Beyond Awareness: How Environmental Knowledge and Maintenance Motivation Shape Household Waste Management Behavior in Urban Makassar, Indonesia

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ABSTRACT

Urban residential areas remain critical sites for improving municipal solid waste management because household practices directly influence segregation, storage, disposal, and community sanitation outcomes. This study examines the effects of environmental knowledge and motivation to maintain the environment on household waste management behavior among residents of the BTN Tabaria housing complex in Makassar, Indonesia. The study employed a quantitative survey design with 100 randomly selected residents. Data were collected through a Likert-scale questionnaire and analyzed using validity and reliability testing, classical assumption tests, multiple linear regression, partial *t* tests, and simultaneous *F* tests. The findings show that environmental knowledge has a positive and significant effect on household waste management behavior ($B = 0.342$, $t = 3.876$, $p < .001$), indicating that residents with a stronger understanding of environmental issues, waste impacts, and 3R practices tend to manage household waste more responsibly. Environmental maintenance motivation exerts an even stronger positive and significant effect ($B = 0.521$, $t = 5.214$, $p < .001$), suggesting that affective commitment and willingness to protect the environment are more decisive than cognition alone in translating awareness into action. Simultaneously, both predictors significantly explain waste management behavior ($F = 42.315$, $p < .001$), with an adjusted R^2 of .452. These results indicate that behavioral improvement in urban waste management depends on the interaction between cognitive and motivational factors rather than on environmental information alone. The study concludes that community-based environmental education, motivational reinforcement, and neighborhood-level support systems should be integrated to strengthen sustainable household waste practices in urban housing settings.

Keywords: environmental knowledge; environmental motivation; household waste management; pro-environmental behavior; urban housing

INTRODUCTION

Household waste management has become one of the most persistent challenges of urban sustainability because residential areas are where waste is generated daily, habits are formed, and environmentally consequential decisions are repeatedly made. Recent reviews show that waste segregation at source remains a cornerstone of sustainable solid waste management, yet household compliance is often uneven because behavior is shaped not only by technical provision but also by knowledge, motivation, habits, and local governance conditions (Trushna et al., 2024; Yuriev et al., 2020). Research in Indonesia likewise shows that public receptivity to waste sorting remains limited in many cities, despite formal regulation and growing environmental discourse, making residential behavior a crucial analytical unit for understanding why municipal waste systems succeed or fail (Setiawan, 2020; Voronkova et al., 2025). In practice, urban neighborhoods sit at the intersection of individual responsibility and collective infrastructure; therefore, understanding what drives residents to manage waste responsibly is essential for both environmental quality and the effectiveness of city-level waste policy.

The behavioral dimension of waste management is increasingly recognized. Some review studies suggest that pro-environmental action cannot be reduced to awareness campaigns alone, as behavior is mediated by attitudes, perceived behavioral control, social expectations, moral norms, and contextual barriers (Ajzen, 2020; Tian & Liu, 2022; Yuriev et al., 2020). More recent syntheses focused specifically on household waste separation show

that intention, perceived behavioral control, infrastructure, and education consistently predict waste behavior, while age, place, and local development contexts moderate those relationships (Trushna et al., 2024). In other words, people may know what they should do, yet still fail to do it when motivation is weak, sorting facilities are absent, or social norms do not reinforce the desired practice.

Environmental knowledge nevertheless remains foundational. Studies conducted in higher education, professional, and community contexts consistently report that better environmental knowledge is associated with stronger pro-environmental attitudes and more responsible behavior, although the strength of that effect varies across settings and populations (Mendes et al., 2025; Burgos-Espinoza et al., 2025). This is particularly relevant in waste management because source separation, reduction, reuse, and proper disposal all require at least a basic understanding of waste categories, health risks, pollution pathways, and the environmental consequences of improper disposal. Yet the literature also shows that knowledge is often a necessary but insufficient condition: the well-known awareness–action gap persists when residents understand environmental issues conceptually but do not convert that understanding into regular everyday behavior. Recent work on environmental awareness in universities and communities continues to confirm this gap, emphasizing the need to link cognition with affective and social drivers of action (Benzehaf et al., 2025; Piao & Managi, 2024).

That gap makes motivation especially important. Environmental motivation refers to the internal and external impulses that encourage individuals to maintain cleanliness, reduce pollution, and act consistently in the interest of environmental protection. In the waste-management literature, motivation is conceptualized through several related constructs, including personal norms, environmental concern, social expectations, perceived behavioral control, and intention. Studies from some countries show that motivation-related variables often outperform knowledge in predicting actual waste behavior because they are closer to action than abstract understanding (Jampala & Shivnani, 2024; Leknoi et al., 2024; Li et al., 2023; Lou et al., 2026; Gunawan et al., 2025). Indonesian evidence is particularly suggestive: recent work shows that community attachment, environmental concern, and responsible consumption matter for whether households participate in better waste practices, implying that affective commitment is central to household environmental action (Voronkova et al., 2025; Gunawan et al., 2025).

The present study is situated in BTN Tabaria, a housing complex in Makassar, South Sulawesi. It identifies persistent neighborhood problems, including indiscriminate disposal, low rates of sorting, and uneven participation in community-based waste management. Within such urban residential settings, waste behavior is shaped by repeated routines rather than by isolated decisions; therefore, examining both environmental knowledge and motivation to maintain the environment provides a theoretically and practically meaningful way to explain variation in behavior. The problem is not merely whether residents know that waste should be managed properly, but whether they are sufficiently motivated to act on that knowledge in their daily household routines. This issue is particularly salient in rapidly urbanizing Indonesian contexts, where environmental literacy may be improving faster than neighborhood practice.

Accordingly, this study asks whether environmental knowledge and motivation to maintain the environment significantly influence residents' waste management behavior in BTN Tabaria, either individually or jointly. The study is important for three reasons. First, it addresses a practical urban environmental problem in a residential rather than institutional setting. Second, it integrates cognitive and affective predictors of behavior, thereby addressing the persistent knowledge-practice gap identified in the broader literature. Third, it provides evidence to inform neighborhood-level interventions, municipal environmental education, and housing management strategies in Makassar and similar urban communities. This study aims to contribute to a more behaviorally grounded understanding of sustainable household waste management.

LITERATURE REVIEW

2.1 Environmental Knowledge and Pro-Environmental Action

Environmental knowledge refers to an individual’s understanding of ecological processes, environmental risks, the consequences of human activity, and appropriate mitigation or preventive practices. In waste studies, this commonly includes knowledge about waste types, source separation, the 3R principle, public health risks, and

the environmental implications of littering or unmanaged dumping. Knowledge remains central because pro-environmental behavior typically requires some awareness of both problem and solution. Large-sample studies in educational and professional settings have shown that environmental knowledge positively influences environmental attitudes and, in many cases, directly influences pro-environmental behavior as well (Mendes et al., 2025; Burgos-Espinoza et al., 2025). These findings echo broader theoretical work that identifies environmental knowledge as one of the most frequently integrated variables in behavioral models, alongside attitude, norm, and perceived behavioral control (Si et al., 2019; Tian & Liu, 2022).

Yet the literature is equally clear that knowledge does not operate in a simple linear way. Ajzen's (2020) clarification of the Theory of Planned Behavior underscores that distal background factors, such as knowledge, shape beliefs, but do not automatically produce behavior unless they alter attitudes, subjective norms, perceived behavioral control, and intention. This insight is reinforced by recent empirical work. In a study of waste behavior among university students in China, environmental knowledge improved waste-management behavior when combined with personal norms and TPB variables rather than operating alone (Wu et al., 2021). Similarly, Mendes et al. (2025) found that environmental knowledge exerted both direct and mediated effects through environmental attitudes. These studies imply that knowledge matters most when it becomes behaviorally meaningful, that is, when individuals not only understand environmental issues but also interpret them as relevant to their own responsibilities and capabilities.

In waste-management settings, knowledge also interacts with the complexity of the required behavior. Sorting household waste is not a single action; it includes identifying categories, distinguishing recyclable from non-recyclable materials, using appropriate disposal points, and maintaining consistency over time. That complexity helps explain why some studies report modest or mediated knowledge effects. Thus, environmental knowledge should be understood as an enabling cognitive resource rather than a guaranteed behavioral driver.

2.2 Motivation to Maintain the Environment

Motivation to maintain the environment refers to the affective and volitional energy that prompts individuals to protect environmental quality in everyday life. In applied research, this construct overlaps with environmental concern, personal norm, moral commitment, willingness to participate, and the intention to act responsibly. Motivation matters because environmental behavior often imposes small but repeated costs: residents must sort waste, store it differently, walk to designated bins, comply with neighborhood rules, or sacrifice convenience. When motivation is weak, even well-informed residents may revert to easier but environmentally harmful practices. Recent behavioral studies consistently confirm that motivation-related variables are powerful predictors of household waste behavior (Li et al., 2023; Zhu et al., 2023; Lou et al., 2026).

Therefore, for various reasons, motivation is important for maintaining the environment. First, motivation internalizes environmental goals, turning them into personal obligations rather than external instructions. Second, motivation is socially reinforced through neighborhood expectations, trust in the waste system, and community attachment. Third, motivation often functions as the bridge between knowing and doing. Studies in several countries show that attitude, subjective norms, trust, and perceived behavioral control are especially influential because they mobilize action rather than merely informing it (Jampala & Shivnani, 2024; Leknoi et al., 2024; Arkorful et al., 2023). Likewise, Zhu et al. (2023) found that personal norms and policy measures interact in shaping residents' waste separation behavior, while Li et al. (2023) showed that information publicity works through moral norms and TPB variables rather than through information exposure alone.

In Indonesian settings, motivational factors appear especially salient. Gunawan et al. (2025) reported that attitudes, perceived behavioral control, intention to sort waste, and responsible consumption significantly influenced household waste behavior among Indonesian families. Voronkova et al. (2025) similarly found that environmental concern and community attachment predicted waste-management behavior in coastal communities in Java and Bali. These findings are important because they suggest that environmentally responsible behavior is partly relational: people are more likely to maintain their environment when they care about the local community, see waste behavior as morally important, and perceive such behavior as socially and practically supported. That logic aligns closely with the present study's emphasis on motivation to maintain the environment.

2.3 Household Waste Management Behavior

Household waste management behavior includes reducing waste generation, separating waste, reusing materials, properly disposing of residual waste, and participating in neighborhood or municipal waste programs. It is a classic form of private-sphere pro-environmental behavior because it is enacted in domestic routines but has public environmental consequences. Reviews of pro-environmental behavior research indicate that waste-related behaviors are among the most commonly studied, as they combine individual agency with strong contextual dependence (Yuriev et al., 2020; Tian & Liu, 2022). In this domain, intention, perceived behavioral control, and infrastructure repeatedly emerge as core determinants, but local norms, trust, policy support, and moral factors also matter substantially.

Household waste behavior is simultaneously psychological and structural, as Huang and Zhong (2023) found that policy support influences domestic waste classification behavior, in part, through perceptions of environmental protection. Tahulela et al. (2025) showed that structural constraints, especially unequal service access, can overwhelm behavioral intention in low-resource settings. Hamed et al. (2025) similarly demonstrated that participation barriers and willingness to pay for recycling services are jointly shaped by environmental goals and practical constraints. These studies indicated that household waste behavior should not be framed as a pure matter of awareness or moral character. It is better understood as a situated behavior that emerges from the interaction of cognition, motivation, opportunity, and local waste-system credibility.

2.4 Conceptual Framework and Hypotheses

The present study adopts a simple conceptual model in which environmental knowledge and motivation to maintain the environment serve as predictor variables, while household waste management behavior serves as the outcome variable. The framework is consistent with broader pro-environmental behavior theory, particularly the view that cognitive resources support the formation of behavior, while motivational or normative commitment determines whether those resources translate into practice (Ajzen, 2020; Wu et al., 2021). The model also fits recent evidence that household waste behavior depends on both what residents know and how strongly they care, intend, or feel capable of acting (Gunawan et al., 2025).

From this framework, three hypotheses are derived. H_1**:** Environmental knowledge has a positive and significant effect on household waste management behavior. H_2: Motivation to maintain the environment has a positive and significant effect on household waste management behavior. H_3: Environmental knowledge and motivation to maintain the environment jointly have a positive and significant effect on household waste management behavior. These hypotheses directly reflect the study's design and align with the model of pro-environmental and waste-separation behavior.

METHOD

This study used a quantitative survey design. The research site was the BTN Tabaria housing complex, located in Mannuruki, Tamalate District, Makassar, Indonesia. The target population comprised residents of the housing complex, and the study employed random sampling to select 100 respondents. Data were collected using a structured questionnaire with a five-point Likert scale covering three variables: environmental knowledge (X_1), motivation to maintain the environment (X_2), and household waste management behavior (Y). Supporting techniques included field observation and documentation. The design is appropriate for assessing modeled relationships among cognitive, affective, and behavioral variables in an urban residential context.

Validity was assessed by comparing item-level r values against an r table threshold of 0.196 for $n = 100$ at $\alpha = .05$, and all reported items exceeded the threshold. Reliability was evaluated using Cronbach's alpha, with values of 0.782 for environmental knowledge, 0.801 for motivation, and 0.815 for behavior, indicating good internal consistency. The analytical strategy then proceeded through classical assumption tests and multiple linear regression. Normality was assessed using the Kolmogorov–Smirnov test; multicollinearity was assessed using tolerance and variance inflation factor values; and hypothesis testing relied on partial t-tests, the simultaneous F-test, and the coefficient of determination (R^2).

RESULTS AND DISCUSSION

4.1 Instrument Quality and Model Adequacy

The first important result is that the measurement was statistically adequate for regression analysis. All questionnaire items were valid because their item correlations exceeded the minimum threshold of 0.196, and all three scales achieved Cronbach's alpha values above 0.70. This is important because studies of environmental behavior are often weakened by vague or unstable constructs; by contrast, the study demonstrated sufficient internal consistency across knowledge, motivation, and behavior measures. The classical assumption tests also supported model estimation: the residual normality significance value was 0.200, and both predictors showed tolerance values of 0.721 and VIF values of 1.387, indicating no problematic multicollinearity. In practical terms, the model was statistically well-behaved enough to justify interpreting the regression coefficients.

In pro-environmental behavior research, construct overlap is common because knowledge, concern, norm, motivation, and responsibility frequently correlate. The absence of multicollinearity in this study indicates that environmental knowledge and motivation to maintain the environment captured distinct yet related dimensions of behavior formation. That distinction is theoretically meaningful and consistent with current work showing that cognition and motivation are complementary rather than interchangeable predictors of waste behavior (Ajzen, 2020; Wu et al., 2021; Gunawan et al., 2025). The data, therefore, support a dual-path interpretation in which knowledge provides the cognitive basis for correct waste handling, whereas motivation provides the energy and commitment necessary to enact that knowledge.

4.2 Environmental Knowledge as a Significant Predictor

The regression results show that environmental knowledge had a positive and significant effect on household waste management behavior ($B = 0.342$, $t = 3.876$, $p < .001$). This finding supports H_1 and suggests that residents who better understand environmental problems, the implications of mismanaged waste, and appropriate handling practices are more likely to engage in responsible waste behavior. The direction of the effect is consistent with the central assumption of environmental education research: knowledge increases the likelihood that individuals recognize why waste matters and what constitutes proper action. In residential contexts, this may include knowing the value of sorting, appreciating the public health risks of unmanaged waste, or recognizing the broader consequences of littering and dumping.

This result is consistent with Mendes et al. (2025), who found that environmental knowledge positively influenced both environmental attitudes and pro-environmental behavior in a large higher-education sample. Burgos-Espinoza et al. (2025) similarly concluded that environmental knowledge supports pro-environmental attitudes and behavior across engineering students and professionals, although the strength of that relationship varies by context. It is in line with what Karim et al. (2022) reported: environmental knowledge contributed significantly to waste-management behavior in an Indonesian residential setting, reinforcing the relevance of the present result for neighborhood-scale waste behavior. Together, this study indicates that knowledge remains a statistically meaningful and practically useful entry point for intervention, especially where residents still lack a clear understanding of waste categories, consequences, and proper management.

At the same time, the participant's coefficient size is moderate rather than dominant. This nuance matters. The study does not show that knowledge alone is sufficient, only that it matters significantly within a broader behavioral process. That interpretation aligns with Ajzen's (2020) argument that background factors such as knowledge influence behavior through their effects on more proximal determinants, and with Wu et al. (2021), who showed that knowledge operates more effectively when accompanied by norms and control beliefs. Therefore, the findings should not be read as support for purely informational campaigns. Instead, they suggest that environmental education remains necessary, but it must be designed to connect knowledge with action routines, perceived capability, and community-level reinforcement.

4.3 Motivation to Maintain the Environment as the Stronger Predictor

The most striking result in the study is that motivation to maintain the environment had a stronger positive and significant effect on waste-management behavior than environmental knowledge ($B = 0.521$, $t = 5.214$, $p < .001$).

This finding supports H_2 and indicates that affective commitment and willingness to preserve environmental quality play a more decisive role than cognition alone in predicting household waste behavior. In practical terms, residents may understand proper waste handling yet still fail to practice it unless they feel sufficiently compelled, responsible, or personally invested in environmental cleanliness. The stronger coefficient for motivation, therefore, highlights the action-oriented nature of household waste management: good practice depends not just on knowing what should be done but on being driven to act consistently.

This pattern is strongly supported by Jampala and Shivnani (2024), who found that subjective norms had the strongest impact on waste-sorting intention among Indian households, even though attitude and perceived behavioral control also mattered. Leknoi et al. (2024) also showed that trust in the recycling system and behavioral intention were decisive in explaining waste-separation behavior in Bangkok, while Li et al. (2023) demonstrated that information affects intention largely by activating moral norms and related motivational pathways. Gunawan et al. (2025) further showed that responsible consumption, intention, and perceived control significantly shape household waste behavior in Indonesia. These studies collectively support the results that motivation-oriented constructs are typically closer to action than knowledge and therefore often exhibit stronger behavioral effects.

The dominance of motivation also helps explain a common environmental paradox: people often endorse environmental ideals without changing everyday routines. Waste management is repetitive, mundane, and often inconvenient. It requires persistence in small domestic actions that may not produce immediate visible rewards. Motivation helps overcome that inertia. It supplies the willingness to separate waste even when rushed, to walk farther to a bin, to store recyclables, or to comply with neighborhood norms. In this sense, the present finding aligns with the broader pro-environmental literature, which shows that intention, perceived behavioral control, personal norm, and environmental concern frequently outperform purely cognitive variables in explaining actual behavior (Trushna et al., 2024; Piao & Managi, 2024).

4.4 Joint Influence and the Meaning of a Moderate R^2

The simultaneous test also confirmed that environmental knowledge and motivation together significantly predicted household waste management behavior ($F = 42.315$, $p < .001$). The R value of 0.682 and R^2 of 0.465 indicate that 46.5% of the variance in behavior was explained by the two predictors, with an adjusted R^2 of 0.452. This is a substantively meaningful result for social-behavioral research. It suggests that nearly half of the observed differences in household waste behavior in BTN Tabaria can be explained by residents' knowledge and their motivation to maintain the environment.

Household waste behavior is also shaped by service quality, access to bins, trust in collection systems, social pressure, policy support, pricing incentives, and neighborhood attachment (Huang & Zhong, 2023; Tahulela et al., 2025; Hamed et al., 2025; Voronkova et al., 2025). The OECD's recent evidence on household waste likewise emphasizes that collection services and pricing structures substantially influence waste-related outcomes. Therefore, the moderate R^2 in the present study should not be read as a limitation of the two predictors, but rather as a reminder that individual behavior operates within a broader social and infrastructural ecology. Environmental knowledge and motivation matter greatly, but they do not act in isolation.

The present findings are also theoretically coherent. If environmental knowledge is interpreted as the cognitive basis for action, and environmental maintenance motivation as the affective-volitional driver, then the joint model captures two core dimensions of household behavior formation. This is consistent with the contemporary trend in pro-environmental behavior research to integrate knowledge, norm, motivation, and contextual opportunity rather than privileging single-variable explanations (Yuriev et al., 2020; Tian & Liu, 2022; Piao & Managi, 2024). In other words, the study supports the interpretation that behavior improves when people both understand the environmental stakes and care enough to act on that understanding.

4.5 Implications for Urban Housing and Community Intervention

From a practical perspective, the findings suggest that neighborhood-level waste interventions should not focus exclusively on awareness raising. Educational messaging remains important, but it will be more effective when

paired with motivational reinforcement. This may include community campaigns, neighborhood clean-up events, visible feedback on waste outcomes, peer recognition, and local leadership that frames waste management as a shared social responsibility rather than a purely personal choice. Recent systematic reviews indicate that household waste-segregation interventions are more effective when information is combined with enabling conditions and behaviorally informed reinforcement, rather than delivered as isolated knowledge transfer (Trushna et al., 2024).

The findings also speak to housing governance. Residential managers and local authorities should treat waste behavior as a socio-technical issue. Motivation may fade if residents perceive that sorted waste is later mixed during collection, that facilities are inadequate, or that rule enforcement is inconsistent. Some studies show that trust, infrastructure, and policy support condition the effectiveness of motivational and normative drivers (Leknoi et al., 2024; Tahulela et al., 2025; Huang & Zhong, 2023). For BTN Tabaria and similar housing complexes, the implication is clear: strengthen resident motivation, but also make responsible behavior easy, visible, and credible.

Another implication concerns urban environmental education. The positive effect of knowledge indicates that targeted information still matters, especially when residents face ambiguity about waste categories or disposal procedures. However, the stronger motivational effect suggests that environmental education should move beyond facts toward behavioral activation. This means connecting waste education to health, neighborhood pride, religious-ethical duty, financial savings, or collective identity, whichever motivational frames resonate locally. Studies on targeted incentives and differentiated user clusters suggest that interventions are more effective when adapted to specific motivational profiles rather than applied uniformly (Höpfl et al., 2024). Thus, the future of residential waste intervention lies not in more information alone, but in better alignment between knowledge, motivation, and neighborhood context.

4.6 Study Contribution and Limitations

The main contribution of this study is to demonstrate, in the context of Indonesian urban housing, that environmental maintenance motivation is more behaviorally decisive than environmental knowledge, even though both are significant. This is a useful contribution because many local environmental programs still assume that raising awareness is enough to transform practice. The study evidence suggests otherwise: cognition matters, but motivation is the stronger lever. This insight complements recent studies that emphasize that waste behavior is shaped by knowledge, norms, perceived behavioral control, and environmental commitment rather than by literacy alone (Amir, 2025). In that sense, the present study contributes to a more behaviorally realistic model of urban household waste management.

Several limitations should nevertheless be noted. First, the study is cross-sectional and based on self-reported behavior, so it cannot establish temporal causality or fully avoid social desirability bias. Second, the study did not report respondent demographics in detail, limiting interpretation by subgroup. Third, the model includes only two predictors, while recent literature shows that infrastructure, trust, community attachment, and policy support also affect household waste behavior. These limitations do not weaken the study's core conclusion, but they do suggest fruitful directions for future research. Subsequent studies could use structural equation modeling, include mediating variables such as norm and perceived control, or combine survey data with direct observation of household waste practices.

CONCLUSION

This study demonstrates that household waste management behavior among residents of BTN Tabaria, Makassar, is significantly shaped by both environmental knowledge and motivation to maintain the environment. Environmental knowledge contributes positively to responsible behavior by providing residents with the cognitive basis needed to understand waste impacts and proper management practices. However, motivation exerts a stronger influence, indicating that behavior is more powerfully driven by affective commitment, willingness, and environmental responsibility than by knowledge alone. Jointly, the two variables explain a substantial proportion of behavioral variance, confirming that sustainable household waste management depends on the interaction of cognitive and motivational dimensions rather than on information transfer in isolation.

The study, therefore, offers a clear implication for urban environmental policy and neighborhood-based intervention. Programs intended to improve waste practices in residential areas should combine environmental education with strategies that strengthen resident motivation, collective norms, and neighborhood ownership of environmental cleanliness. For housing managers and local government, this means coupling information campaigns with visible facilities, community participation, and trust-building measures that make environmentally responsible behavior both meaningful and feasible. Although the study is limited by its cross-sectional design and a restricted set of variables, it provides important evidence from an Indonesian urban housing context: improving household waste behavior requires moving beyond awareness alone toward a more integrated behavioral approach. Future research should incorporate additional contextual factors, such as infrastructure quality, social norms, and local governance support, to produce a more comprehensive model of sustainable household waste management in rapidly urbanizing communities.

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