# INVESTIGATING THE INTENTION-BEHAVIOR GAP IN SOURCE SEPARATION OF HOUSEHOLD WASTE: A CASE STUDY IN THANH KHE, DA NANG

**Nguyen Thi Kim Khanh, Dang Quang Huy, Le Hoang Son***

*The University of Danang - University of Science and Technology, Vietnam*

*Corresponding author: lhson@dut.udn.vn

(Received: February 26, 2026; Revised: May 12, 2026; Accepted: June 05, 2026)

DOI: 10.31130/ud-jst.2026.24(7B).586E

**Abstract –** This study elucidates the intention-behavior gap in household source separation of municipal solid waste in urban Da Nang by concurrently measuring intentions (INT), self-reported behavior (SrB), and objective behavior (OB). Descriptive results and correlation analyses reveal a weak correlation between SrB and OB, while the gap between INT/SrB and OB is predominantly positive with substantial magnitude, confirming a significant discrepancy between "wanting to do/saying one does" and "actually doing". Employing a mediation model (PROCESS Model 4), the study identifies infrastructure and information barriers (IIB) as a pivotal mediator amplifying the intention-behavior gap: INT heightens barrier recognition, whereas IIB diminishes actual behavior, yielding a negative indirect effect. In contrast, institutional and policy factors (IP), perceived behavioral control (PBC), and subjective norms (SN) exhibit limited roles. These findings underscore that narrowing the intention-behavior gap necessitates prioritizing interventions in infrastructure and information conditions over solely enhancing intentions.

**Key words –** Intention; Objective behavior; Intention-behavior gap; Household solid waste; Source separation

## 1. Introduction

Rapid urbanization and population growth are placing increasing pressure on municipal solid waste (MSW) management systems in Vietnam. Currently, national MSW generation exceeds 68,000 tonnes per day, equivalent to approximately 25 million tonnes annually. In Da Nang alone, daily MSW generation has surpassed 2,052 tonnes and is primarily treated through landfilling at the Khanh Son Waste Treatment Complex. This figure is projected to rise to nearly 3,600 tonnes per day by 2030, placing substantial pressure on existing waste collection and treatment systems. In this context, household waste separation at source has emerged as an important strategy for reducing downstream treatment burdens while enhancing recycling efficiency and resource recovery, in line with sustainable development and circular economy objectives. Following the enactment of the 2020 Law on Environmental Protection, local authorities have progressively developed and strengthened regulatory frameworks to promote source-separation practices. However, both domestic and international studies continue to report a significant gap between residents' intentions to sort waste and their actual sorting behavior, suggesting that awareness and policy support alone are insufficient to ensure sustained participation in waste sorting. This gap reflects the limitations of conventional waste management approaches, which primarily emphasize technical and end-of-pipe treatment solutions while paying insufficient attention to behavioral and participatory dimensions [1]. Researchers increasingly argue that effective waste-sorting programs require a deeper understanding of the cognitive, habitual, and contextual factors influencing household sorting behavior, as well as the practical barriers residents encounter during implementation.

The Theory of Planned Behavior (TPB) has been widely applied in environmental behavior research to explain behavioral intentions through attitudes, subjective norms, and perceived behavioral control [2]. Although intention is theoretically regarded as the most proximal predictor of behavior, substantial evidence indicates the existence of a systematic intention-behavior gap, particularly for habitual and context-dependent behaviors such as household waste sorting. In the Vietnamese context, most previous studies have relied primarily on self-reported measures and may therefore overestimate actual behavioral compliance. To address this limitation, the present study simultaneously measures intention, self-reported behavior, and observed waste-sorting behavior within an extended TPB framework. In addition to examining intention as a predictor of behavior, the study investigates the mediating roles of infrastructure and information barriers, as well as institutional and policy factors, in either amplifying or reducing the intention-behavior gap. By doing so, the study provides evidence-based insights to support the development of more effective and behaviorally grounded source-separation policies.

## 2. Literature review

### *2.1. Intention-behavior gap*

The intention-behavior gap reflects the discrepancy between what individuals intend to do and their actual behavior. According to the TPB, intention is considered the most proximal predictor of behavior. However, substantial empirical evidence suggests that having the intention to perform a behavior does not necessarily translate into actual behavior. A large-scale meta-analysis conducted by Paschal Sheeran, based on 422 studies involving more than 82,000 participants, found that intention explained only approximately 28% of the variance in actual behavior [3]. Similarly, another study reported that psychological variables such as attitudes, subjective norms, and intentions explained only about 21% of objectively measured environmental behavior, while most behavior remained influenced by other factors such as habits, practical conditions, and social context [4]. Broader

reviews of TPB-based research similarly indicate that intention typically predicts only 18-23% of behavioral variance across domains [5]. This gap is particularly pronounced in pro-environmental contexts, including water conservation, recycling, and waste sorting, where habitual routines, situational limitations, and entrenched social norms often override individuals' prior intentions. Evidence from studies on residential water-saving behavior and household waste sorting in rural Chinese communities supports this pattern [6], [7], [8], [9]. A previous study found that the TPB model could explain recycling intentions relatively well ($R^2 = 0.608$) as well as self-reported recycling behavior ($R^2 = 0.151$). However, when self-reported data were replaced with actual recycling behavior recorded through an IoT-based monitoring system, the explanatory power of the model declined sharply to only 6.1% [10]. These findings suggest that participants tend to report or evaluate their level of environmental behavior more positively than what they actually perform.

To quantify this discrepancy, the intention-behavior gap (IBG) can be calculated using the following formula:

$$IBG = I - B$$

In this formula, I represents the level of behavior that an individual intends to perform (intention), while B reflects the level of actual behavior that has occurred (behavior). Based on this calculation, a positive IBG value occurs when the level of intention is greater than the actual behavior ($I > B$). This indicates that individuals tend to report or express a higher level of behavioral performance than what they actually carry out in reality, a phenomenon referred to as "overstatement of behavior". In contrast, when IBG = 0, the behavior is performed exactly as intended, whereas a negative value ($I < B$) indicates that actual behavior exceeds the initial level of intention [11].

### *2.2. Theoretical framework*

Grounded in the TPB, this study conceptualizes household waste-sorting behavior as being formed through behavioral intention, where intention is influenced by attitude, subjective norm, and perceived behavioral control. In addition, consistent with Ajzen's view of the TPB as an open theoretical framework that can be extended according to specific contextual conditions, the present study expands the conventional TPB framework in two important ways.

First, instead of relying solely on self-reported measures, which are susceptible to social-desirability bias and may create the so-called "green illusion" [10], this study employs objective behavioral indicators, specifically the observed frequency of waste sorting across three waste categories (hazardous waste, recyclables, and organic waste) over a seven-day period. This approach enables a more accurate measurement of the intention-behavior gap.

Second, two groups of variables are incorporated into the relationship between intention and behavior, namely institutional and policy factors and infrastructure and information barriers. Regarding institutional and policy factors, substantial evidence suggests that mandatory regulations such as reward-penalty mechanisms and pay-as-you-throw (PAYT) schemes significantly reinforce waste-sorting behavior and reduce the intention-behavior gap [12]. Meanwhile, infrastructure-related barriers, including the insufficient availability of sorting bins, collection points, and waste-specific collection schedules, together with limited informational guidance for residents, have been identified as extra-TPB factors that significantly influence waste-management behavior [13]. Therefore, these factors are examined as potential mediating variables in the translation from intention to behavior at the household level.

## 3. Research methodology

### *3.1. Research model*

In this study, the authors test two sets of models:

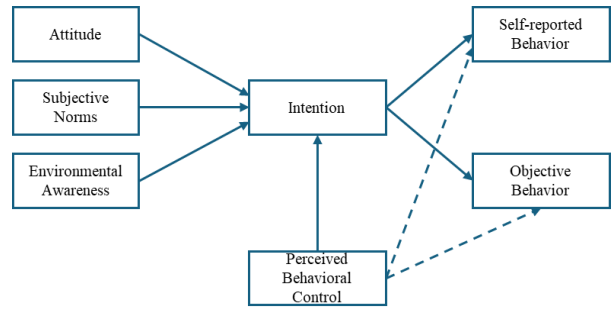


***Figure 1.*** *Extended TPB model*

(1) The extended TPB models, which examine the influence of TPB components on intentions and waste-sorting behaviors for specific waste categories as well as on general waste-sorting behavior. Specifically, the study constructs four models corresponding to four intention-behavior pairs: INT1-OB1 (hazardous waste), INT2-OB2 (recyclables), INT3-OB3 (organic waste), and INT4-OB4 (general waste-sorting behavior). The first three models represent sorting behaviors for specific waste streams, whereas the general waste-sorting behavior model is used to assess the overall level of household participation in source-separation practices. Each model enables an evaluation of the extent to which the TPB explains intention and waste-sorting behavior across different types of waste-sorting activities.

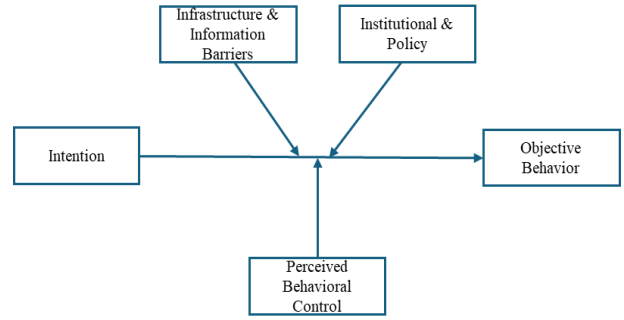


***Figure 2.*** *Intention–behavior mediation model*

(2) The mediation models, which focus on the process of translating intention into actual behavior. In this set of models, three hypothetical mediating variables, namely IP, IIB, and PBC, are tested in the relationship between the four types of intentions and their corresponding observed behaviors to identify which factors may reduce the intention-behavior gap for each specific waste category.

***Table 1.*** *Detailed description and explanation of constructs in the household waste-sorting behavior model*

| Items | Symbol | Definition | Measurement Items |
|---|---|---|---|
| Objective Behavior | OB | Directly observed waste-sorting behavior | Total frequency of waste-sorting activities recorded over seven-day period |
| Intention | INT | Household intention to engage in waste sorting in the near future | Hazardous waste (INT1); Recyclables (INT2); Organic waste (INT3); Intention to maintain waste-sorting practices (INT4) |
| Self-reported Behavior | SrB | Waste-sorting behavior self-reported by households | Hazardous waste (SrB1); Recyclables (SrB2); Organic waste (SrB3); Waste-sorting before disposal (SrB4) |
| Attitude | ATT | Positive perception toward waste-sorting | Reduces pollution (ATT1); Recovers recyclable materials (ATT2); Keeps household clean (ATT3); Improves neighborhood environment (ATT4); Improves city environment (ATT5); Reduces pressure on waste treatment (ATT6) |
| Subjective Norms | SN | Social pressure and expectations from family, friends, neighbors regarding waste sorting | Encouragement from family (SN1); Encouragement from neighbors/friends (SN2); Observation and evaluation if not sorting (SN3); All household members perform sorting (SN4); Widely practiced in the area (SN5) |
| Environmental Awareness | EA | Awareness of environmental impacts related to waste management | Not sorting increases environmental pollution (EA1); Not sorting attracts flies/mosquitoes affecting health (EA2); Causes odor affecting daily life (EA3); Landfills are under high pressure due to increasing waste (EA4); Incorrectly sorted waste makes treatment difficult (EA5); I prioritize reusable products to reduce waste (EA6) |
| Perceived Behavioral Control | PBC | Perceived ability and convenience of performing waste sorting | Know how to sort effectively (PBC1); Sorting is very simple (PBC2); Can sort waste every day (PBC3); Have sufficient sorting equipment (PBC4); Have enough storage space (PBC5); Have enough time to sort before disposal (PBC6) |
| Infrastructure and Information Barriers | IIB | Barriers related to lack of infrastructure and information | Waste-sorting programs rarely promoted in my area (IIB1); My household rarely receives guidance on sorting (IIB2); Periodic awareness campaigns are rarely conducted (IIB3); Neighborhood lacks separate collection points for sorted waste (IIB4); Lack of separate bins and collection/transport vehicles (IIB5); Signage and instructional materials are missing or unclear (IIB6) |
| Institutional and Policy | IP | Influence of policies, incentives, and sanctions on waste sorting | Reduced service fees encourage frequent sorting (IP1); "Cultural Family" criteria encourage serious sorting (IP2); Higher penalties ensure compliance (IP3); Regular inspection promotes sorting (IP4); Collection refusal if waste is unsorted (IP5); PAYT mechanism encourages careful sorting to reduce fees (IP6) |

### *3.2. Questionnaire design*

The questionnaire was self-administered to collect data on household waste-sorting behavior and consisted of three sections: (1) demographic information, including gender, age, education level, occupation, household size, and housing type; (2) measures of behavioral determinants (i.e., latent constructs); and (3) items assessing current waste-sorting practices. Objective behavior (OB) was recorded as the frequency of household waste sorting over seven days. Latent constructs including ATT, EA, SN, PBC, IIB, IP, INT, and SrB - were measured using multiple indicators on a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). All items were standardized in wording and format to ensure that respondents received identical prompts, thereby enhancing comparability and minimizing measurement error.

### *3.3. Research scope and subjects*

The study was conducted in Thanh Khe Ward, Da Nang City, a central urban area characterized by high population density and demographic and socio-economic conditions that are broadly representative of Da Nang's urban population. Thanh Khe Ward was formed through the merger of five former wards: Thanh Khe Dong, Thanh Khe Tay, Xuan Ha, Thac Gian and Chinh Gian, covering an area of approximately 7.92 km$^2$. The ward has actively implemented household waste-sorting policies and programs, making it a suitable site for studying residents' waste-sorting behavior and the effectiveness of related interventions.

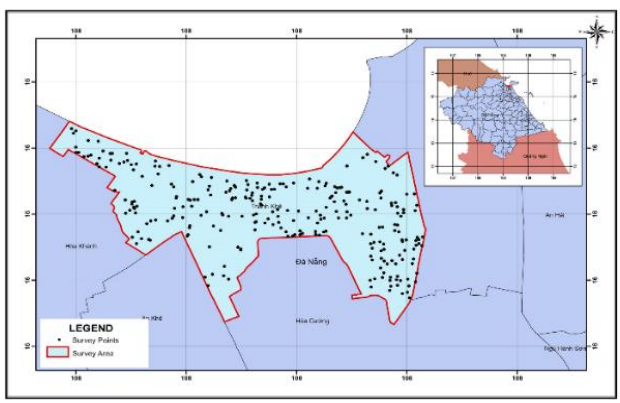


***Figure 3.*** *Research scope: Thanh Khe Ward, Da Nang City*

### *3.4. Data collection methods*

The study combined household surveys with direct observation of waste-sorting behavior. Cluster-based spatial sampling was used to distribute 250 households across Thanh Khe Ward, with households randomly selected within geographic clusters formed from the former wards prior to the administrative merger. Figure 3 shows the study area and the sampled household locations.

Sample adequacy was evaluated using two criteria: the conventional 5:1 observation-to-indicators ratio for exploratory factor analysis (EFA), which required at least

215 observations, and the minimum threshold of 200 observations recommended for structural equation modeling (SEM). With 250 households surveyed, the sample met both requirements.

Observed behavior (OB) was measured by providing each household with three separate bags for hazardous, recyclable, and organic waste. The research team collected the bags each evening and checked whether the waste had been sorted into the appropriate bags. Sorting accuracy was assessed using predefined classification criteria established before data collection. A day was considered valid if the household generated at least two types of waste; days with only one type of waste were excluded. A day was scored as 1 (sorted) if all waste types were placed in separate bags, and as 0 (not sorted) if any waste was mixed. The household OB score was calculated as the ratio of days scored 1 to the total number of valid waste-generating days over seven days, yielding a value between 0 (no sorting) and 1 (all days sorted). Observations were conducted continuously over seven days, including weekdays and weekends, to capture short-term variations in household waste disposal and sorting behavior.

### *3.5. Data analysis methods*

Descriptive statistics were used to characterize the sample and household waste-sorting patterns. Cronbach's alpha was calculated to assess scale reliability. Exploratory Factor Analysis (EFA) was performed to examine the underlying factor structure, followed by Confirmatory Factor Analysis (CFA) to verify the construct validity and convergent validity of the measurement model. Structural Equation Modeling (SEM) using AMOS was then applied to test the TPB-based structural relationships, while mediation effects were examined separately using the PROCESS macro for SPSS. Data were analyzed using Microsoft Excel, SPSS 27.0, AMOS 20, and the PROCESS macro (version 4.2).

## 4. Results

### *4.1. Descriptive statistics analysis*

***Table 2.*** *Descriptive statistics analysis results*

| Characteristics | Frequency | Percentage |
|---|---|---|
| Gender | | |
| Male | 110 | 44% |
| Female | 140 | 56% |
| Education level | | |
| High school or below | 101 | 40.4% |
| College/University | 94 | 37.6% |
| Post-graduate | 55 | 22.0% |
| Housing type | | |
| Owned house | 198 | 79.2% |
| Boarding room | 52 | 20.8% |
| Age | | |
| Min: 18; Max: 75; Mean ± SD: 43.7 ± 13.6 | | |
| Family members | | |
| Min: 1; Max: 6; Mean ± SD: 2.99 ± 0.98 | | |

As shown in Table 2, the sample consisted of 250 households in Thanh Khe Ward, with a relatively balanced gender distribution (56% male, 44% female) and generally high educational attainment (37.6% holding college or university degrees and 22.0% postgraduate qualifications). The majority of households lived in owner-occupied housing (79.2%), reflecting stable living conditions that may facilitate consistent waste-sorting behavior. Participants ranged in age from 18 to 75 years (mean ≈ 43.7 years), primarily concentrated in middle adulthood. Household sizes ranged from 1 to 6 members (mean ≈ 3 members per household). Most respondents were responsible for household chores and waste handling. Overall, the sample represents a relatively consistent demographic characteristics, likely to provide useful insights into household waste-sorting behavior.

### *4.2. Reliability Test and Exploratory Factor Analysis (EFA) results*

The reliability and validity of the scales were assessed using Cronbach's alpha and exploratory factor analysis (EFA). Cronbach's alpha was used to evaluate internal consistency, with coefficients of 0.70 or above considered acceptable and values of 0.80 or above considered good [14]. The results showed that Cronbach's alpha values for all constructs ranged from 0.761 to 0.855, exceeding the 0.70 threshold. This indicates that the scales had high reliability and that the observed indicators within each latent construct were well correlated. In addition, the corrected item-total correlation results showed that most indicators had coefficients ranging from 0.522 to 0.898, exceeding the 0.50 threshold, suggesting adequate internal consistency within their respective latent constructs. However, several indicators, namely IP1 (0.345), PBC1 (0.435), PBC2 (0.468), ATT1 (0.152), ATT6 (0.341), and IIB1 (0.482), fell below this threshold, indicating insufficient contribution to scale homogeneity and were therefore removed to improve the reliability of the scales.

***Table 3.*** *The reliability test and EFA's results*

| Factor | Items | Cronbach's Alpha |
|---|---|---|
| IIB | IIB4, IIB3, IIB2, IIB5, IIB6 | 0.855 |
| INT | INT3, INT2, INT4, INT1 | 0.850 |
| SN | SN3, SN2, SN4, SN5, SN1 | 0.851 |
| ATT | ATT3, ATT2, ATT4, ATT5 | 0.761 |
| PBC | PBC5, PBC6, PBC4, PBC3 | 0.806 |
| SrB | SrB3, SrB4, SrB2, SrB1 | 0.845 |
| IP | IP4, IP3, IP5, IP6 | 0.794 |
| EA | EA5, EA4, EA6, EA1 | 0.824 |

The suitability of the data for factor analysis was confirmed by the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (KMO = 0.842 > 0.50) and Bartlett's test of sphericity, which was statistically significant ($p < 0.05$), indicating that the correlation matrix was appropriate for factor extraction [15], [16]. Factor extraction yielded eight factors with a cumulative explained variance of 71.2%, exceeding the commonly accepted minimum of 50% in social science research. These results indicate the extracted factor structure adequately represents the data and support the retained factor solution. Inspection of the rotated component matrix led to the exclusion of three

items: EA2 (0.21), EA3 (0.18), and IP2 (0.15), whose factor loadings fell below the 0.50 threshold commonly used to assess convergent validity. The refined solution retained 34 items loading unambiguously onto eight factors, consistent with the hypothesized model structure. This outcome confirms satisfactory convergent validity within factors and adequate discriminant validity across factors, supporting the appropriateness of the scale structure for subsequent confirmatory analyses. Factor assignments are detailed in Table 3.

### *4.3. Confirmatory Factor Analysis (CFA) Results*

The results presented in Table 4 indicate that all latent constructs meet the criteria for reliability, convergent validity, and discriminant validity. The Composite Reliability (CR) values of the constructs range from 0.796 to 0.865 (> 0.70), indicating a high level of consistency among the observed indicators measuring the same construct. The Average Variance Extracted (AVE) of the constructs range from 0.500 to 0.599 (> 0.50), demonstrating adequate convergent validity of the observed indicators for each latent construct. The MSV and ASV values are all smaller than the respective AVE values, demonstrating good discriminant validity among the constructs [17].

***Table 4.*** *Reliability and convergent validity of constructs*

| Items | CR | AVE | MSV | ASV |
|---|---|---|---|---|
| EA | 0.796 | 0.500 | 0.277 | 0.088 |
| ATT | 0.855 | 0.599 | 0.277 | 0.113 |
| SN | 0.854 | 0.545 | 0.199 | 0.081 |
| PBC | 0.846 | 0.587 | 0.145 | 0.075 |
| IP | 0.841 | 0.570 | 0.205 | 0.088 |
| IIB | 0.865 | 0.563 | 0.205 | 0.109 |

Furthermore, the results in Table 5 show that all latent constructs satisfy the Fornell-Larcker criterion for discriminant validity. This indicates that each latent construct measures a distinct concept without substantial overlap with other constructs in the model. Overall, these results confirm that the latent constructs EA, ATT, SN, PBC, IP, and IIB satisfy the recommended thresholds for composite reliability, convergent validity, and discriminant validity, making them suitable for inclusion in the SEM and subsequent mediation analyses.

***Table 5.*** *Discriminant validity: Fornell-Larcker criterion*

| | IP | IIB | SN | PBC | ATT | EA |
|---|---|---|---|---|---|---|
| **IP** | 0.755* | | | | | |
| **IIB** | 0.526 | 0.750* | | | | |
| **SN** | -0.091 | -0.325 | 0.738* | | | |
| **PBC** | 0.286 | 0.358 | -0.086 | 0.766* | | |
| **ATT** | 0.145 | 0.008 | 0.446 | 0.118 | 0.774* | |
| **EA** | 0.233 | 0.232 | 0.295 | 0.381 | 0.453 | 0.707* |

Notes: * indicates larger than the squared correlation with any other construct [17].

### *4.4. Structural Equation Modeling (SEM) results*

The SEM results for the three models examining waste-sorting behavior for hazardous, recyclable, and organic waste (Figures 4, 5, and 6) indicate that EA, ATT, and PBC exert significant positive effects on sorting intention, while SN has a negligible influence. Across all three models, INT and PBC predicted self-reported behavior (SrB) with moderate explanatory power, yielding $R^2$ values ranging from 0.12 to 0.28, peaking for recyclable waste. However, both constructs exhibited nearly zero explanatory power for objective behavior (OB), with $R^2$ values between 0.00 and 0.02. The data suggest that, although sorting intentions and self-reported behavior were generally positive, objectively observed sorting behavior remained very limited, particularly for hazardous waste, where both SrB and OB were low. This finding reflects the lack of established sorting habits and limited attention to hazardous waste sorting, highlighting the need for practical interventions.

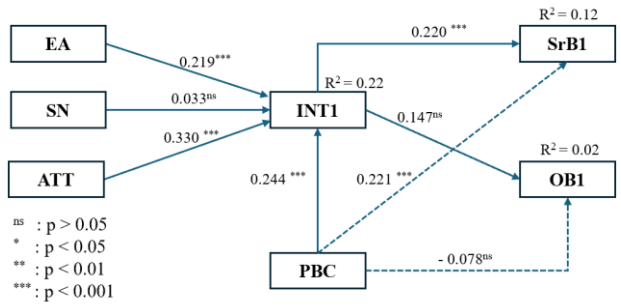


***Figure 4.*** *Path coefficients and significance of model 1 (Hazardous waste)*

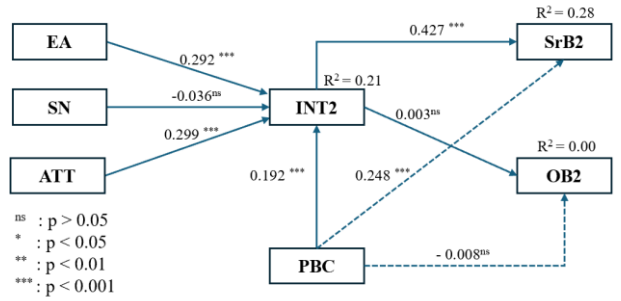


***Figure 5.*** *Path coefficients and significance of model 2 (Recyclable waste)*

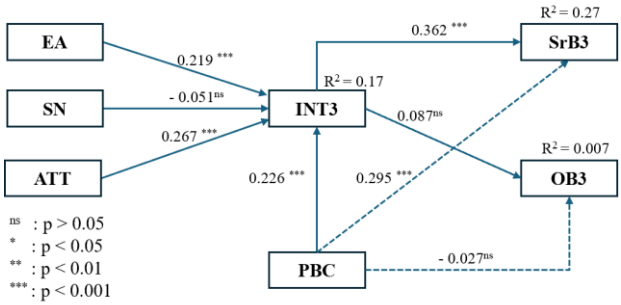


***Figure 6.*** *Path coefficients and significance of model 3 (Organic waste)*

The SEM results for model 4 (general waste-sorting behavior) reveal that sorting intention is significantly and positively determined by EA, ATT, and PBC ($p < 0.001$), while SN exerts comparatively limited influence, a pattern attributable to the absence of well-established social norms in a context where waste-sorting practices among peers remain nascent. INT4 and PBC4 demonstrate moderate predictive validity for self-reported sorting behavior ($R^2 \approx$

23%), yet exhibit negligible explanatory power for objectively observed behavior ($R^2 \approx 1\%$). This marked divergence in explained variance constitutes compelling evidence of a systematic intention-behavior gap, wherein residents articulate strong intentions and report favorable behavior while actual sorting compliance remains critically low, consistent with the broader environmental behavior literature documenting discrepancies between self-reported and objectively measured conduct. These findings carry important methodological implications, as exclusive reliance on self-reported measures may substantially inflate estimates of household sorting compliance.

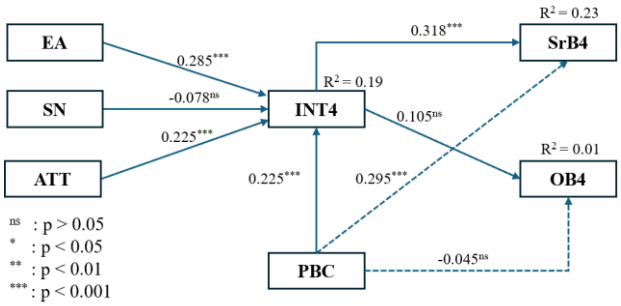


***Figure 7.*** *Path coefficients and significance of model 4 (general waste-sorting behavior)*

### *4.5. Comparison between self-reported and objective waste sorting behavior*

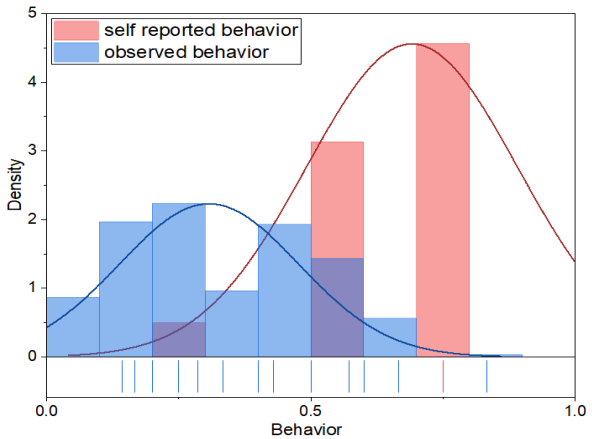


***Figure 8.*** *Discrepancy between self-reported and objectively observed household waste-sorting behavior*

Note: The self-reported behavior scale (SrB), originally measured on a 1-5 Likert scale, was normalized to a 0-1 scale to allow direct comparison with observed behavior (OB).

As illustrated in Figure 8, self-reported behavior values are mostly concentrated in the upper range of the standardized scale (≈ 0.5-1.0), whereas objective behavior is concentrated in the lower range (≈ 0.0-0.6), indicating a systematic tendency among residents to overestimate their actual sorting compliance. This divergence is further supported by a weak correlation between the two measures (Pearson's $r = 0.21$, $p < 0.001$), suggesting that SrB and OB capture different aspects of sorting behavior. Notably, the gap between SrB and OB is consistently positive and substantial; at similar SrB levels (e.g., ≈ 0.75), OB values show wide dispersion (0.0-0.75), indicating that this discrepancy is prevalent across the sample rather than being attributable to isolated cases. These findings align with previous recycling research, confirming the weak association between self-reported and objective behavior and the coexistence of two distinct behavioral realities. Therefore, it can be concluded that intention and self-assessed behavior, while important, remain insufficient to accurately predict household-level compliance with waste sorting. These results further corroborate the intention-behavior gap: strong intentions consistently predict self-reported sorting behavior but do not translate into objectively observed compliance. The substantial divergence between self-reported and objective behavior is consistent with the "green illusion" concept advanced by Zhang and with evidence of behavioral overstatement documented by Jekauc [10], [11].

### *4.6. Mediation results of the intention-behavior gap*

To examine the mechanisms underlying the intention-behavior gap in household waste sorting, the study employs the PROCESS macro (version 4.2) by Hayes, a widely used tool for mediation analysis that allows the simultaneous estimation of direct and indirect effects with bootstrap-derived confidence intervals. All indirect effects are computed using 5000 bootstrap samples to derive 95% confidence intervals. In the standard mediation model, coefficient a denotes the effect of the independent variable (X) on the mediator (M); coefficient b represents the effect of M on the dependent variable (Y) controlling for X; c is the total effect of X on Y in the absence of M, while c' reflects the direct effect of X on Y after accounting for M. The indirect effect a.b is considered significant when the 95% bootstrap confidence interval does not include zero [12]. Path coefficients, p-values, and confidence intervals were interpreted conjointly to determine whether each mediating pathway narrows or amplifies the intention-behavior gap. Specifically, three mediating variables were examined IIB, IP and PBC in the relationship between sorting intention (INT) and objective behavior (OB).

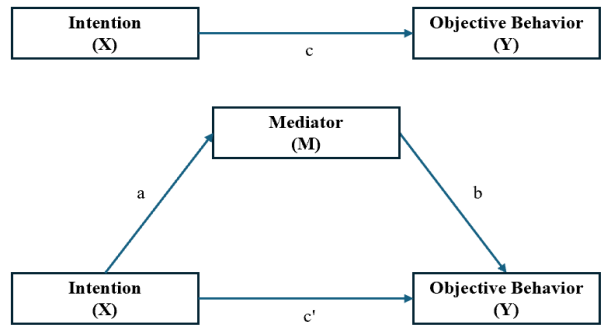


***Figure 9.*** *Mediation model of the relationship between intention and objective behavior*

The mediation analysis in model 4 (general waste-sorting behavior) indicates that perceived infrastructure and information barriers (IIB) serve as the primary mediating mechanism underlying the intention-behavior gap. The results presented in Table 6 indicate that path coefficient a ($p < 0.001$) shows that INT4 exerts a positive and significant effect on IIB, whereas the path coefficient b ($p < 0.01$) indicates that, when controlling for INT4, IIB significantly reduces objective behavior (OB4). Although the total effect

c is not statistically significant ($p > 0.05$), introducing IIB into the model yields a statistically significant direct effect c′ ($p < 0.05$) and a negative indirect effect (a.b = -0.07), with a 95% confidence interval does not include zero. These results confirm IIB as a suppressive mediator: it attenuates the positive influence of intention on actual behavior and contributing to the widening of the intention-behavior gap. In contrast, IP and PBC do not emerge as statistically significant mediators. Although the path a is significant for both IP and PBC ($p < 0.001$), the path b from IP and PBC to OB4 is nonsignificant ($p > 0.05$), and the bootstrap confidence intervals for the indirect effects include zero. These findings indicate that, in the current study context, neither institutional policies nor perceived behavioral control serves as effective bridging mechanisms between intention and observed behavior, reinforcing IIB as the only statistically significant mediator in the model.

The results of the mediation analyses by waste type, presented in Tables 7, 8, and 9, reveal clear differences across the models. For model 1 (hazardous waste) and model 2 (recyclable waste), no statistically significant mediation effects were detected on any of the tested pathways; the a, b, and c′ coefficients, as well as the bootstrapped indirect effects, all failed to reach conventional levels of statistical significance. This lack of significant effects is largely attributable to the limited sample size for hazardous waste (only 15 households generated hazardous waste during the observation period). Over the seven-day observation period, the volume of hazardous waste generated was relatively small compared to other waste streams, which substantially reduced statistical power and precluded robust inference. In the case of recyclable waste, sorting behavior appears to have become routinized in many households through the frequent sale of recyclable materials, making this behavior relatively insensitive to constraints related to infrastructure, information, or institutional arrangements. By contrast, model 3 (organic waste) yielded results consistent with the overall findings of model 4, in which perceived infrastructure and information barriers (IIB) emerged as a key mediating factor in the relationship between INT and OB. The indirect effect of IIB was statistically significant, with a 95% bootstrap confidence interval excluding zero. This pattern may reflect the fact that household organic waste-sorting behavior remains highly dependent on infrastructure and informational support, such as separate collection bins, collection schedules, and sorting guidelines.

***Table 6.*** *Results of three mediators analyses for model 4*

| Mediator | Path a (INT → M) | | Path b (M → OB) | | Path c (INT → OB) | | Path c' (INT → M → OB) | | Indirect effect | Bootstrap | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | β | t | β | t | β | t | β | t | (a.b) | LLCI | ULCI |
| IIB | 0.35 | $5.94^{***}$ | -0.21 | $-3.14^{**}$ | | | 0.17 | $2.53^{*}$ | -0.07 | -0.14 | -0.02 |
| IP | 0.30 | $5.01^{***}$ | -0.09 | $-1.43^{ns}$ | 0.09 | $1.49^{ns}$ | 0.12 | $1.85^{ns}$ | -0.03 | -0.08 | 0.01 |
| PBC | 0.34 | $5.68^{***}$ | -0.04 | $-0.66^{ns}$ | | | 0.11 | $1.62^{ns}$ | -0.07 | -0.006 | 0.03 |

Note: $^{ns:}$ $p > 0.05$; $^{*:}$ $p < 0.05$; $^{**:}$ $p < 0.01$; $^{***:}$ $p < 0.001$

***Table 7.*** *Results of three mediators analyses for model 1*

| Mediator | Path a (INT → M) | | Path b (M → OB) | | Path c (INT → OB) | | Path c' (INT → M → OB) | | Indirect effect | Bootstrap | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | β | t | β | t | β | t | β | t | (a.b) | LLCI | ULCI |
| IIB | 0.15 | $0.70^{ns}$ | 0.48 | $0.03^{ns}$ | | | 0.43 | $0.03^{ns}$ | 0.07 | -1.78 | 3.13 |
| IP | 0.29 | $1.39^{ns}$ | 1.29 | $0.41^{ns}$ | - | - | 0.36 | $0.02^{ns}$ | 0.38 | -10.03 | 34.4 |
| PBC | 0.07 | $0.05^{ns}$ | -0.42 | $-0.12^{ns}$ | | | 0.72 | $0.06^{ns}$ | -0.03 | -5.25 | 9.2 |

Note: $^{ns:}$ $p > 0.05$; $^{*:}$ $p < 0.05$; $^{**:}$ $p < 0.01$; $^{***:}$ $p < 0.001$

***Table 8.*** *Results of three mediators analyses for model 2*

| Mediator | Path a (INT → M) | | Path b (M → OB) | | Path c (INT → OB) | | Path c' (INT → M → OB) | | Indirect effect | Bootstrap | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | β | t | β | t | β | t | β | t | (a.b) | LLCI | ULCI |
| IIB | 0.32 | $5.40^{***}$ | 0.02 | $0.28^{ns}$ | | | -0.005 | $-0.08^{ns}$ | 0.006 | -0.04 | 0.05 |
| IP | 0.25 | $4.11^{**}$ | 0.03 | $0.48^{ns}$ | 0.0007 | $0.01^{ns}$ | -0.007 | $-0.11^{ns}$ | 0.008 | -0.03 | 0.04 |
| PBC | 0.32 | $5.27^{***}$ | -0.008 | $-0.12^{ns}$ | | | 0.003 | $0.05^{ns}$ | -0.003 | -0.04 | 0.04 |

Note: $^{ns:}$ $p > 0.05$; $^{*:}$ $p < 0.05$; $^{**:}$ $p < 0.01$; $^{***:}$ $p < 0.001$

***Table 9.*** *Results of three mediators analyses for model 3*

| Mediator | Path a (INT → M) | | Path b (M → OB) | | Path c (INT → OB) | | Path c' (INT → M → OB) | | Indirect effect | Bootstrap | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | β | t | β | t | β | t | β | t | (a.b) | LLCI | ULCI |
| IIB | 0.31 | $5.15^{***}$ | -0.20 | $-3.07^{**}$ | | | 0.14 | $2.21^{*}$ | -0.06 | -0.12 | -0.02 |
| IP | 0.26 | $4.28^{***}$ | -0.09 | $-1.41^{ns}$ | 0.08 | $1.30^{ns}$ | 0.10 | $1.62^{ns}$ | -0.02 | -0.06 | 0.01 |
| PBC | 0.33 | $5.46^{***}$ | -0.03 | $-0.41^{ns}$ | | | 0.09 | $1.36^{ns}$ | -0.09 | -0.004 | 0.03 |

Note: $^{ns:}$ $p > 0.05$; $^{*:}$ $p < 0.05$; $^{**:}$ $p < 0.01$; $^{***:}$ $p < 0.001$

## 5. Discussions

SEM results across all four models show that EA, ATT, and PBC exert significant positive effects on INT, aligning with previous Vietnamese studies. Subjective norms, however, exert no significant influence, reflecting a community context where social norms surrounding waste sorting are underdeveloped and insufficiently consolidated to guide individual behavior [18]. Mediation analysis via PROCESS identifies IIB as the primary mechanism: households with stronger intentions appear to become more aware of infrastructural and informational barriers, which in turn suppress objective sorting behavior, producing a negative indirect effect that widens the intention-behavior gap. Institutional and Policy (IP) and Perceived Behavioral Control (PBC), despite their positive associations with intention, do not significantly mediate observed behavior, indicating that current policy enforcement remains insufficiently institutionalized and that perceived capability alone cannot overcome structural constraints.

The survey results indicate that most residents in Thanh Khe perceive a lack of information, guidance, and supporting infrastructure as the main barriers to waste sorting. This is clearly reflected in the high levels of agreement with the IIB items, especially the lack of clear signage and guidance materials (IIB6 = 4.45), the absence of separate collection points for different waste types (IIB4 = 4.36), and the lack of direct household guidance (IIB2 = 4.35). In other words, the problem lies not only in awareness, but also in the absence of the conditions needed to translate intention into action. On the policy side, the most strongly supported measures focus on compulsory mechanisms and stronger enforcement, particularly regular inspection and sanctions (IP4 = 4.54), volume-based waste charging (IP6 = 4.50), and refusal of collection when waste is not sorted (IP5 = 4.41). This suggests that residents not only expect support in the form of information and infrastructure, but also accept more binding management measures as a way to make waste sorting a regular practice. Overall, these findings suggest that narrowing the intention-behavior gap requires a combined approach: reducing barriers by improving signage, guidance, separate collection points, and dedicated collection vehicles, while also strengthening enforcement through inspections, penalties, and appropriate fee mechanisms. More broadly, the results imply that closing the gap between intention and behavior requires priority investment in infrastructure and information support, alongside the gradual reinforcement of institutional enforcement and community-level social norms, thereby creating a combination of capability, opportunity, and motivation consistent with international recommendations for translating environmental intentions into sustainable behavior [19].

## 6. Conclusion

This study provides clear empirical evidence of a systematic intention-behavior gap in household waste source separation in Vietnamese urban settings. By simultaneously measuring intention, self-reported behavior, and objectively observed sorting behavior, the results show that residents tend to overestimate their own compliance with waste separation. This is evidenced by the weak correlation between self-report and actual observation ($r = 0.21$) and the very low $R^2$ values linking intention to objective behavior, especially in model 4, where intention explains only about 1% of the variance in objective behavior. These findings underscore that intention, while important, is still insufficient to ensure sustained sorting behavior. At the same time, reliance solely on self-reported measures may create a "green illusion," leading to distorted program evaluation and policy design.

The SEM results across the four waste-specific models consistently show that environmental awareness, attitude, and perceived behavioral control are significant positive antecedents of sorting intention, whereas subjective norms exert little to no meaningful influence. This reflects an underdeveloped community-level social environment in which sorting behavior among peers remains too inconsistent to establish a stable shared norm. The PROCESS mediation analysis further shows that IIB is the only statistically significant mediator in the relationship between intention and objective behavior: higher intention is associated with stronger recognition of barriers, possibly because more motivated individuals are also more aware of practical constraints, which in turn suppresses actual sorting behavior, producing a negative indirect effect and widening the intention-behavior gap. This pattern is replicated for organic waste in Model 3, but not for hazardous and recyclable waste, where small sample size and routinized recycling or selling practices weaken the mediation pathway. Institutional and policy factors and perceived behavioral control do not emerge as significant mediators, suggesting that current regulatory arrangements are not yet sufficiently enforced at the community level and that perceived capability alone cannot compensate for structural deficiencies.

Theoretically, this study advances TPB-based research on pro-environmental behavior by incorporating objective behavioral indicators and structural mediating mechanisms, thereby conceptualizing household source separation as a socio-structural process rather than merely an attitudinal response. Moreover, the findings are consistent with those of the previous study conducted by V. T. Q. Nga et al. [20] and Nguyen et al [21], reinforcing the context-dependent nature of the TPB by demonstrating that the relative importance of behavioral determinants varies across socio-cultural and institutional settings. These findings support the growing body of evidence that extending the TPB with context-specific constructs and theoretically grounded causal pathways provides a more comprehensive explanation of source separation behavior and enhances the model's explanatory power.

Practically, the results suggest that narrowing the intention–behavior gap requires coordinated interventions that prioritize investment in waste-sorting infrastructure, strengthen informational guidance, and reinforce

institutional enforcement while progressively fostering community-based social norms. Such an integrated approach is likely to be more effective than strategies focused solely on changing individual attitudes.

This study has several limitations. The empirical analysis was restricted to a single ward, and observed sorting behavior was monitored over only a seven-day period, which may limit the generalizability of the findings. Future research should extend the geographical scope, employ longitudinal designs to capture behavioral changes over time, and investigate additional mechanisms - such as habit strength, perceived convenience, and economic incentives - to further explain the intention-behavior relationship

## REFERENCES


[1] L. T. Ha, P. H. Chuong, V. Cuong, and V. T. Trang, "Factors Affecting Household Waste Sorting Behavior in Tuy Hoa City, Phu Yen Province: An Approach from the Theory of Planned Behavior", *Journal of Economics and Development*, vol. 326, no. 2, pp. 2-11, 2024. https://doi.org/10.33301/JED.VI.1815

[2] I. Ajzen, "The Theory of Planned Behavior," *Organizational Behavior and Human Decision Processes*, vol. 50, no. 2, pp. 179-211, 1991. https://doi.org/10.1016/0749-5978(91)90020-T.

[3] P. Sheeran, "Intention-Behavior Relations: A Conceptual and Empirical Review," *European Review of Social Psychology*, vol. 12, no. 1, pp. 1–36, 2002. https://doi.org/10.1080/14792772143000003.

[4] C. Kormos and R. Gifford, "The validity of self-report measures of proenvironmental behavior: A meta-analytic review," *Journal of Environmental Psychology,* vol. 40, pp. 359–371, 2014. https://doi.org/10.1016/j.jenvp.2014.09.003

[5] M. Conner and P. Norman, "Understanding the intention-behavior gap: The role of intention strength," *Frontiers in Psychology, vol. 13, 2022.* https://doi.org/10.3389/fpsyg.2022.923464

[6] C. A. de Matos, L. Luppi, and R. T. Veiga, "Assessing the intention-behavior gap in the pro-environmental behavior context: a longitudinal study about water conservation," *Journal of Cleaner Production*, vol. 524, 2025. https://doi.org/10.1016/j.jclepro.2025.146499.

[7] Y. Zhou, B. Wei, R. Zhang, L. Zhang, H. Zhu, and T. Wen, "Narrowing the gap between intention and behavior? An empirical study of farmers' waste classification in China," *Frontiers in Environmental Science*, vol. 11, 2023. https://doi.org/10.3389/fenvs.2023.1045816.

[8] S. J. Geiger, C. Brick, L. Nalborczyk, A. Bosshard, and N. B. Jostmann, "More green than gray? Toward a sustainable overview of environmental spillover effects: A Bayesian meta-analysis," *Journal of Environmental Psychology*, vol. 78, 2021. https://doi.org/10.1016/j.jenvp.2021.101694.

[9] E. K. Papies *et al.*, "Grounding motivation for behavior change," *Advances in Experimental Social Psychology*, vol. 66, pp. 107–189, 2022. https://doi.org/10.1016/bs.aesp.2022.04.002

[10] S. Zhang, Z. Xia, C. Zhang, X. Tian, and J. Xie, "Green illusions in self-reporting? Reassessing the intention-behavior gap in waste recycling behaviors," *Waste Management*, vol. 166, pp. 171–180, 2023. https://doi.org/10.1016/j.wasman.2023.04.036.

[11] D. Jekauc, M. C. Voelkle, M. Giurgiu, and C. R. Nigg, "Unveiling the Multidimensional Nature of the Intention-Behavior Gap: Dynamics of Intentions and Behaviors," *European Journal of Health Psychology,* vol. 32, no. 1, pp. 34–50, 2025. https://doi.org/10.1027/2512-8442/a000162.

[12] R. Zheng, M. Qiu, Y. Wang, D. Zhang, Z. Wang, and Y. Cheng, "Identifying the influencing factors and constructing incentive pattern of residents' waste classification behavior using PCA-logistic regression," *Environmental Science and Pollution Research*, vol. 30, no. 7, pp. 17149–17165, 2023. https://doi.org/10.1007/s11356-022-23363-4.

[13] H. T. Hue, N. T. H. Hanh, B. T. T. Trang, T. V. Tinh, D. Q. Tri, and N. T. H. Thuong, "Assessing knowledge, attitude, and behavior in household solid waste management in northern Vietnam," *Civil and Environmental Engineering*, vol. 20, no. 1, pp. 508–525, 2024. https://doi.org/10.2478/cee-2024-0039.

[14] S. Kilic, "Cronbach's alpha reliability coefficient," *Journal of Mood Disorders*, vol. 6, no. 1, p. 47, 2016. https://doi.org/10.5455/jmood.20160307122823.

[15] M. S. Bartlett, "A Note on the Multiplying Factors for Various Chi Square Approximations," *Journal of the Royal Statistical Society Series B: Statistical Methodology*, vol. 16, no. 2, pp. 296-298, 1954. https://doi.org/10.1111/j.2517-6161.1954.tb00174.x

[16] J. F. Hair, W. C. Black, B. J. Babin, and R. E. Anderson, *Multivariate Data Analysis*, 8th ed. Andover, UK: Cengage Learning EMEA, 2019.

[17] C. Fornell and D. F. Larcker, "Evaluating Structural Equation Models with Unobservable Variables and Measurement Error," *Journal of Marketing Research*, vol. 18, no. 1, p. 39-50, 1981. https://doi.org/10.2307/3151312.

[18] J. J. Igartua and A. F. Hayes, "Mediation, Moderation, and Conditional Process Analysis: Concepts, Computations, and Some Common Confusions," *The Spanish Journal of Psychology*, vol. 24, no. 6, 2021. https://doi.org/10.1017/SJP.2021.46.

[19] R. West and S. Michie, "A Brief Introduction to the COM-B Model of Behaviour and the PRIME Theory of Motivation," *Qeios*, vol. 2, 2020. https://doi.org/10.32388/WW04E6.2

[20] V.T.Q. Nga, M.H. Nhi, and L.M. Quan, "A Systematic Literature Review of the Application of the Theory of Planned Behavior (TPB) to Tourists at Tourism Destinations", *The University of Danang – Journal of Science and Technology*, vol 21, no. 4, pp. 17–26, 2023.

[21] N. V. Bien, L. M. Chau, V. D. Q. Nhat, and N. P. Q. Duy, "Extending the theory of planned behavior to explore the intent to use electric motorcycles in Da Nang", *The University of Danang – Journal of Science and Technology*, vol. 22, no. 11C, pp. 38–43, 2024. https://doi.org/10.31130/ud-jst.2024.554E.