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Household Behavioral Compliance in Waste Management Using the Extended Theory of Planned Behavior

Mary Ellen Camarillo†
Industrial Engineering Department, Cebu Technological University, Argao, Cebu, 6021, Philippines
†Corresponding author: Mary Ellen C. Camarillo; maryellencamarillo@gmail.com

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ABSTRACT

Despite the expansion of waste management infrastructure and regulations, behavioral compliance with proper waste management practices remains inconsistent, particularly in developing-country contexts. This study investigates the factors influencing household compliance with waste management practices by extending the Theory of Planned Behavior (TPB) to incorporate motivational and deterrence-related mechanisms. A quantitative research design was employed using survey data collected from 106 household respondents and analyzed through Partial Least Squares Structural Equation Modeling (PLS-SEM) using SmartPLS 4. The measurement and structural models were evaluated to assess construct validity, reliability, and the significance of the hypothesized relationships. The PLS-SEM results revealed that motivation was the strongest predictor of behavioral compliance ($\beta = 0.499$, $p < 0.001$). These findings indicate that motivation is the strongest predictor of behavioral compliance, while perceptions of the waste management system also exert a significant positive influence. Penalty awareness does not directly affect compliance but significantly enhances motivation, suggesting an indirect deterrence mechanism. In contrast, attitudes toward waste management practices do not demonstrate a significant effect on compliance behavior. Furthermore, the study contributes to the literature by empirically validating an extended TPB framework in a developing-country setting such as the Philippines and demonstrating the importance of integrating penalty- and motivation-related constructs in explaining behavioral compliance. The policy implications of this study emphasize the need for behavior-centered governance strategies that complement infrastructure investments through visible enforcement, motivational interventions, and improved public perceptions of waste management systems.

1. INTRODUCTION

Effective waste management relies not only on infrastructure and enforcement but also on consistent compliance at the household level (Jayaraman & Tripathi 2026). While many municipalities in the Philippines have invested in collection systems, segregation facilities, and the legal framework provided by the Ecological Solid Waste Management Act of 2000, which mandates source segregation, proper disposal, and community participation, improper waste handling remains widespread. This indicates that structural provisions and policy enforcement alone are insufficient to ensure compliance. Furthermore, although policy responses have focused on improving services, existing research shows that compliance varies significantly across communities with similar infrastructure and enforcement (Sobrino-García 2025). Therefore, the success of waste management systems ultimately hinges on understanding the behavioral determinants

that shape how individuals respond to policies and systems.

The concept of behavioral compliance in waste management differs from voluntary pro-environmental behavior because it occurs within a regulatory context in which adherence is expected, and noncompliance may carry consequences. Individuals weigh perceived benefits, social expectations, personal motivations, and awareness of penalties when deciding whether to follow prescribed waste management practices (Kim 2023). Previous behavioral research has shown that attitudes toward environmental practices and perceptions of policy effectiveness influence behavioral outcomes. However, compliance behavior is also shaped by motivational drivers and deterrence mechanisms that have received insufficient attention in community-level waste management studies (Ibokette et al. 2024).

Understanding these behavioral determinants and their relationships is critical because policy effectiveness depends not only on system design but also on citizen participation and adherence to regulations. If individuals perceive policies as ineffective, lack motivation to comply, or are unaware of enforcement consequences, compliance levels may remain low regardless of infrastructure availability (Simpson & Evens 2024), thereby affecting the community, as waste management is a critical component of local systems. Conversely, when regulatory awareness and motivational drivers align with positive attitudes and trust in policy effectiveness, compliance behavior may improve. To provide clearer policy guidance for encouraging behavioral compliance among households and communities in waste management, this study examines the factors influencing household compliance with waste management practices. Specifically, it investigates the roles of attitudes toward waste management, perceptions of policy effectiveness, motivation, and penalty awareness in shaping compliance behavior. By situating compliance decisions within both psychological and regulatory contexts, the study moves beyond purely voluntary models of environmental behavior to explain rule-adherent behavior.

The primary methodology employed in this study is Partial Least Squares Structural Equation Modeling (PLS-SEM), which supports the study's aim of empirically evaluating the relative influence of these determinants on household-level compliance behavior in a developing country such as the Philippines. PLS-SEM was selected because the study seeks to explain and predict household behavioral compliance through an extended TPB framework, and this method is particularly suitable for exploratory and prediction-oriented research. Additionally, PLS-SEM places fewer restrictions on data normality, allowing the data to be analyzed in its original form without requiring extensive preprocessing. It also enables the simultaneous assessment of measurement reliability and structural relationships.

2. BACKGROUND RESEARCH

2.1. Behavioral Compliance in Waste Management

The public's compliance with household and community waste management depends significantly on municipal systems, infrastructure, and policy enforcement. Compliance behaviors in waste management include waste segregation, proper disposal, following collection schedules, and avoiding illegal dumping. Wang et al. (2018) found that only 36% of sampled villages provided garbage collection services, and among those, only 81% of residents disposed of waste at designated sites. This underscores how household compliance is heavily influenced by existing systems and policies. The study also indicates that organized disposal sites greatly promote proper waste disposal behavior. Another study revealed that compliance intentions are driven by perceived deterrent severity and certainty, which positively affect waste separation compliance (Kim 2023). Perceived deterrent severity raises the perceived cost of non-compliance, while perceived certainty increases the likelihood of sanctions. These perceptions heighten the perceived risk of rule violation and reinforce compliance intentions. Additionally, Pulido et al. (2025) identified factors contributing to non-compliance in the Philippines, such as lack of awareness or understanding of policies, insufficient resources, and inadequate training or guidance. From these studies, it is clear that behavioral compliance depends on both internal motivation and external factors influencing individuals, households, and communities. These findings suggest that non-compliance results not only from personal willingness but also from informational gaps, structural barriers, and institutional shortcomings. This complex interplay points to the limitations of interventions that focus solely on infrastructure.

2.2. Extended Theory of Planned Behavior

The Theory of Planned Behavior (TPB) is one of the most frequently used frameworks for explaining environmentally responsible actions. It suggests that behavior is mainly driven by behavioral intentions, which are influenced by attitudes toward the behavior, subjective norms, and perceived behavioral control (Liu 2025). Numerous studies on environmental behavior have applied TPB to examine recycling, waste segregation, and sustainable consumption, illustrating its effectiveness across various socio-cultural contexts (Concari 2023, Esfandiar et al. 2023, Kumar 2019).

By emphasizing cognitive evaluation, social influence, and perceived ability, TPB offers a straightforward and well-supported model for understanding how behavioral intentions are formed.

Although the Theory of Planned Behavior (TPB) offers valuable insights, it falls short of fully explaining behavior compliance in waste management systems, as it is embedded within broader frameworks of policy enforcement, monitoring, and institutional accountability. In such contexts, behavioral decisions are shaped not only by attitudes, norms, and perceived control-core elements of the original TPB-but also by cost–benefit analyses related to penalties, the perceived likelihood of enforcement, and motivational factors that promote sustained adherence. A study by Simpson & Evens (2024) demonstrated that individuals may comply not just because they view compliance positively, but also because they perceive risks or penalties associated with non-compliance, and internalized responsibility further reinforces their commitment to policies.

Several studies have expanded the Theory of Planned Behavior (TPB) by incorporating deterrence and motivational mechanisms. This research adopts an extended TPB framework to more accurately depict compliance behavior in real-world scenarios. Notably, it introduces a novel application of the extended TPB in a developing country context, utilizing structural equation modeling. The study examines how deterrence and motivation, integrated with core TPB constructs, influence compliance behavior amid the specific institutional and enforcement conditions of such settings.

2.3. Latent Variables in the Context of Behavioral Compliance in Waste Management

2.3.1. Attitude towards Waste Management Compliance

Attitude reflects an individual's overall assessment of engaging in a behavior. In waste management, it indicates whether people see compliance as beneficial, worthwhile, or burdensome (Park & Spence 2022). Research repeatedly shows that positive environmental attitudes correlate with stronger intentions to recycle and segregate waste (Cheng et al. 2021). Those who believe that waste compliance helps protect the environment, maintain community cleanliness, and promote public health are more likely to practice proper disposal, as evidenced by Nabila et al. (2020). Conversely, if compliance is considered time-consuming, inconvenient, or ineffective, participation tends to decrease.

Furthermore, studies highlight that positive environmental attitudes do not automatically lead to compliant behavior, emphasizing that while attitudinal support is essential, it alone is not enough. This discrepancy underscores the importance of factoring in additional cognitive and contextual influences.

2.3.2. Perceived Behavioral Control

Perceived behavioral control refers to an individual's assessment of their capability to perform a specific behavior, taking into account available resources, knowledge, and situational limitations (Chen et al. 2023). In the context of waste management, it encompasses access to segregation bins, proximity to disposal sites, clarity of guidelines, time availability, and perceived convenience (Cheng 2020). Additionally, research consistently shows that even when attitudes and social norms are positive, compliance tends to decrease if individuals find the behavior difficult or inconvenient (Amir et al. 2025).

In multiple studies, households tend to adhere more effectively when waste segregation systems are straightforward, collection schedules are dependable, and instructions are clearly communicated (Sahoo et al. 2022). Additionally, perception directly predicts behavior in TPB-based models, especially when strong actual control conditions significantly impact behavioral execution.

2.3.3. Motivation

Motivation encompasses both internal and external factors that energize and sustain behavior. In Romaniuc and Bazart's book (Romaniuc & Bazart 2026), motivation is often categorized as intrinsic-such as environmental concern or moral obligation-or extrinsic, like rewards, social recognition, or avoiding sanctions. Research shows that intrinsic motivation promotes long-term compliance, while extrinsic motivation may only produce short-term adherence if intrinsic commitment is lacking (Izuakor et al. 2026). Combining intrinsic and extrinsic motivators can enhance behavioral consistency, especially during the initial adoption phase (Vorobeva et al. 2022). Therefore, motivation is a vital addition to the Theory of Planned Behavior when studying regulated environmental actions driven by personal values and external incentives.

2.3.4. Penalty Awareness and Deterrence Mechanisms

Penalty awareness pertains to an individual's understanding and perception of sanctions linked to non-compliance. In regulatory contexts, deterrence theory indicates that people are more inclined to obey rules when penalties are perceived as certain, visible, and enforceable (Kim 2023). Several environmental compliance studies show that enforcement visibility and penalty awareness significantly impact adherence to waste disposal regulations. For example, Amin et al. (2024) found that increased visibility and severity of fines for improper waste disposal enhanced public awareness and education campaigns. This public awareness, in turn, influenced compliance when people believed there was a credible risk of fines and punishment.

However, literature such as Kardiat & Jamaruddin's (2025) study suggests that penalties alone do not ensure long-term compliance. An over-reliance on enforcement may lead to compliance driven by fear rather than internal responsibility. Effective strategies often combine enforcement with education, social norms, and motivational interventions (Khan et al. 2024).

2.3.5. Behavioral Intention and Compliance Behavior

Behavioral intention reflects an individual's readiness to engage in a behavior and serves as the immediate precursor to action in the Theory of Planned Behavior (Getahun & Mengstie 2024). Recent research consistently shows that intention is a predictor of participation in recycling and waste segregation. However, the gap between intention and behavior remains a significant challenge in environmental compliance studies (de Matos et al. 2025). External factors, such as convenience barriers and enforcement conditions, often hinder the translation of intentions into action. Consequently, models that incorporate perceived control, motivational factors, and deterrence elements tend to better explain compliance behaviors (Love et al. 2024).

3. CONCEPTUAL FRAMEWORK

The conceptual framework proposes that attitude, perception, motivation, and awareness of penalties each have a direct impact on proper waste management behaviors. Additionally, awareness of penalties is believed to influence motivation and attitude, which in turn act as mediators that indirectly shape behavior.

Each hypothesis (H1–H6) represents a directional relationship between constructs as follows:

- Attitude → Behavioral Compliance (H1)

  This hypothesis shows that individuals with more favorable attitudes toward waste management are expected to exhibit higher levels of behavioral compliance.

- Perception → Behavioral Compliance (H2)

  This hypothesis shows that individuals with higher levels of perception when it comes to waste management are expected to manifest behavioral compliance.

- Motivation → Behavioral Compliance (H3)

  This hypothesis shows that individuals with high motivation and understanding of waste management and its benefits are expected to show a high level of behavioral compliance.

- Penalty Awareness → Behavioral Compliance (H4)

  This hypothesis shows that individuals with high awareness levels of deterrence mechanisms are also expected to show higher levels of behavioral compliance.

- Penalty Awareness → Motivation (H5)

  This hypothesis exhibits that individuals with higher levels of penalty awareness are also expected to show higher levels of motivation towards behavioral compliance in the context of waste management practices.

- Penalty Awareness → Attitude (H6)

This hypothesis shows that individuals with a high level of awareness of the waste management deterrence mechanisms are also the ones expected to have a positive attitude towards waste management practices or protocols in place.

4. RESEARCH OBJECTIVES

The main objective of this study is to examine the

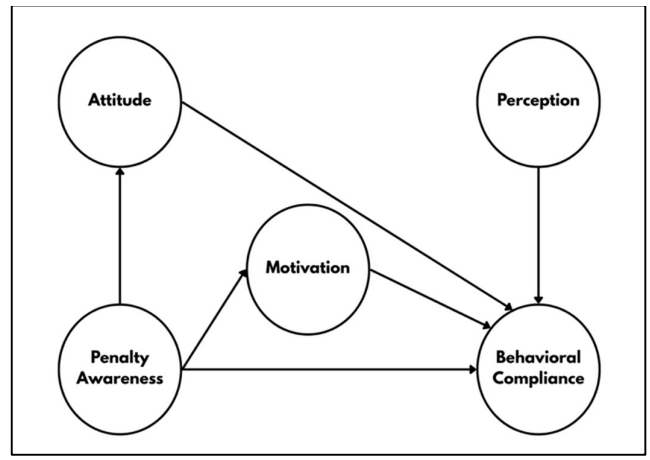


Fig. 1: Conceptual Framework of the extended Theory of Planned Behavior.

interrelationships among attitudinal, perceptual, motivational, and deterrence-related factors and their association with behavioral compliance in waste management at the household and community levels in the Philippines.

Specifically, the study aims to examine the influence of attitude, perception, motivation, and penalty awareness on behavioral intention, which translates into compliance within the context of waste management systems. It also seeks to evaluate the effects of penalty awareness, both directly and indirectly, through motivation and attitude.

Moreover, the study intends to assess the overall explanatory power of the structural model using PLS-SEM. These objectives are aligned with the broader goal of identifying actionable insights to strengthen community-based environmental programs and policies. In the long term, the findings can inform the development of targeted interventions that enhance household and community adherence to waste management regulations, thereby reducing environmental health risks, improving the effectiveness of enforcement strategies, and fostering sustainable pro-environmental habits. Finally, these insights contribute to strengthening institutional capacity, promoting civic responsibility, and supporting more resilient and sustainable waste management systems in the Philippine context.

5. METHODOLOGY

This study employs a quantitative, cross-sectional design utilizing a structured survey questionnaire as the primary data collection tool. The target population comprises households or individuals residing in a designated municipality covered by local solid waste management ordinances and practices. A total of 106 respondents participated in the survey. Since the minimum sample size for a PLS-SEM model is 50-due to its exploratory nature-this sample exceeds the threshold, indicating sufficient statistical power. Unlike confirmatory CB-SEM, which requires a larger sample, PLS-SEM's flexibility allows for smaller samples.

Participants were recruited via convenience sampling from households accessible during the survey period, with voluntary consent obtained. Eligible respondents were adults aged 18 or older, including household heads or those directly involved in waste management. This approach enabled efficient data collection within resource and time constraints, while focusing on residents actively engaged in household waste activities. All respondents were from the municipality of Argao.

The survey measured constructs such as attitude, perception, motivation, penalty awareness, and behavioral compliance, using a 5-point Likert scale from 'strongly disagree' to 'strongly agree.' These items were developed based on validated instruments in environmental behavior research and pilot-tested for content validity and clarity within the local context. Examples include: 'Proper waste disposal benefits the community' (attitude), 'I believe waste management policies are effectively implemented' (perception), 'Community programs motivate me to segregate waste' (motivation), 'I am aware of fines for improper waste disposal' (penalty awareness), and 'I regularly segregate waste at home' (behavior). The questionnaire was adapted from established instruments and aligned with the extended Theory of Planned Behavior framework.

A pilot test was conducted to validate the content, ensuring item clarity and validity. This involved 30 participants who completed the initial version of the questionnaire. Their responses were then analyzed using SmartPLS software to assess construct validity and reliability, examining indicator loadings, average variance extracted (AVE), and Cronbach's Alpha scores. The pilot results indicated strong reliability, with favorable indicator loadings, AVE, and Cronbach's Alpha. Following this, the main survey was carried out from January to February 2026 through face-to-face interviews. Prior to the interviews, respondents were informed of the study's purpose, assured of response confidentiality, and told that participation was voluntary.

The data analysis was conducted in multiple stages. Initially, data screening identified missing data, outliers, and non-normal distribution. The measurement model was then evaluated for indicator reliability (outer loadings ≥ 0.70), internal consistency (Cronbach's alpha and composite reliability ≥ 0.70), convergent validity (average variance extracted ≥ 0.50), and discriminant validity using the Fornell–Larcker criterion. Once a valid and reliable measurement model was confirmed, the structural model was assessed for path significance and R^2 values. The final stage involved bootstrapping with 5,000 resamples to test the significance of paths.

6. RESULTS AND DISCUSSION

To examine the significance and magnitude of the relationships in the proposed conceptual framework, which is the extended TPB model applied to household waste management compliance in Argao, Cebu, as presented in Fig. 2, structural equation modeling (SEM) using a partial least squares (PLS-SEM) approach was employed. PLS-SEM allows for the simultaneous assessment of measurement model reliability and structural relationships among latent variables, making it suitable for analyzing complex behavioral models involving multiple interrelated

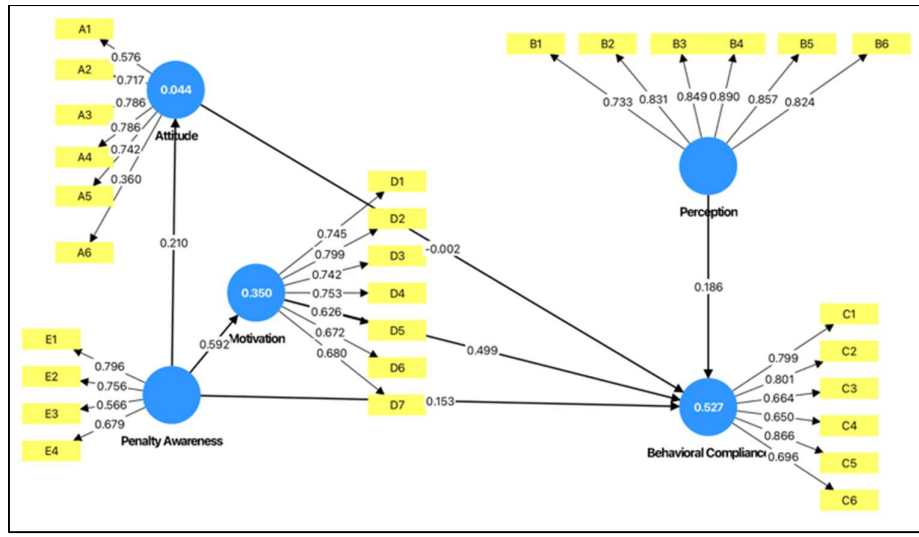


Fig. 2: Graphical output of the PLS-SEM Algorithm for the extended TPB.

constructs. Using this method, the study evaluates the model's explanatory power.

Furthermore, structural equation modeling can reveal the significance and validity of the relationships and the hypotheses (arrows) by extension. In this context, behavioral compliance is the endogenous dependent variable, meaning that all connections and structural relationships ultimately point to it as a latent variable.

6.1. Establishing the Measurement Quality of Behavioral Compliance Constructs

The measurement model was initially assessed to ensure that the observed indicators accurately represent the latent constructs within the extended Theory of Planned Behavior framework. This evaluation prioritized verifying the reliability and validity of the measurement instruments. Establishing measurement reliability is essential before analyzing structural relationships, as it confirms that the survey items effectively capture the behavioral and perceptual aspects related to waste management compliance. Reliability and validity were examined through indicator reliability, internal consistency, and convergent validity. Indicator reliability was determined using outer loadings from the PLS algorithm (Table 1), while internal consistency and convergent validity were assessed via Cronbach's alpha, composite reliability, and average variance extracted (AVE).

The results show that the measurement indicators exhibit satisfactory reliability and internal consistency. Although some indicator loadings are slightly below the recommended threshold of 0.70, they were retained in the PLS-SEM model because their values exceeded the minimum acceptable level and they contributed meaningfully to representing their constructs. As long as composite reliability and convergent validity are maintained, indicator loadings between 0.40 and 0.70 can be retained. Moreover, removing these indicators could risk omitting important aspects of household waste management behavior from the model.

In the Attitude variable, two indicators exhibit small outer loadings, suggesting they do not strongly represent the construct. Since these indicators are part of a reflective measurement model, and with a threshold set at 0.7, their lower loadings indicate weaker representation. In the Behavioral Compliance variable, three indicators are marked in red because their loadings are below 0.7, implying they do not adequately reflect the construct. Similarly, the Motivation variable has three indicators marked in red for the same reason. For Penalty Awareness, two indicators appear misaligned or less representative of the concept; though their loadings remain relatively high, they simply do not reach the 0.7 cutoff. Conversely, all indicators for the Perception variable have loadings above 0.7, indicating that these survey items effectively represent the underlying concept of Perception.

Similarly, the internal consistency measures surpassed standard benchmarks, indicating that the constructs are measured reliably. Cronbach's alpha, the most traditional criterion for internal consistency, estimates reliability based on intercorrelations among observed indicator variables. Although some constructs' alpha values fell slightly below the conventional 0.70 threshold, they still demonstrated satisfactory composite reliability, which offers a more precise assessment by considering differing indicator

Table 1: Outer loadings.

	Attitude	Behavioral Compliance	Motivation	Penalty Awareness	Perception
A1	0.576				
A2	0.717				
A3	0.786				
A4	0.786				
A5	0.742				
A6	0.36				
B1					0.733
B2					0.831
B3					0.849
B4					0.89
B5					0.857
B6					0.824
C1		0.799			
C2		0.801			
C3		0.664			
C4		0.65			
C5		0.866			
C6		0.696			
D1			0.745		
D2			0.799		
D3			0.742		
D4			0.753		
D5			0.626		
D6			0.672		
D7			0.68		
E1				0.796	
E2				0.756	
E3				0.566	
E4				0.679	

Table 2: Construct reliability and validity.

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Attitude	0.765	0.803	0.829	0.460
Behavioral Compliance	0.842	0.856	0.884	0.563
Motivation	0.844	0.852	0.882	0.517
Penalty Awareness	0.662	0.682	0.795	0.497
Perception	0.910	0.917	0.931	0.692

loadings. Convergent validity, reflecting the degree to which a measure correlates positively with other measures of the same construct, further supports the model's validity by confirming it accurately captures the observed reality. This is indicated by the average variance extracted.

Table 2 displays the construct reliability and validity of the model. The Cronbach's alpha results show that only the Penalty Awareness variable falls below the 0.7 threshold, indicating that its items may not be consistently aligned or may not accurately represent the underlying concept.

Conversely, all latent variables or constructs measured by composite reliability exceed the 0.7 threshold, confirming the reliability and validity of the survey items. The last column of Table 2 shows the average variance extracted (AVE), with the variables Attitude and Penalty Awareness falling below the 0.5 threshold. This suggests that some indicators within these variables do not adequately explain their respective latent constructs. Despite some values being slightly below the established thresholds, they are high enough to be acceptable. Overall, these results suggest that the constructs related to attitudes, perceptions, motivations, and deterrence effectively provide a reliable empirical framework for understanding behavioral factors influencing household waste management compliance.

6.2. Distinguishing the Behavioral Dimensions of Compliance

Discriminant validity refers to the degree to which a construct is genuinely distinct from other constructs based on empirical evidence. It indicates that a construct is unique and different from other elements within the model. In this study, the Fornell-Larcker criterion was used to evaluate the discriminant validity of the model. This method compares the square root of the Average Variance Extracted (AVE) values with the correlations between constructs. The logic is that a construct should share more variance with its associated indicators or survey items. An alternative to the Fornell-Larcker approach is examining cross-loadings, which assess loadings instead of AVE values but follow the same principle.

In waste management compliance research, constructs such as attitude, perception, motivation, and penalty awareness represent distinct psychological and behavioral mechanisms. It is essential to establish discriminant validity to ensure these constructs measure unique aspects of compliance rather than overlapping concepts. Discriminant validity can be assessed using a matrix where the Fornell-Larcker criterion requires that each construct's diagonal value (the square root of the Average Variance Extracted, or AVE) be larger than the off-diagonal values in its row and column. As shown in Table 3, each construct's diagonal value is the highest in its respective column. For example, the Attitude variable has a Fornell-Larcker score of 0.678, the highest among its column values. Similar patterns are observed among the other latent variables. The results confirm that the square roots of the AVE values exceed the inter-construct correlations, satisfying the Fornell–Larcker criterion for discriminant validity.

These results confirm that the behavioral determinants within the extended TPB framework are empirically separable. This distinction is especially crucial for understanding compliance, as it indicates that attitudes, motivations, and deterrence perceptions function as distinct mechanisms shaping waste management behaviors.

6.3. Evaluating the Explanatory Capacity of the Extended TPB Model

After confirming the validity of the measurement, the next step was to examine the structural model to assess the extended Theory of Planned Behavior framework's effectiveness in explaining household waste management compliance. Following the evaluation of the measurement models presented in Sections 6.1 and 6.2 of the Results and Discussion, we proceeded to assess the inner model. This assessment emphasizes the model's predictive power and how well the included constructs explain variations in the endogenous variables. The key indicators used for this evaluation include the coefficient of determination (R^2), predictive relevance (Q^2), and collinearity diagnostics.

The explanatory power of the model is best assessed using the coefficient of determination (R-squared value), which measures its predictive accuracy. This coefficient is calculated as the squared correlation between an endogenous construct's actual and predicted values. In this study, the structural model accounted for 54.6% of the variance in behavioral compliance ($R^2 = 0.527$). According to Hair et al. (2022), R^2 values around 0.25, 0.50, and 0.75 are considered to represent weak, moderate, and substantial explanatory power, respectively. Thus, the R^2 value indicates a moderate level of explanatory strength, meaning the chosen predictors adequately explain household behavioral compliance concerning waste management.

Furthermore, the coefficient indicates the combined effects of the exogenous constructs on the endogenous

Table 3: Discriminant validity (Fornell-Larcker).

	Attitude	Behavioral Compliance	Motivation	Penalty Awareness	Perception
Attitude	0.678				
Behavioral Compliance	0.328	0.750			
Motivation	0.453	0.687	0.719		
Penalty Awareness	0.210	0.554	0.592	0.705	
Perception	0.386	0.537	0.530	0.575	0.832

Table 4: R-Square.

	R-square	R-square adjusted
Attitude	0.044	0.035
Behavioral Compliance	0.527	0.508
Motivation	0.350	0.344

construct. This is also why only variables with arrows pointing inwards display R-squared values. The coefficient reflects how much variance in the primary endogenous construct—behavioral compliance—is explained. An R-squared value closer to 1 signifies greater predictive accuracy.

In Table 4, focusing on the adjusted R-square, the model's predictive power for the main endogenous construct, behavioral compliance, is 0.508. This indicates that, considering the other variables and their predispositions, the extended theory of planned behavior explains 50.80% of the variance in households' waste management behavior. This is relatively high, given that only four other variables were included in the model (Fig. 1). However, it also suggests that many relevant factors are missing and could improve the prediction of behavioral compliance. Since the context is household waste management, additional household-related factors-such as system and infrastructure conditions-should be considered. The current model does not account for policies or infrastructure, which likely influence household behavior and may explain why the model's explained variance is limited to 50.80%.

In addition to assessing the coefficient of determination for the structural model, it is necessary to evaluate collinearity. Collinearity diagnostics confirm that multicollinearity among predictor constructs is not a concern. To ensure this, each set of predictor constructs was examined separately for each part of the structural model. The VIF values are presented in Table 5. These findings indicate that the extended TPB model offers a suitable analytical framework for analyzing behavioral compliance with waste management practices in this context.

Table 5: Collinearity VIF.

	VIF
A1	1.450
A2	1.759
A3	1.730
A4	1.847
A5	1.380
A6	1.272
B1	1.809
B2	2.639
B3	2.757
B4	3.426
B5	3.142
B6	2.239
C1	1.860
C2	2.141
C3	1.470
C4	1.397
C5	2.663
C6	1.596
D1	1.931
D2	2.170
D3	2.117
D4	2.365
D5	2.210
D6	2.743
D7	2.230
E1	2.031
E2	2.055
E3	1.869
E4	1.870

6.4. Structural Relationships and Behavioral Pathways of Compliance

In the PLS-SEM model, the focus centers on path coefficients that represent the proposed relationships among constructs. These coefficients, scaled between -1 and +1, reflect the strength of these relationships—the closer to 1 or -1, the stronger the impact. Within the extended Theory of Planned Behavior (TPB) framework, these paths depict the behavioral mechanisms that influence household compliance. Notably, the path from penalty awareness to motivation has the highest coefficient at 0.592, indicating that awareness of penalties—such as fines or negative outcomes like delayed waste collection-significantly motivates proper waste management behaviors. Clear and consistent communication of penalties enhances this motivational effect, encouraging households to comply with waste policies. Ultimately, compliance appears more driven by regulatory enforcement than by internal pro-environmental motivation.

The second most influential path coefficient is the effect of motivation on behavioral compliance (0.499), highlighting that motivation is a significant direct factor contributing to compliance, consistent with real-world observations. Motivation can be driven by incentives, health benefits, or daily considerations related to household waste. A key motivator is individuals' perception of the severity of negative consequences from pollutants released

into the air if household waste is not properly disposed of or managed. However, in this study, motivation was not further distinguished into internal or external types, which could affect how respondents responded to related indicators.

The third highest path coefficient is from Penalty Awareness to Attitude, reinforcing the idea that penalties serve as a primary driver of behavioral compliance. However, this influence is moderated by the constructs of Attitude and Motivation. Attitude also encompasses other factors, such as overall feelings towards the system, and heavily depends on personal viewpoints. In waste management, some individuals may hold a negative attitude towards allowing local authorities to handle waste disposal, as they might associate it with large, unsustainable landfills that could be mismanaged and cause regional harm.

Among the various paths, the one with the lowest and possibly negative coefficient is from Attitude to Behavioral Compliance, indicating an inverse relationship (Table 6). This suggests that a positive attitude alone does not guarantee households will comply with waste management practices, especially if there is no awareness of penalties.

The magnitude of these relationships highlights the importance of considering not only attitudinal and perceptual factors traditionally emphasized in the Theory of Planned Behavior but also motivational drivers and awareness of enforcement consequences. The observed relationships provide an initial indication that compliance behavior emerges from a combination of internal behavioral motivations and external regulatory considerations, and not just from a single driver.

The bootstrap analysis was performed to assess the statistical significance of the proposed relationships within the extended Theory of Planned Behavior (TPB) framework. As shown in Table 7, three structural paths were statistically significant, while the others did not meet conventional significance levels. Notably, motivation exhibited the strongest and most significant positive effect on behavioral compliance ($\beta = 0.499$, $p < 0.001$). This suggests that motivation reflects an individual's persistence in engaging in environmentally responsible actions, supporting the idea that households are more likely to comply when waste management behaviors are seen as personally meaningful or advantageous. The strength of this relationship indicates that internal behavioral drivers are crucial in transforming policy expectations into actual compliance with recommended practices.

The relationship between Penalty Awareness and Motivation is also significant ($\beta = 0.592$, $p < 0.001$). Awareness of penalties or deterrence strategies can further boost individuals' or households' motivation to comply with waste management policies and protocols. Instead of acting in isolation, penalty awareness helps shape behavioral readiness by increasing accountability and emphasizing the importance of adhering to proper waste management practices and regulations. This significant relationship indicates that awareness of deterrence measures can trigger internal motivational responses. While motivation may already be present, penalty awareness can reinforce it, leading to voluntary compliance.

The final significant relationship is between Perception and Behavioral Compliance ($\beta = 0.186$, $p = 0.038$). This

Table 6: Path coefficients.

	Original sample [O]	Sample mean [M]	Standard deviation [STDEV]	T statistics [|O/STDEV|]	P values
Attitude -> Behavioral Compliance	-0.002	-0.002	0.101	0.023	0.982
Motivation -> Behavioral Compliance	0.499	0.504	0.101	4.926	<0.001
Penalty Awareness -> Attitude	0.210	0.252	0.116	1.813	0.070
Penalty Awareness -> Behavioral Compliance	0.153	0.160	0.090	1.694	0.090
Penalty Awareness -> Motivation	0.592	0.602	0.069	8.555	<0.001
Perception -> Behavioral Compliance	0.186	0.181	0.089	2.081	0.038

Table 7: Bootstrapping results.

	Path coefficients
Attitude -> Behavioral Compliance	-0.002
Motivation -> Behavioral Compliance	0.499
Penalty Awareness -> Attitude	0.210
Penalty Awareness -> Behavioral Compliance	0.153
Penalty Awareness -> Motivation	0.592
Perception -> Behavioral Compliance	0.186

suggests that households' interpretations and personal assessments of the waste management system significantly impact their compliance behavior. Perception represents how individuals understand waste management structures, factoring in motivational elements within cultural, social, or environmental contexts. For instance, households are more likely to participate actively in compliance when they view the systems as functional and advantageous. This underscores that behavioral compliance is partly shaped by how policies are perceived and experienced at the community level, rather than solely by their formal implementation.

6.5. Interpreting Compliance Behavior within the Philippine Context

The findings offer valuable insights into the behavioral factors influencing household waste management compliance in Argao, Cebu. While institutional policies and waste management infrastructure are officially in place, the results reveal that individual behavioral determinants play a more significant role in driving compliance than structural provisions alone. Guided by the extended Theory of Planned Behavior (TPB), this study emphasizes psychological and regulatory drivers such as motivation, perceptions, and awareness of penalties, rather than infrastructure performance itself. However, the findings suggest that infrastructure indirectly influences behavior by shaping household perceptions and experiences of waste management systems. When facilities are perceived as organized, accessible, and supportive of daily routines, they can foster intrinsic motivation and promote compliance with waste management practices. This aligns with the broader understanding that environmental policy effectiveness depends not only on institutional design but also on how individuals cognitively and behaviorally respond to these policies in their daily lives.

Perceptions of enforcement further elucidate how compliance behaviors develop within regulated environments. The structural model highlights the pathway Penalty Awareness → Motivation → Behavioral Compliance as the most significant mechanism influencing household behavior. This indicates that awareness of penalties does not directly lead to compliance but enhances motivation among households. In this context, deterrence and penalties function less as coercive measures and more as signals of the seriousness and legitimacy of environmental regulations, emphasizing the urgency of compliance. This aligns with previous studies showing that limited awareness and weak enforcement diminish policy effectiveness, especially in developing countries where institutional implementation varies. By demonstrating that penalty awareness boosts motivation-and that motivation drives compliance—the study supports expanding the TPB to incorporate regulatory and deterrence factors that strengthen internal behavioral processes, beyond mere attitude change.

Household-level realities further contextualize the observed behavioral patterns. The existing variations in household structure, work arrangements, and daily routines may influence the capacity of residents to comply consistently with waste segregation and disposal requirements. Some practical constraints, such as absence during collection schedules or limited time for waste preparation, can hinder compliance even when positive attitudes or motivations are present. Recognizing these constraints highlights the importance of designing waste management policies that are responsive to diverse household conditions, which thereby reduces structural barriers that may unintentionally discourage participation.

Despite the contributions of this study, there are several limitations that should be reiterated. First, the study was conducted within a specific geographic area, which may have an influence on the generalizability of the findings to other communities with different socioeconomic, cultural, or environmental conditions. Second, the causal relationships among the variables cannot be established with certainty. Third, although the extended Theory of Planned Behavior model incorporated motivation and penalty awareness, other factors that may influence household waste management compliance, such as environmental knowledge, access to waste management facilities, institutional trust, and community participation, were not included in the present analysis. The viability of the discussion and recommendations should be able to address the limitations of future studies.

Overall, the findings indicate that enhancing waste management outcomes relies on behavioral interventions that complement existing infrastructure and policies. While infrastructure and regulations form essential foundations, actual behavioral compliance depends heavily on how policies can stimulate motivation, influence perceptions, and reflect community and household realities. In community-based waste management, strategies that prioritize enforcement, boost motivational engagement, and address local social dynamics are likely more effective in ensuring lasting behavioral change than merely investing in infrastructure and revisiting policies.

7. CONCLUSIONS AND POLICY INSIGHTS

This research indicates that to achieve better compliance with household waste management policies in the Philippines, there must be a phased approach based on behavioral change that will likely be more effective than using only infrastructure development or strict enforcement. Compliance behavior with household waste management

policies is primarily motivated by individual and community perceptions of penalties; therefore, policy interventions need to be designed in such a way as to gradually create improved compliance to the extent that it is within the current institutional constraints.

7.1. Short-Term: Low-Cost, Behavior-Oriented Interventions

In the short run, local government units (LGUs) and barangays can implement low-cost, readily implementable strategies that directly address the behavioral determinants of compliance. First, improving Information, Education, and Communication (IEC) campaigns to show individuals how proper waste management relates to their own cleanliness, health, and community order will increase motivation and promote compliance. Current IEC messages about the environment are often abstract. Using the environment as a motivator will provide daily relevance for households and increase the likelihood that individuals will comply with the rules. In alignment with this, it is encouraged to do a quarterly barangay-based waste segregation workshop with attendance integrated into community environmental programs.

Second, increasing the visibility of enforcement efforts and clearly communicating the penalties for waste disposal violations can raise awareness and encourage compliance. LGUs should disseminate information about rules, penalties, and collection schedules through multiple channels, such as bulletin boards and community notices, ensuring consistent and fair communication. To reinforce compliance, Argao could implement or enhance incentive programs like barangay recognition awards and waste exchange initiatives. Third, LGUs can support households by providing simple, standardized guides on waste separation, color-coding, and collection schedules. These tools will lessen families' cognitive and physical burdens, improving adherence to waste management rules.

7.2. Medium-Term: Strengthening System Credibility and Community Engagement

Medium-term policy initiatives should focus on improving the public's perception of the waste management system and increasing trust in the involved institutions, as these factors strongly influence compliance behavior. Enhancing the reliability and accessibility of services is crucial. Consistent waste collection times and easily accessible disposal sites directly impact households' perceptions of service efficiency and are linked to higher compliance rates. Addressing these issues involves both technical improvements and behavioral strategies. When adjusting collection schedules or days, household feedback should be considered to ensure schedules meet community needs.

Local government units (LGUs) should establish formal channels for residents and communities to communicate and provide feedback on waste management. This includes engaging with barangays, creating complaint reporting procedures, and regularly assessing waste management practices within each community. Allowing community members to share their feedback helps identify system performance issues and improves responsiveness, fostering a perception of equitable treatment. Additionally, LGUs must enforce waste management rules consistently and transparently across all households. Visible and fair enforcement encourages greater compliance and trust within the community.

7.3. Long-Term: Institutionalizing Household-Sensitive and Adaptive Policies

Over time, waste management policies will evolve to develop household-sensitive and adaptive systems that account for how different types of households influence their compliance with waste responsibilities. Policies should consider various factors affecting daily household operations and their impact on waste management. This may involve implementing more flexible collection schedules, localized service modifications to suit work hours, available time, and space limitations, or providing tailored support from local governments to assist households with structural constraints. By aligning systems with household realities, these solutions can lower barriers to compliance and foster long-term participation. Furthermore, LGUs might establish participatory governance frameworks, enabling communities to contribute to the design and evaluation of waste systems. While full co-governance may not be immediately feasible in all areas, gradually incorporating community input can enhance accountability, a sense of ownership, and promote sustainable behavioral change.

7.4. Integrated Perspective: Waste Management as a Socio-Technical System

The findings from this study across four stages highlight that waste management systems should be viewed as socio-technical entities, emphasizing the interdependence of technical infrastructure and human behavior. To develop effective waste management policies and systems, it is essential to integrate these components: (a) motivational mechanisms that sustain long-term behavioral engagement, (b) visible, credible enforcement systems that reinforce compliance, (c) reliable, user-oriented service delivery that enhances perceptions of system effectiveness, and

(d) household-sensitive adaptations that address practical constraints affecting waste management behaviors. Incorporating these elements will lead to policies that are both operationally efficient and behaviorally supportive, thereby increasing the likelihood of long-term success.

The research suggests that successful behavioral change in the Philippines can be achieved through phased, behavior-focused interventions. While short-term results can be attained with low-cost strategies, sustaining credibility over the medium and long term is crucial for lasting effectiveness. By aligning policies with households' perceptions, experiences, and responses to waste management systems, local government units (LGUs) can improve household compliance and overall system effectiveness. Ultimately, the success of a waste management program depends not only on infrastructure and regulations but also on its ability to foster consistent, scalable behavioral adherence among households.

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