values) emerge as relevant predictors of the intentions to select sustainable

means of transport, they only play a negligible role in predicting actual travel mode choices, suggesting a deep intention-behavior gap [24].

Whereas all aforementioned theories are based on a rationalistic perspective claiming that behaviors are the outcome of an elaborated cognitive process, there is a third stream of research asserting that such process usually becomes deactivated when the activity has become habitual and the individual performs it almost automatically [34,35]. "When habits arise, conscious planning gets deactivated, norms and attitudes see their role in shaping behaviors weakened, and consideration of alternatives and the processing of information about them are no longer in place" [36] (p. 36). Ronis and colleagues also claimed that the effect of habits on behaviors is independent of intentions, and repeated behaviors might be largely determined by habits rather than by attitudinal variables, even though attitudes are central to the formation as well as modification of habits (theory of repeated behavior) [37].

Habit is connected to but is not limited to past behavior: they represent two different constructs, with the latter being a necessary yet not sufficient condition for the development of the former. More specifically, to become a habit, a behavior needs to not only be performed in the past, but also to satisfy the key characteristics namely goal-orientation, repetition, automaticity, and stable contexts. In other words, habits are defined as repeated, goal-directed behaviors which have become automatic responses in recurrent and stable contexts [38]. As this definition entails, habit is a complex psychological construct rather than purely past behavior frequency; hence, it should be operationalized in a more elaborate manner. Some common methods of measuring habits, in increasing order of complexity and sophistication, are the response-frequency measure of habit [39] and the Self-Reported Habit Index [40].

Since mobility behaviors are usually performed repeatedly in stable contexts and decisional settings, habit is a particularly relevant variable, and has been widely adopted to examine transport mode choice [24,33]. In many studies, however, habit was not analyzed on its own, but in combination with other variables from the previously illustrated rationalistic theoretical frameworks.

Indeed, growing awareness on the complexity of the drivers' underpinning behaviors are triggered by different variables (both rational and automaticity-related), whose salience might vary depending on the subject and the context. Acknowledging that both rational cognitive processes and habits represent critical drivers of behaviors, many authors attempted to integrate them into new, and comprehensive theoretical frameworks.

Triandis proposed the theory of interpersonal behavior (TIB) where habits and intentions interact in predicting behaviors [35,41]. In more detail, the theory claims that habits can mediate the impacts of intentions on behaviors: the stronger the habit, the weaker the intention–behavior relationship.

Secondly, the Attitude-Behavior-Context (ABC) framework assumes that behavior is an interactive product of attitudinal (intrinsic) variables and contextual (extrinsic) factors [42]. The theory states that the stronger are the contextual factors' impacts, the weaker the attitude-behavior association is. According to the synthesis of Stern, the ABC model encompasses four types of causal variables: attitudinal factors, contextual forces, personal capabilities, and habits [31].

Most recently, Klöckner and Blöbaum proposed and tested the Comprehensive Action Determination Model (CADM): the model combines and utilizes TPB, NAM, habits, as well as some objective situational constraints and facilitators to explain sustainable behaviors [43]. It argues that pro-environmental behaviors are influenced by intentional, habitual, and situational forces; additionally, intentional and habitual forces are in turn affected by normative processes like social or personal norms. In short, the theory incorporates the indirect normative impacts and the direct intentional, habitual, and situational impacts on sustainable behaviors. Acknowledging the need to combine all three main streams of research into a clear, coherent, and comprehensive framework and inspired by the CADM of Klöckner and Blöbaum [43], our paper proposes a simplified research model (Figure 1) with the following hypotheses:

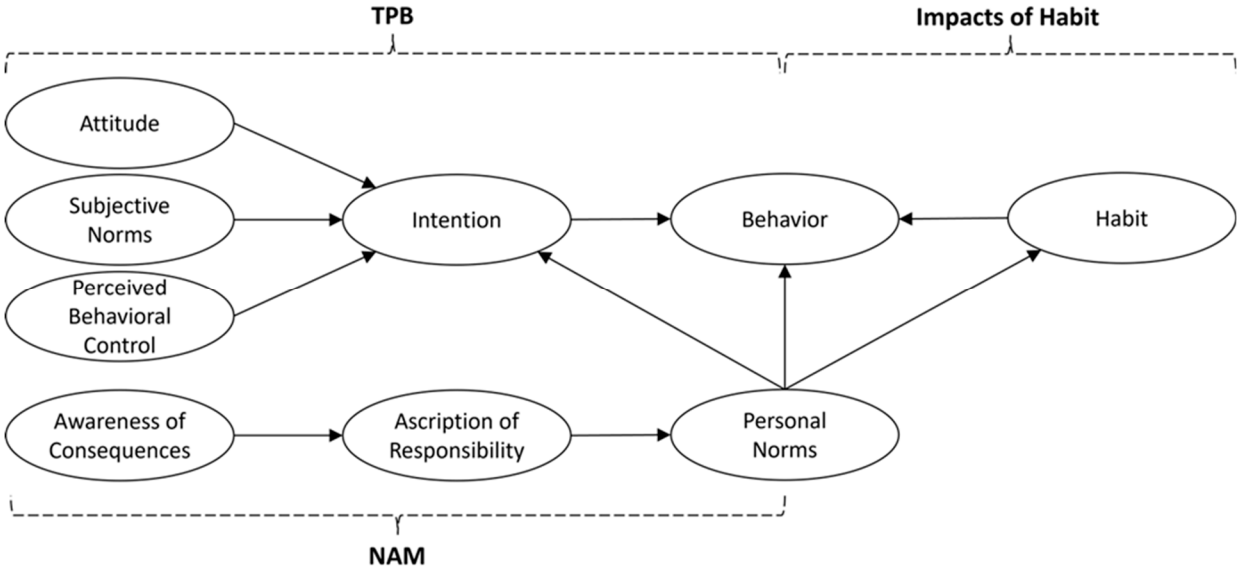


**Figure 1.** The proposed model.

TPB-related hypotheses:

**Hypothesis 1 (H1):** *Positive attitudes towards green transport modes lead to higher intention to use these modes.*

**Hypothesis 2 (H2):** *Positive subjective norms towards green transport modes lead to higher intention to use these modes.*

**Hypothesis 3 (H3):** *Higher perceived behavioral control over green transport modes results in higher intention to use these modes.*

**Hypothesis 4 (H4):** *Higher intention to use green transport modes results in higher actual use of these modes (i.e., actual behaviors).*

NAM-related hypotheses:

**Hypothesis 5 (H5):** *Individuals' awareness of the adverse consequences of car/motorcycle transport positively correlates with their ascription of personal responsibility for such negative outcomes.*

**Hypothesis 6 (H6):** *Individuals' ascription of responsibility positively correlates with their personal norms on transport mode choice.*

**Hypothesis 7 (H7):** *Positive personal norms towards green transport modes lead to higher intention to use these modes.*

**Hypothesis 8 (H8):** *Positive personal norms towards green transport modes lead to higher actual use of these modes (i.e., actual behaviors).*

Habit-related hypothesis:

**Hypothesis 9 (H9):** *Stronger habits of using green transport modes result in higher actual use of these modes (i.e., actual behaviors).*

Additional, CADM-related hypotheses:

**Hypothesis 10 (H10):** *Positive personal norms towards green transport modes lead to stronger habits of using these modes.*

**Hypothesis 11 (H11):** *Personal norms towards green transport modes indirectly affect actual use of these modes through intention.*

**Hypothesis 12 (H12):** *Personal norms towards green transport modes indirectly affect actual use of these modes through habits.*

## 3. Research Setting: Vietnam

Vietnam has been selected for data collection, as it represents the ideal setting for an empirical study on sustainable mobility in fast-developing countries. With a rising population of 99 million and a steadily growing economy (the GDP more than doubled over the past ten years [44] and there is an expected GDP growth of 5.8% in 2024 and 6.9% in 2025 [44]), Vietnam is experiencing a sharp increase in the circulating fleet of private vehicles, and consequently traffic congestion, rising GHG emissions, and severe pollution. On the one hand, the increase of the middle class is broadening the market of households that can afford to purchase private cars [45], with young adults in their 20s purchasing their first car often counting on loan opportunities or the financial support of parents. On the other hand, however, brand new vehicles are still expensive for the majority of households. This leads to the flourishing of second-hand market, with old and polluting vehicles (often imported, mainly from Japan and South Korea) exacerbating air pollution [46].

For example, over the past three decades, the number of 2 Ws in Vietnam increased from 1.2 to over 58 million vehicles [47], most of which concentrated in the two major cities: Hanoi and Ho Chi Minh City. Similarly, the number of private cars doubled from around 2.5 million at the end of 2016 to almost 5 million in September 2022 [48]. The consequences on air quality in urban areas and on the environment at large are extremely relevant: the transport sector alone released over 36 million tons of GHG emissions in 2018 [49] (18% of Vietnam's total national GHG emissions [50]), contributing to the country's serious issue of air pollution which is responsible for an estimated 60,000 deaths every year [51].

The choice of Vietnam has also been guided by the fact that most existing research on psychological determinants of transport mode choice has been conducted in Western, developed countries, where also the theoretical frameworks have been originally developed and tested. In emerging Southeast Asia, for instance, to the best of authors' knowledge, only a few empirical studies have been recently conducted [52,53], mostly applying extended versions of the TPB framework to examine public transport use while other variables and theoretical models (e.g., NAM and Habits) are not included, representing a gap in the existing literature that our current study aims to fill.

## 4. Methods

### *4.1. Procedure and Participants*

To provide policy makers, practitioners and scholars with sophisticated market insights trespassing the boundaries of a merely descriptive approach, the present study proposes a comprehensive model on transport mode choice including habits on the one hand and rationality-based constructs on the other hand. The focus is on sustainable mobility, which encompasses different alternatives to internal combustion engine (ICE) private vehicles such as PT [54], active transportation [55], or EVs [56].

Adopting a convenience sample approach, an online self-administered questionnaire was distributed via social media from 19 March to 9 April 2021, targeting the population of Vietnamese citizens currently residing in Vietnam. The questionnaire was first designed in English, then translated to Vietnamese and pre-tested so as to (i) ensure that no questions were misleading, and (ii) provide general feedback on the structure of the questionnaire and its clarity. Based on the pre-testing phase, the questionnaire was fine-tuned and uploaded

on Qualtrics. The final sample (after deleting incomplete responses and responses that failed attention checks) consisted of 898 respondents (n = 898), with a mean age of 23 and a high prevalence of citizens living in large cities; the sample is consistent with the envisaged goal of analyzing younger generations living in urban areas, and is representative of a country with a very young population, with around 50% of citizens being under 30 years old [57]. In Table 1, some socio-demographic characteristics of the sample are presented.

**Table 1.** Socio-demographic characteristics of participants.

| Socio-Demographic Variables | | Frequency | Percentage |
|---|---|---|---|
| Gender | Male | 185 | 20.6% |
| | Female | 709 | 79.0% |
| | Prefer not to answer | 4 | 0.4% |
| Age | ≤19 | 203 | 22.6% |
| | 20–29 | 584 | 65.0% |
| | 30–39 | 55 | 6.1% |
| | ≥40 | 24 | 2.7% |
| | Prefer not to answer | 32 | 3.6% |
| Education | High school or below | 63 | 7.0% |
| | Bachelor's degree | 740 | 82.4% |
| | Master's degree | 76 | 8.5% |
| | PhD | 12 | 1.3% |
| | Others | 7 | 0.8% |
| Student | Yes | 668 | 74.4% |
| | No | 230 | 25.6% |
| Income | Below the average income | 163 | 18.2% |
| | In line with the average income | 644 | 71.7% |
| | Over the average income | 65 | 7.2% |
| | Prefer not to answer | 26 | 2.9% |
| Area of living | Urban | 760 | 84.6% |
| | Suburban | 108 | 12.0% |
| | Rural | 30 | 3.3% |
| Private car and/or motorcycle ownership | Yes | 638 | 71.0% |
| | No | 260 | 29.0% |

A two-step structural equation modeling (SEM) process was used to test the research hypotheses [58,59]. The SEM technique is widely used to empirically investigate theoretical frameworks that are based on traditional theories and include various complex relationships. Specifically, we firstly conducted a confirmatory factor analysis (CFA) on the measurement model to verify the construct validity, the composite reliability, and the discriminant validity of all the proposed constructs. Then, we adopted a PLS-SEM approach to explore the proposed relationships among the constructs consistently with many recent travel behavior analyses using this method [60]. Moreover, PLS-SEM was found to provide statistically reliable estimates of the inter-relationships among the constructs in complex theoretical frameworks. For an in-depth description of the theory and equations underlying the model, see [59,61,62].

All the analyses were implemented using lavaan, an R package for SEM [63].

### *4.2. Constructs*

To ensure validity and reliability of measurement scales, the paper adopted established scales from the literature, adapted when necessary to fit the current research context. Except for behaviors and demographic variables, most of the constructs were measured on a 5-point Likert scale (the complete list of questions can be obtained upon reasonable request from the authors).

As regards behaviors, past behaviors were used as a proxy for actual behaviors, consistently with mainstream studies on modal choice [26,27,64–67]. More specifically, Transport Mode Choice Behaviors (B) were measured by asking respondents to indicate in percentages how much they normally use each transport mode in their monthly travel.

As regards habits, on the other hand, Habit strength (H) was operationalized according to the Self-Report Habit Index (SRHI) proposed by Verplanken and Orbell [40], which has been adopted in a vast number of investigations on modal choice [68–72]. The original SRHI scale comprises 12 items reflecting on automaticity, frequency, and relevance to self-identity.

TPB constructs were measured according to the original questionnaire of Ajzen and slightly modified to accommodate travel mode choice research [73].

Attitudes (A) towards various transport modes were measured by asking participants to rate the use of each mode in the future on two scales: harmful–beneficial and unpleasant–pleasant.

Subjective norms (SN) were operationalized with two items: "most people who are important to me would approve that I use . . . as transport mode" (disagree–agree) and "most people like me use . . . as transport mode" (disagree–agree).

Perceived Behavioral Control (PBC) was evaluated with two items: "to me, using the following transport modes for my daily travel would be (difficult-easy)" and "whether I use the following transport modes for my daily travel is completely up to me" (disagree–agree).

Intentions (I) were also measured using two scale items: "my intention to use the following transport modes next week is (weak-strong)" and "I intend to use the following transport modes next week" (unlikely-likely).

NAM constructs were measured according to previous research on sustainable transport behavior [74], adopting a 5-point Likert scale from strongly disagree to strongly agree.

Awareness of consequences (AC) was evaluated based on the level of agreement with four statements on the negative consequences of car/motorcycle transport, specifically: "increasing use of cars/motorcycles leads to gradual depletion of fossil fuels"; "car/motorcycle transport is one of the important causes of traffic jam and related traffic accidents"; "cars/motorcycles cause traffic noise and exhaust emission, lowering the quality of city life"; and "increasing car/motorcycle traffic is a very serious problem for me and my families".

Ascription of responsibility (AR) was evaluated based on the level of agreement with two statements on personal responsibilities for problems caused by car/motorcycle: "as a driver, I bear joint liability for the gradual depletion of fossil fuel caused by car/motorcycle transport" and "car/motorcycle transport is one of the causes of global warming for which I am jointly and severely liable as a driver".

Personal norms (PN) were evaluated based on the level of agreement with the following three statements: "if I often use other modes of transport rather than car/motorcycle, I would be a more responsible person"; "when choosing among transport options, I feel that I am obliged to consider the environmental consequences of car/motorcycle transport"; and "I feel that I am morally obliged to minimize car/motorcycle usage regardless of others' behavior".

## 5. Results and Discussion

We propose a model (Figure 1) which combines habits with TPB and NAM constructs, and we adopt the SEM approach [58,59], conducting a CFA to check the measurement model. As the construct "behavior" contains one single item, its reliability and validity have not been tested and it has been considered as an observed variable [75,76].

Construct validity and composite reliability show that all estimated standardized factor loadings were statistically significant and exceeded 0.50, with the only exceptions being attitudes and PBC. Such identification problems for the TPB constructs reflect on the Cronbach's alphas, the average variance extracted (AVE) and the CR indices, while for all the other constructs, the AVE was equal to or greater than 0.50, Cronbach's alphas were greater than 0.75, and CR indices were greater than 0.75 [77,78] reflecting an adequate

degree of convergent validity and reliability. Moreover, discriminant validity was almost always supported as the AVE square root of each pair of constructs was greater than the correlation between them [59], and VIF values were all below the standard threshold values of 3 [59], thus granting the absence of multicollinearity.

Whether the scale was suitable for factor analysis was determined using the KMO value and Bartlett's test of sphericity. It was concluded that the KMO value was 0.916 (well above the 0.6 threshold) and the significance probability value was $p < 0.001$, indicating that the measurement model was suitable for factor analysis.

Table 2 presents the descriptive statistics, the correlations of all constructs and the discriminant validity, while Table 3 lists all the measurement items and reports the results of the CFA.

**Table 2.** Descriptive statistics, correlation, and discriminant validity of the constructs.

| Constructs | Mean | SD | SN | A | PBC | I | AC | AR | PN | H | VIF |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SN: Subjective Norms | 3.277 | 0.562 | (0.603) | | | | | | | | 1.27 |
| A: Attitudes | 3.136 | 0.485 | 0.506 ** | (0.608) | | | | | | | 1.12 |
| PBC: Perceived Behavior Control | 3.345 | 0.667 | 0.732 *** | 0.345 ** | (0.501) | | | | | | 1.26 |
| I: Intentions | 2.713 | 1.224 | 0.552 *** | 0.302 ** | 0.687 *** | (0.842) | | | | | 1.94 |
| AC: Awareness of Consequences | 4.160 | 0.594 | 0.146 ** | 0.098 $^{(ns)}$ | 0.183 ** | 0.127 ** | (0.692) | | | | 1.83 |
| AR: Ascription of Responsibility | 4.075 | 0.683 | 0.078 $^{(ns)}$ | 0.040 $^{(ns)}$ | 0.029 $^{(ns)}$ | 0.005 $^{(ns)}$ | 0.766 *** | (0.805) | | | 1.98 |
| PN: Personal Norms | 3.789 | 0.752 | 0.179 ** | 0.120 * | 0.167 ** | 0.174 *** | 0.570 *** | 0.688 *** | (0.795) | | 1.69 |
| H: Habits | 2.818 | 0.878 | 0.374 *** | 0.183 ** | 0.475 *** | 0.561 *** | 0.085 * | 0.013 $^{(ns)}$ | 0.226 *** | (0.763) | 1.61 |

Notes: Correlation test (two-tailed): *** $p$-value < 0.001, ** $p$-value < 0.01, * $p$-value < 0.05 level, $^{(ns)}$ Correlation is not statistically significant. Diagonal values in parentheses are values of square root of AVEs. VIF value for Behavior is 2.03.

**Table 3.** CFA results.

| Constructs | Items | Factor Loadings | Cronbach's Alpha | CR | AVE | Mean | SD |
|---|---|---|---|---|---|---|---|
| Subjective Norms | SN_1 | 0.601 | 0.531 | 0.533 | 0.364 | 3.30 | 0.65 |
| | SN_2 | 0.605 | | | | 3.26 | 0.71 |
| Attitudes | A_1 | 0.385 | 0.485 | 0.522 | 0.369 | 3.13 | 0.67 |
| | A_2 | 0.858 | | | | 3.14 | 0.52 |
| Perceived Behavior Control | PBC_1 | 0.668 | 0.344 | 0.379 | 0.251 | 3.08 | 0.80 |
| | PBC_2 | 0.313 | | | | 3.61 | 0.91 |
| Intentions | I_1 | 0.885 | 0.830 | 0.803 | 0.709 | 2.53 | 1.27 |
| | I_2 | 0.803 | | | | 2.90 | 1.37 |
| Awareness of Consequences | AC_1 | 0.615 | 0.775 | 0.785 | 0.479 | 4.18 | 0.73 |
| | AC_2 | 0.741 | | | | 4.23 | 0.77 |
| | AC_3 | 0.841 | | | | 4.34 | 0.67 |
| | AC_4 | 0.604 | | | | 3.89 | 0.89 |
| Ascription of Responsibility | AR_1 | 0.759 | 0.785 | 0.787 | 0.65 | 4.04 | 0.75 |
| | AR_2 | 0.851 | | | | 4.11 | 0.75 |
| Personal Norms | PN_1 | 0.715 | 0.832 | 0.837 | 0.632 | 3.87 | 0.87 |
| | PN_2 | 0.847 | | | | 3.79 | 0.85 |
| | PN_3 | 0.818 | | | | 3.71 | 0.89 |

**Table 3.** *Cont.*

| Constructs | Items | Factor Loadings | Cronbach's Alpha | CR | AVE | Mean | SD |
|---|---|---|---|---|---|---|---|
| Habits | H_1 | 0.784 | 0.939 | 0.942 | 0.583 | 2.98 | 1.26 |
| | H_2 | 0.833 | | | | 2.95 | 1.19 |
| | H_3 | 0.822 | | | | 2.90 | 1.17 |
| | H_4 | 0.675 | | | | 2.54 | 1.01 |
| | H_5 | 0.790 | | | | 2.77 | 1.12 |
| | H_6 | 0.415 | | | | 2.61 | 1.05 |
| | H_7 | 0.837 | | | | 2.96 | 1.21 |
| | H_8 | 0.791 | | | | 2.65 | 1.07 |
| | H_9 | 0.683 | | | | 2.65 | 1.06 |
| | H_10 | 0.763 | | | | 2.85 | 1.10 |
| | H_11 | 0.744 | | | | 2.85 | 1.06 |
| | H_12 | 0.815 | | | | 3.11 | 1.30 |

Notes: CR: composite reliability; AVE: average variance extracted; SD: standard deviation. To mitigate the difference in magnitude of Behavior values, the variable was scaled from its original value (Min = 0 and Max = 100) to the same scale as other constructs (Min = 1 and Max = 5), providing a mean value of 2.86 with SD = 1.45.

To determine the extent of method variance in the current data, we used Harman's single-factor method, and the multi-item constructs were loaded on one latent variable. Compared with the measurement model, this model had a significantly poorer fit ($\Delta\chi^2$ = 4375.3, *p*-value = 0.000), confirming that common method variance was not a major issue in our data.

A SEM was then adopted to empirically test the factors that affect sustainable mobility behaviors, which is illustrated in Figure 1. The maximum likelihood method was adopted to estimate the model, which presents very good goodness-of-fit indices that are significant in their respective model criteria: $\chi^2$(df) = 1354.939 (376), CFI = 0.931, TLI = 0.921, RMSEA = 0.054, SRMR = 0.11.

SEM results are illustrated in Figure 2 and summarized in Table 4, which reports the standardized estimated coefficients for both the direct and indirect effects hypothesized in the models.

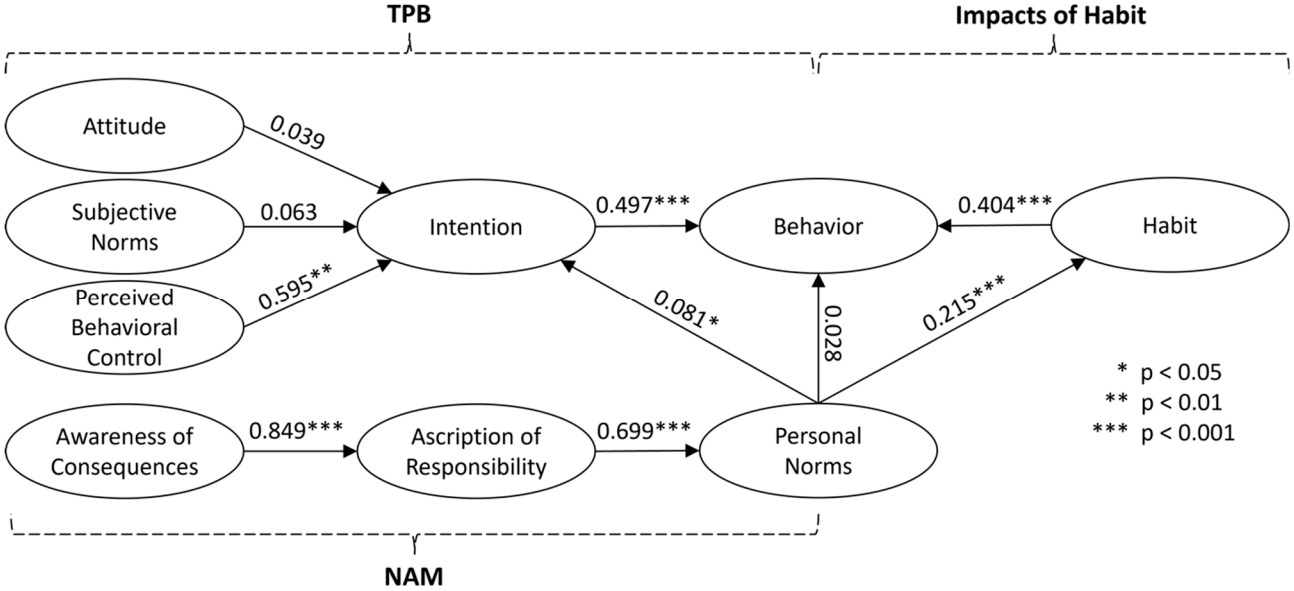


**Figure 2.** SEM results.

**Table 4.** SEM results.

| Theories | Direct Effect | Beta | SE | t-Value | *p*-Value | Hypothesis |
|---|---|---|---|---|---|---|
| TPB | H1: A → I | 0.039 | 0.246 | 0.724 | 0.469 | Not supported |
| | H2: SN → I | 0.063 | 0.509 | 0.369 | 0.712 | Not supported |
| | H3: PBC → I | 0.595 | 0.438 | 2.921 | 0.003 | Supported |
| | H4: I → B | 0.497 | 0.043 | 16.393 | 0.000 | Supported |
| NAM | H5: AC → AR | 0.849 | 0.065 | 15.563 | 0.000 | Supported |
| | H6: AR → PN | 0.699 | 0.049 | 15.486 | 0.000 | Supported |
| | H7: PN → I | 0.081 | 0.066 | 2.286 | 0.022 | Supported |
| | H8: PN → B | 0.028 | 0.075 | 1.008 | 0.313 | Not supported |
| Habit | H9: Habits → B | 0.404 | 51.000 | 14.599 | 0.000 | Supported |
| | H10: PN → Habits | 0.215 | 0.054 | 6.661 | 0.000 | Supported |
| | **Indirect Effect** | **Beta** | **SE** | **t-Value** | ***p*-Value** | **Hypothesis** |
| | H11: PN → I → B | 0.040 | 0.047 | 2.266 | 0.023 | Supported |
| | H12: PN → Habits → B | 0.087 | 0.043 | 5.359 | 0.000 | Supported |

Although results confirm that both Intentions and Habits positively correlate with and are significant antecedents of sustainable travel behaviors (H4 and H9 are supported), it emerges that Personal Norms do not have a direct influence on green mobility behaviors, while they only act indirectly via Intentions and Habits, as demonstrated by the non-significant direct effect and the positive and significant indirect effects (H8 is not supported, H7, H10, H11, and H12 are supported). This is a direct consequence of the specific situation of developing countries, having relevant policy implications, while in Western societies, there is an important (and growing) share of citizens with strong environmental concerns also guiding choices in the mobility domain, individuals in countries with lower (albeit rapidly improving) standards of living only marginally orient their modal choices based on sustainability-related arguments. As a consequence, policy makers need to frame their communication strategies as to focus on proximity benefits for commuters: that is, individuals need to feel empowered, perceiving that by adopting sound mobility behaviors not only they support a shift to more sustainable paradigms, but are primarily increasing their own convenience and comfort. Sustainability should, in other words, be an added value rather than the killing argument for convincing commuters to shift to greener modal options.

The results of the study are consistent with past findings and emphasized the importance of combining the three research streams (Habits, TPB and NAM) in predicting mobility choices.

With respect to NAM variables, our paper confirms previous findings that Awareness of Consequences significantly and positively affects Ascription of Responsibility (H5 is supported), which in turn significantly and positively influences Personal Norms (H6 is supported).

On the other hand, findings regarding TPB constructs are more unexpected: only PBC significantly affects Intention (H3 is supported), while Attitude and Subjective Norms showed no significant effect (H1 and H2 are not supported). While this questions the use of the very well-known and widely adopted TPB in predicting transport mode choice in socio-economic contexts different from those where the model was originally developed, a possible explanation for the results could be represented by the measurement of TPB constructs. It should be indeed noted that although rooted in and taken from extant research, the items (i.e., survey questions) selected to measure attitude and subjective norms had low internal consistency (as reflected by the low Cronbach's alphas). This may be a result of language or cultural differences since the items had to be translated from their original language (i.e., English) to Vietnamese; future research should thus use more items to measure each latent construct.

Despite some insignificant relationships that have been discussed, the overall model has adequate fit ($p < 0.001$, $\chi^2/df = 3.604$, TLI = 0.921, CFI = 0.931, RMSEA = 0.054), indicating that it is an effective framework for investigating pro-environmental mobility behaviors in Vietnam. Consequently, not only does this conclusion emphasize the importance of a comprehensive framework where all three research streams are combined in predicting sustainable transport mode choice, it also proves that such framework, which originated from Western and developed countries' points of view, can indeed also be applied to predict green mobility behaviors in strikingly different developing country settings.

## 6. Policy Implications

The need to shed further light on the demand side of mobility could not be overemphasized: "[a] full understanding of travel mode choice and guiding people to choose sustainable modes, such as public transportation, new-energy vehicles and cycling is the basis for mitigating the (…) negative effects and promoting a sustainable transportation system" [79] (p. 2). This is particularly relevant for contexts such as those of emerging economies where urban areas are overwhelmed by a fast-growing circulating fleet of highly polluting vehicles and where few studies investigated the specificities of the context when it comes to commuters' behavior. In Vietnamese cities, the situation is particularly critical, as the annual average concentrations of PM2.5 in Hanoi and Ho Chi Minh City (whose populations grew by over 20% over the past 10 years [80,81]) are well above what is provided for by the national standard [82,83].

The informational background obtained by the present study can be useful to frame (or, in some cases, fine tune) public policies aimed at promoting sustainable mobility patterns, or even strategies of private companies and organizations, with an interest in the shift to new, more environmentally friendly mobility paradigms.

Education and empowerment emerge as key concepts: our findings suggest that more education and awareness campaigns should be organized to enhance citizens' awareness of negative environmental consequences of private endothermic vehicles, as NAM was proven relevant and personal norms indirectly affect green mobility behaviors. Education can make individuals feel more personally responsible for protecting the environment, strengthening their personal norms, as well as the general social norms towards sustainable transport. Moreover, by providing easily comprehensible guidance on how to use green transport modes, education can also improve consumers' PBC, which was shown to positively influence sustainable mobility intention. While there is, indeed, good room for improvement, commuters not only need to be informed, they also need to be empowered and perceive that their daily behaviors can actually make a difference, and that such a difference will be beneficial for them individually, and not just for the environment or society at large. Indeed, as emerging economies face relevant socio-economic issues, a focus on the environmental benefits of sustainable transportation alone would likely fall short of effectively spurring behavioral changes in the population, consistent with studies suggesting that, in southeast Asia, "commuters of developing countries showed environmental concern as least influential [factor]" [84] (p. 6).

Next, as habits also significantly shape behaviors, attempts should be made to jump start new green transport habits from citizens. From a practical standpoint, this might translate into different policies delving either into the infrastructural (capillarity of PT systems, bike lanes, etc.) or economic (subsidized public transport fares, higher taxes on private endothermic vehicles) dimension. Besides policy makers, public and private firms could contribute to the movement: companies could encourage employees to adopt green transport modes for going to work, with various highly visible perks such as providing bicycle parking areas, offering private shuttle buses to the closest public transport connections, or combinations of similar strategies [85,86]. In short, a combination of education and awareness campaigns inducing bottom-up voluntary change, government's top-down regulatory measures, and private firms' supportive strategies would create meaningful impacts on mobility behaviors in fast developing countries like Vietnam.

While these policy recommendations may sound like common sense in Western environments, they are not obvious and are highly relevant for the case of Vietnam, where even the simplest means of transport—walking or biking—are relatively unsafe and uncomfortable; bike lanes are scant, pavements are small and very often taken advantage of by local restaurants or small businesses as extra selling or parking space. This infrastructural problem emerges also from our survey, as 70% of respondents agree that bike lanes and sidewalks in their area are either not available or inadequate. Almost a decade of government's attempts at clearing the existing pavements for pedestrians (with the first related policy dating back to 2014) showed no significant results [87] which all comes down to the problem of low citizens' awareness, and emphasizes the need for top-down regulatory measures to be coupled with educational campaigns encouraging bottom-up voluntary changes. Due to the lack of designated lanes and proper parking facilities, biking is often considered unsafe, and only 3% of the Vietnamese population use bicycles as their means of transport [88], suggesting that future investments in infrastructure are a necessary prerequisite for creating new (and enhancing existing) biking habits [89]. Given the current situation on the streets, however, one might argue that reserving spaces for bike lanes without further pushing the shift to PT would likely result in a worsening of traffic congestion. Consequently, the top priority of policy makers should be that of improving PT system: indeed, at the time of data collection, Hanoi and Ho Chi Minh City, with a population of 8.3 and 9.2 million, respectively [90], had no metro services and based their PT systems exclusively on buses. In Hanoi, a recent study focused on the inadequate coverage of the bus network, with an average distance between bus stops of around 1.1 km against a perceived acceptable walking distance of around 400–500 m [91], and most of the bus stops lacking roofs and waiting chairs [91]. Capillarity of the service, especially in peripheral areas of big cities, is a shortcoming common to many urban areas in southeast Asia [92], and is also mirrored by the results of our survey, as half of participants claimed that there are not enough bus stops and the frequency of buses is low, and 58% said the quality of PT is low. The main concern of commuters is not economic as fares are affordable and highly subsidized by the government; rather, investments should be aimed at improving the capillarity of the network and the comfort of the trip experience.

Relevant investments are nonetheless under way, like the country's first ever metro line, which recently opened in Hanoi after ten years of construction [93]. The metro also represents a good example of how transport infrastructures need time to be adequately exploited by the community; indeed, despite positive reviews on service quality, the metro line initially suffered from a severe lack of riders [93], demonstrating that supply-side investments in alternative transport modes alone are not enough and demand-side factors also need to be taken into consideration. There is a need for heavy investments on informational campaigns on the benefits of a shift to PT, as modal behaviors suffer from a strong inertia which, coupled with negative attitudes towards old public transport networks (i.e., buses) subconsciously spilling over to new opportunities, hinder the potential uptake of such solutions made available. At the time of writing (December 2023), the metro line has finally started to witness promising numbers [94].

A final word should be devoted to the electrification of mobility, which is indeed another route to achieve a switch to more sustainable mobility paradigms. In a scenario still dominated by private mobility with an ownership rate of around 70% (including cars and 2 Ws) [95], EVs are gaining shares especially in the 2 Ws market, rising from 5.4% in 2019 to 10% in 2021 [95], while in the car market, the presence of EVs is marginal as only recently the first domestic models were introduced [96]. Interestingly, VinGroup, a private Vietnamese conglomerate, is currently working on introducing modern electric buses and e-taxis to the country. EVs are likely to become more important, as Vietnamese policymakers are discussing ways to limit or restrict private vehicles in downtown areas of its five major cities after 2030 [97] and EVs might be exempted (like in other countries) from such restrictions. However, as electrification of the circulating fleet is likely to be a very long process, the envisaged plans are not viable without first raising public awareness and

increasing the capacity and quality of public transport (i.e., regular bus, rapid transit bus, elevated railway, and subway): "public transport projects must be at top priority to have a means for private vehicle use limitation", as "only when the traffic facilities are sufficient to satisfy the public needs can the policy [. . .] be adopted" [97].

## 7. Limitations and Avenues for Future Research

The paper has limitations that should be addressed by future research.

From a methodological standpoint, as previously stated, multiple items should be used to measure each latent construct and minimize biases connected with cultural and linguistic differences playing a role in the translation process. To fine-tune the research protocols, future research could indeed address the issue of Cross-Cultural Adaptation (CCA) of the questionnaire, as to deploy a sophisticated validation process ensuring that the differences of how specific questions are perceived due to cultural rather than linguistic diversity are minimized. On the other hand, since the sampling method consisted of a combination of convenience and virtual snowball sampling, it might be subject to volunteer bias [98], which might also explain gender balance issues. Indeed, as for other survey-based studies in Vietnam [99], there is an over-representation of female respondents; future research should address the issue so as to have a more balanced sample.

As a final caveat to the reader, it is also worth stressing that as the COVID pandemic spread in early 2020 heavily affected mobility and travel behaviors worldwide, the need for social distancing led to a temporary shift to individual modes (private cars, active transportation, etc.) at the expense of PT. While one may argue that the effects on modal choice might show some persistence over time, even after the end of the pandemic, the effects on the results of the present study should not be overestimated. Vietnam (unlike other countries in the area) has been only marginally struck by the pandemic, and data collection took place over one year after the end of the emergency phase. Indeed, Vietnamese cities have been praised as a virtuous example of successful handling of the pandemic, where PT policies focused on safety measures such as face masks and hand sanitizers rather than travel restrictions, and commuters showed great compliance with such measures and little changes in travel behaviors; available information confirms that commuting behaviors and public transport ridership were back to pre-pandemic numbers by the end of 2020, months before data was collected for this paper [100].

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