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Research Paper

Community-Based Waste Management in The Township PT. Bukit Asam, Tanjung Enim, Indonesia

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Abstract
Community-based waste management in the PT. Bukit Asam Township, Tanjung Enim, is essential. This study involved 67 respondents residing in the Township. A mixed-method approach was used, including interviews, observations, and SWOT analysis. The results indicate that residents are actively engaged in waste containment, with most households (85%) disposing of all waste without sorting. Only a small percentage reuse items (5%) and compost (2%). The average waste generated per socioeconomic group exceeds the standards set by SNI 3242-2008. Community-based waste management at PT. Bukit Asam has the potential for success due to active participation and company support. The SWOT analysis reveals strengths in participation, company support, education, and a structured system but weaknesses in dependence on participation and funding, and limitations in human resources and infrastructure. Opportunities include government support, new technologies, and collaboration with NGOs, while threats arise from policy changes, social issues, regulations, environmental impacts, and disasters. Improvement strategies include initial assessments, stakeholder mapping, awareness enhancement, facility provision, supervision, monitoring, incentives, periodic evaluations, and continuous innovation. With these strategies, the program is expected to be effective and sustainable, address waste issues, create new economic opportunities, and serve as a model for other communities.

Keywords
Waste Management, Community Participation, Township, SWOT

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1. INTRODUCTION

The amount and type of waste mainly produced depend on lifestyle and the types of materials consumed. As household economies improve, the variety and quantity of waste generated also increase. Community-based integrated waste management is an approach tailored to community needs and demands, wherein waste management is planned, implemented, controlled, and evaluated in collaboration with the community (Fernandez-Brana and Dias-Ferreira, 2023; Suryawan and Lee, 2023). If the community is not prepared, the government or other institutions must prepare them through training, comparative studies, and demonstrations of successful programs. The increase in waste generation is not matched by adequate waste management infrastructure and facilities, leading to escalating environmental pollution each year. Relying on the collect-transport-dispose pattern causes pollution to accumulate at landfill sites, and waste management often fails to meet established standards (Hidayatullah and Fadhliana, 2023; Nanda et al., 2023).

Waste management encompasses both waste reduction and waste handling. Waste reduction involves limiting generation, recycling, and reuse, while waste handling includes sorting, collection, transportation, processing, and final disposal. Community participation is crucial in reducing and handling waste because residents are the primary waste producers who best understand their environmental conditions and experience the impact of improper waste management (Jomehpour and Behzad, 2020; Zambezi et al., 2021). Effective waste reduction at the source, especially household waste, requires family involvement. Waste handling efforts also need community contributions, such as providing land, paying levies or fees, forming community institutions, and offering other support, which significantly impact the sustainability of waste management (Olukanni et al., 2020; Ezeudu et al., 2021). Active participation from various stakeholders, including the community and government, is

essential for successful waste management (Brotosusilo et al., 2020; Suryawan and Lee, 2023).

Previous research on community-based waste management has been conducted in Indonesia (Raharjo et al., 2017; Kubota et al., 2020; Pakasi et al., 2024). One approach, using the Bumdes system for independent waste sorting, has been implemented by the Panggungharjo Village community (Qomariyah and Hamid, 2023). This method has been widely debated by experts and policymakers. A community-based waste collection method using social action waste alms has also been explored (Yandri et al., 2023). The waste bank project, implemented in Pangandaran, is considered suitable for coastal areas (Ismiraj et al., 2023). To the best of our knowledge, research examining community-based waste management is still limited to housing or industrial townships. PT. Bukit Asam, a mining company in South Sumatra, has residential Townships that require effective community-based waste management. Therefore, this research aims to evaluate waste management practices, and community participation in waste management, and develop strategies for effective waste management in the PT. Bukit Asam Township. The volume and characteristics of waste in Township housing are identified according to employee position levels at PT. Bukit Asam (Directors, Level 1 (Vice President), Level 2 (Assistant Vice President), and Level 3 (Assistant Manager). This research also analyzes household perceptions and the role of the community regarding waste management in the Township at PT. Bukit Asam.

2. EXPERIMENTAL SECTION

2.1 Research Study Area

This research explores the level of community readiness and participation in managing household waste in PT. Bukit Asam Township Housing, located in Lawang Kidul Village, Tanjung Enim, South Sumatra. The Township covers an area of approximately 55 hectares and is specifically provided as a facility for company employees. Employee housing represents the company's appreciation and support for its workforce, aiming to enhance employee welfare and retention, and to strengthen the relationship between employees and the company. Administratively, the Township's housing is divided into four categories based on the level of PT. Bukit Asam employees: Director's house, Senior Manager's house, Manager's house, and Assistant Manager's house based on Figure 1 (Latitude: 3°46'16.45"S, Longitude: 103°47'1.37"E).

2.2 Data Analysis

This study employs a descriptive research design with a qualitative approach, collecting both secondary and primary data. Secondary data were obtained from various sources, such as management heads and related literature, including books, journals, and other relevant publications. Primary data were gathered through interviews with respondents, covering sample characteristics, types of waste collected, and evaluations of waste management activities. This data collection involved continuous sampling and measurement of waste generation over eight days, following the SNI 19-3964-1994 standards for sampling and measuring urban waste generation and composition. The interview and waste collection processes were conducted from October 21 to 28, 2023. 67 respondents were randomly sampled and interviewed to obtain demographic information and other waste management-related data. Waste generation samples, however, were collected from 47 housing units: one unit for Directors, four units for Level 1 employees (Vice President), ten units for Level 2 employees (Assistant Vice President), and thirty-two units for Level 3 employees (Assistant Manager). The collected data were analyzed using Microsoft Office Excel, with assessment scales tailored to the specific data sets. The analysis combined the results of focused discussions for comprehensive insights.

3. RESULT AND DISCUSSION

A structured approach involving field surveys and face-to-face interviews was employed across four socio-economic groups to collect and analyze data. These methods ensure a comprehensive understanding of demographic characteristics and solid waste management practices within each group. This multi-method approach enables data triangulation, thereby enhancing the reliability and validity of the findings. Moreover, employing multiple data collection techniques facilitates in-depth analysis, allowing for exploring of diverse perspectives and experiences related to waste management. The collected data is analyzed to conclude. This section provides background information, including an overview of the social, economic, and demographic characteristics of respondents, representing individuals residing in the Township's residential neighborhoods, categorized by job titles and income levels (Table 1).

3.1 Analysis of Waste Volume and Characteristics

Human activities aimed at meeting daily needs invariably result in the generation of waste. According to Law No. 18 of 2008, waste is defined as the solid residue resulting from human daily activities and/or natural processes. Consequently, waste remains a significant issue in Indonesia. Township residential waste transportation services are responsible for transporting various types of waste, including organic waste, plastic, paper, bottles, glass, and metal. Organic waste transported comprises yard waste and food waste originating from residential areas within the Township. In addition to community culture, the presence of inorganic waste in waste piles is influenced by the initial waste-handling methods (Puspitasari et al., 2022). This process entails a series of activities from waste generation to transportation to final disposal sites (TPA), involving separating organic and inorganic waste at the source by community members and waste transport personnel. This separation process has significantly contributed to the substantial increase in inorganic

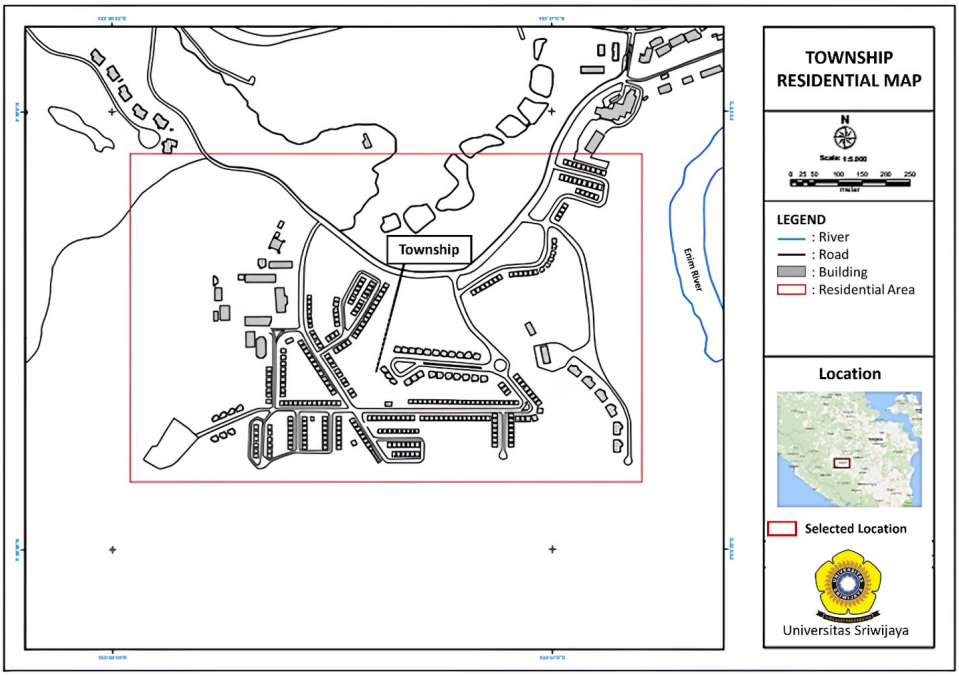

Figure 1. Study Location

Table 1. Description of Sampel Households

Social Demographic Variable	Frequency (f)	Percentage (%)
Gender		
Male	11	16.42
Female	56	83.58
Total	**67**	**100**
Age		
15-24	2	2.99
25-34	12	17.91
34-44	23	34.33
45-54	30	44.78
55-64	0	0
Total	**67**	**100**
Education		
University	52	77.61
Senior High School	15	22.39
Junior High School		
Elementary School		
Total	**67**	**100**
Income Level		
Low Income	18	26.87
Medium Income	48	71.64
High Income	1	1.49
Total	**67**	**100**

waste (plastic, paper, bottles, glass, metal) (Prasasti et al., 2021).

The current state of household waste management at the source level involves storage, sorting, and collection activities. Containerization marks the initial step in waste management. The provision of containers by the community

facilitates the waste transportation process. Waste sorting entails categorizing waste based on its type, with this study focusing on sorting organic and inorganic waste. According to the research findings, out of the 67 respondents, 25 have engaged in waste sorting, while the remaining 42 have not sorted their waste, citing reasons outlined in Figure 2. Respondents perceive direct waste disposal without sorting as more practical (32%). This sentiment is closely followed by the belief that waste sorting is unnecessary (30%).

The community primarily sorts non-organic waste such as plastic bottles, cardboard, and cans. Sorting aids the public service units of the company in waste management and enables residents to earn additional income by selling recyclable materials to scrap collectors. The main reason for the Township residents' reluctance to sort waste is the perceived practicality of disposing of it in a single location. They find this method easier and lack the time to sort waste at home due to their busy schedules, delegating waste sorting tasks to household assistants. However, the research findings indicate that 100% of households engage in waste collection activities, depositing waste in front of their respective homes at the temporary storage location.

The level of waste generation is influenced by several factors, including population growth, local living standards, consumption patterns, and commercial activities within a community. Currently, residents of Township housing produce substantial amounts of solid waste that surpass the capacity of the solid waste management system. Figures 3-4 illustrates the waste volume generated by residents based on their employment levels at PT. Bukit Asam. Samples were collected from 47 selected households, comprising 175 individuals, resulting in a total waste production of 630.34 kg over one week in October 2023. The average waste amounts collected from each socio-economic group were 1.58 kg/day (Directors), 8.82 kg/day (Vice president), 17.91 kg/day (Assistant Vice President), and 50.49 kg/day (Assistant Managers). The average waste production per capita per day equates to 0.53 kg/person/day (Directors), 0.52 kg/person/day (Vice President), 0.36 kg/person/day (Assistant Vice President), and 0.48 kg/capita/day (Assistant Manager) for high, middle, and low-income groups, respectively. Additionally, respondents provided information about the waste types generated in their households, which correlated with their monthly income. The variation in waste weight and volume in the samples can be attributed to the waste compaction factor, where organic waste tends to have greater weight but smaller volume. In contrast, inorganic waste has a lighter weight but larger volume (Puspitasari et al., 2022).

3.2 Identification of Community Willingness to Manage Household Waste at Source Level

Based on the research findings, it is evident that 100% of households in Township Housing have engaged in waste storage. The waste containers utilized are 40-liter capacity buckets provided by the Public Services Working Unit. Moreover, the community's involvement in waste management within the Township reached 85%, with the majority of households disposing of all waste (85%), some disposing of most waste (10%), and a minority reusing waste, particularly inorganic waste (5%) (Figure 5). This reflects the level of awareness and participation from the Township community in waste management. Most households that dispose of their waste indicate a low awareness of the importance of waste management beyond mere disposal. However, a small proportion of individuals still dispose of most of the waste, likely due to some inorganic waste being provided to waste service workers for resale. Additionally, a small percentage of individuals reuse waste (inorganic waste), indicating efforts to reduce waste and the potential for enhancing recycling practices and waste reduction at the household level.

If we examine the volume of waste produced per individual per day in Township Housing, this value surpasses the weight and volume of waste generated by permanent houses according to SNI 3242-2008, which is 0.35–0.4 kg/person/day and 2.25–2.50 liters/person/day. This circumstance prompts community initiatives in Township Housing to undertake waste management activities at the source level. Community-based waste management activities can be successful through several factors, including the role of community leaders, the willingness of residents, and the availability of infrastructure (A'yunin et al., 2022). Community leaders play a crucial role as mobilizers and coordinators in implementing activities to ensure a smooth process. In the context of community-based waste management, the role of community leaders is pivotal in coordinating citizen participation. As many as 75% of households have acknowledged the role of community leaders in Township housing, such as the RT Head, who actively encourages residents to maintain cleanliness in the environment. However, the role of community leaders must be bolstered by active community participation. Therefore, this research delves into the extent of the community's willingness to manage waste at the individual level.

Community willingness is paramount for the success of a community-based waste management system because it signifies their readiness to engage in these activities (Latanna et al., 2023; Nurcahyo et al., 2024). The higher the level of community participation, the more effective the implementation of waste management. According to research findings, 95% of households in Township Housing demonstrated their readiness to participate in waste management. This indicates that most individuals are prepared to engage in waste management activities starting from the source, such as providing waste containers, sorting organic and non-organic waste, participating in socialization activities organized by the RT and maintaining environmental cleanliness. This community's willingness underscores their endorsement of waste management activities daily. With increased community participation, the execution of waste management will be more efficacious (Rachman et al., 2020; Al-Raqeb et al.,

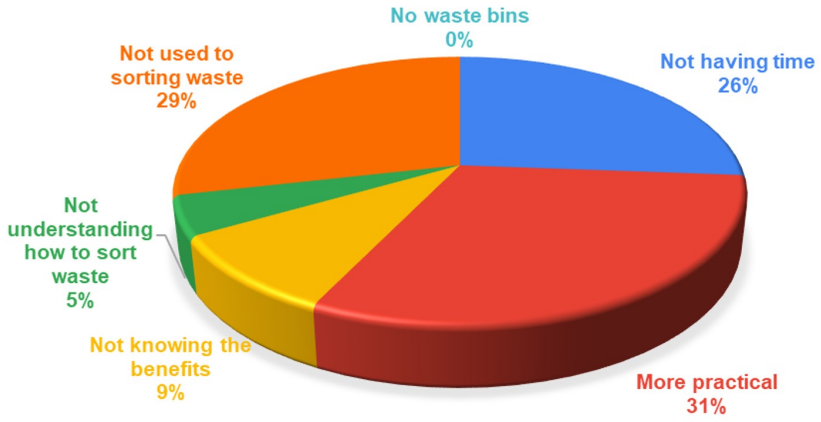

Figure 2. Characteristics of Community Habits in Waste Disposal Activities

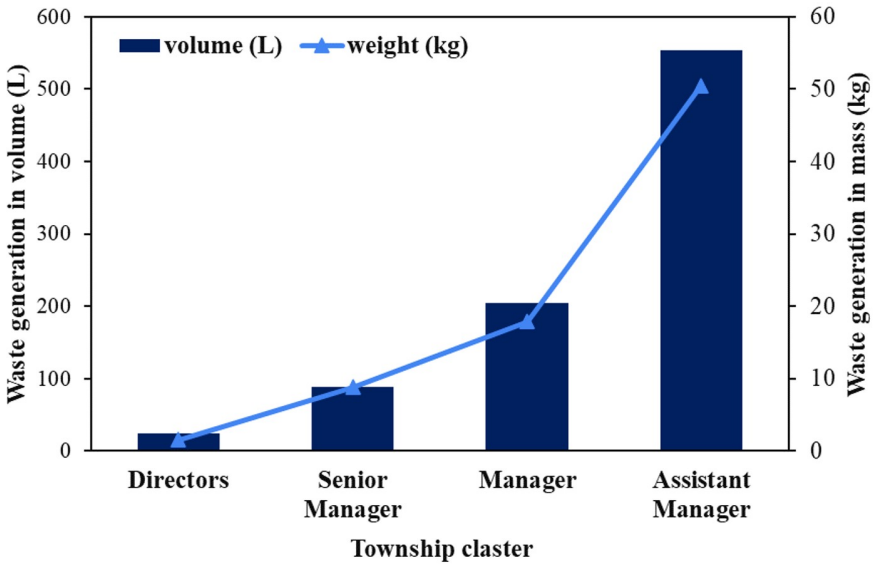

Figure 3. Waste Accumulation and Volume

2023; Mor and Ravindra, 2023). The community's willingness to manage waste can also be gauged by their eagerness to partake in these activities, encompassing ideas, energy, and financial participation. Figure 6 illustrates that the community in Tanah Putih Township Housing possesses the desire to manage waste, yet the current waste infrastructure remains inadequate (39%). Suggestions and feedback from respondents also included the establishment of a TPS 3R (Reduce, Reuse, Recycle Temporary Waste Disposal Site) as many as 32%. Consequently, they aspire for the community to engage more actively in waste management within their environment.

3.3 Forms of Willingness in Energy Participation

According to Oyegunle and Thompson (2018), regarding labor participation, the community can engage in activities to foster a clean environment. Community involvement in contributing energy is crucial for achieving this objective, as it provides active support in waste management activities. This participation is intended to bolster the implementation of waste management activities, reflecting the community's active engagement with their environment. A significant portion, 93%, of individuals are willing to segregate organic and inorganic waste, indicating a high level of awareness of waste management practices within the community (Figure 7). This practice demonstrates an increased awareness of the significance of waste segregation to support recycling and waste reduction efforts. However, the low utilization rate of used goods, at only 5%, and composting, conducted by 2% of the community, suggests that there is still potential to enhance more sustainable waste management practices in these communities.

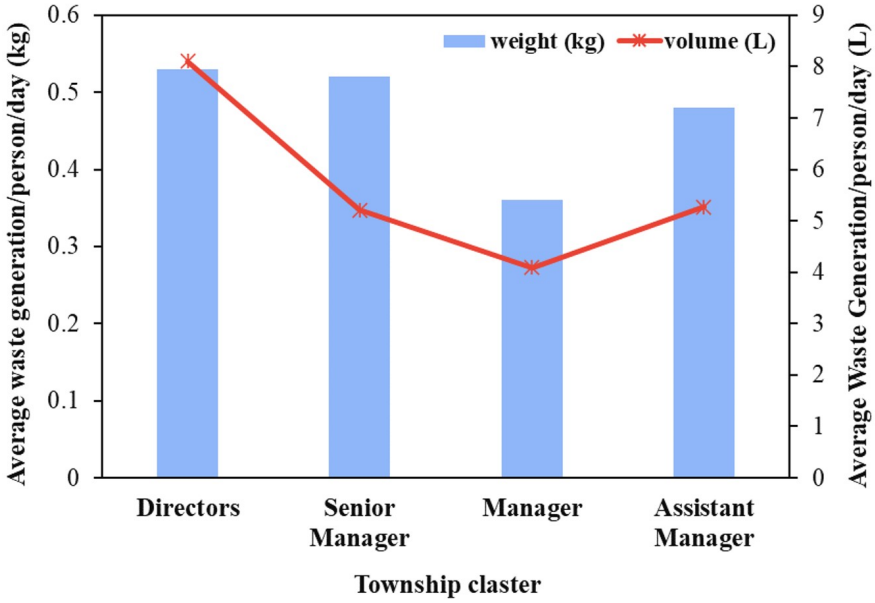

Figure 4. Average Waste Generation and Volume/Person/Day

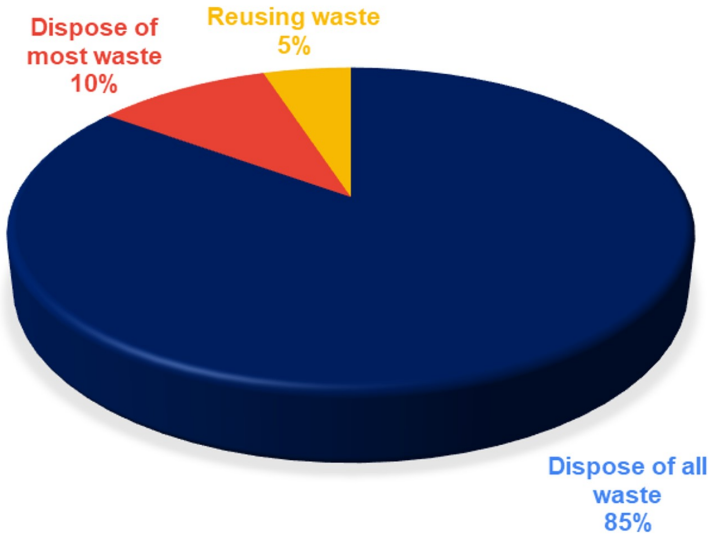

Figure 5. Participation of Township Housing Communities in Waste Disposal

3.4 Forms of Willingness in Waste Sorting and Containerization

Community willingness to sort and contain waste is a pivotal factor in sustainable waste management endeavors. Active community engagement in waste sorting initiatives, coupled with convenient access to facilities and infrastructure supporting waste sorting, also influences the level of community willingness. According to SNI 3242-2008 concerning waste management in residential areas, it is mandated to have a minimum of two waste containers per household, designated for separating organic and non-organic waste. Research findings indicate that 94% of households are willing to furnish containers for organic, non-organic, and residue. Several factors influence this willingness, including adherence to government directives (78%), recognizing the importance of waste sorting to prevent mixing wet and dry waste (10%), the economic value of waste selling (6%), and efforts to enhance knowledge (6%) (Figure 8).

Figure 6. Forms of Idea Participation in the Form of Community Opinions on Waste Management

Table 2. Calculation of Weights and Ratings for Strength and Weakness (IFAS Matrix)

	Strategy Factors	Significance Level	Weight	Rating	Score
Strengths (S)	Active involvement of local communities in waste management increases the sense of responsibility and ownership of the program.	3.00	0.14	4.00	0.55
	There is financial and logistical support from PT. Bukit Asam, ensure the program has adequate resources.	3.00	0.14	4.00	0.55
	This program can increase public awareness and knowledge about the importance of good and correct waste management.	2.00	0.09	3.00	0.27
	Community-based waste management allows the implementation of a structured and sustainable system.	2.00	0.09	2.50	0.23
	Increasing efficiency in waste management and reducing the volume of waste disposed of in landfills.	1.00	0.05	2.50	0.11
Weaknesses (W)	Reliance on community participation can be a challenge if that participation is inconsistent.	3.00	0.14	1.00	0.14
	Dependence on funds from the company may not guarantee sustainability if there is a change in company policy.	3.00	0.14	1.00	0.14
	Limited human resources who are trained and experienced in waste management can be an obstacle.	2.00	0.09	1.50	0.14
	Waste management infrastructure may be inadequate or need to be updated regularly.	3.00	0.14	1.00	0.14
Total		22.00	1.00		2.25

Table 3. Calculation of Weights and Ratings for Opportunities and Threats (EFAS Matrix)

	Strategy Factors	Significance level	Weight	Rating	Score
Opportunities (O)	The existence of government programs and policies that support community-based waste management can strengthen this program.	3.00	0.14	4.00	0.57
	The use of new technology in waste management can increase program efficiency and effectiveness.	3.00	0.14	3.50	0.50
	This program can serve as a model for other communities to adopt, expanding its positive impact.	2.00	0.10	2.50	0.24
	Effective waste management can open up new economic opportunities, such as recycling and composting, which can provide additional income for the community.	1.00	0.05	2.00	0.10
	Collaboration with Non-Governmental Organizations (NGOs) working in the environmental sector can increase program capacity and effectiveness.	2.00	0.10	2.50	0.24
Threads (T)	Changes in internal policies of PT. Bukit Asam, who may no longer prioritize this program.	3.00	0.14	1.00	0.14
	Potential social conflict in society that could disrupt program implementation.	1.00	0.05	2.00	0.10
	Changes in regulations or government regulations that may not support or even hinder the program.	2.00	0.10	2.00	0.19
	The impact of mining activities carried out by PT. Bukit Asam, which can affect the effectiveness of waste management programs.	3.00	0.14	1.00	0.14
	Unexpected events such as pandemics or natural disasters can hamper program implementation and sustainability.	1.00	0.05	2.00	0.10
Total		21.00	1.00		2.31

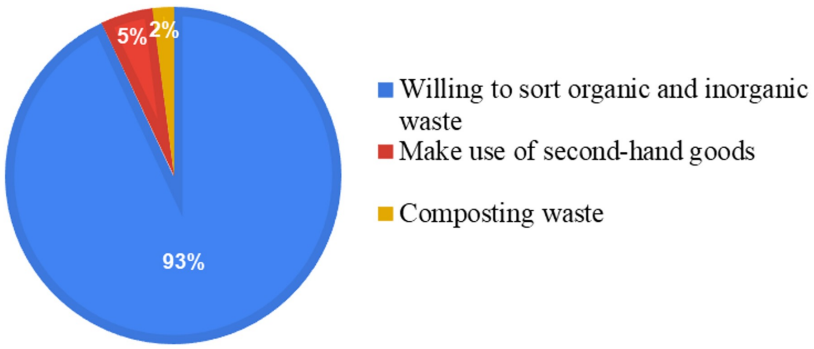

Figure 7. Forms of Labor Participation in Handling Waste

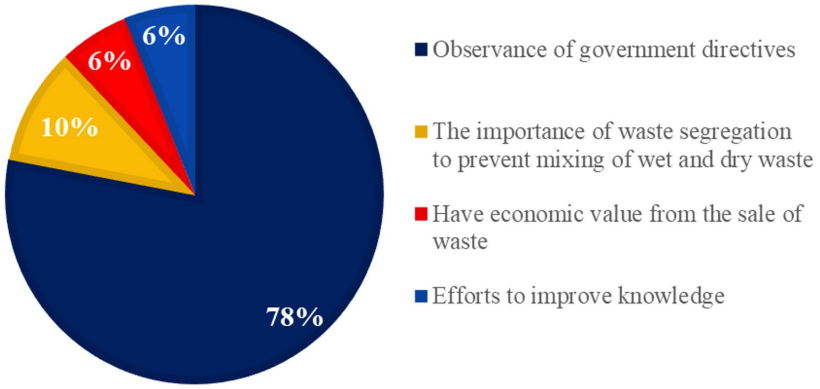

Figure 8. Forms of Community Willingness in Waste Sorting and Containerization

3.5 Forms of Willingness in Garbage Collection

Waste collection entails gathering waste for transport to Temporary Waste Disposal Sites (TPS), either individually or through Public Service Work Units (Layum). Presently, waste collection is directly undertaken by community members from their residences. Subsequently, at 07:00 a.m, the Layum collects refuse from each household for transportation to the Bukit Kancil Final Disposal Site (TPA) in Muara Enim, approximately 17 km away from the residential area. The segregation of waste into organic and inorganic categories facilitates the waste management process for Layum. With clear segregation, Layum can allocate resources and labor more efficiently, thereby reducing the time and costs involved in waste processing and transportation. Besides streamlining the waste management process, sorting organic and inorganic waste also presents income-generating opportunities for Layum. By selling inorganic waste to scrap dealers or other reuse entities, Layum can generate revenue from materials that were previously deemed waste. Layum services entail community involvement to enhance awareness regarding the significance of maintaining a clean environment. However, in Housing Township, the community is not yet fully prepared to engage in on-site waste processing, such as composting. Nevertheless, they have expressed interest in waste sorting, particularly if a TPS 3R is established in the Housing Township, which could encourage them to become more active in the process.

3.6 Waste Management Strategy Through SWOT Analysis

SWOT analysis is utilized to formulate factors and strategies for community-based waste management. The outcomes of this SWOT analysis vividly demonstrate how external opportunities and threats encountered by the organization can be aligned with its strengths and weaknesses. This SWOT analysis will be conducted concerning the strategic management of waste processing at PT. Bukit Asam. The Internal and External Factor Analysis Summary matrix is presented in Tables 2-3.

Based on the calculations of the IFAS and EFAS matrices, the values for both IFAS and EFAS are > 2, indicating that waste management issues are addressed by capitalizing on opportunities and leveraging strengths. The presence of government programs and policies supporting community-based waste management can bolster this waste management initiative in PT Bukit Asam Townships. Utilizing new technologies, such as designing a TPS 3R (Reduce, Reuse, Recycle Temporary Waste Disposal Site), in waste management can enhance the efficiency and effectiveness of the program, potentially serving as a model for other housing developments. This community-based waste management program can create new economic opportunities, such as recycling and composting. The active involvement of the local community in waste management forms the foundation for robust program implementation, with financial support from PT. Bukit Asam. Furthermore, PT. Bukit Asam ensures the establishment of a structured and sustainable system, aiming to reduce waste volume and ensure effective management.

From the results of the analysis using SWOT, further strategies and recommendations can be derived to strengthen community-based waste management in Townships at PT. Bukit Asam.

- Providing supporting facilities such as segregated waste bins, composting equipment, and recycling centers. These facilities must be placed in strategic locations and easily accessible to the public.
- Establishing an oversight team to monitor program implementation and ensure community compliance in the Township. Implementing a routine reporting and evaluation system to identify and resolve emerging problems.
- Implementing incentive and reward systems to encourage active community participation, such as granting awards to house clusters that excel in waste management. Collaboration with PT. Bukit Asam through CSR funds can facilitate the provision of rewards.
- Conducting continuous evaluation and development.

Carrying out surveys and interviews with the community to obtain feedback.
- Enhancing the capacity of the community and management team through further training and workshops involving experts and practitioners to provide more in-depth and specific training.
- Considering further recommendations by joining a waste management network or association to access wider information and support.
- Staying abreast of new developments and adopting the latest technology and methods in waste management.

By implementing the formulated strategies and improvement stages, the community-based waste management program in the Township of PT. Bukit Asam is expected to operate more effectively, efficiently, and sustainably.

4. CONCLUSIONS

The research on community-based waste management in the Township of PT. Bukit Asam, Tanjung Enim, demonstrates active resident participation in waste collection but highlights a need for increased awareness regarding waste segregation to bolster recycling and reduction efforts. Despite the limited engagement in reusing and composting, the significant support from both the community and the company, coupled with structured educational and systemic frameworks, underscores the program's potential for success. Strengths such as community involvement and company backing are balanced by challenges like dependency on participation and funding, and infrastructural limitations. Opportunities for enhancement include leveraging government support, technology adoption, and NGO collaboration, while threats like policy changes and environmental impacts from mining must be managed. Strategies to overcome these challenges focus on stakeholder mapping, community education, facility provision, and continuous innovation, aiming to ensure the program's effectiveness and sustainability. By addressing these areas, the initiative not only aims to resolve waste management issues but also to create economic opportunities and serve as a replicable model for other communities.

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