

Knowledge, Attitudes, and Practices of Proper Waste Segregation in Enhancing Solid Waste Management in the Municipality of Camaligan, Camarines Sur, Philippines

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Abstract:

This study examines the knowledge, attitudes, and practices (KAP) of households regarding proper waste segregation and its role in enhancing solid waste management in the Municipality of Camaligan, Camarines Sur, Philippines, within the framework of Republic Act No. 9003 or the Ecological Solid Waste Management Act. Using a descriptive research design, data were gathered through structured household surveys, key informant interviews with municipal and barangay solid waste management personnel, and field observations of waste collection and handling operations. Findings reveal that households generally demonstrate high levels of knowledge and positive attitudes toward proper waste segregation; however, actual segregation practices remain only moderate. This discrepancy highlights a persistent gap between awareness and behavior, largely influenced by structural and operational barriers such as limited access to color-coded waste bins, inconsistent waste collection schedules, weak enforcement of barangay-level ordinances, and space constraints in densely populated residential areas. Despite these challenges, proper waste segregation was found to significantly enhance solid waste management by improving material recovery, reducing mixed and residual waste volumes, and increasing the operational efficiency of municipal collection and disposal systems. Segregation at source supports recycling and composting initiatives, lowers waste management costs, and strengthens compliance with national environmental policy. The study recommends strengthened barangay-level enforcement, enhanced logistical support, and sustained community-based information and education campaigns to translate household knowledge and positive attitudes into consistent waste segregation practices. Overall, the findings provide evidence-based insights for local policymakers and environmental managers, emphasizing the importance of aligning household behavior with institutional capacity to achieve sustainable and effective solid waste management.

Keywords: Knowledge, Attitudes and Practices, Waste Segregation, Solid Waste Management, Republic Act 9003, Local Governance.

1. INTRODUCTION

Municipal solid waste continues to pose significant challenges to developing countries, particularly in rapidly urbanizing communities where increased population density and intensified economic activity

place substantial pressure on local waste management systems. In the Philippines, Republic Act 9003 (RA 9003), or the Ecological Solid Waste Management Act of 2000, provides the national framework for waste reduction, resource recovery, and environmentally sound disposal practices. As one of its core mandates, proper waste segregation at the household level serves as the primary mechanism for improving material recovery and minimizing contamination of recyclable and biodegradable waste streams.

Nonetheless, compliance with RA 9003 remains uneven across local government units, with many households lacking consistent segregation practices despite nominal awareness (Catiil & Daud, 2025). For instance, a study in Gingoog City found that while 58% of participants were aware of RA 9003, only 26% actually practiced proper waste segregation and disposal. Similarly, in selected barangays of Baliwag, Bulacan, researchers observed that increased household awareness, attitude, and prior exposure to information campaigns significantly improved waste segregation practices and perception of the program's effectiveness. These findings underscore a persistent gap between legal/ policy awareness and actual household behavior reinforcing the notion that legislation alone does not guarantee effective implementation. The Municipality of Camaligan in Camarines Sur presents a distinct context for examining waste segregation effectiveness. Characterized by its small land area, high population density, and mixed residential-commercial land use, Camaligan faces compounded difficulties in maintaining an efficient solid waste management (SWM) system. Issues such as improper waste disposal, clogged drainage systems, increasing residual waste volumes, and insufficient materials recovery facility (MRF) capacity mirror the challenges experienced by many small Philippine municipalities. While waste segregation is recognized as a basic requirement for effective SWM, the level of household compliance and its direct contribution to the municipality's waste management performance remain inadequately understood. Effective waste segregation improves recycling efficiency, minimizes mixed waste generation, enhances composting outcomes, and reduces municipal disposal burdens benefits that have been documented in both local- and international-scale studies. In fact, recent research confirms that household environmental knowledge significantly influences waste management behavior, including willingness to segregate and actual disposal practices.

However, segregation remains a behavior-dependent process influenced by household knowledge, attitudes, and daily practices. The Knowledge, Attitude, and Practice (KAP) framework provides a useful lens for understanding community participation; yet, structural factors such as enforcement, logistics, infrastructure, and institutional capacity also play critical roles in shaping compliance. In waste management contexts, these findings suggest that even knowledgeable households may struggle to implement segregation when confronted with logistical obstacles such as limited bin access or unclear barangay guidelines (Sumayao & De Guzman, 2012; Romualdo, Arroyo & Cristobal-Cipriano, 2022). This study evaluates the effectiveness of proper waste segregation in enhancing the solid waste management system of Camaligan, Camarines Sur by examining household KAP, identifying operational barriers faced by SWM personnel, and assessing the perceived impact of segregation on municipal waste processes. Through these findings, the study aims to inform evidence-based policy enhancements, support community education efforts, and strengthen local environmental governance. Ultimately, understanding the interplay between behavioral and institutional factors provides critical insights for achieving sustainable, community-driven solid waste management.

2. LITERATURE REVIEW

Solid waste generation remains one of the most pressing environmental challenges worldwide, driven largely by rapid urbanization, industrialization, and evolving consumption patterns. According to the World Bank (2019), global waste generation is projected to increase from 2.01 billion tons to 3.40 billion tons by 2050, placing considerable pressure on governments to strengthen their waste management systems. Segregation at source has been widely identified as an essential strategy for enhancing recycling efficiency, reducing greenhouse gas emissions, and minimizing landfill dependency (Kaza et al., 2018). The United Nations Environment Programme (2020) further emphasizes that without proper segregation, even technically advanced waste treatment technologies fail to achieve optimal recovery rates. These global perspectives highlight the importance of integrating household-level behaviors into broader waste management systems, particularly in communities with limited waste infrastructure.

The Philippines generates an estimated 21 million tons of waste annually, with projections showing a continuous upward trend due to increasing population and economic activity (National Solid Waste Management Commission, 2021). Republic Act 9003 mandates waste segregation at source, establishment of materials recovery facilities (MRFs), and the implementation of environmentally sound disposal systems. However, several nationwide assessments indicate inconsistent compliance across local government units. Challenges include inadequate budget allocation, limited availability of color-coded bins, low operational MRF capacity, and lack of community participation (Lopez & Bautista, 2021; Dizon & Reyes, 2020). Supporting these findings, Serillano (2025) observed that smaller municipalities often struggle with operationalizing RA 9003 due to constrained financial resources and weak enforcement mechanisms, resulting in continued mixed-waste disposal despite existing policies.

Segregation at source is widely recognized as a critical determinant of recycling success and overall SWM efficiency. Liu and Yang (2021) assert that segregation can increase material recovery rates by up to 50%, especially when supported by appropriate sorting infrastructure. However, in many developing countries, segregation remains inconsistent due to unclear waste categories, insufficient knowledge among households, and irregular collection schedules (Gupta & Jain, 2020). Serillano (2025) similarly found that households in densely populated municipalities exhibit partial compliance with segregation guidelines, often influenced by inconsistent collection practices and the absence of visible incentives. These constraints mirror conditions in many Philippine localities, indicating that technical guidelines alone are insufficient without operational consistency and community-level reinforcement.

The Knowledge, Attitude, and Practice (KAP) model provides a valuable framework for understanding individual participation in segregation initiatives. Several studies reveal that households often possess favorable attitudes toward segregation but fail to translate them into consistent action (Tan & Sim, 2020; Navarro & Reyes, 2021). Ajzen's Theory of Planned Behavior supports this observation by stating that attitudes alone are insufficient predictors of behavior; perceived behavioral control, availability of infrastructure, and prevailing social norms significantly influence compliance (Ajzen, 1991). In line with this framework, Serillano (2025) emphasized that while respondents demonstrated moderate to high knowledge of waste segregation, actual practices were constrained by limited access to bins, unclear barangay instructions, and weak monitoring reinforcing the gap between awareness and implementation.

Research conducted within the Bicol Region demonstrates similar challenges in local SWM implementation. Calubaquib (2020) reports persistent issues in Naga City and Pili involving mixed waste

collection, low recycling efficiency, and inadequate household compliance. Gonzales (2021) identifies operational bottlenecks in Pasacao, particularly in enforcing RA 9003 and sustaining barangay-level monitoring. These regional findings are consistent with Serillano's (2025) conclusions that effective segregation in small municipalities is highly dependent on barangay-level governance and sustained community engagement. Together, these studies reinforce the need for municipality-specific assessments that consider local demographic, spatial, and operational characteristics.

The reviewed literature consistently shows that effective waste segregation is achieved through the convergence of informed household behavior and adequate institutional support. While many communities demonstrate moderate to high levels of awareness, segregation practices often remain hindered by logistical, environmental, and organizational constraints. Serillano (2025) contributes to this body of knowledge by highlighting how spatial limitations and resource scarcity intensify SWM challenges in small, densely populated municipalities. This underscores a crucial research gap: the need to evaluate segregation effectiveness within contexts such as Camaligan, where localized evidence is essential for developing targeted, evidence-based interventions that strengthen compliance with RA 9003 and promote long-term environmental sustainability.

3. METHODOLOGY

This study employed a descriptive research design using a combination of household surveys, key informant interviews (KIIs), and field observations to assess knowledge, attitudes, and practices (KAP) on waste segregation in Camaligan, Camarines Sur. Structured questionnaires with Likert-scale items measured household awareness, perceptions, and behaviors regarding solid waste management, while KIIs with municipal SWM personnel and barangay officials provided qualitative insights into operational challenges and compliance barriers. Field observations documented segregation practices, the availability and use of color-coded bins, and collection procedures. This approach aligns with previous Philippine studies on municipal SWM, such as Tecson et al. (2024) in Suyac Island and Cando et al. (2022) in Butuan City, which used descriptive-survey designs, validated questionnaires, and KIIs to evaluate household behavior and institutional performance in waste management. Quantitative data were analyzed using descriptive statistics (weighted means, frequencies, and rankings), and qualitative responses underwent thematic analysis to triangulate findings, consistent with established KAP research methodologies (Baliwag, Bulacan study, 2021).

4. RESULTS

This section presents the findings of the study regarding household knowledge, attitudes, and practices (KAP) on proper waste segregation in Camaligan, Camarines Sur, and examines how these behaviors influence the effectiveness of the municipal solid waste management (SWM) system. It also highlights operational challenges identified by SWM personnel and discusses their implications for local policy and community participation. The discussion is structured around four key dimensions: household knowledge, household attitudes, household practices, and operational challenges.

Household Knowledge on Proper Waste Segregation

The findings in the level of household knowledge on proper waste segregation in Camaligan, Camarines Sur. Knowledge is a critical determinant of effective solid waste management, as households serve as the primary source of waste generation and segregation at origin. Understanding national policies such as Republic Act 9003 and the proper classification of waste types is essential to ensuring compliance with

ecological solid waste management (ESWM) practices. This table specifically measures respondents' awareness of RA 9003 and their ability to identify biodegradable, recyclable, and residual wastes.

The data reveal a Grand Mean of 3.39, interpreted as Highly Knowledgeable (HK), indicating that households generally possess a strong understanding of proper waste segregation. High weighted means were recorded for knowledge of residual waste (WM = 3.70), recyclable waste (WM = 3.68), and biodegradable waste (WM = 3.41), all falling under the Highly Knowledgeable category. These findings suggest that most respondents can correctly classify common household wastes, which is a fundamental requirement for effective segregation at source. However, knowledge of RA 9003 requirements obtained a comparatively lower weighted mean of 2.79, interpreted as Knowledgeable (K), indicating that while residents are aware of the law, their understanding of its specific provisions, responsibilities, and penalties may be limited.

The results indicate that household knowledge in Camaligan is stronger at the practical level than at the policy level, which has important implications for solid waste management implementation. While residents demonstrate competence in identifying waste categories, limited familiarity with RA 9003 may weaken sustained compliance and civic accountability. This pattern is consistent with previous studies showing that households often learn segregation practices through community experience rather than formal policy education (Guerrero, Maas, & Hogland, 2013; Liu & Yang, 2021). Similarly, Philippine-based studies emphasize that awareness of waste classification does not always translate into full legal compliance unless reinforced by continuous information campaigns and barangay-level enforcement (Bernardo, 2020; Department of Environment and Natural Resources [DENR], 2019). Thus, the findings support the need for intensified information, education, and communication (IEC) programs focusing not only on waste types but also on the legal framework of RA 9003 to strengthen long-term behavioral compliance and improve overall solid waste management outcomes.

Table 1. Household Knowledge on Proper Waste Segregation in Camaligan, Camarines Sur, 2025.

Indicators	WM	Int.
Households are knowledgeable about the requirements and provisions of Republic Act 900	2.79	HK
Households possess adequate knowledge in accurately identifying biodegradable waste materials.	3.41	HK
Households demonstrate adequate knowledge in identifying recyclable waste materials.	3.68	HK
Households possess adequate knowledge in accurately identifying residual waste materials.	3.70	HK
Grand Mean	3.39	HK

Legend:

Rating Scale	Interpretation
3.36-4.00	High Knowledgeable (HK)
2.51-3.25	Knowledgeable (K)
1.76-2.50	Slightly Knowledgeable (SK)
1.00-1.75	Not Knowledgeable (NK)

Household Attitudes Toward Waste Segregation

In table 2 reveals that the household attitudes toward waste segregation in Camaligan, Camarines Sur. Attitude is a crucial behavioral determinant that influences whether knowledge is translated into actual waste segregation practices. Positive environmental attitudes, community responsibility, and willingness to participate in local programs strengthen the effectiveness of solid waste management initiatives, particularly at the barangay and municipal levels. This table assesses households' perceptions of the environmental benefits of segregation, its role in reducing municipal waste volume, their sense of shared responsibility, and their willingness to engage in segregation programs.

The results indicate a Grand Mean of 3.42, interpreted as Strongly Agree (SA), reflecting an overall positive attitude toward waste segregation among households. The highest weighted mean was recorded for the belief that waste segregation is beneficial to the environment (WM = 3.79, SA), followed by willingness to participate in segregation programs (WM = 3.70, SA). These findings suggest a high level of environmental concern and readiness among residents to support waste management initiatives. Meanwhile, attitudes regarding waste segregation as a shared community responsibility (WM = 3.22, A) and its role in reducing municipal waste volume (WM = 3.00, A) were slightly lower but still positive, indicating general agreement though with comparatively less intensity.

These findings imply that households in Camaligan possess favorable attitudes that can support sustained participation in waste segregation efforts, provided that enabling mechanisms are in place. Strong agreement on environmental benefits and program participation suggests openness to behavior change, while moderate agreement on community responsibility and waste reduction highlights areas where further advocacy may be needed. This pattern aligns with studies showing that positive attitudes significantly predict participation in segregation practices when reinforced by institutional support and community-based programs (Ajzen, 1991; Guerrero, Maas, & Hogland, 2013). Moreover, local and international research emphasizes that attitudes alone are insufficient unless paired with consistent information campaigns, infrastructure, and policy enforcement to sustain pro-environmental behavior (Liu & Yang, 2021; Bernardo, 2020). Thus, the results reinforce the importance of strengthening barangay-led engagement strategies and municipal support systems to translate favorable attitudes into consistent waste segregation practices.

Table 2. Household Toward Waste Segregation in Camaligan, Camarines Sur, 2025.

Indicators	WM	Int.
Households believe that waste segregation is beneficial to the environment.	3.79	SA
Households believe that waste segregation helps reduce the volume of municipal waste.	3.00	A
Households believe that waste segregation is a shared responsibility within the community.	3.22	A
Households are willing to participate in waste segregation programs implemented in the community.	3.70	SA
Grand Mean	3.42	SA

Legend:

Rating Scale	Interpretation
3.36-4.00	Strongly Agree (SA)
2.51-3.25	Agree (A)
1.76-2.50	Less Agree (LA)
1.00-1.75	Not Agree (NA)

Household Practices on Waste Segregation

Table 3 indicates that the household practices on waste segregation in Camaligan, Camarines Sur. Practice reflects the actual execution of waste segregation behaviors at the household level and serves as the most direct indicator of the effectiveness of solid waste management programs. While knowledge and attitudes are essential precursors, consistent daily practices determine whether segregation at source is successfully implemented. This table evaluates the regularity of waste segregation at home, the use of color-coded bins, proper disposal of recyclables, and adherence to barangay waste segregation guidelines.

The results show a Grand Mean of 2.47, interpreted as Low (L), indicating that household waste segregation practices are only minimal implemented. Among the indicators, proper disposal of recyclable materials obtained the highest weighted mean (WM = 3.00, M), followed by daily segregation of waste at home (WM = 2.79, M) and consistency in following barangay guidelines (WM = 2.70, M). In contrast, the use of color-coded bins recorded a notably low weighted mean (WM = 1.41, L), suggesting minimal adoption of standardized segregation tools at the household level. This disparity reveals uneven practice implementation, where some segregation behaviors are observed while others remain poorly practiced.

Findings indicate a clear gap between households' knowledge and positive attitudes toward waste segregation and their actual practices. Although residents generally understand waste categories and express favorable attitudes toward segregation, practical constraints such as limited access to color-coded bins, inconsistent monitoring, and inadequate logistical support may hinder full compliance. This observation is consistent with studies emphasizing that behavior change is often constrained by structural and resource-related barriers rather than lack of awareness alone (Guerrero, Maas, & Hogland, 2013; Liu & Yang, 2021). Philippine studies further highlight that effective waste segregation practices require continuous enforcement, availability of segregation facilities, and sustained barangay-level support to translate awareness into routine action (Bernardo, 2020; DENR, 2019). Thus, the findings underscore the need for improved infrastructure provision and stronger local enforcement mechanisms to enhance household waste segregation practices in Camaligan.

Table 3. Household Practice on Waste Segregation in Camaligan, Camarines Sur, 2025.

Indicators	WM	Int.
Households regularly segregate their waste at home on a daily basis.	2.79	M
Households use color-coded bins for proper waste segregation.	1.41	L
Households properly dispose of recyclable materials.	3.00	M
Households consistently follow barangay-issued waste segregation.	2.70	M

Grand Mean	2.47	L
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Legend:

Rating Scale	Interpretation
3.36-4.00	High (H)
2.51-3.25	Moderate (M)
1.76-2.50	Low (L)
1.00-1.75	Very Low (VL)

Summary of the Knowledge, Attitude, and Practices on Waste Segregation

The summary of the households' knowledge, attitudes, and practices (KAP) on waste segregation in Camaligan, Camarines Sur. The KAP framework is widely used to assess behavioral readiness and actual compliance with environmental programs, as it highlights the relationship between what people know, how they feel, and what they do. This table synthesizes the results from Tables 1 to 3 by comparing the overall weighted means, interpretations, and rankings of knowledge, attitude, and practice indicators to provide an integrated assessment of household waste segregation behavior.

The results show that attitude ranked first with a weighted mean of 3.42, interpreted as Strongly Agree (SA), followed by knowledge with a weighted mean of 3.39, interpreted as Highly Knowledgeable (HK), and practices ranking last with a weighted mean of 2.47, interpreted as Moderate (M). The overall grand mean of 3.09 corresponds to a Knowledgeable (K) level, indicating that while households generally possess adequate awareness and favorable attitudes toward waste segregation, these do not fully translate into consistent practice. The ranking pattern highlights a pronounced disparity between cognitive and affective components versus actual behavioral execution.

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The presence of a knowledge, attitude, and practice gap in household waste segregation in Camaligan. Despite strong environmental attitudes and substantial knowledge, moderate practice levels suggest that structural, institutional, and resource-related barriers may limit behavior adoption. This pattern is consistent with established literature emphasizing that positive attitudes and awareness alone are insufficient to ensure sustained environmental practices without enabling conditions such as infrastructure, policy enforcement, and continuous community engagement (Ajzen, 1991; Guerrero, Maas, & Hogland, 2013). Similarly, studies in developing-country contexts show that weak implementation mechanisms and limited access to segregation facilities often undermine the effectiveness of solid waste management programs, despite high public support (Liu & Yang, 2021; Bernardo, 2020). Thus, the results underscore the need for strengthened barangay-level enforcement, improved provision of segregation tools, and sustained information and education campaigns to bridge the gap between awareness and practice.

Table 4. Summary of the Knowledge, Attitude, and Practices on Waste Segregation in Camaligan Camarines Sur, 2025.

Indicators	WM	Int.	Rank
Knowledge	3.39	HK	2
Attitude	3.42	SA	1
Practices	2.47	M	3
Grand Mean	3.09	K	

Operational Challenges Identified by SWM Personnel

The operational challenges encountered by Solid Waste Management (SWM) personnel in Camaligan, Camarines Sur. Identifying operational constraints is essential in assessing the effectiveness of waste segregation and collection systems, as frontline personnel directly experience implementation gaps at the community level. These challenges influence the consistency of waste collection, the integrity of segregated waste streams, and overall compliance with Republic Act 9003. The table outlines the most frequently cited operational issues affecting SWM implementation in the municipality.

The data show that the most frequently reported challenge was the lack of household compliance with proper waste segregation, ranking first among the identified issues. This was followed by the absence or limited use of color-coded bins at the household level and insufficient information and education campaigns, which ranked second and third, respectively. Other major concerns included inadequate monitoring and enforcement of RA 9003, limited garbage collection vehicles, and irregular collection schedules. Lower-ranked but still significant challenges involved manpower shortages, mixing of segregated waste during collection, limited budget allocation, and weak coordination between households and barangay officials. The frequency distribution indicates that both behavioral and structural issues contribute to operational difficulties faced by SWM personnel.

Table 5. Operation Challenges Identified by SWM Personnel in Camaligan, Camarines Sur, 2025.

Indicators	Frequency	Rank
Lack of household compliance with proper waste segregation.	42	1
Absence or limited use of color-coded bins at the household level.	39	2
Insufficient information and education campaigns (IEC).	36	3
Inadequate monitoring and enforcement of RA 9003.	34	4
Limited number of garbage collection vehicles.	31	5
Irregular or delayed waste collection schedule.	29	6
Shortage of SWM personnel and collectors.	27	7
Mixing of segregated waste during collection.	25	8
Limited budget allocation for SWM programs.	23	9
Lack of coordination between households and barangay officials.	21	10

These indicate that operational challenges in Camaligan are multifaceted, involving household behavior, institutional capacity, and logistical limitations. The prominence of non-compliance and lack of segregation facilities reflects the observed gap between household knowledge and actual practices, as identified in earlier tables. This aligns with previous studies emphasizing that effective waste segregation requires not only public awareness but also adequate infrastructure, consistent enforcement, and institutional support (Guerrero, Maas, & Hogland, 2013; Liu & Yang, 2021). Philippine studies further highlight that weak enforcement mechanisms and resource constraints at the local government level significantly hinder the implementation of RA 9003, even in communities with high environmental awareness (DENR, 2019; Bernardo, 2020). Thus, the findings underscore the need for strengthened enforcement, improved logistical support, and sustained IEC campaigns to address operational bottlenecks and enhance the overall effectiveness of solid waste management in Camaligan.

4. CONCLUSIONS AND RECOMMENDATIONS

The study concludes that households in Camaligan possess moderate to high knowledge and positive attitudes toward waste segregation, with particular familiarity in handling biodegradable waste. Despite this, actual practices remain moderate due to limitations such as inconsistent daily segregation, low use of color-coded bins, and spatial constraints. Operational challenges reported by SWM personnel including irregular collection schedules, insufficient bins, weak barangay enforcement, and frequent mixed waste collection further hinder the effectiveness of municipal solid waste management. Proper waste segregation, when consistently applied, clearly contributes to reducing mixed waste, enhancing recycling efficiency, and promoting overall environmental cleanliness. Sustainable implementation, however, depends on the alignment of household behavior with municipal capacity, infrastructure, and enforcement mechanisms.

To enhance segregation outcomes, it is recommended that the municipality expand the availability of color-coded bins, provide practical demonstrations, and institutionalize consistent collection schedules. Strengthening barangay-level enforcement and fostering community engagement through education campaigns and incentive programs are also vital. Optimizing materials recovery facility (MRF) operations and conducting longitudinal or experimental research on intervention strategies can further improve compliance and efficiency. By addressing both behavioral and institutional factors, these measures can ensure the long-term effectiveness and sustainability of the solid waste management system in Camaligan.

5. ADVANCED RESEARCH

Future research may explore experimental or quasi-experimental interventions to improve household waste segregation, such as the distribution of color-coded bins, digital waste monitoring systems, or incentive-based programs to encourage consistent compliance. Longitudinal studies can track behavioral changes over time, while spatial analyses using GIS can optimize collection routes and identify areas with low compliance for targeted interventions. Expanding research to include commercial establishments, schools, and other institutions can provide a more comprehensive understanding of the municipality's waste ecosystem and inform evidence-based strategies for enhancing the overall effectiveness and sustainability of solid waste management.

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