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Solid waste management awareness and practices in coastal communities

Ricksterlie C. Verzosa[1,2]*, Francis Jay M. Katipunan[1], Jose Gabriel B. Lumangyao[1], Emily S. Antonio[1,2]

[1]*Environmental Science Program. Faculty of Agriculture and Life Sciences, Davao Oriental State University, City of Mati, Davao Oriental, 8200 Philippines, Ricksterlie C. Verzosa, ORCID: https://orcid.org/0000-0003-1872-6232, Francis Jay M. Katipunan, ORCID: https://orcid.org/0009-0001-5985-4356, Jose Gabriel B. Lumangyao, ORCID: https://orcid.org/0000-0005-8687-4925,*

[2]*Macro- and Micro-Plastic Pollution in Marine Ecosystems and Fisheries in Southeastern Mindanao (M2P2) Research Program. Davao Oriental State University, City of Mati, Davao Oriental, 8200 Philippines, Ricksterlie C. Verzosa, ORCID: https://orcid.org/0000-0003-1872-6232, Emily S. Antonio, ORCID: https://orcid.org/0000-0001-7254-5315*

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*Corresponding author: ricks.verzosa@dorsu.edu.ph

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ABSTRACT

Effective solid waste management (SWM) is paramount for environmental sustainability and public health, particularly in coastal communities. This cross-sectional descriptive study determines SWM awareness and practices among 399 households in selected coastal barangays in the City of Mati, Davao Oriental, Philippines. Employing a structured four-point Likert-type survey through KoboCollect applications, this study evaluates SWM awareness and practices while examining the impact of socio-demographic factors on these aspects. The results reveal moderate SWM awareness ($\bar{X}$=2.55) and practices ($\bar{X}$=2.66) in these coastal communities, indicating a baseline level of environmental consciousness and waste management efforts. However, there was lack of familiarity with legal and regulatory frameworks ($\bar{X}$=1.97), including the Republic Act 9003 and local ordinances related to SWM. Notable gaps are also identified in SWM practices, mainly in waste segregation ($\bar{X}$=2.55) and avoidance to waste-burning ($\bar{X}$=2.56). Socio-demographic factors, such as age, educational attainment, household size, and family income, significantly influence SWM awareness and practices. These findings underscore the need for targeted educational campaigns and community engagement strategies to enhance awareness of SWM regulations. Addressing these gaps is necessary for developing effective interventions to promote sustainable waste management practices in these coastal areas, thus protecting marine ecosystems and supporting the well-being of local communities.

Keywords: City of Mati , coastal communities, SWM awareness and practices, waste management

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INTRODUCTION

Poor solid waste management (SWM) is a critical global environmental concern affecting coastal and marine ecosystems. These ecosystems, vital for ecological balance, are increasingly threatened by the improper disposal of solid waste (UNEP, 2006). SWM issues and challenges are even more pronounced in rapidly urbanizing coastal regions, where increased human activity leads to higher waste generation (Mance et al., 2020; Oliveira and Turra, 2015). In the context of the Philippines, an archipelagic nation heavily reliant on its marine and coastal resources (Azanza et al., 2017), these challenges are pronounced. The country struggles to manage waste effectively amidst a growing population, burgeoning tourism industry, and ongoing urbanization (Atienza, 2011).

To address its growing solid waste crisis, the Philippines enacted the Ecological Solid Waste Management Act (RA 9003) in 2000 (Galarpe et al., 2021). This legislation aims to establish a systematic, comprehensive, and ecological solid waste management program (Premakumara et al., 2014). However, more than two decades later, the Commission on Audit (COA) reported a dramatic increase in annual solid waste generation from 9.07 million metric tons in 2000 to 16.63 million metric tons in 2020. This problem points to weak enforcement and compliance with the law, primarily due to political, financial, and technical limitations of Local Government Units (LGUs) and other implementing agencies (COA, 2023).

Beyond legislative and infrastructural challenges, social and behavioral factors are crucial in SWM effectiveness. Public awareness and community engagement are pivotal for the successful implementation of waste management programs (Abir et al., 2023; Hasan, 2004; Mir et al., 2021). In many coastal communities, old practices and a lackof education about the environmental impacts of improper waste disposal exacerbate the problem (Etnayanti et al., 2020; Herdiansyah et al., 2021; Maliangkay et al., 2021). Understanding the local context, including social norms and socioeconomic conditions, is essential for designing effective SWM interventions that are both sustainable and socially sensitive.

The City of Mati, located in Davao Oriental, illustrates solid waste management challenges in coastal areas. Renowned for its rich marine biodiversity (Jimenez et al., 2015), Mati faces the immediate threat of environmental degradation due to waste, particularly in its coastal and marine areas. The complexity of SWM in Mati is highlighted by the interaction between terrestrial and marine waste disposal, as demonstrated in studies on anthropogenic marine debris and face mask litter accumulation in coastal areas (Abreo et al., 2018, 2021; Entrino et al., 2023; Inoco and Villegas, 2024; Morales et al., 2023). These findings highlight the critical need for effective SWM in Mati, as the consequences of mismanagement directly impact both the environment and the livelihoods dependent on it.

Despite these insights, a gap exists in recognizing the awareness and practices of SWM at the household level within Mati's coastal communities. This paper aimed to provide baseline information on the SWM awareness and practices of households in selected coastal communities of the City of Mati. These findings will inform policy and practice and will aid in crafting targeted interventions for sustainable SWM in Mati and similar coastal regions while contributing empirical evidence and support in enhancing policy and legislative frameworks on waste management.

MATERIALS AND METHODS

Study area

This cross-sectional survey was conducted in the coastal communities of Barangays Central and Matiao in the City of Mati, Province of Davao Oriental. These barangays are characterized by mixed-

use areas that include residential zones and fishing communities, commercial establishments, a park and baywalk, a port for cargo vessels, a fish landing port, and a small-scale factory producing coconut oil and copra byproducts. The environmental significance of these areas is heightened by their proximity to the coastal and marine ecosystems of Pujada Bay. The bay is a 21,200-hectare protected landscape/seascape declared under National Integrated Protected Areas System (NIPAS) through Proclamation No. 431 in 1994 by the Philippine government. It was also recognized as one of the most beautiful baysin the world in 2022 by The Most Beautiful Bays in the World Club. Aside from its rich marine biodiversity and scenic views, the bay plays a vital role in the local lifestyle and economy of the city. The bay is surrounded by ten coastal barangays (shown in Figure 1), with Central (population: 34,947) and Matiao (population: 16,234) being the most populated coastal communities (Philippine Statistics Authority, 2021).

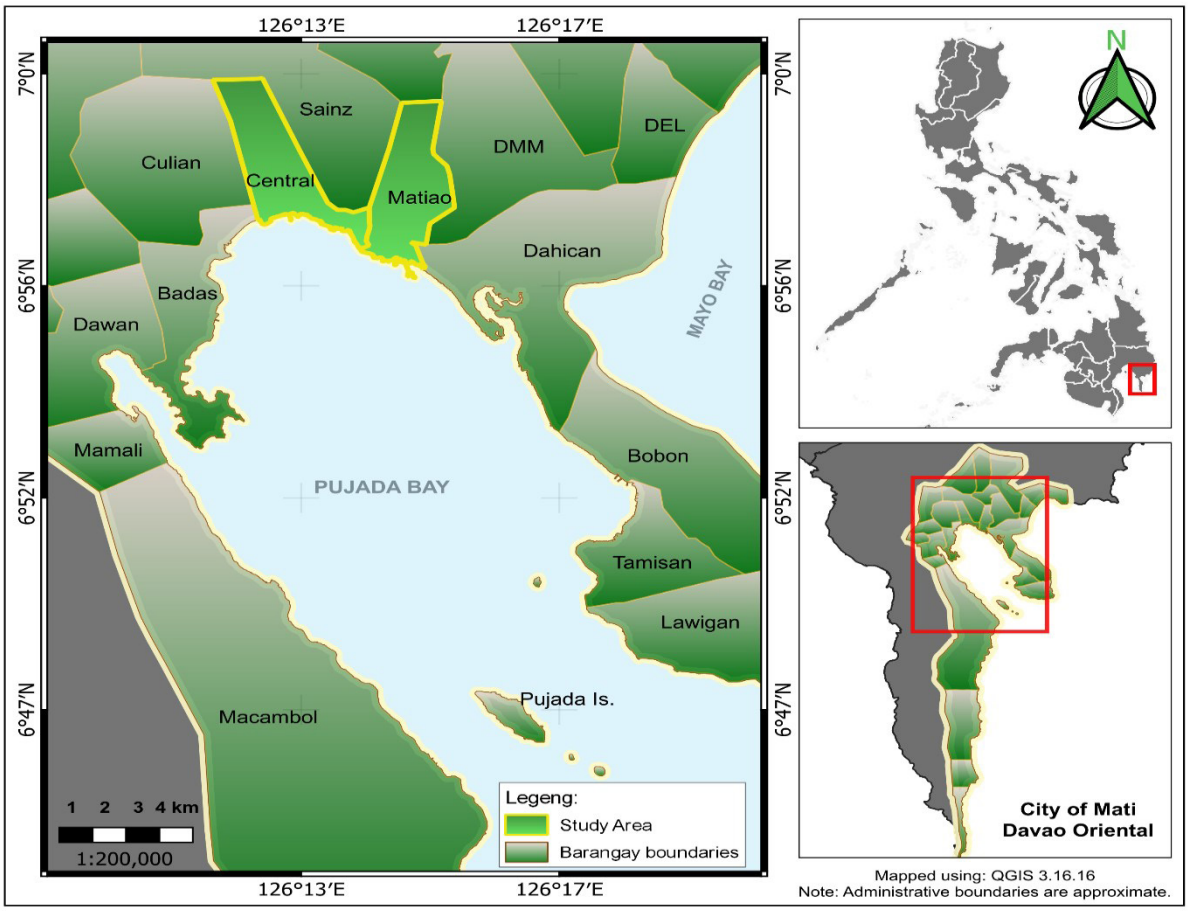

Figure 1. Map of the study area.

Respondents and sample size

The study focused on residents from two coastal barangays in the City of Mati, Davao Oriental, to gain insights into Solid Waste Management (SWM) awareness and practices. The survey targeted one member per household, aged 18 to 65 years old, to ensure a broad representation of adults who are likely to be active in household and community activities. The lower age limit of 18 aligns with the legal adult age in the Philippines. Senior citizens, specifically those between 60 and 65 years old, were also included in the study, as they can offer valuable insights into waste management practices based on their experience and perspective.

A two-stage sampling procedure was done through proportionate and systematic random sampling techniques to achieve a

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representative population sample. Proportionate sampling was used to distribute the number of household samples per coastal community in the two barangays. Then, systematic sampling was done by selecting the sample household every two houses starting from a predetermined landmark in the area (i.e., church, purok). The total household population in the coastal communities of the two barangays was 3,974 households, with 2,468 households in Central and 1,506 households in Matiao.

The household sample size was determined using Yamane's formula, a commonly used method in survey research (Adam, 2020). Applying this formula, the initial sample was 363 households. Ten percent of the sample size was added to this initial figure to account for potential non-responses and ensure the robustness of the study's findings. This adjustment resulted in a final sample size of approximately 399 households, broadly representing the two coastal barangays.

Survey tool

The research instrument used is a modified tool from the study of Lantajo and Lanciano (2019) and Paghasian (2017). This four-point Likert-type survey tool consists of three parts: the demographic profile of the respondents, SWM awareness, and SWM practices. Respondents were asked to rate each item in the questionnaire based on their level of awareness (1-Fully Not Aware, 2-Not Aware, 3-Aware, 4-Fully Aware) and practices (1-Not Practiced, 2-Rarely Practiced, 3-Moderately Practiced, 4-Fully Practiced regarding household SWM. The questionnaire was prepared in English and vernacular *Bisaya.*

Three expert evaluators validated the survey tool, and it was pilot-tested on a smaller group of respondents (n=90) outside the target population, and the data was excluded from the final analysis. A reliability test was implemented using Cronbach's alpha, with 0.871 for the SWM awareness and 0.833 for the SWM practices, and an overall coefficient of 0.901, indicating high reliability. After data collection, negatively coded items were reversed for clear analysis and presentation of findings.

Data collection

Data was collected from March to May 2023 through face-to-face surveys using the Kobo Collect application on Android phones. This method was chosen for its efficacy and accuracy in data collection (Sherin et al., 2017). Using a mobile application to gather data enhanced the efficiency of data entry and management (Lakshminarasimhappa, 2021), reducing the likelihood of errors commonly associated with manual data recording.

Prior to conducting this study, approval was obtained from the local government units of the barangays (BLGUs). Respondents were fully informed about the study's purpose, provided informed consent, and assured of voluntary and anonymous participation with the option to withdraw at any time. To ensure ethical and responsible research, vulnerable individuals, such as children and persons with special needs, were excluded. Senior citizens aged 60 to 65 years were included if they were the only head of the household and willing to participate. Efforts were made to ensure that senior respondents were comfortable during the survey and able to effectively answer the questions.

Data analysis

Descriptive statistics, such as frequency counts, percentages, mean ($\bar{X}$), and standard deviation (SD), were primarily utilized to quantify the respondents' level of SWM awareness and practices. A descriptive scale (shown in Table 1) was developed to interpret the data, categorizing the SWM awareness and practices into four distinct levels following the mean range, as suggested by Pimentel (2019). Additionally, the Kruskal-Wallis test was used to determine significant differences in SWM awareness and practices across various socio-demographic groups. This

nonparametric test was selected due to its suitability for data that do not follow a normal distribution and for analyzing ordinal variables (Ruxton and Beauchamp, 2008), thereby providing a robust alternative to parametric tests like ANOVA when assumptions of normality and homogeneity of variance are not met.

Table 1. Scale for level of SWM awareness and practices of households.

Scale	Descriptive level for SWM awareness	Descriptive level for SWM practices	Mean range	Interpretation
4	Fully aware	Fully practiced	3.28 – 4.00	High
3	Aware	Moderately practiced	2.52 - 3.27	Moderate
2	Not aware	Rarely practiced	1.76 - 2.51	Low
1	Fully not aware	Not practiced	1.00 - 1.75	Very low

RESULTS

Respondents' profile

The study surveyed 399 respondents from the coastal communities of Barangays Central and Matiao, City of Mati, Davao Oriental. The socio-demographic profile of the respondents shown in Table 2 revealed a diverse sample. Of the respondents, 53% were male (n=213) and 47% were female (n=186). The age distribution showed that 33% were 25 to 34 years old (n=130), 28% were 35 to 44 years old (n=112), 12% were 18 to 24 years old (n=50), 16% were 45 to 54 years old (n=63), and 11% were 55 to 65 years old (n=44). In terms of educational attainment, 11% had elementary education (n=45), 17% were elementary graduates (n=67), 31% had high school education (n=124), 10% were high school graduates (n=40), 15% did not finish college level (n=61), and 16% were college graduates (n=62). The household sizes varied, with 34% reporting four members or fewer (n=137), 40% with five to eight members (n=159), and 26% with nine or more members (n=103). Family monthly income was reported as follows: 38% earned below Php 9,100 (n=153), 40% earned between Php 9,100 and Php 18,200 (n=157), and 22% earned more than Php 18,200 (n=89). The residency duration varied, with 30% having lived in their current location for ten years or less (n=119), 41% for 11 to 20 years (n=162), and 29% for 21 years or more (n=118) (see Table 2).

Table 2. Socio-demographic profile of the respondents.

Socio-demographic characteristics		Percentage (%)
Gender	Female	47
	Male	53
Age group (in years)	18 – 24	12
	25 – 34	33
	35 – 44	28
	45 – 54	16
	55 – 65	11
Educational attainment	Elementary Level	11
	Elementary Graduate	17
	High School Level	31
	High School Graduate	10
	College Level	15
	College Graduate	16
Household size	4 members and below	34
	5 – 8 members	40
	9 members and above	26
Family monthly income (in Php)	Less than 9,100	38
	9,100 – 18,200	40
	more than 18,200	22
Residency duration	10 years and below	30
	11 – 20 years	41
	21 years and above	29

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Households' level of awareness of SWM

The households' level of SWM awareness was assessed using 20 items. The results revealed a varied level of awareness of the different aspects of SWM (Table 3). The overall mean score for the level of awareness of solid waste management among households was 2.55 (SD = 0.95). This finding indicates a moderate level of awareness regarding various aspects of solid waste management.

A. Legal and regulatory frameworks. Awareness of policies and regulations related to SWM was notably low, with mean scores ranging from 1.78 to 2.11. Specific items assessed include awareness of the Republic Act 9003 (Ecological Solid Waste Management Act of 2000), local ordinances (No. 394, s. 2020 and No. 28, s. 2008), and the SWM program in the barangay. For instance, knowledge about the SWM committee and corresponding sanctions for violations scored low, suggesting a significant gap in understanding the specific policies and regulations governing SWM. This low awareness implies that many households are not fully informed about the legal requirements and guidelines for proper waste management, which could hinder compliance and effective implementation of SWM programs.

B. Importance and benefits of SWM. In contrast, awareness regarding the importance and benefits of SWM was moderate, with mean scores for items related to the role and benefits of SWM ranging from 2.81 to 2.97. This includes the understanding that SWM contributes to a clean environment, saves money, and conserves energy. This moderate awareness indicates that while households recognize the general benefits of SWM, there is still room for improvement in fully internalizing these benefits and translating them into consistent practices. For example, although residents may acknowledge that proper waste management is beneficial, this awareness might not always lead to proactive and sustained waste management behaviors.

C. Proper SWM practices. Awareness of proper SWM practices also showed moderate levels, with mean scores ranging from 2.70 to 2.89. This includes understanding proper garbage disposal methods, the potential diseases from improper waste disposal, and the importance of waste minimization practices like reuse, recycling, and reduction. These findings suggest that while there is some knowledge about correct waste management practices, this awareness does not always translate into action. For instance, households may know the importance of separating biodegradable from non-biodegradable waste, yet they might not consistently practice it.

Table 3. Households' level of awareness of solid waste management.

	Solid waste management awareness	**Mean**	**SD**	**Interpretation**
A.	Legal and regulatory frameworks			
1.	Republic Act 9003 or the Ecological Solid Waste Management Act of 2000.	1.78	1.05	Low
2.	Ordinances (No. 394, s. 2020 and No. 28, s. 2008) on Integrated Ecological Solid Waste Management in the City of Mati	1.92	1.23	Low
3.	SWM program in the Barangay	1.91	1.03	Low
4.	Barangay orientation on SWM program	2.02	1.17	Low
5.	SWM committee in the Barangay	1.94	1.02	Low
6.	Policies of the SWM program	2.10	1.13	Low
7.	Corresponding sanctions for any violations of the SWM program	2.11	1.10	Low
	Overall	**1.97**	**1.10**	**Low**

B.	Importance and benefits of SWM			
8.	Importance of solid waste management	2.96	0.78	Moderate
9.	solid waste management program significantly contributes to a clean and green environment	2.97	0.79	Moderate
10.	Purpose of the management in implementing the SWM program	2.92	0.84	Moderate
11.	Practicing SWM saves money and energy	2.94	0.89	Moderate
12.	Residents' roles and responsibilities towards Barangay's SWM program	2.88	0.90	Moderate
13.	Significance of unity in making up and internalizing the SWM	2.82	0.89	Moderate
14.	Successful and effective implementation requires participation from concerned individuals	2.83	0.88	Moderate
15.	Importance of discipline in solid waste management.	2.81	0.92	Moderate
	Overall	**2.89**	**0.86**	**Moderate**
C.	Proper SWM practices			
16.	Proper garbage disposal methods	2.89	0.85	Moderate
17.	Possible diseases that can result from improper waste disposal.	2.82	0.91	Moderate
18.	Importance of reading signs on garbage cans for proper waste segregation.	2.79	0.85	Moderate
19.	Identification of biodegradable from non-biodegradable waste	2.83	0.87	Moderate
20.	Waste minimization practices like reuse, recycling, and reduce	2.70	0.85	Moderate
	Overall	**2.81**	**0.87**	**Moderate**
	Overall level of awareness	**2.55**	**0.95**	**Moderate**

Households' level of practices on SWM

The results from Table 4, summarizing Solid Waste Management (SWM) practices in the coastal communities of Barangays Central and Matiao, City of Mati, Davao Oriental, reveal moderate engagement levels across various SWM practices. The practices considered include segregation, reduction, reuse, recycling, disposal, and incineration avoidance.

Each of these practices shows a mean score around the moderate range, with segregation, incineration avoidance, and disposal showing slightly lower mean scores than reduction, reuse, and recycling. The overall mean score for all practices is 2.66, indicating that, on average, households engage in SWM practices to a moderate degree.

Table 4. Level of SWM Practices of households in the coastal communities.

Level of SWM practices		Mean ($\bar{X}$)	SD	Interpretation
A.	Segregation			
1.	Separating recyclable items for proper collection.	2.68	0.86	Moderate
2.	Ensuring no mixing of different waste types in the same garbage container.	1.97	0.87	Low
3.	Use of designated containers for sorting waste into biodegradable, non-biodegradable, recyclable, and non-recyclable categories.	2.84	0.96	Moderate
4.	Segregating non-hazardous waste from hazardous and toxic materials, such as pens, chemicals, and batteries.	2.75	0.90	Moderate
5.	Participating in the barangay's program for proper waste segregation.	2.49	0.97	Low
	Overall segregation practice	2.55	0.95	Moderate

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B. Reduction				
6.	Using reusable containers instead of buying bottled water when going to public places	2.64	0.92	Moderate
7.	Adherence to the 'no littering policy' implemented in the Barangay.	2.95	0.85	Moderate
8.	Choosing products with minimal packaging and avoiding individually wrapped items.	2.78	0.89	Moderate
9.	Buying only what is needed to minimize food waste	2.76	0.88	Moderate
10.	Minimizing the use and purchase of single-use products	2.60	0.88	Moderate
	Overall reduction practice	**2.75**	**0.88**	**Moderate**
C. Reuse				
11.	Reusing old materials instead of purchasing new ones.	2.67	0.95	Moderate
12.	Reusing grocery bags for multiple purposes.	3.13	0.83	Moderate
13.	Converting compostable waste into organic fertilizers.	2.71	0.95	Moderate
14.	Recovering wastepaper into paper pulp for various uses (e.g., cooking)	2.69	0.89	Moderate
15.	Repurposing food containers as storage bins or for other uses	2.65	0.95	Moderate
	Overall reuse practice	**2.77**	**0.91**	**Moderate**
D. Recycling				
16.	Engaging in recycling practices because of its importance	2.67	0.91	Moderate
17.	Generating income out of recyclable waste materials	3.07	0.86	Moderate
18.	Converting or redesigning waste materials to create new products	2.74	0.96	Moderate
19.	Selling unused bottles (glass or plastics) for recycling	2.66	0.92	Moderate
20.	Recycling a portion of recyclable household waste	2.61	0.92	Moderate
	Overall recycling practice	**2.75**	**0.91**	**Moderate**
E. Disposal				
21.	Throwing garbage in designated areas	2.52	0.88	Moderate
22.	Avoiding open dumps in disposing of waste materials	3.09	0.85	Moderate
23.	Disposing of recyclable waste at local junk shops.	2.62	0.97	Moderate
24.	Disposing of hazardous, toxic, and special waste in appropriate waste containers	2.37	0.90	Low
25.	Disposing of biodegradable waste through compost pit	2.55	0.92	Moderate
	Overall disposal practice	**2.63**	**0.90**	**Moderate**
F.	Waste burning Avoidance			
26.	Refraining from burning household waste materials	2.83	0.91	Moderate
27.	Avoiding the use of plastic when making fire	1.94	0.86	Low
28.	Refraining from making burn piles in the garden	2.47	1.00	Low
29.	Refraining from burning dry leaves in the backyard	2.63	0.97	Moderate
30.	Avoiding the use of burning barrels for waste disposal	2.92	0.98	Moderate
	Overall incineration avoidance	**2.56**	**0.94**	**Moderate**
	Overall level of SWM Practices	**2.66**	**0.92**	**Moderate**

The moderate level of SWM practices suggests practical participation in environmentally responsible behaviors while also highlighting areas for improvement. The following sections provide insights into strengths and opportunities for enhancing SWM practices within these communities.

A. Segregation. Waste segregation is integral to effective solid waste management (SWM). The findings on the level of waste segregation practices among households in the coastal communities are presented in Table 4. The overall mean score for waste segregation practices was 2.55, indicating a moderate level of practice among the respondents. This further underscores the need to improve segregation practices in these coastal communities. Specific practices like separating recyclable items for collection ($\bar{X}$=2.68) and sorting waste into different waste types ($\bar{X}$=2.84) were categorized as moderate level. This suggests a reasonable awareness and application of basic segregation practices. The relatively high mean score for separating hazardous materials ($\bar{X}$=2.75) may indicate a specific awareness of the risks of improper disposal of hazardous materials.

However, there were areas of concern. The practice of avoiding mixing different types of waste in the same container ($\bar{X}$=1.97) and active participation in the barangay's segregation program ($\bar{X}$=2.49) were both rated low. This implies a gap between awareness and actual practice of segregation or possible challenges in implementing community -level waste management programs.

B. Reduction. Table 4 reveals a moderate level of engagement in waste reduction practices among households. A notable finding is the adherence to the 'no littering policy' ($\bar{X}$=2.95), suggesting a strong community commitment to waste reduction. Using reusable bottles and minimizing single-use products scored slightly lower (2.64 and 2.60, respectively) than other items but within moderate level. These scores suggest some awareness and effort towards reducing waste, particularly in single-use plastic consumption. Mean scores on choosing products with minimal packaging ($\bar{X}$=2.78) and purchasing only necessary food items ($\bar{X}$=2.76) also indicate a moderate level of practice in minimizing waste at the source. These scores show a conscious effort among some locals to consider the environmental impact of their purchasing decisions. The overall mean score of 2.75 indicates a moderate level of engagement in waste reduction practices among the households.

C. Reuse. The highest score was for the reuse of grocery bags ($\bar{X}$=3.13), indicating that this practice is relatively well-adopted in the community. This could be attributed to its practical nature and its direct benefits, such as cost savings and convenience. The widespread adoption of this practice also suggests community responsiveness to straightforward and tangible reuse methods. Reusing old materials, converting compostable waste into fertilizers, recovering wastepaper, and repurposing food containers all received scores in the moderate range, between 2.65 and 2.71. These scores reflect a community that recognizes the value of waste reuse and engages in it to some extent but perhaps lacks the total commitment or resources to make it a more widespread habit.

The overall mean score for waste reuse practices is 2.77, suggesting moderate engagement in these activities. This level of participation indicates that while reuse practices are present in the community, they may not be fully integrated or consistently applied. The moderate scores across these varied practices suggest a general awareness and application of waste reuse principles but also highlight significant opportunities for improvement.

D. Recycling. Table 4 reveals a moderate level of engagement in recycling practices in the coastal communities of the City of Mati, with an overall mean score of 2.75. However, the breakdown of specific recycling behaviors shows a disparity in the level of participation and understanding

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of the value of recycling. The practice of actively engaging in recycling due to understanding its importance achieved a moderate score ($\bar{X}$=2.67), suggesting that while there is some level of engagement, a deeper awareness or motivation regarding the environmental impact of recycling might be lacking. This indicates a potential gap in environmental education and advocacy, highlighting the need for initiatives to enhance the community's understanding of the environmental benefits of recycling.

In contrast, generating income from recyclable waste materials received the highest score ($\bar{X}$=3.07), reflecting a practical, economically driven approach to recycling. This suggests that the financial incentives associated with selling recyclable materials are a significant motivation for recycling activities in the community. It points to the effectiveness of economic benefits as a driver for environmentally friendly practices. Moderate scores for converting or redesigning waste materials ($\bar{X}$=2.74), selling unused bottles ($\bar{X}$=2.66), and recycling a portion of household waste ($\bar{X}$=2.61) indicate a reasonable level of recycling activity. These practices show that some aspects of recycling are well integrated into household SWM, though the variation in scores across these different activities suggests that certain recycling practices, especially those requiring more active involvement, are less common.

E. Disposal. Proper waste disposal is crucial for minimizing environmental impact and maintaining public health. This section examines the residents' waste disposal practices, as revealed in the study. As presented in Table 4, the cumulative mean score for waste disposal practices was 2.63, indicating that households had a moderate engagement level. However, specific practices within the broader waste disposal scope showed varying engagement levels. Throwing garbage in designated areas received a moderate score of 2.52, suggesting that while there is some compliance, there is room for improvement in consistently using designated disposal sites. This indicates enhanced community awareness and infrastructure need to support proper waste disposal. On a positive note, the community's effort to avoid open dumps is commendable, evidenced by a higher mean score of 3.09. This reflects a stronger awareness and adherence to avoidance of unregulated dumping practices, a positive sign for effective ecological SWM.

The disposal of recyclable waste at local junk shops also falls at a moderate level ($\bar{X}$=2.62). This practice demonstrates community engagement in recycling, although there is potential for more consistent participation. On the other hand, the disposal of hazardous, toxic, and special waste in appropriate containers is an area of concern, with a lower mean score of 2.37, categorized as low. This indicates a gap in the community's practices and knowledge regarding the safe handling of hazardous materials, highlighting a critical area for targeted educational campaigns and infrastructure development. Disposing of biodegradable waste through composting is moderately adhered to, with a score of 2.55. This suggests a reasonable level of engagement in managing organic waste, which is essential in waste minimization.

F. Waste-burning Avoidance. Waste incineration, while a common practice in some areas, has significant environmental implications. Table 4 presents the findings on the level of practice among households in the coastal communities, focusing on avoidance in waste burning. The findings indicate a moderate level of avoidance to burning of waste among the households, with an overall mean score of 2.56. Notably, the practice of not burning waste in a burning barrel ($\bar{X}$=2.92), avoiding the burning of household waste materials ($\bar{X}$=2.83), and burning dry leaves in backyards ($\bar{X}$=2.63) received moderately high scores, suggesting better compliance with these specific aspects of waste management. However, avoiding the use of plastic in making fires ($\bar{X}$=1.94) and refraining from making burn piles in the garden ($\bar{X}$=2.47) scored lower, indicating

these practices are areas where compliance is not as substantial.

Differences in SWM awareness and practices across respondents' socio-demographics

The study employed the Kruskal-Wallis test to examine the differences in SWM awareness and practices across various socio-demographic characteristics. Results are presented in Table 5. Based on gender, no significant differences exist in SWM awareness and practices. Both awareness ($H(1)=2.399$, $p=.121$) and practices ($H(1)=0.001$, $p=.981$) levels were similar between females and males, suggesting that gender does not significantly influence SWM engagement in these communities.

A significant difference in SWM awareness was observed across different age groups ($H(4)=43.224$, $p<.001$), with the highest mean rank noted in the '35-44' age group. However, this difference in awareness did not translate significantly in practices across age groups ($H(4)=7.311$, $p=.120$). This indicates that while awareness levels vary with age, practices do not follow the same trend.

In terms of educational attainment, a significant difference in SWM awareness was found across different levels ($H(5)=27.901$, $p<.001$), with individuals who graduated with elementary education only exhibiting the highest mean rank. This may be attributed to other factors like exposure to awareness campaigns and participation in SWM-related activities in their community. However, for practices, the Kruskal-Wallis test did not reveal any significant differences ($H(5)=6.637$, $p=.249$), implying that the level of education does not significantly affect SWM practices among households.

The study identified significant differences in both awareness ($H(2)=72.718$, $p<.001$) and practices ($H(2)=26.568$, $p<.001$) related to SWM based on household size. The highest mean rank for awareness was observed in households with '4 members and below', suggesting that smaller households may be more aware of SWM issues. Similarly, smaller households (4 members and below) also showed the highest mean rank for practices, indicating that they may engage more actively in SWM practices.

There were significant differences in SWM awareness ($H(2)=27.129$, $p<.001$) and practices ($H(2)=9.117$, $p0.010$) across different income levels. Households earning 'less than 9,100' had the highest mean rank for both awareness and practices, suggesting that SWM engagement might be higher among the lower-income groups.

Table 5. Comparative analysis of households' SWM awareness and practices across socio-demographics using the Kruskal-Wallis test.

Socio-demographic characteristics	N	Awareness level			Practices level		
		Mean	*H*	*p*-value	*Mean*	*H*	*p*-value
Gender							
Female	186	208.99	2.399	.121	200.13	0.001	.981
Male	213	192.15			199.88		
Age group (years)							
18 – 24	50	165.48	43.224	< .001*	176.20	7.311	.120
25 – 34	130	168.61			197.88		
35 – 44	112	253.20			219.15		
45 – 54	63	194.90			199.71		
55 – 65	44	203.85			185.00		

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Educational attainment							
Elementary level	45	161.27	27.901	< .001*	185.30	6.637	.249
Elementary graduate	67	235.10			221.49		
High school level	124	213.77			203.20		
High school graduate	50	223.11			205.51		
College level	62	181.42			195.88		
College graduate	51	154.51			176.57		
Household size							
4 members and below	137	257.84	72.718	< .001*	231.05	26.568	< .001*
5 – 8 members	159	189.33			198.61		
9 members and above	103	139.55			160.84		
Family monthly income							
less than 9,100	153	235.19	27.129	< .001*	219.00	9.117	.010*
9,100 – 18,200	157	183.11			193.00		
more than 18,200	89	169.29			179.69		
Residency duration							
10 years and below	119	217.74	22.029	< .001*	204.28	9.187	.010*
11 – 20 years	162	215.55			214.09		
21 years and above	118	160.76			176.34		

*p < .05

Additionally, a significant difference in SWM awareness ($H(2) = 22.029$, $p < .001$) and practices ($H(2) = 9.187$, $p = .010$) was found concerning how long residents have lived in their current location. Specifically, residents who had lived in the area for 10 years or less showed the highest levels of awareness, while those who had been there for 11-20 years exhibited the best practices. This suggests that newer residents may be more informed about SWM due to recent exposure to local environmental initiatives or a fresh perspective on the importance of proper waste management. Conversely, those with slightly longer residency may have had more time to develop consistent waste management habits, resulting in better practices. This pattern highlights the potential impact of both recent awareness campaigns, and the time needed to integrate SWM practices into daily routines, underscoring the importance of targeted interventions for different residency durations to enhance overall SWM outcomes.

DISCUSSION

This study reveals a moderate level of SWM awareness among residents, specifically on the importance and benefits of SWM, as well as their knowledge of proper SWM practices. However, awareness of legal and regulatory frameworks, such as Republic Act 9003 and local ordinances was notably low in these communities. This finding is consistent with Sanchez (2023), who reported that residents of Brgy. Cawilan, Tagana-an in Surigao del Norte recognized the importance of SWM but was largely unaware of specific laws and regulations. In contrast, Lantajo and Lanciano (2019) found higher regulatory awareness among households in a Davao City community, suggesting potential regional disparities in environmental education and policy dissemination.

The lack of familiarity with legal and regulatory aspects of SWM, along with limited awareness of sanctions for violations, likely hinders compliance and effective waste management in coastal communities. Joshi and Ahmed (2016) noted that inadequate public awareness, insufficient technical knowledge, and poor law enforcement are significant barriers to successful SWM programs, particularly in coastal regions where these challenges are more pronounced. Addressing these barriers requires enhanced educational campaigns tailored to community needs and stricter enforcement of regulations through local authorities and community-based monitoring.

Regarding SWM practices, this study found that while residents demonstrated a moderate level of engagement, specific practices such as waste segregation, disposal, and the avoidance of waste burning scored particularly low. These findings align with Jeremias and Fellizar (2019), who reported similar issues in Sorsogon City, Philippines, and Fadhullah et al. (2022) who found poor waste segregation levels among Malaysian coastal residents. This persistent challenge highlights the need for targeted interventions that address the underlying socio-economic and infrastructural barriers to effective waste segregation. Rousta et al. (2020) emphasized that participation in household waste sorting in developing countries is influenced not only by knowledge but also by situational factors, such as the availability of waste collection points, sorting facilities, and governmental incentives. Addressing these practical barriers is crucial to improving SWM practices in coastal communities.

Moreover, this study found only moderate compliance with regulations against waste burning, highlighting significant gaps in both awareness and practical application despite the legal prohibition under RA 9003. This result aligns with the findings of Saplala-Yaptenco (2015), who identified residents' lack of knowledge about the health risks and legal regulations associated with waste burning as substantial barriers to the full implementation of these laws. Furthermore, Ramadan et al. (2022) emphasized the link between waste-burning practices and mismanagement in municipal waste systems. Implementing alternative waste disposal methods, such as community composting programs and accessible disposal sites, could help mitigate reliance on open burning.

The principles of reduce, reuse, and recycle (3Rs) are fundamental to minimizing waste generation. In this study, these practices, though moderately implemented, could be significantly improved. These findings align with those of Limon et al. (2020), who observed minimal efforts in reusing and recycling household wastes among residents in Currimao, Ilocos Norte. Knickmeyer (2020) noted that urban areas still perform poorly in waste recycling, often linked to inadequate waste collection services and insufficient recycling infrastructure (Sewak et al., 2021). Expanding recycling facilities and ensuring regular waste collection services are necessary to support higher recycling rates and effective SWM practices.

Socio-demographic factors, such as gender, age, education, household size, family income, and residency duration, play a significant role in shaping SWM awareness and practices. However, in this study, no significant differences were observed in SWM awareness and practices across gender groups. This parallels the findings of Lalamonan and Comighud (2020), where no gender differences were observed among teachers and students in schools of Bayawan City, Negros Oriental. However, contrasting findings by Zhang et al. (2017) and Zand et al. (2022) indicate that gender may influence SWM practices in other cultural and regional contexts, with women often more engaged in waste sorting than men. These discrepancies suggest that cultural norms, access to education, and regional differences may all play a role in shaping gender-specific SWM behaviors, emphasizing the need for targeted approaches in different communities.

The significant differences observed across age groups suggest that different cohorts may respond differently to SWM initiatives. For instance, the higher awareness observed in the 35-44 age group could be attributed to their life stage, where responsibilities related to family and community may make them more receptive to SWM information. This contrasts with findings by T. K. Liu et al. (2023) in Taiwan, where younger individuals demonstrated greater engagement with environmental issues compared to older groups. Wang et al. (2020) also found that younger adults (aged 20 – 30 yrs old), particularly college students, exhibited high awareness of recycling. These findings indicate that the relationship between age and SWM awareness may vary

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across different cultural contexts.

Despite the established link between educational attainment and increased SWM awareness, this does not always translate into improved practices. This gap between knowledge and action has been noted in several studies (Barloa et al., 2016; Kayamo, 2022; Shahzadi et al., 2018), highlighting the complexity of changing behaviors related to SWM. In this study, no significant differences in practice levels were observed across different educational backgrounds. However, respondents with a college education had lower mean rank scores (Table 5). In contrast, A. Liu et al. (2020) found that the level of education significantly influenced households' decisions to sort waste and protect the environment in their study. This suggests that the impact of education on SWM practices may vary depending on contextual factors, including the availability of resources and the strength of environmental policies and incentives.

Household size and income also influence SWM awareness and practices. This study found that smaller households and those with lower income exhibited higher levels of awareness and better SWM practices. This may be due to a necessity-driven engagement with waste management, as these households might have fewer resources and therefore feel a stronger need to manage waste efficiently. In contrast, larger households may face challenges in coordinating waste management practices, while higher-income households might benefit from better access to SWM services. Coronel-Chugden et al. (2023) and T. K. Liu et al. (2023) both observed that higher-income families were more aware of waste management practices, suggesting that economic resources can enhance SWM engagement. Therefore, interventions aimed at improving SWM practices must consider the varying needs and capacities of households based on their size and income levels.

Additionally, residency duration played a role in shaping SWM practices. Newer residents, as indicated by their shorter residency duration, exhibited a high level of awareness, suggesting that they may bring fresh perspectives or show greater motivation to engage with SWM efforts. This could be due to recent exposure to environmental education or proactive engagement with new community standards. However, residents with 11-20 years of residency exhibited the highest scores for actual practices, indicating that over time, awareness translates into more consistent implementation of SWM practices. Conversely, those with over 20 years of residency exhibited the lowest mean rank scores in both awareness and practices. This trend might suggest that long-term residents have become accustomed to existing practices and are less responsive to ongoing environmental campaigns, possibly due to a sense of complacency or adherence to older, less strict waste management standards. This finding differs from Felisilda et al. (2018), who observed that length of residency positively influenced awareness in Macajalar Bay, Philippines. The discrepancy could be attributed to different local contexts, varying levels of environmental education, or differences in the effectiveness of local SWM initiatives.

These findings underscore the importance of considering the socio-demographic context when designing and implementing SWM initiatives. Targeted, action-oriented initiatives are vital for bridging the gap between awareness and practice, which is necessary for promoting sustainable waste management behaviors in coastal communities. As Taye et al. (2024) noted, achieving a clean, healthy, and sustainable urban environment depends on the government's ability to develop and enforce SWM strategies that respond to the unique demographic and socio-economic dynamics of the population. A holistic approach that integrates education, infrastructure, and policy is essential to ensure that SWM efforts are sustainable and effective, helping to protect marine ecosystems and public health in coastal areas.

CONCLUSION

The study conducted in the coastal communities of Barangays Central and Matiao in the City of Mati, Davao Oriental, reveals a moderate level of awareness and implementation of SWM practices among households. Despite the legislative framework provided by RA 9003, there are clear gaps in the practical application of waste management practices, influenced by socio-demographic factors such as age, education, household size, income, and residency duration. These factors play crucial roles in shaping residents' awareness and practices towards waste management.

To address these challenges, a comprehensive strategy integrating educational campaigns, infrastructural improvements, and targeted policy initiatives is essential. This approach could include consistent communication, education, and public awareness (CEPA) initiatives in every barangay, as well as incorporating waste management education into school curricula to instill good practices from an early age. Developing a regular waste collection schedule will help prevent waste accumulation and reduce the likelihood of residents resorting to waste burning. Additionally, establishing barangay recycling centers, enforcing penalties or community service for law violations, and providing waste collection vehicles for narrow roads are crucial steps to improving household SWM practices. Additionally, involving non-government organizations (NGOs) and civil society organizations (CSOs) in these efforts can further enhance the effectiveness of waste management practices in the community. Tailoring these interventions to local socio-demographic dynamics and community-specific needs will be key to promoting sustainable practices, preserving marine ecosystems, and improving public health in coastal communities.

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