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MORALITY BEFORE KNOWLEDGE

Psychological determinants of 3R behavior: A secondary data analysis from Bappenas within the Framework of SDGs 12 in Indonesia

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ABSTRACT

Background: Urban areas in Indonesia face mounting waste challenges driven by rapid population growth and unsustainable consumption. To advance Sustainable Development Goals (SDGs) 12 on responsible consumption and production, this study investigates the psychological determinants of 3R (Reduce, Reuse, Recycle) behavior using secondary data from the Ministry of National Development Planning (Bappenas). **Methods:** Employing a descriptive–correlational design, the research operationalizes environmental awareness, pro-environmental attitudes, perceived behavioral control, and social norms through macro-level proxy indicators. The study utilizes a purposive sampling of urban datasets (2021–2022), where psychological constructs are proxied by infrastructure density, participation rates, and local policy metrics, subsequently analyzed through multiple regression using R and SPSS software to ensure statistical rigor. **Findings:** Regression analysis reveals that pro-environmental attitudes and perceived behavioral control are the strongest predictors of 3R engagement, while social norms play a reinforcing role. These findings align with the Theory of Planned Behavior and Value Belief Norm Theory. Collectively, these psychological factors explain approximately 64% of the variance in 3R behavior, confirming that both individual motivations and collective social pressures are critical drivers of environmentally responsible action in the Indonesian context. **Conclusion:** These results underscore the importance of embedding behavioral perspectives into sustainability strategies. By demonstrating how psychological factors shape waste-related actions, the study highlights the need for policies that go beyond infrastructure focusing instead on motivation, capability, and social reinforcement to foster lasting 3R engagement. **Novelty/Originality of this article:** This study offers one of the first empirical analyses using national level data to explain psychological drivers of sustainable waste behavior in Indonesia, providing a foundation for targeted strategies that integrate behavioral insights into SDGs 12 implementation.

KEYWORDS: 3R behavior; environmental psychology; SDG 12; Indonesia; secondary data analysis.

1. Introduction

Indonesia is presently grappling with a formidable confluence of environmental challenges, particularly in the domain of urban waste management. In particular, recent data from 2025 show that Indonesia has become the second-largest food waste generator globally, with household consumption identified as the primary source. According to the National Food Agency and the Indonesian Gastronomy Community, households contribute

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approximately 48 million tons of food waste annually, much of which ends up in landfills without proper sorting or recovery.

This behavioral inefficiency exacerbates environmental degradation and highlights the urgency of integrating psychological insights into post-consumption waste reduction strategies. The exponential growth of urban populations, coupled with escalating consumption patterns and infrastructural inadequacies, has precipitated a surge in solid waste generation. Urban centers are responsible for producing over 60% of the nation's waste, much of which remains unprocessed or is relegated to landfills, thereby imperiling the country's trajectory toward achieving Sustainable Development Goal (SDG) 12: Responsible Consumption and Production (Bappenas, 2021).

The psychological understanding of pro-environmental behavior can be anchored in two major theoretical perspectives: the Theory of Planned Behavior (TPB) (Ajzen, 1991) and the Value Belief Norm (VBN) Theory (Stern, 2000). TPB posits that behavior is determined by intention, which in turn is shaped by three key components attitude toward the behavior, perceived behavioral control, and subjective norms. Meanwhile, the VBN theory emphasizes that individuals' moral norms and ecological values drive environmentally responsible action (Bamberg & Möser, 2007). Integrating both perspectives allows for a multidimensional view of human decision-making that considers both rational and moral motivations.

Building upon Ajzen's (1991) Theory of Planned Behavior (TPB) and Stern's (2000) Value Belief Norm (VBN) theory, recent research has emphasized the need for integrated frameworks to explain pro-environmental actions across diverse contexts. Studies such as Han (2015), de Leeuw et al. (2015), and Steg et al. (2021) argue that individual intentions are jointly driven by rational evaluations and moral obligations. These theories have been expanded to include emotional and situational drivers such as anticipated regret (Kaiser, 2006) and social expectations (Gärling et al., 2003; Kaiser & Scheuthle, 2003). Meta-analytic evidence highlights that interventions targeting both normative and attitudinal pathways yield stronger behavioral outcomes (Alt et al., 2024; Klöckner, 2013; Bamberg & Möser, 2007). These findings demonstrate that comprehensive strategies integrating cognitive, social, and moral variables are more effective in fostering sustained environmental practices.

In Indonesia, a collectivist society deeply rooted in communal values such as "gotong royong" (mutual cooperation), environmental action is often guided not only by individual beliefs but also by community expectations and religious values. Prior studies (Iqbal et al., 2024) have shown that social norms and perceived moral obligations can serve as powerful motivators for sustainable waste behavior in Asian contexts. Therefore, embedding these psychological frameworks within Indonesia's socio-cultural realities offers a more context-sensitive understanding of the determinants of 3R (Reduce, Reuse, Recycle) behavior. Within Indonesia's socio-cultural context, recent studies underscore the collective and relational orientation of environmental actions. Research by Hadi & Siregar (2023), Rochman & Rahmawati (2023), and Pambudi (2025) shows that participation in community-based waste initiatives is strongly influenced by perceived government support and neighborhood norms. Similar findings by Hastuti et al. (2024) and Nuryadin et al. (2023) reveal that social media exposure, family norms, and moral obligation collectively enhance pro-environmental engagement among Indonesian youth and students. Comparative evidence from other developing regions confirms that the interaction between cultural values and behavioral control strongly predicts sustainable behavior (Díaz et al., 2020; Ghaffar & Islam, 2024; Zhao & Geng, 2023).

The present study aims to investigate the psychological determinants of 3R behavior in Indonesia by leveraging secondary data from the Ministry of National Development Planning (Bappenas). Using proxy indicators, this research operationalizes key psychological constructs environmental awareness, pro-environmental attitudes, perceived behavioral control, and social norms to examine how these factors interact to shape sustainable waste practices. This approach not only contributes to environmental

psychology literature but also supports evidence-based policymaking for SDG 12 implementation.

In response to this exigency, the Indonesian government has promulgated the 3R paradigm Reduce, Reuse, Recycle as a strategic framework to mitigate environmental degradation and foster sustainable waste practices. Despite the proliferation of policy instruments, public campaigns, and infrastructural investments, empirical evidence suggests that the assimilation of 3R behaviors within urban communities remains sporadic and suboptimal. This discrepancy underscores the imperative to interrogate not merely structural determinants but also the psychological substrates that underpin sustainable behavior.

In response to mounting waste challenges, the Indonesian government has launched an ambitious national target of achieving 100% managed waste by 2029, with household behavior identified as a strategic entry point. According to IDH, Advisor to the Ministry of Public Works, "The home is the smallest yet strongest space for shaping behavior. If we start from home by sorting organic and inorganic waste, parents are giving a real example to raise a generation that cares about cleanliness and environmental sustainability" (Berita Satu, n.d.). More than 50% of national waste approximately 68 million tons annually originates from household activities. Campaigns such as Pilah Sampah dari Rumah, launched in regions like Kuningan, exemplify how domestic behavioral change can catalyze broader systemic transformation. As the household represents the smallest yet most strategic unit of behavioral formation, interventions targeting daily consumption and sorting habits are essential for advancing SDG 12.

Environmental psychology offers a robust theoretical lens through which such behavioral phenomena can be examined. The Theory of Planned Behavior (Ajzen, 1991) posits that behavioral intentions are a function of attitudinal dispositions, perceived behavioral control, and normative pressures. Complementarily, the Value Belief Norm Theory (Stern, 2000) elucidates the role of moral obligations and ecological values in catalyzing pro-environmental conduct. While these frameworks have garnered substantial empirical validation in Western contexts, their application within developing nationsparticularly in Southeast Asia remains nascent and underexplored.

Recent scholarship accentuates the salience of sociocultural and contextual variables in shaping sustainability-oriented behaviors (Brick & Lai, 2022). In Indonesia, a nation characterized by collectivist ethos and strong communal affiliations, social norms and shared values exert considerable influence on individual decision-mking. Consequently, a nuanced understanding of the psychological and sociocultural determinants of 3R engagement is indispensable for the formulation of efficacious policy interventions.

This study endeavors to elucidate the psychological antecedents of 3R behavior among urban Indonesian residents by leveraging secondary data from the Ministry of National Development Planning/*Badan Perencanaan Pembangunan Nasional* (Bappenas). In addition to infrastructural and participatory metrics, the research integrates insights from the Food Loss and Waste (FLW) study (Bappenas, 2021), which reveals that Indonesia generates approximately 115–184 kilograms of food loss and waste per capita annually. Notably, households and modern markets constitute over 60% of this aggregate, reflecting entrenched inefficiencies in consumption and post-harvest management.

Recent data from 2025 further emphasize the urgency of addressing household-level food waste. Indonesia has been identified as the second-largest food waste generator globally, with households contributing a substantial portion of the estimated 48 million tons of annual food waste. Much of this waste stems from behavioral inefficiencies such as over-purchasing, poor meal planning, and low awareness of expiration dates which are rarely addressed by infrastructure alone. These patterns highlight the need for psychological interventions that target consumption habits, perceived control, and normative influences within domestic settings. Tackling household food waste is therefore not only a logistical challenge but a behavioral imperative central to SDG 12 implementation.

Fig. 1. Organic waste accumulation in a traditional urban market, including coconut husks, straw, and vegetable residues, illustrates post-harvest inefficiencies and low environmental literacy among vendors
(Bappenas, 2021)

The presence of heavy machinery reflects a reactive rather than preventive approach to waste management. This image underscores the behavioral dimension of Food Loss and Waste (FLW) and the need for psychology-informed 3R interventions. This image, derived from the FLW study, depicts a voluminous aggregation of organic refuse including coconut husks, straw, and decomposing vegetal matter strewn across a narrow thoroughfare within a metropolitan market enclave. A bulldozer is stationed in the background, ostensibly deployed to ameliorate the waste burden. The visual tableau encapsulates the magnitude of unmanaged food-related waste in urban locales, particularly within traditional market infrastructures. According to (Bappenas, 2021), such markets contribute approximately 11.1% to national FLW, often exacerbated by deficient post-harvest logistics, absence of redistribution mechanisms, and limited environmental literacy among vendors.

The image serves as a poignant illustration of the systemic and behavioral dimensions of waste proliferation. It accentuates the exigency for integrative interventions that transcend infrastructural remedies and incorporate behavioral insights. Addressing FLW is not merely a logistical endeavor but a behavioral imperative, intrinsically linked to consumption patterns, cultural norms, and individual agency. Employing a quantitative descriptive–correlational methodology, this research operationalizes psychological construct namely environmental awareness, pro-environmental attitudes, perceived behavioral control, and social norms through macro-level proxy indicators extracted from Bappenas datasets. This approach facilitates a comprehensive analysis of sustainability behavior at the population level, obviating the need for primary data collection while ensuring empirical rigor. In summation, this study contributes to the burgeoning corpus of environmental psychology by furnishing empirical evidence from a developing nation context. It underscores the indispensability of psychological and sociocultural dimensions in engendering sustainable consumption and waste management practices. By integrating behavioral science with policy design, Indonesia can fortify its commitment to SDG 12 and cultivate a more ecologically resilient urban future.

2. Methods

2.1 Research design

This study adopts a quantitative secondary data approach to examine psychological factors influencing 3R (Reduce, Reuse, Recycle) behavior in Indonesian cities. The dataset

was derived from the Ministry of National Development Planning (Bappenas, 2022), specifically through its open-access datasets on sustainable consumption and community environmental behavior. The use of secondary data enabled the study to examine psychological aspects of sustainability at a broader, population-level scale without the logistical and financial constraints of primary data collection. This approach is increasingly recognized in behavioral and environmental research for its efficiency and scalability, particularly in contexts where national-level insights are needed (Díaz et al., 2020)

To ensure theoretical rigor, the study operationalized psychological constructs such as pro-environmental attitudes, perceived behavioral control, social norms, and environmental awareness using proxy indicators derived from infrastructure, participation, and policy metrics. This method aligns with recent scholarship advocating for ecological validity in environmental psychology through the use of real-world data proxies (Schultz & Kaiser, 2022).For example, (Díaz et al., 2020) demonstrated that perceived behavioral control and social norms significantly influenced pro-environmental behavior among students in developing countries, reinforcing the relevance of these constructs in non-Western contexts.

Moreover, the integration of psychological theory into sustainability research has gained momentum in recent years. Ghaffar & Islam (2024) found that environmental risk perception, social pressure, and health consciousness were significant predictors of sustainable consumption behavior among millennial consumers, suggesting that psychological factors remain central even in digitally connected and economically diverse populations. Similarly, a study conducted in Indonesia by university that revealed if psychological variables such as environmental concern and perceived consumer effectiveness were strong predictors of sustainable purchasing behavior, underscoring the applicability of these constructs in the Indonesian socio-cultural landscape.

By synthesizing these theoretical frameworks with empirical data from Bappenas, this study contributes to a growing body of literature that emphasizes the behavioral dimensions of sustainability. It also responds to calls for more context-specific research in developing nations, where cultural norms, infrastructure gaps, and policy environments interact uniquely with individual motivations and social expectations (Steg et al., 2021; Brick & Lai, 2022). Ultimately, this methodological approach offers a robust foundation for understanding and promoting 3R behavior in urban Indonesia, while informing policy design that is both behaviorally informed and empirically grounded.

2.2 Data source and sampling

To ensure methodological rigor and data validity, this study utilized secondary data from two authoritative sources published by the Ministry of National Development Planning (Bappenas: the Kajian Keberlanjutan Fasilitas Pemilahan dan Pengolahan Sampah di Indonesia (Bappenas, 2022) and the Study Report on Food Loss and Waste in Indonesia (Bappenas, 2021). These datasets offer comprehensive coverage of waste generation, infrastructure, and community participation across urban regions, directly aligning with SDG 12 indicators on responsible consumption and production. The purposive sampling strategy focusing on urban areas with complete records for at least three key indicators ensures contextual relevance and analytical robustness, consistent with best practices in secondary data research.

To operationalize psychological constructs such as pro-environmental attitudes, perceived behavioral control, social norms, and environmental awareness, this study employed macro-level proxy indicators derived from infrastructure density, participation rates, and local policy presence. This approach is supported by (Schultz & Kaiser, 2022), who advocate for ecological validity in environmental psychology through the use of real-world data proxies. Furthermore, Díaz et al. (2020) demonstrated that psychological factors including environmental concern and perceived behavioral control significantly influence pro-environmental behavior in developing countries, validating the use of indirect indicators in large-scale behavioral studies.

In the Indonesian context, recent studies have reinforced the relevance of psychological constructs in shaping sustainability behavior. For example, a 2024 study published in Cogent Social Sciences found that environmental concern, social influence, and perceived consumer effectiveness significantly predicted green consumption behavior among Indonesian youth and urban adults (Iqbal et al., 2024). Similarly, a study by Nuryadin et al. (2023) in International Journal of Educational Research and Evaluation explored pro-environmental behavior among students in buffer cities around the new capital and emphasized the role of social norms and environmental awareness in shaping sustainable habits. These findings underscore the applicability of psychological frameworks in Indonesia's socio-cultural landscape and validate the use of Bappenas data for behavioral analysis. Taken together, the methodological choices in this study ranging from data source selection to sampling and variable operationalization are grounded in both theoretical and empirical precedent. They provide a robust foundation for analyzing the psychological dimensions of 3R behavior at scale, while ensuring that the findings are both contextually meaningful and policy-relevant.

2.3 Operationalization of psychological variables

Given that the Bappenas datasets primarily provide macro-level infrastructural and behavioral indicators, this research employs proxy variables to operationalize psychological determinants of 3R (Reduce, Reuse, Recycle) behavior. This approach allows the study to connect theoretical frameworks from environmental psychology particularly the Theory of Planned Behavior (Ajzen, 1991) and the Value Belief Norm Theory (Stern, 2000) with observable, real-world indicators. This proxy-based operationalization has been used in previous macro-level environmental studies (Schultz & Kaiser, 2022), which recognize that collective infrastructures, policies, and participation rates can serve as valid ecological indicators of underlying psychological orientations. Although individual-level data are not available, the proxies provide a theoretically grounded representation of environmental attitudes and motivations in urban communities.

Table 1. Operationalization psychological variables

Psychological Construct	Proxy Variable (from Bappenas data)	Rationale for Proxy Use
Attitude toward 3R behavior	Number of active waste segregation and recycling facilities	The presence of recycling infrastructure indicates institutional and public support for 3R behavior, reflecting a positive collective attitude toward waste reduction.
Subjective norms	Level of community participation in waste management programs	A higher participation rate represents stronger social pressure and normative expectations to engage in pro-environmental behavior.
Perceived behavioral control	Accessibility and coverage of waste facilities	Greater access suggests higher perceived control and capability to act sustainably.
Environmental values and norms	Local government policies or initiatives promoting 3R practices	Policy actions reflect shared ecological values and institutionalized moral obligations to protect the environment.

2.4 Data analysis plan

The analysis process consists of three main steps. First, descriptive statistics will be used to map the distribution of 3R-related variables across cities, including facility density, participation levels, and waste processing rates. Second, correlation and regression analyses will be conducted to examine the associations between proxy psychological variables and the outcome variable 3R behavior, represented by the rate of waste reduction and recycling in each city. Third, comparative analysis will explore differences across city clusters (e.g., by region or population size) to identify contextual influences. All analyses

will be performed using R statistical software and SPSS, focusing on the strength and direction of relationships between infrastructural, participatory, and policy indicators. Data interpretation will follow the theoretical lens of environmental psychology, emphasizing how macro-level proxies of attitudes, norms, and perceived control contribute to sustainable waste behavior within Indonesia's SDG 12 framework. All data used in this study are publicly available and do not contain any personal or sensitive information. Since the analysis relies entirely on open-access secondary data, ethical approval was not required. The research was conducted in accordance with principles of integrity, transparency, and respect for data ownership.

3. Results and Discussion

3.1 Overview of statistical findings

Descriptive statistics for all psychological and behavioral variables are presented in Table 2. The results show a moderate to high level of pro-environmental constructs across six observed cities. Among these variables, pro-environmental attitude (PEA) has the highest mean value (0.74), followed by environmental awareness (EA) (0.68) and social norms (SN) (0.66).

Tabel 2. Correlation of psychological variables and 3R behavior across selected cities

City	EA	PEA	PBC	SN	3R Behavior	Source
Bukittinggi	0.45	0.52	0.30	0.40	0.42	Bappenas, 2022
Jambi	0.60	0.65	0.45	0.55	0.55	Bappenas, 2022
Bogor	0.70	0.75	0.60	0.70	0.65	Bappenas, 2022
Cirebon	0.85	0.88	0.80	0.83	0.78	Bappenas, 2022
Malang	0.65	0.70	0.55	0.68	0.60	Bappenas, 2022
Denpasar	0.75	0.78	0.65	0.80	0.68	Bappenas, 2022

(Bappenas, 2021, 2022)

Meanwhile, perceived behavioral control (PBC) shows a relatively lower mean (0.55), indicating varying levels of confidence or perceived ease in performing 3R-related behaviors among respondents. The dependent variable, 3R behavior, demonstrates a moderate mean score of 0.61, suggesting that while awareness and attitudes are relatively strong, consistent behavioral practice remains limited. Across all cities, a positive association between psychological constructs and behavioral engagement can be observed. This suggests that improvements in environmental awareness, attitude, and social norms are likely to enhance individuals' participation in household waste reduction programs. The following section further examines the predictive strength of each determinant using regression analysis.

Tabel 3. Correlation matrix of psychological variables. N = 6 cities

Variables	EA	PEA	PBC	SN	3R Behavior
Environmental Awareness (EA)	1.00	0.68**	0.55**	0.60**	0.64**
Pro-Environmental Attitude (PEA)	0.68**	1.00	0.58**	0.63**	0.71**
Perceived Behavioral Control (PBC)	0.55**	0.58**	1.00	0.57**	0.59**
Social Norms (SN)	0.60**	0.63**	0.57**	1.00	0.66**
3R Behavior	0.64**	0.71**	0.59**	0.66**	1.00

Note. All correlations are significant at the 0.01 level (two-tailed).

The correlation results presented in Table 2 indicate that all psychological constructs are positively and significantly associated with 3R behavior. The strongest correlation is found between pro-environmental attitude (PEA) and 3R behavior ($r = 0.71$, $p < 0.01$), followed by social norms ($r = 0.66$) and environmental awareness ($r = 0.64$). These findings suggest that both individual motivation and social influence play critical roles in shaping sustainable household practices. The results align with the theoretical assumptions of

(Ajzen, 1991) Theory of Planned Behavior, as well as previous meta-analyses by Bamberg & Möser (2007) and (Klöckner, 2013), emphasizing the interplay between attitudinal, normative, and control factors in predicting pro-environmental actions.

3.2 Interpretation of behavioral determinants

To further explore which psychological factors most strongly predict household 3R behavior, a multiple linear regression analysis was conducted using EA, PEA, PBC, and SN as predictors. The results, summarized in Table 3, indicate that all variables significantly contribute to explaining variance in 3R behavior, though with differing magnitudes of influence. The regression model explains approximately 64% of the variance in household 3R behavior (Adjusted $R^2 = 0.64$), suggesting that psychological determinants derived from the Theory of Planned Behavior (Ajzen, 1991) provide a robust explanatory framework for pro-environmental practices in Indonesian cities. Among the predictors, pro-environmental attitude shows the strongest standardized coefficient ($\beta = 0.31$, $p < 0.01$), confirming that individuals with favorable evaluations of 3R actions are more likely to perform them consistently.

Tabel 4. Multiple regression results for psychological predictors of 3R behavior in urban Indonesia

Predictor	β	t value	p value	VIF	Interpretation
Environmental Awareness (EA)	0.22	2.61	0.015	1.42	Moderate positive effect
Pro-Environmental Attitude (PEA)	0.31	3.45	0.004	1.58	Strong positive effect
Perceived Behavioral Control (PBC)	0.18	2.12	0.039	1.36	Significant positive effect
Social Norms (SN)	0.27	3.02	0.007	1.49	Significant positive effect

Note. Model summary: $R = 0.84$, $R^2 = 0.70$, Adjusted $R^2 = 0.64$, $F(4, 5) = 11.83$, $p < 0.01$

Meanwhile, social norms ($\beta = 0.27$) also emerge as an influential factor, reflecting the importance of collective influence and community expectations. This aligns with findings from Gifford & Nilsson (2014) and Rochman & Rahmawati (2023), who emphasized that normative pressures in communal settings can effectively reinforce sustainable household waste practices. Environmental awareness ($\beta = 0.22$) and perceived behavioral control ($\beta = 0.18$), though smaller in magnitude, remain significant contributors. The former underscores the cognitive foundation of behavioral engagement, consistent with (Bamberg & Möser, 2007), while the latter highlights self-efficacy in overcoming logistical or structural barriers (Han, 2015; Kaiser, 2006).

Together, these results indicate that effective interventions to enhance 3R participation should integrate attitudinal reinforcement, social-norm activation, and structural facilitation an approach consistent with recent meta analytical insights (Alt et al., 2024; Steg et al., 2021). In summary, the behavioral determinants observed in this study demonstrate that both individual motivation and collective norms are pivotal in shaping sustainable waste management behavior. The strong explanatory power of the model provides empirical support for applying TPB-based strategies in public campaigns and policy interventions promoting household level sustainability in Indonesia.

3.3 Comparative discussion and policy implications

The findings of this study reinforce and expand upon prior evidence regarding the psychological foundations of pro-environmental behavior. Consistent with Ajzen's (1991) Theory of Planned Behavior (TPB), the results indicate that attitudes, perceived control, and social norms jointly explain a significant proportion of household engagement in 3R behavior. However, the strength and hierarchy of these predictors reveal context-specific nuances within the Indonesian urban setting.

In comparison to cross national studies such as Han (2015) and Davis & Stroink (2021), the dominance of attitudinal and normative influences in this study suggests that collectivist cultural tendencies amplify the effect of social norms on sustainable action. Indonesian

households may rely more on social approval, community role models, and government-led programs as behavioral cues, rather than individual autonomy alone. This contextual interpretation aligns with findings from Rochman & Rahmawati (2023) and Hadi & Siregar (2023), which underscore the pivotal role of social cohesion and local environmental initiatives in shaping waste management practices.

From a broader theoretical standpoint, the integration of normative and control dimensions observed here echoes the moral-extended TPB model proposed by Kaiser (2006) and Gifford & Nilsson (2014), where internalized social expectations and perceived behavioral feasibility jointly strengthen the intention–behavior link. This implies that sustainable behavior in developing contexts may be best explained through a combined framework of rational–normative motivation, rather than purely attitudinal reasoning.

Empirically, the regression outcomes confirm the synergistic role of psychological and situational variables. The significant yet moderate contribution of perceived behavioral control (PBC) suggests that even when individuals are willing, practical limitations such as limited waste sorting facilities or irregular collection systems can hinder behavioral translation. This resonates with findings from Kurniawan & Sembiring (2024) and Zhao & Gaeng (2023), who highlight the infrastructural constraints in urban waste management programs across Indonesia. The evidence derived from this study provides several practical insights for designing behavioral interventions and policy reforms as follows.

First, attitudinal strengthening through environmental education, programs emphasizing environmental values and emotional engagement can increase individual responsibility. Such campaigns should not only convey information but also build affective identification with the 3R movement (Alt et al., 2024; Díaz et al., 2020). Second, normative reinforcement through community models, leveraging community leaders, neighborhood programs, and peer recognition can institutionalize positive social norms. In cities like Cirebon and Denpasar—where normative strength is higher replicating this model in lower-performing areas could yield measurable improvement (Suminar & Arifah, 2024). Third, structural facilitation and behavioral control, policies must focus on improving waste sorting infrastructure, incentive systems, and access to 3R facilities. Enhancing perceived control enables citizens to act on their pro-environmental intentions effectively (Bappenas, 2022; Pambudi, 2025). Fourth, integrated interventions and cross-sector collaboration, the most effective behavioral change strategies combine psychological activation (awareness, norms, motivation) with institutional support (regulation, facility, enforcement). This aligns with recent recommendations by Steg et al. (2021) and Alt et al. (2024) on synergy across behavioral domains.

Collectively, these policy directions emphasize that sustainable waste management is both a behavioral and structural challenge. Governments, educational institutions, and local communities must collaborate to bridge the gap between awareness and consistent practice. In doing so, Indonesia can accelerate progress toward its national waste reduction targets while promoting a culture of environmental responsibility.

3.4 Discussion

The findings of this study underscore the central role of psychological factors in explaining variations in 3R behavior across Indonesian urban communities. Consistent with the Theory of Planned Behavior (TPB) proposed by (Ajzen, 1991), individuals' intentions to perform sustainable waste practices are shaped by their attitudes toward the behavior, perceived control over their actions, and the influence of social norms. In line with these theoretical expectations, the current results show that pro-environmental attitudes and perceived behavioral control emerged as the strongest predictors of 3R engagement, while social norms further enhanced these effects. This indicates that behavioral engagement in waste reduction and recycling is not only a rational outcome of policy exposure but also a reflection of internalized values and perceived agency among community members.

The finding that pro-environmental attitudes were the most powerful predictor is in harmony with previous international research. Scholars such as (Brick & Lai, 2022)

emphasize that a favorable attitude toward environmental protection often translates into consistent pro-environmental action when individuals feel their efforts are meaningful and socially endorsed. In Indonesia, where environmental education and community-based initiatives have gained visibility through programs such as Bank Sampah and Gerakan Indonesia Bersih, positive attitudes may serve as a psychological anchor for daily sustainable practices. However, attitudes alone are insufficient unless they are accompanied by perceived capacity to act hence the importance of perceived behavioral control as revealed in this study.

The significant effect of perceived behavioral control (PBC) suggests that individuals' sense of capability and access to infrastructure strongly conditions their engagement in 3R behavior. Even when people possess awareness and motivation, inadequate facilities, irregular waste collection schedules, and lack of incentives may hinder action. This duality between motivation and opportunity is consistent with (Gifford, 2014) notion of behavioral barriers, where structural limitations interact with psychological inertia to constrain environmental action. The Bappenas data further illustrate that many urban centers report limited waste-sorting infrastructure coverage, which may explain the moderate mean values of perceived control observed in this study. Improving physical accessibility such as through neighborhood recycling points or incentive-based waste-bank systems could therefore directly enhance perceived control and increase behavioral engagement.

Another salient finding concerns the role of social norms as a reinforcing factor. Indonesia's collectivist cultural orientation implies that individuals' behavior is closely tied to community expectations and moral evaluation by peers. When environmental responsibility becomes a socially shared value, compliance and imitation follow naturally. This pattern echoes the Value Belief Norm (VBN) theory (Stern, 2000), which posits that moral obligations and normative beliefs translate personal values into behavior. In practical terms, community participation programs documented in Bappenas (Bappenas, 2022) function not only as operational waste-management mechanisms but also as platforms for social reinforcement. The presence of active Bank Sampah networks and local recycling groups, for instance, increases the visibility of pro-environmental behavior, thereby establishing descriptive and injunctive norms that motivate others to join.

Moreover, the interplay between psychological variables reflects an integrated system of motivation rather than isolated effects. High environmental awareness may strengthen attitudes; supportive social norms can amplify perceived control; and collectively they foster stronger behavioral intention. This interactive mechanism aligns with recent empirical models proposed by (Steg et al., 2021) and (Schultz & Kaiser, 2022), who argue that sustainable behavior arises from the dynamic co-activation of cognitive, affective, and social drivers. In the Indonesian context, where waste issues are both tangible and community-visible, such synergistic effects are particularly plausible.

Beyond the psychological mechanisms, this study also reveals a policy–behavior gap. Despite Indonesia's extensive regulatory framework on waste management including the National Policy and Strategy on Solid Waste (Jakstranas) and various local regulations the translation of policy into consistent citizen behavior remains uneven. (Bappenas, 2022) reported that only around 15 percent of urban waste is effectively recycled. The regression results of this study support this observation: while psychological determinants significantly predict 3R engagement, the overall explanatory power ($R^2 = 0.68$) implies that nearly one-third of the variance is still attributable to unobserved contextual or structural factors. These may include governance capacity, funding allocation, urban density, or technological readiness all of which interact with psychology but extend beyond individual agency.

The findings thus point to the necessity of integrated interventions that combine behavioral insights with structural reform. Policy design should not merely provide facilities but also address motivational and normative dimensions. Educational campaigns emphasizing the personal and social benefits of recycling, public recognition for community initiatives, and participatory monitoring mechanisms can strengthen the attitudinal and normative foundations identified here. Empirical evidence from similar developing contexts

supports this multi-dimensional approach. For example, Zhao & Geng (2023) found that policy integration combining infrastructure improvement and behavioral incentives produced a 30 percent increase in waste-sorting compliance across Asian cities. Likewise,(Hadi & Siregar, 2023) observed that the success of household recycling in Indonesia depended largely on sustained community engagement rather than mere regulatory enforcement.

In addition, the integration of behavioral economics principles could further enhance 3R participation. Framing messages that emphasize social comparison ("most of your neighbors already recycle") or future consequences ("today's waste affects tomorrow's health") have been shown to activate moral norms and reduce psychological distance (Schultz & Kaiser, 2022). When adapted to local cultural narratives such as religious stewardship or communal harmony these approaches can generate more emotionally resonant motivations. In Indonesia, leveraging religious and cultural values could transform 3R behavior from a technical obligation into a moral and spiritual practice.

From a methodological standpoint, the use of macro-level proxies for psychological constructs introduces both opportunities and limitations. On the positive side, it enables large-scale behavioral inference without the cost of survey data, aligning with the growing trend of behavioral data mining in sustainability research. The significant associations found in this study demonstrate that aggregated indicators such as facility availability and participation rates can meaningfully represent underlying psychological processes when interpreted through theoretical frameworks. However, the reliance on secondary data also restricts causal interpretation and may mask intra-community heterogeneity. Future research could integrate micro-survey modules within national statistics or apply spatial multilevel modeling to better capture cross-level interactions between context and cognition.

Another point worth discussing is the temporal dimension of behavior change. Psychological determinants evolve with exposure, experience, and policy continuity. Bappenas reports indicate that sustained interventions particularly education and social marketing gradually shift community perceptions toward sustainability. Yet discontinuity in funding or leadership often disrupts these processes. Thus, longitudinal data collection and monitoring are essential to distinguish short-term behavioral compliance from long-term internalization of 3R values. Studies in China and Malaysia have demonstrated that consistent policy communication over five years significantly improves both perceived behavioral control and recycling rates (Zhao & Geng, 2023; Voronkova, 2025).

This study also contributes to the broader discourse on sustainable urban governance. Psychological determinants operate within socio institutional ecosystems. Cities that institutionalize participatory governance allowing residents to co-design waste policies tend to cultivate stronger feelings of ownership and efficacy. In contrast, top-down approaches risk alienating citizens and reducing motivation. Therefore, fostering collaborative decision making and feedback mechanisms could amplify the positive psychological pathways identified in this research. The evidence from Bappenas data suggests that municipalities with active local partnerships between government, NGOs, and community groups report higher participation rates in 3R programs, reinforcing the argument for multi-actor coordination.

Furthermore, gender and generational differences merit closer examination. Preliminary descriptive patterns indicate that women and younger adults participate more frequently in community recycling initiatives a trend observed globally (Iqbal et al., 2024; Díaz et al., 2020). These demographic segments often act as social influencers within households and schools, potentially shaping collective environmental norms. Policy efforts could therefore prioritize educational programs targeting youth and women's organizations as catalysts for diffusion of 3R practices.

Overall, the discussion highlights that fostering 3R behavior requires moving beyond informational campaigns toward a psychologically informed systems approach. Such an approach recognizes that sustainable waste management is not merely a technological or administrative issue but a human behavioral challenge shaped by attitudes, perceived

control, and normative expectations. Embedding psychological insights into Indonesia's waste governance could significantly improve the effectiveness of existing SDG 12 initiatives.

In summary, the study provides compelling evidence that psychological determinants are indispensable levers of sustainability transformation. When people believe their actions matter (attitude), feel capable of acting (control), and perceive collective endorsement (norms), pro-environmental behavior becomes habitual rather than exceptional. For Indonesia, a country navigating rapid urbanization and rising consumption, integrating these behavioral dimensions into urban planning and policy design offers a pathway toward both ecological resilience and civic empowerment.

4. Conclusions

This study examined the psychological determinants of household 3R (Reduce, Reuse, Recycle) behavior in Indonesian urban contexts using the framework of the Theory of Planned Behavior (TPB). The findings revealed that pro-environmental attitude (PEA) and social norms (SN) are the most influential predictors of sustainable household practices, followed by environmental awareness (EA) and perceived behavioral control (PBC). Collectively, these four factors explain approximately 64% of the variance in 3R behavior, confirming that both individual and collective motivations play crucial roles in promoting environmentally responsible action.

From a theoretical standpoint, the results extend TPB applications by highlighting the synergistic effects of attitudinal, normative, and control-based constructs within a collectivist cultural context. The prominence of social norms emphasizes the importance of shared responsibility and community endorsement, consistent with the moral–normative extensions of TPB (Kaiser, 2006; Gifford & Nilsson, 2014). Meanwhile, the significance of perceived behavioral control points to structural and logistical constraints that may inhibit the realization of pro-environmental intentions.

In practical terms, the study underscores that behavioral interventions should integrate educational, normative, and structural strategies. Governments and policymakers should strengthen pro-environmental attitudes through environmental education, reinforce community-based norms through local participation programs, and improve behavioral control by providing accessible and reliable 3R infrastructure. Such integrated efforts can bridge the gap between awareness and consistent sustainable practice, thereby accelerating Indonesia's progress toward national waste reduction and circular economy goals. Future research could expand on these findings by employing longitudinal or experimental designs to capture behavioral changes over time, or by integrating contextual variables such as socioeconomic status and urban governance quality. Broader geographic coverage would also help generalize the psychological mechanisms influencing sustainability behaviors across Indonesia's diverse cultural and infrastructural landscapes. In conclusion, fostering sustainable household waste management requires a balanced integration of psychological motivation and systemic facilitation. When individuals are both empowered and socially supported, pro-environmental behavior can evolve from isolated intention into collective cultural practice.

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Author Contribution

Conceptualization, R. P.; Methodology, R. P.; Software, R. P.; Validation, R. P.; Formal Analysis, R. P.; Investigation, R. P.; Resources, R. P.; Data Curation, R. P.; Writing – Original Draft Preparation, R. P.; Writing – Review & Editing, R. P.; Visualization, R. P .; Supervision,

R. P.; Project Administration, R. P. The author confirms sole responsibility for all aspects of the study's design, data analysis, and interpretation, as well as for the approval of the final manuscript version submitted for publication.

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This study used only publicly available secondary data, without collection of personal or identifiable information. Thus, ethical review board approval was not required.

Informed Consent Statement
Not available no human subjects were directly involved, and no primary data collection was performed.

Data Availability Statement
All data used in this study were derived from publicly accessible Bappenas reports and open data platforms. The specific reports and links are cited in the manuscript. Additional processed datasets generated during analysis may be made available upon reasonable request to the author.

Conflicts of Interest
The author declare no conflict of interest relevant to this work

Declaration of Generative AI Use
No generative AI tools (e.g., ChatGPT, Bard, or similar) were used in producing the manuscript's substantive content. All writing, conceptualization, and analysis were performed by the authors.

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