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Waste management literacy in Indonesian secondary schools: Assessing knowledge, attitudes, and behavior

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ABSTRACT

This study explores waste management literacy among secondary school communities in Tangerang City, Indonesia, using the Knowledge, Attitude, Behavior (KAB) model within the 3R (Reduce, Reuse, Recycle) framework. Employing a mixed-methods sequential explanatory design, the research integrates quantitative data from 357 participants including principals, teachers, staff, and students from seven schools near the Rawa Kucing Landfill, with qualitative insights from follow up interviews. This study was applied to multiple regression and correlation analyses to evaluate relationships between knowledge, attitude, and behavior. Results show that while knowledge positively influences behavior, attitude unexpectedly correlates negatively, revealing an attitude-behavior gap. Although respondents generally hold positive attitudes toward waste management, these attitudes do not consistently translate into active engagement. The study's qualitative phase uses interviews to identify barriers contributing to this gap, uncovering individual, social, and structural obstacles such as inadequate facilities and established waste practices that hinder effective waste management. Advocating for a comprehensive approach, the study recommends providing schools with 3R bins and training, sustainable behavior modeling by teachers, alignment of municipal waste collection with school efforts, family reinforcement of waste practices, and curricular integration of waste management. This coordinated approach seeks to bridge the attitude-behavior gap and promote sustainable waste practices across school communities in Tangerang City.

Keywords: waste management literacy, knowledge, attitude, behavior, school communities

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INTRODUCTION

Waste management remains a critical barrier to achieving sustainable living. According to the World Bank's *What a Waste 2.0* report, global municipal solid waste generation reaches approximately 2.01 billion tons annually, of which 33% is improperly managed, resulting in significant environmental impacts (Kaza et al., 2018). In Indonesia, waste generation in 2020 was estimated at 65.2 million tons (World Bank, 2023). The Ministry of Environment and Forestry (KLHK) reports that the public sector contributes 50.41% of the total waste generated (KLHK, 2023). The high levels of waste production across regions are attributed to the widespread use of single-use products, alongside the slow adoption of eco-friendly practices, further aggravating the issue (Aprilia, 2021; Beylot et al., 2016; Chen et al., 2021; Waluyo & Kharisma, 2023). At an individual level, waste management is a responsibility that every person should acknowledge. However, many individuals continue to neglect this duty, perceiving waste management as solely the responsibility of the government or external agencies. This perception results in a lack of

active community participation in maintaining environmental cleanliness (Fadhullah et al., 2022; Sahu & Mishra, 2023). Enhancing waste management literacy could be a vital strategy for increasing public awareness and environmental responsibility. With improved literacy, individuals can better comprehend the adverse effects of unsustainable consumption patterns and the importance of sustainable waste management (Debrah et al., 2021; Stöckert & Bogner, 2020; Zhou et al., 2022).

Developing effective waste management habits can begin by strengthening waste management literacy at the community level. In this context, literacy refers to the capacity to apply knowledge and skills to real-world issues, engage in critical analysis, and effectively communicate insights, solutions, and interpretations across diverse situations (OECD, 2010). In terms of environmental literacy, this involves increasing awareness and understanding of environmental issues. Community participation is essential for achieving integrated waste management, and enhancing waste management literacy can enhance both awareness and participation by equipping individuals with the knowledge and skills needed to manage waste effectively (Kundu et al., 2021). Such literacy not only imparts theoretical knowledge but also fosters attitudes and behaviors that promote proper waste management practices.

Existing studies have largely focused on measuring waste management literacy within community groups, especially households, to understand the extent of literacy at the individual household level (Babaei et al., 2015; Castin et al., 2022; Limon et al., 2020; Ling et al., 2018). Research has also examined waste management literacy among university students, often within higher education settings (Spínola, 2023). However, relatively few studies have investigated waste management literacy within school communities. Research involving schools has primarily emphasized general environmental education and the impact of school sustainability programs on students' waste management understanding, while detailed investigastions into students' specific knowledge, attitudes, and behaviors concerning waste remain limited (Debrah et al., 2021). Schools, as educational institutions, are strategically positioned to raise student awareness of environmental issues, particularly waste management. Strong waste management literacy within schools can cultivate a more environmentally conscious generation, and data on waste management literacy among students can provide valuable insights for developing sustainable policies and curriculum frameworks.

Targeting the school community is well-justified, given its vital role in character formation, especially in instilling environmental awareness and fostering a sense of responsibility toward environmental issues. Schools are expected to cultivate students' environmental consciousness and encourage behaviors that contribute to maintaining school cleanliness and supporting broader environmental conservation efforts (Siskayanti & Chastanti, 2022). This aligns with the principles of sustainable development, emphasizing environmental stewardship (Pauw et al., 2015). The Sustainable Development Goals (SDGs) set by the United Nations advocate for school communities to acquire the knowledge and skills necessary to advance sustainable development (O'Flaherty & Liddy, 2018). Through formal education, schools can address waste management issues effectively (Bonnett, 1999). This educational role aligns with the United Nations Decade of Education for Sustainable Development (DESD), led by UNESCO, which promotes an educational approach centered on sustainable development, particularly in the realm of waste management (Pauw et al., 2015).

Understanding and explaining waste management behavior can benefit from a psychological framework that examines the relationship between knowledge, attitudes, and behavior. Knowledge or cognition is a crucial element in shaping a person's actions, as research and experience suggest that behavior rooted in knowledge tends to be more effective than behavior lacking such a foundation (Gusti et al., 2015). Assessing the levels of waste management literacy within school communities involves three core concepts knowledge, attitude, and behavior in the context of the 3R principles (Reduce, Reuse, and Recycle). Numerous studies affirm the relationship between adopting the 3R concept and effective waste management practices. Embracing the 3R principles enables individuals to reduce waste generation, reuse materials, and recycle by sorting waste for reusable components (Law et al., 2023). The Knowledge, Attitude, and Behavior (KAB) model, developed by sociologist Everett Rogers, has

been widely applied across various fields, particularly in health sciences and human behavior studies, to measure behavior change and innovation dissemination within communities. KAB studies are valuable for assessing a known situation and validating or challenging hypotheses, thereby providing new insights into observed realities (Yap et al., 2010). Such studies can equip researchers to recommend effective strategies to policymakers (WHO, 2008). Current understanding suggests that knowledge is directly proportional to attitude and behavior, with these three factors correlating to the success of preventive strategies (WHO, 2008).

The conventional Knowledge, Attitude, and Behaviour (KAB) model posits that behavior is directly influenced by attitude and knowledge, with attitudes themselves shaped by knowledge. This core assumption is valid if, and only if, knowledge is accurate, attitudes are reliably measurable, and behavior consistently reflects knowledge. This study seeks to assess waste management literacy within secondary school communities in Tangerang City, Indonesia, through the KAB model (Knowledge, Attitude, and Behavior) concerning the 3R principles (Reduce, Reuse, and Recycle).

Inadequate waste management, both globally and nationally, particularly in Indonesia, remains a pressing issue. This challenge is largely driven by unsustainable consumption patterns and insufficient public awareness, suggesting that effective waste management strategies should encompass educational and behavioral change components and infrastructural solutions. Prioritizing waste management literacy within school communities is essential, as it has the potential to foster sustainable practices by embedding the 3R principles (Reduce, Reuse, Recycle). Utilizing the Knowledge, Attitude, and Behavior (KAB) model, this study aims to elevate awareness and encourage improved practices, asserting that informed education is fundamental to long-term sustainability. The broader implications of this approach underscore the need for integrated strategies that align educational initiatives with policy frameworks and community involvement, ultimately advancing comprehensive environmental goals.

METHOD

Research design

This study utilizes a mixed method approach with a sequential explanatory design, integrating quantitative and qualitative methods in successive phases. In the initial phase, a quantitative approach is employed to assess the knowledge, attitudes, and behaviors regarding waste management among secondary school communities in Tangerang. This phase is followed by a qualitative approach to further explore and contextualize the findings from the quantitative assessment (Creswell & Poth, 2016). The quantitative phase includes measuring knowledge, attitudes, and behaviors related to waste management among various school community members. The process involved feedback validation from three expert validators and a pilot study with 200 participants from junior high school communities in Tangerang City (Naga, 2012). Construct validity was assessed using the Pearson Product-Moment correlation, while reliability was evaluated using Cronbach's Alpha. The study includes principals, teachers, students, and staff from seven junior high schools. The insights from this quantitative assessment will be enriched through qualitative analysis to capture the social context and factors influencing knowledge, attitudes, and behaviors related to waste management within school communities. The research was conducted from April to May 2024 in Tangerang City, selected due to its status as the eighth-highest waste-producing city in Indonesia and the location of the Rawa Kucing Final Disposal Site in the Neglasari District. Furthermore, Tangerang has the highest concentration of Adiwiyata schools in Indonesia, totaling 521 institutions. Focusing on junior high schools aligns with the implementation of sustainable living themes within the Strengthening of the Pancasila Student Profile project, which is part of the Merdeka curriculum.

Sampling and data collection techniques

This study employs two primary data collection methods: questionnaires and interviews. Data collection began with a questionnaire distributed via Google Forms, targeting three core areas: knowledge, attitudes, and behaviors related to the 3R principles (Reduce, Reuse, Recycle).

The questionnaire consisted of 59 statements rated on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). For example, the statement "I always try to reduce plastic use" assesses respondents' attitudes toward the "Reduce" principle. To ensure validity, the questionnaire was subjected to content validation.

According to data from the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia (Dapodik), eleven junior high schools are situated near the Rawa Kucing Final Disposal Site in the Neglasari District, encompassing one public and ten private schools (both Adiwiyata and non-Adiwiyata schools). The total school community population is 3,287 individuals, including 3,060 students, 142 teachers, 74 staff, and 11 principals. Using the Slovin formula with a 5% margin of error, the required sample size was calculated to be 357 participants. Stratified proportional random sampling was applied, categorizing the population into strata: students (3,060), teachers (142), staff (74), and principals (11). The sample was then proportionally selected from each group: 332 students, 15 teachers, 8 staff members, and 2 principals, with participants randomly chosen from lists provided by the schools.

Semi-structured interviews were conducted using a guiding set of questions, allowing flexibility for deeper exploration based on the informants' responses. Seven informants were purposively selected due to their roles and experiences related to waste management within the school setting, ensuring that they could offer relevant and valuable insights. All interviews were recorded, and data accuracy and contextual relevance were verified through triangulation of sources and techniques. Source triangulation consisted of comparing interview responses from principals, teachers, and staff to confirm consistent findings regarding waste management practices within schools.

Data analysis techniques

This study employs correlation analysis to evaluate the significance of the relationships among knowledge, attitude, and behavior (Gravetter & Wallnau, 2017). Additionally, to assess the effects of knowledge and attitude on behavior, both partially and simultaneously, multiple regression analysis is conducted (Hair et al., 2019). In alignment with the research objectives, the main hypothesis is divided into two sections: partial effect testing and simultaneous effect testing. The study proposes three hypotheses shown in Figure 1: a) H1: Does the waste management knowledge of school communities have a significant impact on their behavior? b) H2: Does the attitude toward waste management significantly influence their behavior? c) H3: Do knowledge and attitude toward waste management simultaneously have a significant impact on their behavior?

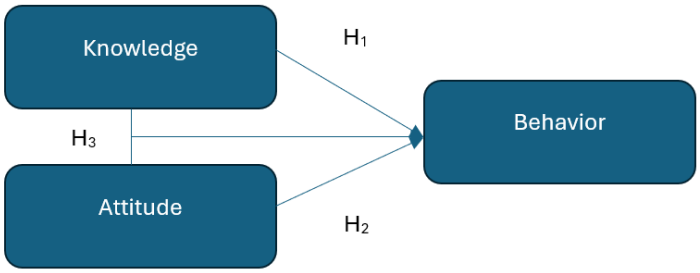

Figure 1. The research hypothesis

Prior to conducting multiple regression analysis, several classical assumption tests are performed to ensure the validity of the model, including linearity testing by examining scatterplots for knowledge and attitude against behavior, normality testing using the Kolmogorov-Smirnov and Shapiro-Wilk tests (Razali & Wah, 2011), homogeneity testing through Levene's Test (Lavene, 1960), and multicollinearity testing (Hair et al., 2019). Once these classical assumptions are validated, multiple regression analysis is conducted, followed by the interpretation of results. Both correlation and multiple regression analyses, along with the assumption tests, are performed using R Studio. For qualitative data, interview recordings are transcribed and analyzed using the Interactive Model developed by Miles, Huberman, and Saldana, which consists of four stages:

data collection, data condensation, data display, and conclusion drawing (Miles et al., 2013). Thematic analysis is utilized to identify patterns and themes within the qualitative data (Braun & Clarke, 2006). This structured approach ensures that qualitative data analysis is both systematic and comprehensive, enhancing understanding of the context and factors influencing waste management knowledge, attitudes, and behaviors within school communities. This method enables the researcher to distill complex information into meaningful insights, ensuring that participants' perspectives are accurately captured and interpreted.

FINDINGS AND DISCUSSION

Findings

Profile of respondents

The demographic trends among the 357 respondents reveal a strong predominance of students (93%) primarily under the age of 15 (75.9%), with the majority holding an elementary school education level (93%). Gender representation leans slightly toward females (56.6%), and the highest representation is from Public Junior High School A, followed by various private institutions. This demographic profile underscores the significance of waste management literacy at an early educational stage, highlighting a young, predominantly student-based sample that is essential for fostering foundational attitudes and behaviors toward sustainable waste management practices. Table 1 presents a detailed profile of the 357 respondents, categorized by demographic characteristics and educational levels.

Table 1. Profile of the respondents

Description (n=357)		Frequency (n)	Percentage (%)
Gender	Male	155	43.4
	Female	202	56.6
School	Public Junior High School A	142	39.8
	Private Junior High School A	53	14.8
	Private Junior High School B	43	12
	Private Junior High School C	36	10.1
	Private Junior High School D	29	8.1
	Private Junior High School E	28	7.8
	Private Junior High School F	26	7.3
Role	School Principal	2	0.6
	Teacher	15	4.2
	Staff	8	2.2
	Student	332	93
Age	Under 15 years	271	75.9
	15 - 25 years	67	18.8
	41 - 60 years	11	3.1
	26 - 40 years	8	2.24
Educational Level	Elementary School	332	93
	Junior High School	0	0
	Senior High School	5	1.4
	Bachelor (S1)	19	5.3
	Master (S2)	1	0.3

The validity and reliability test

The validity of the questionnaire was assessed using the Pearson Product-Moment correlation, with a cutoff value of 0.30. Items with correlation coefficients below this threshold were considered invalid and subsequently removed from the analysis. Initially, the questionnaire included 65 statements. Following the validity test, 6 items were identified with correlation values below 0.30 and were excluded, resulting in a final total of 59 valid items. This refinement ensured that only statements with statistically significant relationships to the underlying constructions were retained. The reliability of the data was evaluated using Cronbach's Alpha. The Attitude and

Behavior variables demonstrated Cronbach's alpha values above the 0.70 threshold, indicating strong internal reliability. The Knowledge variable showed a Cronbach's alpha of 0.674, which rounds to 0.70, meeting the standard for acceptable reliability. Consequently, all remaining variables met or exceeded the 0.70 threshold, confirming the data's consistency and suitability for further analysis.

Correlation analysis

The degree and direction of the association between knowledge, attitude, and behavior in waste management within school communities were evaluated using the Pearson correlation coefficient. Coefficients approaching an absolute value of 1 indicate a stronger relationship (Yap et al., 2010). Table 2 reveals a moderately strong positive correlation between knowledge and attitudes toward waste management ($r = 0.351$, Sig. = 0.000), suggesting that higher levels of knowledge are associated with more positive attitudes. This outcome is consistent with findings from studies in various regions and populations, underscoring a persistent link between environmental knowledge and positive waste management attitudes. For example, Cahyono et al. (2023) found that increased environmental knowledge significantly enhanced student attitudes toward the 3R (Reduce, Reuse, Recycle) approach. Similarly, Benitez (2018) reported a positive correlation between solid waste management knowledge and favorable attitudes among students in the Philippines (Benitez, 2018). In Nigeria, Dung et al. (2017) observed that although students exhibited relatively low waste management knowledge, any increase in knowledge further strengthened their already positive attitudes (Dung et al., 2017).

Additionally, Iyer (2018) identified that greater awareness of e-waste issues in Bengaluru, India, encouraged more responsible attitudes toward e-waste generation (Iyer, 2018). Echoing these findings, Jinn et al. (2023) showed a robust association between 3R knowledge and positive waste management attitudes among Malaysian students (Jinn et al., 2023). However, Suwerda et al. (2018) cautioned that even with adequate knowledge, practical barriers such as limited waste disposal facilities and challenges related to personal motivation can hinder proper waste management practices (Suwerda et al., 2018). Collectively, these studies highlight a reliable trend: as knowledge of waste management principles, such as the 3Rs, grows, attitudes toward waste management tend to improve across diverse cultural and geographical contexts. Nevertheless, addressing practical barriers remains essential to translating positive attitudes into consistent waste management behaviors.

The study identifies a low correlation between environmental knowledge and waste management behavior within school communities in Tangerang ($r = 0.081$, Sig. = 0.125), suggesting that knowledge alone does not significantly influence behavior. This finding aligns with research by Yusuf and Fajri (2022), which similarly found that environmental knowledge among students at Syiah Kuala University, Indonesia, does not necessarily translate into corresponding waste management actions (Yusuf & Fajri, 2022). In other words, while students may possess solid environmental knowledge, this does not guarantee that they engage in environmentally responsible behaviors. The research also reveals a slightly negative relationship between attitude and behavior ($r = -0.115$, Sig. = 0.030), suggesting that even when individuals hold positive attitudes, their actual behaviors may not align accordingly. This significant yet unexpected result suggests that additional factors, such as the availability of facilities and prevailing social norms, likely impact waste management practices within the school community. Although increased knowledge may enhance attitudes, it does not automatically translate into improved behaviors, underscoring a gap shaped by external influences. A study conducted across European Union countries by Minelgaitė and Liobikienė (2019) found that while individuals held positive attitudes toward waste management, these attitudes did not necessarily result in behaviors such as waste reduction and recycling (Minelgaitė & Liobikienė, 2019). Notably, only individuals who recognized their personal responsibility in contributing to waste engaged in active waste management practices. Additionally, attitudes toward resource efficiency were found to have no significant impact on waste management behaviors, further reinforcing that awareness alone is insufficient to drive effective action. These studies highlight a critical insight: while environmental knowledge and general attitudes are important, they often do not suffice on their

own to instill sustainable waste management behaviors. Cultivating a sense of personal responsibility appears essential for transforming knowledge into meaningful, sustainable action. Table 2 presents the correlation analysis between knowledge, attitude, and behavior regarding waste management within Tangerang school communities.

Table 2. Correlation between knowledge, attitude, and behavior of school communities waste management

		Knowledge	Attitude	Behavior
Knowledge	Pearson Corr.	1	.351*	.081
	Sign. (2-tailed)		18	.125
	N	357	357	357
Attitude	Pearson Corr.	.351*	1	-.115*
	Sign. (2-tailed)	.000		.030
	N	357		357
Behavior	Pearson Corr.	.081	-.115*	1
	Sign. (2-tailed)	.125	.030	
	N	357	357	357

Note: *Correlation is significant at the 0,05 level (2-tailed)

Multiple regression analysis

Multiple regression analysis was utilized to investigate the relationship between a single dependent variable (behavior) and two independent variables (knowledge and attitude) related to waste management within school communities. Prior to conducting multiple regression analysis, classical assumption tests were performed to ensure data suitability. The linearity of data patterns was evaluated using scatterplots for each independent variable (knowledge and attitude) in relation to the dependent variable (behavior). Normal testing conducted using the Kolmogorov-Smirnov and Shapiro-Wilk methods, yielded significance values of 0.071, 0.083, and 0.069, respectively, all exceeding the 0.05 threshold (MoE), confirming a normal distribution for all variables (knowledge, attitude, and behavior). Homogeneity was tested with Levene's test, resulting in a significance value of 0.062, which also exceeded the 0.05 criterion (MoE), thereby meeting the requirement for homogeneity. Additionally, multicollinearity between the independent variables (knowledge and attitude) was assessed, with a tolerance value of 0.877 (> 0.1) and a VIF value of 1.140 (< 10.0), indicating no multicollinearity concerns. Given that all classical assumptions were satisfied, the multiple regression analysis was deemed appropriate for this study. Table 3 presents the Multiple Regression Analysis.

Table 3. Multiple regression analysis

Independent Variables	Number of Items		Hypothesis	Result
	β	Sig.		
Knowledge	0.594	0.014	H1	Significant
Attitude	-0.355	0.004	H2	Significant
F Value	5.496	0.004	H3	Significant
R Square	0.30			

In multiple regression analysis, the simultaneous test, commonly known as the F-test, evaluates whether the combined effect of independent variables (knowledge and attitude) on the dependent variable (behavior) is significant. Table 3 presents the results of the simultaneous test, indicating a significant value of 0.004, which is below the conventional 0.05 threshold. These results suggest that knowledge and attitude jointly exert a significant effect on waste management behavior within school communities in Tangerang City. These findings are supported by previous research. A study conducted in Padang, Indonesia, demonstrated a significant relationship between knowledge about sustainable waste management and the attitudes and behavioral intentions of primary school students (Gusti, 2016).

Similarly, research in Tangerang indicated that energy knowledge and attitudes influenced energy-saving behavior among elementary students (Bahij et al., 2020). However, a study in

South Tangerang found no significant relationship between knowledge, attitudes, and waste management practices among housewives (Puji et al., 2020). Additionally, research on primary school children highlighted that although waste management knowledge was generally sufficient, there was a need to encourage the practical application of this knowledge in everyday life (Sulistyawati et al., 2020). These findings suggest that while knowledge and attitudes are crucial factors, other elements such as facilities and practical opportunities may also play an essential role in shaping waste management behaviors in school communities.

The Theory of Planned Behavior supports these findings, positing that behavior is influenced by attitudes, subjective norms, and perceived behavioral control (Ajzen & Schmidt, 2020). In this study's context, while knowledge can enhance attitudes, actual behavior is also shaped by the perceived ability to manage waste effectively and the influence of social norms within the school community. Consequently, the significant impact of both knowledge and attitude highlights the need for a holistic approach in educational interventions, integrating both cognitive understanding and attitudinal shifts to promote effective waste management behaviors.

A partial test was also conducted to explore the individual effects of knowledge and attitude on behavior. As indicated in Table 3, the knowledge variable yielded a t-value of 2.482 with a significance level of 0.014, suggesting that knowledge significantly influences behavior at the 5% significance level ($p < 0.05$). This implies that knowledge has a meaningful impact on behavior. Similarly, for the attitude variable, a t-value of -2.929 and a significance level of 0.004 were observed, indicating a statistically significant influence on behavior at the 5% significance level ($p < 0.05$). However, the influence of attitudes on behavior was negative, revealing a notable attitude-behavior gap, a phenomenon also observed in prior studies (Minelgaitė & Liobikienė, 2019).

Research indicates that while personal attitudes toward waste generation may positively impact waste management behaviors, broader attitudes toward waste management often adversely affect efforts to reduce and recycle waste (Minelgaitė & Liobikienė, 2019). This finding aligns with Blake's (1999) Value-Action Gap, which posits that individuals may hold supportive values or attitudes towards specific actions, yet their behaviors do not consistently reflect these attitudes. Environmental knowledge is essential for shaping attitudes and influencing behavior. Environmental knowledge is critical for forming attitudes and influencing behavior (Dennis V. Madrigal & Enrique G. Oracion, 2017; Raghu & Rodrigues, 2022). However, factors such as subjective norms, perceived behavioral control, and intention also significantly impact waste management practices (Raghu & Rodrigues, 2022). In addition, cultural, social, and political barriers—such as perceptions of responsibility and a lack of trust in waste management authorities—contribute to the gap between attitudes and actions (Fahy, 2005). Despite rising environmental awareness, municipal waste disposal in landfills has increased, emphasizing the need for effective strategies to bridge the attitude-behavior gap in waste management practices (Fahy, 2005).

Moreover, the low R^2 value in the regression model (approximately 30%) indicates that knowledge and attitude account for only a minor portion of the variance in waste management behavior, suggesting that other factors, such as established habits, social pressures, or external conditions, exert a stronger influence. This observation supports Blake's (1999) assertion that external barriers often impede the translation of positive intentions or attitudes into action.

Exploring barriers to bridging the value-action gap in school communities

Blake (1999) identifies various barriers contributing to the Value-Action Gap, including individual, social, and structural obstacles. Within this study's context, the negative influence of attitudes on behavior may reflect the presence of these barriers. For instance, while students and teachers may hold positive attitudes toward waste management, they often encounter practical challenges, such as a lack of concrete knowledge on effective waste management practices despite understanding its importance. Additionally, social barriers, including influences from family, peers, and prevailing norms within the school community, may discourage pro-environmental behavior. If surrounding norms do not support effective waste management, positive attitudes alone are insufficient to drive meaningful action. In interviews, teachers at Public Secondary

School A in Tangerang consistently noted the impact of students' backgrounds on their waste management behavior. One teacher articulated this concern, stating:

> *"Most of the students at this school come from families of scavengers, given its location near the Rawa Kucing Landfill. This family background undoubtedly affects their upbringing, mindset, and habits. As a result, I assume that because these students live close to waste, they perceive it as not a significant problem."* (Teacher LQ, Tangerang Public Secondary School, interviewed on July 23, 2024).

This perspective reflects a consensus among faculty that the socio-economic context and familial influences significantly shape students' perceptions of waste. Addressing these barriers is essential to fostering more effective waste management practices within the school community.

Institutional barriers, such as the lack of adequate waste management facilities, including the absence of separate bins for recycling programs, further impede the alignment of behavior with attitudes toward waste management. Interview findings indicated that several secondary schools in Tangerang City still lack 3R (Reduce, Reuse, Recycle) bins, leading to the continued mixing of waste types despite the school community's commitment to proper waste disposal practices. As Teacher AH from a private secondary school in Tangerang remarked:

> *"We are grateful that students, teachers, and staff at our school already dispose of their waste in designated bins, but unfortunately, we still only have one bin to accommodate all types of waste produced by the school community."* (Teacher AH, a private secondary school in Tangerang, interviewed on May 4, 2024).

This statement reflects the challenges schools face in aligning waste management practices with available infrastructure, underscoring the need for enhanced waste sorting systems to support these efforts. Furthermore, the conventional waste management system operated by the Tangerang local government undermines school waste management initiatives, diminishing their effectiveness. This misalignment has led some schools to express frustration. For example, Private Junior School D and Junior School F in Tangerang have voiced concerns that their commitment to good waste disposal practices—such as sorting organic and inorganic waste and composting on school grounds—often feels "futile" due to ineffective external waste management practices. As a teacher overseeing the Adiwiyata program explained:

> *"Within the school environment, we have managed waste quite well, such as separating organic and inorganic waste and composting on school grounds. However, once the sanitation workers collect the waste, it gets mixed again. This happens because the workers only use one bin, so all types of waste are remixed,"* (Teacher from Private Junior School D, interviewed on May 4, 2024).

This quote illustrates the disconnect between internal school efforts and external waste management systems, a persistent barrier to effective waste management in Tangerang's schools. The finding that attitudes can negatively influence behaviour may also reflect frustration among students and staff regarding their limited ability to implement effective waste management practices due to institutional constraints. Positive attitudes may inversely relate to behaviour when individuals feel their actions lack impact or when external barriers render these actions impractical or challenging.

The limited explanatory power of knowledge and attitudes in predicting waste management behaviour within Tangerang's school communities suggests that additional, more influential factors are at play. This insight has critical implications for environmental education programs, highlighting the insufficiency of focusing solely on knowledge enhancement to achieve sustainable behavioural change. A comprehensive, multifaceted approach is essential, one that includes the provision of appropriate facilities, the establishment of social norms supportive of eco-friendly practices, and the mitigation of logistical barriers faced by students, teachers, and

staff. Addressing these institutional and social challenges is crucial to bridging the Value-Action Gap and fostering waste management behaviours that genuinely reflect the environmentally responsible values held by the school community. These findings call for an evolved environmental education framework, one that not only informs but also strategically motivates and facilitates meaningful behavioural shifts.

CONCLUSION

This study underscores a significant relationship between knowledge, attitude, and behavior in waste management within school communities in Tangerang City, revealing that, while knowledge positively influences behavior, attitudes may exert a negative effect, suggesting an attitude-behavior gap. The Value-Action Gap, as conceptualized by Blake (1999), is evident in these communities: although positive attitudes toward waste management are present, translating these attitudes into effective actions is hindered by individual limitations, social influences, and institutional barriers. The lack of adequate waste management infrastructure, such as separate recycling bins, impedes the alignment of actions with attitudes, creating frustration among school community members. Furthermore, conventional waste management systems exacerbate these issues by leading to mixed waste disposal, which reduces motivation to implement the 3R (Reduce, Reuse, Recycle) principles. The low R^2 value indicates that knowledge and attitude together explain only a small portion of the variance in waste management behavior, suggesting that other factors, such as established habits and social pressures, play a substantial role. Consequently, a more comprehensive approach is essential to enhance environmental education, including the provision of adequate facilities and the development of supportive social norms, which are critical to bridging the Value-Action Gap and advancing sustainable waste management practices within schools. Future research should aim to identify factors that contribute to the attitude-behavior gap and evaluate the effectiveness of educational interventions. Additionally, studies should explore the role of community engagement in fostering sustainability within schools and conduct longitudinal analyses to understand the long-term impact of institutional support on waste management behaviors.

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