

From Beliefs to Action: Structural Pathways Influencing Household Waste Sorting Behavior in Pontianak City, Indonesia

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Abstract

Household waste sorting is a critical behavioral component of sustainable urban waste management; however, its adoption often depends on complex interactions among beliefs, perceptions, social influences, and individual intentions. This study examines the structural pathways through which social, psychological, and environmental factors influence household waste sorting behavior in Pontianak Kota District, Indonesia. Grounded in an Extended Theory of Planned Behavior framework, this study employed a quantitative explanatory design involving 395 household respondents. Data were analyzed using Structural Equation Modeling–Partial Least Squares (SEM-PLS) with bootstrapping to assess the significance of structural relationships. The findings show that intention is the strongest direct predictor of household waste sorting behavior, with a path coefficient of 0.775 and a T-statistic of 33.613. Behavioral beliefs significantly influenced both perception and attitude, while normative beliefs strongly shaped social norms. Social norms, perception, and attitude were also found to significantly influence intention, indicating that household waste sorting behavior emerges through interconnected cognitive and social pathways. Knowledge significantly influenced attitude but did not directly strengthen intention, suggesting that information-based interventions alone may be insufficient without motivational and social reinforcement. These findings highlight the importance of transforming beliefs into positive attitudes, perceived benefits, supportive norms, and strong behavioral intentions. The study contributes to the pro-environmental behavior literature by clarifying how belief-based constructs translate into household waste sorting actions within an urban Indonesian context.

INTRODUCTION

Household waste sorting is a critical behavioral component of sustainable urban waste management; however, its adoption often depends on complex interactions among beliefs, perceptions, social influence, and individual intention. This study examines the structural pathways through which social, psychological, and environmental factors influence household waste sorting behavior in Pontianak Kota District, Indonesia. Grounded in an Extended Theory of Planned Behavior framework, the study employed a quantitative explanatory design involving 395 household respondents. Data were analyzed using Structural Equation Modeling–Partial Least Squares (SEM-PLS) with bootstrapping to assess the significance of structural relationships. The findings show that intention is the strongest direct predictor of household waste sorting behavior, with a path coefficient of 0.775 and a T-statistic of 33.613. Behavioral beliefs significantly influenced both perception and attitude, while normative

beliefs strongly shaped social norms. Social norms, perception, and attitude were also found to significantly influence intention, indicating that household waste sorting behavior emerges through interconnected cognitive and social pathways. Knowledge significantly influenced attitude but did not directly strengthen intention, suggesting that information-based interventions alone may be insufficient without motivational and social reinforcement. These findings highlight the importance of transforming beliefs into positive attitudes, perceived benefits, supportive norms, and strong behavioral intentions. The study contributes to the pro-environmental behavior literature by clarifying how belief-based constructs translate into household waste sorting actions within an urban Indonesian context.

Household waste sorting has become an increasingly important issue in sustainable urban waste governance because the success of waste reduction, recycling, and circular resource recovery depends largely on how waste is managed at the source (Xu et al., 2017; Kumar et al., 2017; Ma et al., 2019). The growing volume of municipal solid waste in urban areas has intensified pressure on existing waste management systems, with many cities struggling to keep pace with the rapid increase in waste generation (Ferronato & Torretta, 2019; Kaza et al., 2018). In many urban areas, technical improvements in collection, transportation, and final disposal have not been sufficient to reduce the growing pressure on municipal waste systems (Ferronato & Torretta, 2019; Kaza et al., 2018). This persistent challenge underscores the need to address waste management not only through infrastructure development but also through behavioral change at the household level (Geiger et al., 2019; Wang et al., 2021). This condition indicates that waste management is not only an infrastructural or administrative problem but also a behavioral challenge rooted in daily household practices (Geiger et al., 2019; Wang et al., 2021). When residents do not separate organic, inorganic, and recyclable materials at the household level, downstream waste processing becomes less efficient, more costly, and environmentally burdensome (Xu et al., 2017). Therefore, understanding why households are willing or unwilling to sort waste is essential for designing interventions that are socially responsive and behaviorally effective (Nigbur et al., 2015). In this context, behavioral research provides an important foundation for explaining how individual cognition, social influence, perceived capability, and environmental conditions interact in shaping pro-environmental actions (Ajzen, 2020; Geiger et al., 2019; Wang et al., 2021). This understanding is particularly relevant for rapidly growing urban areas where household waste generation continues to increase alongside changes in consumption patterns and residential density, as observed in many Indonesian cities (Kaza et al., 2018; Ferronato & Torretta, 2019).

Previous studies have widely applied the Theory of Planned Behavior (TPB) to explain pro-environmental behaviors, including recycling, waste separation, and other household-level environmental practices (Xu et al., 2017; Bardus & Massoud, 2022; Pan & Liu, 2024). A recent meta-analysis of 39 studies confirmed that TPB is a valid framework for understanding and predicting waste sorting behavior, with attitudes, subjective norms, and perceived behavioral control all showing positive and significant effects on behavioral intention (Novanda et al., 2026). This framework argues that behavior is primarily shaped by intention, which is influenced by attitude, subjective norms, and perceived behavioral control (Ajzen, 2020; Xu et al., 2017). The relationship between perceived behavioral control and intention was found to exert the strongest influence among the TPB constructs, followed by attitudes and subjective norms (Novanda et al., 2026). However, empirical findings in waste sorting studies show that

the pathway from knowledge to behavior is often indirect and inconsistent (Pan & Liu, 2024; Hu et al., 2026). Individuals may understand the importance of waste sorting but still fail to practice it when social support, perceived convenience, facilities, or personal commitment are weak (Bardus & Massoud, 2022; Hu et al., 2026). In the Indonesian context, research has shown that inadequate facilities and a lack of social support from family members or neighbors often become barriers to consistent waste sorting behavior (Marbun et al., 2025). Similarly, policy support and infrastructure provision may not directly lead to behavioral change when residents do not perceive waste sorting as meaningful, feasible, or socially expected (Xu et al., 2017; Zaikova et al., 2022). For instance, in Jakarta, waste sorting efforts are frequently undermined by residents' perceptions that their sorting activities will ultimately be ineffective because waste collectors combine all materials into a single truck (Marbun et al., 2025). This suggests that household waste sorting behavior should be examined through a structural pathway perspective rather than through isolated variable relationships (Xu et al., 2017; Bardus & Massoud, 2022). A structural approach allows researchers to identify not only which determinants are significant but also how beliefs, perceptions, norms, attitudes, and intentions are connected in producing actual behavior (Pan & Liu, 2024; Hu et al., 2026).

The present study differs from general determinant-based studies by focusing on the structural relationships among latent constructs that shape household waste sorting behavior (Xu et al., 2017; Lou et al., 2020; Wu et al., 2022). While previous research has often examined the direct effects of individual factors, few studies have comprehensively modeled the sequential pathways through which beliefs are transformed into perceptions, attitudes, social norms, intentions, and actual behavior (Cao et al., 2023; Pan & Liu, 2024). Instead of merely ranking influential factors, this study investigates how behavioral beliefs shape attitudes and perceptions, how normative beliefs construct social norms, and how these constructs subsequently influence intentions and actual waste sorting practices (Ajzen, 2020; Xu et al., 2017; Marbun et al., 2025). This perspective is important because behavioral change often occurs through sequential psychological processes rather than through a single direct stimulus (Lou et al., 2020; Hu et al., 2026). For example, a resident's belief that waste sorting is useful may first shape a positive perception or attitude before developing into a strong intention to act (Xu et al., 2017; Wu et al., 2022). Likewise, social expectations from family, neighbors, or community leaders may influence behavior through the strengthening of intentions rather than through direct behavioral enforcement (Marbun et al., 2025). Empirical evidence from Indonesia suggests that support from family members and neighborhood associations plays a crucial role in reinforcing waste sorting habits, while a lack of such support often leads to disengagement (Marbun et al., 2025; Pramudita & Herwangi, 2025). By testing these pathways, the study offers a more nuanced explanation of how household waste sorting behavior is formed in an urban Indonesian context (Marbun et al., 2025; Pramudita & Herwangi, 2025). This approach also provides a stronger empirical basis for designing interventions that target the most influential behavioral mechanisms (Lou et al., 2020; Hu et al., 2026).

Pontianak Kota District presents a particularly relevant setting for this investigation due to its dense urban characteristics and pressing waste management challenges. According to the Pontianak City Environmental Agency, the city produces approximately 400 to 411.96 tons of waste per day, yet only about 25 percent of this volume can be effectively managed (RRI, 2025; RRI, 2026). The existing waste management infrastructure, including the Batu Layang landfill,

faces severe capacity constraints, and the local government has begun transitioning from open dumping to a sanitary landfill system integrated with TPS3R (Tempat Pengolahan Sampah Reduce-Reuse-Recycle) facilities (RRI, 2026). Community leaders and the Pontianak City Secretary have repeatedly called for residents to start sorting waste at the household level as a fundamental strategy to reduce landfill pressure and improve recycling outcomes (RRI, 2025; RRI, 2026). The complexity of household waste management in this area requires more than conventional waste-handling strategies, particularly because community participation remains central to successful source-based sorting (Zhang et al., 2015; Xu et al., 2017; Roustae et al., 2020). Local waste management policies may provide the regulatory foundation, but their effectiveness depends on residents' behavioral readiness and the social conditions that support action (Pan & Liu, 2024). The socio-demographic diversity of District Pontianak Kota, with its mix of residential, commercial, and public service areas, further underscores the need to understand the behavioral mechanisms underlying household waste sorting in this specific urban context. Thus, examining the structural pathways behind household waste sorting can help explain why some policy and educational efforts succeed while others have limited behavioral impacts (Xu et al., 2017; Hu et al., 2026).

The novelty of this study lies in its use of an Extended Theory of Planned Behavior framework to examine the structural pathways linking social, psychological, and environmental constructs with household waste sorting behavior in the under-researched context of Pontianak City (Cao et al., 2023; Pan & Liu, 2024). While previous Indonesian studies have examined waste sorting behavior in Jakarta, Surabaya, and Yogyakarta, limited attention has been given to secondary cities such as Pontianak that face distinct infrastructural and socio-cultural challenges (Marbun et al., 2025; Pramudita & Herwangi, 2025; Prasetyo et al., 2024). By employing SEM-PLS with bootstrapping to evaluate both direct and indirect pathways, this study provides a more comprehensive understanding of the mechanisms through which behavioral and normative beliefs are translated into actual waste sorting practices. The findings are expected to contribute to the literature on pro-environmental behavior by clarifying the mechanisms through which intention, perception, attitude, social norms, knowledge, governmental support, and facility availability operate within an integrated model (Zhang et al., 2015; Xu et al., 2017; Hu et al., 2026). Furthermore, the study has significant practical implications for policymakers and community organizations in Pontianak, as it identifies the most influential behavioral pathways that should be strengthened to enhance community participation in household waste sorting. This study aims to examine the structural relationships among social, psychological, and environmental factors influencing household waste sorting behavior in District Pontianak Kota. The analysis employs a Structural Equation Modeling–Partial Least Squares (SEM-PLS) approach grounded in an Extended Theory of Planned Behavior framework.

METHOD

This study employed a quantitative explanatory design to test the structural pathways underlying household waste sorting behavior in District Pontianak Kota, Indonesia. Unlike descriptive behavioral studies that primarily focus on identifying isolated determinants, this study emphasized hypothesis testing among latent constructs within an Extended Theory of Planned Behavior framework (Zhang et al., 2015; Hair et al., 2019). The model was specified

to examine how behavioral beliefs, normative beliefs, control beliefs, knowledge, governmental support, and facility availability contributed to the formation of attitude, perception, social norms, intention, and actual household waste sorting behavior. This design was appropriate because the research objective was not only to determine whether variables were associated but also to evaluate the direction and statistical significance of theoretically derived relationships among constructs (Zhang et al., 2015). The use of SEM-PLS was suitable for this study because it enabled the analysis of complex models involving multiple latent constructs and the simultaneous estimation of direct and indirect effects (Hair et al., 2019).

The study was conducted in District Pontianak Kota, an urban district consisting of five subdistricts: Darat Sekip, Mariana, Sungai Bangkong, Sungai Jawi, and Tengah. This district was selected because it represented a dense urban setting where household waste generation, public mobility, and local environmental governance interacted closely. The study population consisted of household representatives residing in the district. Respondents were eligible if they were between 21 and 55 years old and had lived in the study area for at least two years. These criteria ensured that participants had sufficient familiarity with local waste management conditions and were involved in household waste management decisions (Zhang et al., 2015; Etikan & Bala, 2017). The sample size was determined using Slovin's formula with a 5% margin of error. Based on an estimated population of 30,967 households, the minimum required sample size was 395 respondents. A stratified random sampling procedure was applied to ensure proportional representation from each subdistrict. The number of respondents in each stratum was allocated according to the proportion of households in each subdistrict relative to the total household population of District Pontianak Kota. This procedure was intended to reduce selection bias and improve the representativeness of the dataset across different urban neighborhood characteristics (Etikan & Bala, 2017; Sharma, 2017).

Primary data were collected using a structured questionnaire developed based on the Extended Theory of Planned Behavior framework. The instrument measured behavioral beliefs, normative beliefs, control beliefs, attitude, social norms, perceived behavioral control, intention, knowledge, governmental support, facility availability, and household waste sorting behavior (Xu et al., 2017; Pan & Liu, 2024). Most latent constructs were measured using a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). Knowledge, governmental support, and facility availability were measured using ordinal response categories according to their respective conceptual characteristics. The questionnaire was distributed through Google Forms and supplemented with direct interviews to accommodate respondents with limited digital access. Before analysis, the dataset was screened for completeness, response consistency, and coding accuracy. Data analysis was conducted using Structural Equation Modeling–Partial Least Squares (SEM-PLS) with SmartPLS 3.0 (Hair et al., 2019). The analysis consisted of descriptive statistical analysis to describe respondents' socio-demographic characteristics and structural model evaluation to test the hypothesized relationships among constructs. Bootstrapping with 5,000 resamples was applied to estimate the stability and significance of path coefficients without requiring strict distributional assumptions. Each hypothesis was evaluated using T-statistics and P-values, with relationships considered statistically significant when the T-statistic exceeded 1.96 and the P-value was below 0.05 at the 5% significance level (Hair et al., 2019). Direct, indirect, and total effects

were also examined to identify the most influential structural pathways leading to household waste sorting behavior.

RESULTS AND DISCUSSION

Respondent Characteristics

Table 1. Frequency Distribution of Household Respondent Characteristics

Variable	Category	N	%
Urban village	Sungai Bangkong	79	20.0
	Sungai Jawi	77	19.5
	Darat Sekip	79	20.0
	Mariana	81	20.5
	Tengah	79	20.0
Total		395	100.0
Gender	Male	262	66.3
	Female	133	33.7
Total		395	100.0
Age	21–29 years	126	31.9
	30–39 years	104	26.3
	40–49 years	97	24.6
	50–55 years	68	17.2
Total		395	100.0
Educational attainment	Senior high school/vocational high school or equivalent	150	38.0
	Diploma degree (D1–D3)	90	22.8
	Bachelor's degree	93	23.5
	Master's degree	62	15.7
Total		395	100.0
Occupation	Civil servant/government employee	94	23.8
	Private-sector employee	102	25.8
	Entrepreneur/self-employed	79	20.0
	Homemaker	37	9.4
	Student	72	18.2
	Retired	11	2.8
Total		395	100.0
Waste collection service	Yes	131	33.2
	No	264	66.8
Total		395	100.0

Source: SPSS output, processed research data (2025).

The primary data were obtained from 395 household heads in District Pontianak Kota. The distribution of respondents across the five urban villages was relatively balanced, ranging from 19.5% to 20.5%, indicating that no single urban village dominated the sample. Mariana

contributed the largest proportion of respondents with 81 households or 20.5%, followed by *Sungai Bangkok*, *Darat Sekip*, and *Tengah* with 79 respondents each or 20.0%, while *Sungai Jawi* accounted for 77 respondents or 19.5%. In terms of gender, the respondents were predominantly male, representing 66.3% of the sample, while female respondents accounted for 33.7%. This gender distribution reflects the cultural context in which household heads are typically male in many Indonesian urban households, although women often play a significant role in daily waste management practices (Marbun et al., 2025). Most respondents were within the productive age group, with those aged 21–49 years comprising 82.8% of the total sample. Regarding education, the largest proportion of respondents had completed senior high school or equivalent education, accounting for 38.0%, followed by undergraduate degree holders at 23.5%, diploma graduates at 22.8%, and master's degree holders at 15.7%. The relatively high educational attainment of the sample suggests that respondents possess adequate cognitive capacity to understand waste sorting information and participate in behavioral interventions. Occupationally, the respondents were mainly employed in formal and productive sectors, including private employees, civil servants, and entrepreneurs, which together represented 69.6% of the sample. However, only 33.2% of respondents reported having access to waste collection services, while 66.8% did not, indicating a potential infrastructural gap in household waste management services in the study area. This finding aligns with the local government's data showing that only about 25% of the city's waste is effectively managed, highlighting a significant gap between waste generation and collection capacity (RRI, 2025; RRI, 2026). This respondent profile reflects the characteristics of an urban community with diverse socio-economic backgrounds and varying levels of access to waste management services (Zhang et al., 2015).

Structural Pathway Assessment

The structural pathway assessment was conducted using the bootstrapping procedure in SEM-PLS to examine the statistical significance of the relationships among variables in the proposed model. Bootstrapping is a resampling-based statistical technique used to estimate the sampling distribution and assess structural relationships without requiring strict assumptions regarding data normality. This approach enables the generation of more stable and robust statistical estimates, making it particularly appropriate for evaluating complex behavioral models such as those examined in this study (Hair et al., 2019).

The results of the bootstrapping procedure are presented in a table containing the T-statistics and P-values for each tested pathway. A structural pathway was considered statistically significant when the T-statistic exceeded 1.96 at the 5% significance level and the P-value was below 0.05. Pathways meeting these criteria were interpreted as providing empirical support for the proposed relationships in the model (Hair et al., 2019). The bootstrapping analysis provides empirical evidence regarding how social, psychological, and environmental factors interact to shape household waste sorting behavior. The results offer important insights into the mechanisms through which beliefs, perceptions, attitudes, social norms, and intention contribute to the transition from cognitive evaluation to actual pro-environmental behavior.

By applying the bootstrapping procedure, this study produced more reliable estimates for assessing the structural pathways within the SEM-PLS model. The analysis also enabled the identification of key pathways that should be strengthened to enhance community participation

in household waste sorting in District Pontianak Kota (Figure 1). Thus, the structural pathway assessment serves not only as a statistical evaluation of the proposed model but also as an empirical basis for developing more targeted behavioral and policy interventions.

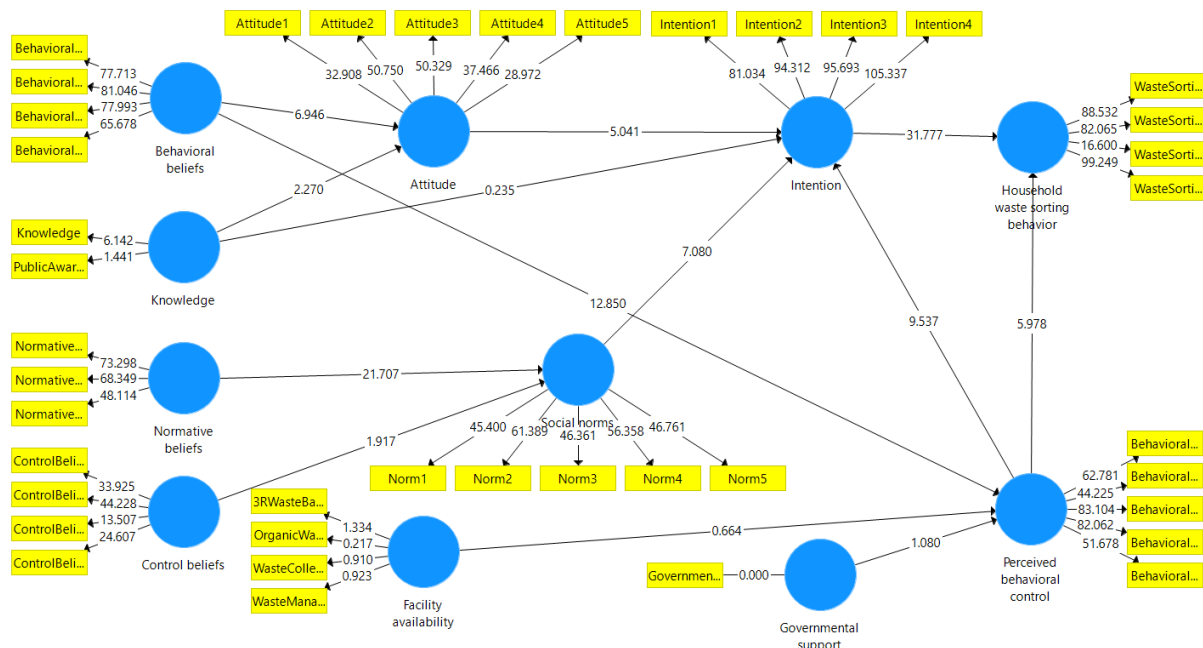


Figure 1. Bootstrapping results of the structural model

Structural Pathway Interpretation

Table 2. Bootstrapping Results for the Structural Pathways

Structural Pathway	Standard Deviation	T-statistic	P-value	Decision
Governmental support → Perception	0.05	1.01	0.31	Not supported
Facility availability → Perception	0.11	0.65	0.52	Not supported
Control beliefs → Social norms	0.04	1.76	0.08	Not supported
Normative beliefs → Social norms	0.04	18.94	<0.001	Supported
Behavioral beliefs → Perception	0.04	12.30	<0.001	Supported
Behavioral beliefs → Attitude	0.05	6.88	<0.001	Supported
Intention → Household waste sorting behavior	0.02	33.61	<0.001	Supported
Social norms → Intention	0.04	7.15	<0.001	Supported
Knowledge → Intention	0.04	0.27	0.79	Not supported
Knowledge → Attitude	0.05	2.28	0.02	Supported
Perception → Intention	0.04	9.20	<0.001	Supported
Perception → Household waste sorting behavior	0.03	6.57	<0.001	Supported
Attitude → Intention	0.04	4.83	<0.001	Supported

Source: A pathway is considered statistically significant when the T-statistic is greater than 1.96 and the P-value is less than 0.05.

Based on the path analysis presented in the table, the relationships among the variables in the proposed model demonstrate how social, psychological, and environmental factors influence household waste sorting behavior. This study examined the effects of these factors using data analyzed through the SEM-PLS approach. The following interpretation discusses the structural relationships based on the obtained T-statistics and P-values.

The relationship between normative beliefs and social norms showed a highly significant result, with a path coefficient of 0.680 and a T-statistic of 18.943. This finding indicates that individuals' beliefs regarding social expectations strongly influence the formation of social norms within the community (Bardus & Massoud, 2022; Leknoi et al., 2024). Social norms that support household waste sorting are more likely to be accepted when individuals hold strong beliefs regarding the importance of such norms. The very low P-value confirms that the relationship between normative beliefs and social norms is statistically significant. Strategically, this result suggests that waste sorting programs should strengthen community-level expectations by making household waste sorting a visible and socially valued practice (Bardus & Massoud, 2022). Local authorities and community leaders can promote collective commitments, such as neighborhood waste sorting agreements, public declarations, or community-based environmental pledges. Campaign messages should emphasize that waste sorting is not merely an individual responsibility but a shared social standard expected within the community. In addition, involving respected local figures, neighborhood associations, and family groups can help reinforce normative pressure in a positive and culturally acceptable manner (Leknoi et al., 2024). Public recognition for households or neighborhoods that consistently sort waste may also strengthen the perception that waste sorting is socially approved and appreciated. Therefore, interventions aimed at improving household waste sorting should not only provide information but also cultivate supportive social norms that encourage residents to act in accordance with collective environmental expectations (Bardus & Massoud, 2022; Leknoi et al., 2024). This finding is consistent with previous research in Indonesia showing that support from family members and community leaders significantly shapes individuals' motivation to sort waste (Marbun et al., 2025).

Behavioral beliefs had a significant effect on perception, with a path coefficient of 0.479 and a T-statistic of 12.302. This result suggests that individuals' beliefs regarding household waste sorting substantially shape their perception of the benefits and importance of the practice (Xu et al., 2017; Lou et al., 2020; Ma et al., 2020). The very low P-value indicates that behavioral beliefs are a critical factor in forming positive perceptions that support household waste sorting behavior. Strategically, this finding implies that interventions should focus on strengthening residents' beliefs that waste sorting produces tangible environmental, social, and practical benefits (Lou et al., 2020; Ma et al., 2020; Hu et al., 2026). Public campaigns should communicate clear and evidence-based messages on how household waste sorting reduces landfill burden, improves neighborhood cleanliness, supports recycling systems, and contributes to healthier urban environments. Educational materials should avoid abstract environmental messages and instead present concrete examples that are directly relevant to daily household life. Demonstration-based programs, such as household waste sorting simulations, community recycling workshops, and waste bank activities, can help residents experience the practical value of sorting waste. Local governments and community organizations should also highlight success stories from households or neighborhoods that have benefited from consistent waste sorting practices. By reinforcing the perceived usefulness and feasibility of waste sorting, these strategies can strengthen behavioral beliefs and transform them into more positive perceptions that support sustained pro-environmental action (Xu et al., 2017; Lou et al., 2020; Hu et al., 2026). In the context of Pontianak, community campaigns

emphasizing that sorted waste can be processed at TPS3R facilities and waste banks may enhance residents' perceptions of the practice's feasibility and benefits (RRI, 2025).

Behavioral beliefs also had a significant effect on attitude, with a path coefficient of 0.318 and a T-statistic of 6.878. This finding indicates that stronger beliefs in the value and importance of household waste sorting contribute to more favorable attitudes toward the practice (Xu et al., 2017; Lou et al., 2020; Pan & Liu, 2024). In this context, individuals are more likely to develop a positive attitude toward waste sorting when they believe that the behavior is meaningful, beneficial, and necessary (Xu et al., 2017; Wu et al., 2022). The low P-value further confirms the statistical significance of this relationship. Strategically, this result suggests that attitude-oriented interventions should focus on strengthening residents' belief that waste sorting is both personally relevant and socially beneficial (Lou et al., 2020; Pan & Liu, 2024). Educational campaigns should frame waste sorting not only as an environmental obligation but also as a practical household habit that contributes to cleanliness, health, and resource efficiency. Local governments and community organizations can use persuasive messages that connect waste sorting with daily benefits, such as cleaner neighborhoods, reduced odor, fewer pests, and improved recycling value. Practical demonstrations may also help transform abstract beliefs into positive attitudes by showing residents that waste sorting is simple and achievable. In addition, repeated exposure to positive messages through community meetings, schools, social media, and local waste bank activities can gradually normalize favorable attitudes toward waste sorting. Therefore, strengthening behavioral beliefs should be integrated with attitude-building strategies to ensure that residents perceive household waste sorting as a valuable, feasible, and desirable practice (Xu et al., 2017; Lou et al., 2020; Wu et al., 2022; Pan & Liu, 2024).

The effect of intention on household waste sorting behavior was significant. The path coefficient of 0.775 and the very high T-statistic of 33.613 indicate that intention has a substantial influence on individuals' decisions to perform household waste sorting (Xu et al., 2017; Bardus & Massoud, 2022; Pan & Liu, 2024). Intention functions as a central motivational factor that drives individuals to translate their beliefs and evaluations into actual behavior (Xu et al., 2017; Pan & Liu, 2024). The very low P-value confirms that intention is a primary determinant of household waste sorting behavior. Strategically, this finding suggests that intervention programs should prioritize the formation of strong behavioral intention before expecting consistent waste sorting practices (Bardus & Massoud, 2022; Cao, 2026). Local governments and community organizations should design commitment-based programs, such as household pledges, neighborhood waste sorting targets, and routine monitoring activities, to transform intention into sustained action. Educational campaigns should also emphasize immediate and visible benefits, such as cleaner surroundings, reduced waste accumulation, and improved community health, to strengthen residents' willingness to act. In addition, reminder systems through community groups, digital platforms, and local leaders can help maintain intention and reduce the gap between willingness and actual behavior. Waste sorting programs should also provide simple, achievable steps so that residents feel capable of translating their intention into daily practice. Therefore, strengthening intention should be treated as the central strategy for promoting household waste sorting, supported by practical guidance, social reinforcement, and consistent community engagement (Xu et al., 2017; Bardus & Massoud, 2022; Pan & Liu, 2024; Cao, 2026). This finding is consistent with the meta-analytic evidence

showing that intention is the strongest predictor of waste sorting behavior, with a robust effect size across various contexts (Novanda et al., 2026).

Social norms had a significant effect on intention, with a path coefficient of 0.280 and a T-statistic of 7.149. This result indicates that supportive social norms can strengthen individuals' intention to sort household waste (Bardus & Massoud, 2022; Pan & Liu, 2024). Although the magnitude of this effect is lower than the direct effect of intention on behavior, social norms remain an important mechanism in shaping behavioral intention. The statistically significant P-value demonstrates that social expectations and community-level influence contribute meaningfully to the formation of intention (Pan & Liu, 2024). Strategically, this finding suggests that household waste sorting programs should be designed to create a social environment in which sorting waste is perceived as a common and expected practice. Community-based campaigns can emphasize that most responsible households participate in waste sorting, thereby strengthening descriptive norms and encouraging residents to align their behavior with community expectations. Local leaders, neighborhood associations, and religious or educational institutions should be actively involved in promoting waste sorting as a shared social responsibility. Public recognition of neighborhoods or households that consistently practice waste sorting can also reinforce the perception that such behavior is socially valued. In addition, regular community activities, such as collective clean-up programs and waste bank participation, can strengthen social interaction and normalize waste sorting practices. Therefore, strengthening social norms should be integrated into behavioral interventions to increase residents' intention and sustain long-term participation in household waste sorting (Bardus & Massoud, 2022; Pan & Liu, 2024). These findings align with the work of community leaders in Pontianak who have called for collective action through neighborhood-level initiatives and regular gotong royong activities to promote waste sorting as a social norm (RRI, 2025).

Knowledge was found to influence attitude, although the relationship was relatively limited. The negative path coefficient of -0.116, with a T-statistic of 2.278 and a P-value of 0.023, indicates that knowledge alone may not always produce a stronger positive attitude toward household waste sorting. This finding suggests that while knowledge is important, its influence on attitude may depend on other psychological and social factors, such as behavioral beliefs, perceived benefits, and social reinforcement (Xu et al., 2017; Sembiring et al., 2024; Hu et al., 2026). Therefore, knowledge-based interventions should be complemented by strategies that strengthen motivation, perceived usefulness, and community support (Sembiring et al., 2024; Hu et al., 2026). Strategically, educational programs should move beyond simply providing information and should be designed to connect knowledge with practical benefits and daily household experiences. Waste sorting education should include hands-on demonstrations, visual guidelines, and real examples showing how waste separation can reduce environmental problems and improve neighborhood cleanliness. Information campaigns should also be combined with persuasive communication that emphasizes the usefulness, ease, and social value of household waste sorting. Schools, community groups, and local government agencies can collaborate to deliver repeated and context-specific education rather than one-time socialization activities. In addition, knowledge-based interventions should be supported by accessible facilities and community encouragement so that residents can immediately apply what they have learned (Xu et al., 2017; Sembiring et al., 2024; Hu et al., 2026). Thus,

knowledge can become more effective in shaping positive attitudes when it is integrated with practical training, social reinforcement, and enabling environmental conditions. The non-significant relationship between knowledge and intention further underscores that information alone is insufficient to drive behavioral change, consistent with findings from previous Indonesian studies (Sembiring et al., 2024).

Perception had a significant effect on household waste sorting behavior, with a path coefficient of 0.195 and a sufficiently high T-statistic. Although this effect was smaller than that of intention, the result indicates that individuals' perceptions of the benefits and positive impacts of waste sorting remain important in encouraging actual behavior (Xu et al., 2017; Ma et al., 2020; Hu et al., 2026). A positive perception of waste sorting as useful, feasible, and environmentally beneficial can support the adoption of household waste sorting practices (Lou et al., 2020; Ma et al., 2020). Strategically, this finding suggests that interventions should focus on shaping residents' perceptions that waste sorting is practical, beneficial, and relevant to their daily lives. Local governments and community organizations should communicate the direct advantages of waste sorting, such as cleaner neighborhoods, reduced unpleasant odors, lower health risks, and improved recycling opportunities. Visual campaigns, infographics, and community demonstrations can be used to make the benefits of waste sorting more concrete and easily understood. Waste sorting programs should also highlight simple household-level practices so that residents perceive the behavior as manageable rather than burdensome. Providing visible evidence of program outcomes, such as reduced waste accumulation or increased waste bank participation, can further strengthen positive perceptions. Therefore, perception-oriented strategies should be integrated with educational, infrastructural, and community-based interventions to encourage more consistent household waste sorting behavior (Xu et al., 2017; Lou et al., 2020; Hu et al., 2026).

Attitude had a significant effect on intention, with a path coefficient of 0.211. This finding indicates that a positive attitude toward household waste sorting can strengthen individuals' intention to participate in the practice (Xu et al., 2017; Bardus & Massoud, 2022; Pan & Liu, 2024). Therefore, improving residents' attitudes toward waste sorting is an important step in promoting stronger behavioral intention and, ultimately, actual participation in household waste sorting (Xu et al., 2017; Pan & Liu, 2024). Strategically, this result suggests that interventions should focus on creating positive emotional and practical evaluations of waste sorting among residents. Local governments and community organizations can design campaigns that frame waste sorting as a simple, meaningful, and beneficial household practice rather than as an additional burden. Messages should emphasize that waste sorting contributes to cleaner homes, healthier neighborhoods, reduced environmental pollution, and more efficient waste management. Attitude-building programs can also involve practical demonstrations, community discussions, and testimonials from residents who have successfully adopted waste sorting in their daily routines. Schools, neighborhood groups, and local institutions can serve as platforms for repeatedly reinforcing positive attitudes toward waste sorting. By improving residents' attitudes through persuasive communication and practical experience, their intention to engage in household waste sorting can be strengthened and translated into more consistent behavior (Xu et al., 2017; Bardus & Massoud, 2022; Pan & Liu, 2024).

The non-significant relationships found in this study also provide valuable insights. Governmental support and facility availability did not significantly influence perception, suggesting that the mere presence of policies or infrastructure may not automatically translate into positive perceptions of waste sorting. This finding implies that residents may not perceive government initiatives as directly relevant to their daily waste management practices unless these initiatives are accompanied by effective communication and community engagement. Similarly, control beliefs did not significantly shape social norms, indicating that individuals' beliefs about their personal capacity to sort waste may not necessarily translate into perceived social expectations. This underscores the distinction between individual capability beliefs and collective normative beliefs, which may require different intervention strategies to strengthen.

The structural pathway analysis indicates that intention, behavioral beliefs, social norms, perception, and attitude play important roles in shaping household waste sorting behavior. Intention emerged as the most direct and influential determinant, while behavioral beliefs and social norms contributed indirectly by shaping perception, attitude, and intention. These findings are consistent with the extended TPB literature, which emphasizes the mediating role of intention and the importance of sequential psychological processes in translating beliefs into action (Ajzen, 2020; Novanda et al., 2026). The non-significant pathways involving governmental support and facility availability highlight the need for more targeted approaches that address not only infrastructure gaps but also the cognitive and social determinants of behavior. These findings suggest that efforts to promote household waste sorting should not rely solely on increasing knowledge, but should also strengthen intention, positive attitudes, perceived benefits, and supportive social norms. Such an integrated behavioral strategy is likely to be more effective in encouraging sustainable household waste sorting practices.

CONCLUSION

This study examined the structural relationships among social, psychological, and environmental factors influencing household waste sorting behavior in District Pontianak Kota using an SEM-PLS approach grounded in the Extended Theory of Planned Behavior. The findings demonstrate that household waste sorting behavior was not formed by a single determinant but through a sequence of interconnected pathways linking beliefs, perceptions, attitudes, social norms, intentions, and actual behavior. Among the tested pathways, intention emerged as the strongest direct predictor of household waste sorting behavior, confirming its central role in translating cognitive and social evaluations into pro-environmental actions. The path coefficient of 0.775 indicated that intention explained a substantial proportion of the variance in actual waste sorting behavior, underscoring the importance of motivational factors in promoting household-level environmental practices.

The results further showed that behavioral beliefs significantly influenced both perception and attitude, indicating that residents who believed waste sorting was beneficial, meaningful, and necessary were more likely to develop positive evaluations of the practice. Normative beliefs also strongly shaped social norms, suggesting that perceived social expectations played an important role in constructing community-level support for waste sorting. In turn, social norms and attitudes significantly strengthened intention, while perception influenced both intention and actual behavior. These findings confirmed that household waste sorting behavior was formed through both direct and indirect mechanisms.

The significant influence of normative beliefs on social norms highlighted the role of social influence in shaping collective environmental practices, while the direct effect of perception on behavior suggested that residents' evaluative judgments regarding waste sorting remained important beyond their influence on intention.

An important finding of this study was that knowledge alone did not necessarily lead to stronger intentions or consistently positive attitudes toward waste sorting. This suggested that information-based interventions should not be implemented independently but should be integrated with strategies that strengthened perceived benefits, social reinforcement, practical experience, and behavioral commitment. The non-significant pathways involving governmental support and facility availability further indicated that infrastructure and policy interventions might be insufficient without corresponding efforts to shape residents' perceptions, attitudes, and social norms. This finding aligned with community initiatives in Pontianak, which emphasized that behavioral change required a combination of infrastructural support, social encouragement, and individual commitment (RRI, 2025; RRI, 2026). Therefore, effective waste sorting programs in Pontianak should prioritize intention building, positive perception formation, attitude improvement, and the strengthening of supportive social norms.

Based on these findings, several suggestions for future research are proposed. First, longitudinal studies are recommended to examine how the structural pathways identified in this study evolve over time and how intervention programs influence these relationships. Second, comparative studies across different districts in Pontianak or multiple cities in Indonesia could help identify contextual variations in the determinants of waste sorting behavior. Third, qualitative research could complement these quantitative findings by exploring residents' lived experiences, barriers, and motivations in greater depth. Fourth, future research should investigate the role of emerging technologies, such as waste sorting applications and digital platforms, in facilitating behavioral change. Finally, experimental studies testing specific interventions targeting intention, social norms, and perception would provide more direct evidence regarding the effectiveness of the pathways identified in this study.

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