



Socioeconomic Factors associated with Household-Level Solid Waste Management Practices in Morogoro Municipality, Tanzania

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Abstract: Effective solid waste management stands as a critical global challenge, impacting human well-being, environmental sustainability, and the ongoing climate crisis. In Morogoro Municipality, the complex interplay between household-level waste management and socioeconomic factors amplifies this concern. As urbanization and consumption patterns evolve, comprehending the dynamics shaping waste practices becomes paramount. This study investigates the intricate relationship between socioeconomic factors and household-level solid waste management. Employing a descriptive cross-sectional design, we engaged 70 households across diverse wards: Mji mkuu, Mazimbu, and Mji mpya. Through structured interviews, we extracted insights, complemented by perspectives from ten purposively selected key informants. Leveraging the robust Kobo Collect survey tool and a designed question checklist, we harnessed descriptive statistics to fathom waste management associations within and across wards. Binary logistic regression analysis unveiled intricate relationships between socioeconomic characteristics and waste practices. Noteworthy trends emerged, indicating a majority of female respondents (65.7%), aged 46 to 60 (34.3%), married (67.1%), with primary education (55.7%). A substantial number of self-employed individuals (65.7%) actively participated in waste management. Deeper analysis underscored the significant impact of independent variables on waste disposal practices through binary logistic regression. Chi-Square Tests illuminated associations between waste practices across wards, highlighting the nuanced challenge. In conclusion, household waste management in Morogoro Municipality is intricately tied to socioeconomic factors. These findings drive policy adjustments, given the inadequacy of current waste practices. Urgent steps include grassroots environmental education and comprehensive policy enhancements to foster progress in waste management practices.

Keywords: Solid waste management, waste disposal practices, household-level practices, socioeconomic factors, Morogoro Municipality

1. Background Information

Solid waste management is a crucial aspect of maintaining a healthy environment and protecting public health. It involves a multidisciplinary approach encompassing natural and social sciences, including processes such as collection, sorting, transportation, storage, treatment, and final disposal of solid waste (Nanda and Berruti, 2021). Effective solid waste management practices are necessary to prevent disease outbreaks like cholera and to mitigate the environmental impacts caused by inorganic and biodegradable waste (Allison, 2014). The management of solid waste plays a vital role in reducing and controlling the amount of waste generated from various human activities, thereby preserving the environment and safeguarding public health (Rasmeni and Madyira, 2019). However, improper waste management practices can contribute to environmental degradation and pose health risks to individuals through air and land pollution. Since different types of solid waste are produced

within communities, there is no universal approach to managing all waste materials under all circumstances (EPA, 2020).

The implementation of solid waste management practices varies across different communities, and several factors influence their effectiveness. These factors include the availability of infrastructure, income levels, and policy frameworks. Each community develops its own waste disposal system, considering these influential factors in shaping their approach to solid waste management. Solid waste management has emerged as a significant and pressing issue due to inadequate practices in storage, transportation, treatment, and disposal. The improper handling of solid waste results in a considerable portion of it being deposited in the environment through unacceptable means of disposal. This situation poses serious risks to both the environment and public health (Alam and Ahmade, 2013).



Existing literature, as explored by Birhanu and Berisa (2015), Yoda *et al.* (2014), and Fadhullah *et al.* (2022), sheds light on common solid waste management practices at the household level and their environmental challenges. Inadequate practices in solid waste management can result in improper waste handling, leading to the spread of diseases. Dumping, an insufficient municipal solid waste management service prevalent in developing countries like Tanzania and Ethiopia, contributes to environmental degradation and the outbreak of communicable diseases (Ferronato and Torretta, 2019). Although landfills are one of the oldest, cheapest, and widely used practices for solid waste management, they pose risks to soil fertility. However, for certain types of waste, such as hazardous materials, landfills may still be the most suitable option for safe disposal (Kamaruddin *et al.*, 2017). Burning waste is an environmentally unfriendly practice, as it causes air pollution and adverse health effects such as respiratory issues, nausea, headaches, rashes, and cardiovascular diseases (Ramadan *et al.*, 2022). Reuse, on the other hand, presents a promising approach to solid waste management, involving activities like repair, refurbishment, and repurposing. By promoting reuse, significant reductions in waste generation and the need for new products and materials can be achieved, leading to notable environmental, social, and economic benefits (Pariatamby *et al.*, 2014). The United Nations Environment Programme (UNEP) emphasizes the positive impacts of reuse in reducing waste generation and associated environmental impacts (UNEP report).

Many developing nations rely on environmentally harmful solid waste disposal practices such as landfilling, burning, and open dumping, according to research by Fadhullah *et al.* (2022), Nyampundu *et al.* (2020), and Michael *et al.* (2019). Human health hazards from these behaviors include the possible spread of diseases like cholera and typhoid. For instance, Teshome (2021) observes that due to the inadequate and rudimentary solid waste services offered in Ethiopia, the majority of people frequently dispose of their solid trash through open dumping, burning, or landfilling. Such situations frequently have inadequate infrastructure and few resources, such as one dump truck for the collection and disposal of solid waste for an entire town. Warunasinghe and Yapa (2016) also draw attention to the predominance of dumping, landfilling, and burning as typical methods for disposing of solid waste, particularly when the garbage is primarily made up of organic elements like leaves and food scraps. These techniques, nevertheless, are not long-term, and they run the risk of seriously harming the environment and the health and welfare of the local populace.

Similarly, research have highlighted the strong correlation between socioeconomic and demographic parameters and household decisions about solid waste management techniques. These studies include those by Yoda *et al.* (2014), Fadhullah *et al.* (2022), Coker *et al.* (2016), and

McAllister (2015). The availability and ease of services frequently has an impact on household decisions regarding the management of solid waste. A study by Abegaz *et al.* (2021) examined the effects of variables like age, education level, employment status, and monthly income on solid waste management practices. The results showed that these variables are critical in influencing whether households adopt good solid waste management methods or not.

Environmental pollution, including air and land pollution, has increased as a result of the inadequate and ineffective implementation of solid waste management procedures, making the environment inhospitable for organisms and a variety of activities (McAllister, 2015). The issues with solid waste management techniques are highlighted in the literature as provided by Srivastava *et al.* (2015), Fernando (2019), and Dlamini *et al.* (2019). These issues include inadequate planning, governance problems, a lack of relevant technology, lax enforcement of current laws, and a lack of financial incentives to encourage ecologically friendly growth. Examining the socioeconomic aspects of home solid waste management practices in Morogoro Municipality is the primary goal of this study. The study's specific goal was to investigate particular methods used in solid waste management.

2. Theoretical Framework on the Socioeconomic Factors Associated with Household-Level Solid Waste Management Practices

The theoretical framework for understanding the socioeconomic factors associated with household-level solid waste management practices encompasses various perspectives and theories. This study adopted the Integrated Waste Management (IWM) model as an approach of waste management that incorporates multiple strategies and techniques to minimize the impact of waste on the environment and human health (UNEP, 2006). The IWM model assumes that an integrated and comprehensive approach to waste management is essential. It recognizes that solid waste management involves a range of activities, including waste reduction, reuse, recycling, and appropriate disposal methods, which should be considered holistically.

Likewise, the IWM model assumes that socioeconomic factors significantly influence household-level solid waste management practices. It acknowledges that individuals' socioeconomic characteristics, such as income, education, and occupation, can shape their waste management behaviors and choices. Furthermore, the IWM model assumes that effective waste management requires collaboration among various stakeholders, including households, government agencies, waste management authorities, and the private sector. It emphasizes the importance of partnerships and coordination to achieve sustainable waste management outcomes.



However, critics suggest that the implementation of the Integrated Waste Management (IWM) model can be challenging due to resource constraints, inadequate infrastructure, and limited stakeholder engagement. Achieving the integration of waste management activities at all stages requires significant investments, coordination, and cooperation among multiple actors, which can be difficult to achieve in practice (Ezeah *et al.*, 2015; Taghizadeh and Tan, 2018). Similarly, critics suggest that the applicability of the IWM model may vary across different contexts and regions. Socioeconomic factors, waste management infrastructure, and cultural norms can differ significantly, affecting the feasibility and effectiveness of implementing an integrated waste management approach (Wilson *et al.*, 2012; Eneje and Abaje, 2018). In the same vein, some critics argue that the IWM model may be overly complex and difficult to operationalize. The integration of multiple waste management practices and the involvement of various stakeholders require careful planning, capacity-building, and effective governance, which can be resource-intensive and time-consuming" (Grossmann *et al.*, 2019; Othman and Rahman, 2019).

Despite the critics, the IWM model is highly relevant in addressing the socioeconomic factors associated with household-level solid waste management practices. It provides a comprehensive framework for understanding and addressing waste management challenges by considering the interplay between socioeconomic factors, waste reduction strategies, recycling initiatives, and appropriate disposal methods. By promoting collaboration among stakeholders and emphasizing the importance of holistic waste management approaches, the IWM model offers a pathway towards sustainable waste management practices.

In this study, several important findings have been realised. The socioeconomic factors, such as income and education level, play a significant role in influencing household waste management practices. Higher income levels and greater educational attainment tend to be associated with better waste management behaviours. Similarly, integrated waste management approaches, which include waste reduction, recycling, and proper disposal methods, has been shown to be more effective in achieving sustainable waste management outcomes compared to single-focused strategies. Likewise, multi-stakeholder collaboration and engagement has been shown to be crucial for the successful implementation of integrated waste management practices. Furthermore, effective partnerships among households, government agencies, waste management authorities, and the private sector has been shown to enhance waste management infrastructure, promote awareness, and facilitate behaviour change. Economic incentives, such as pay-as-you-throw systems or financial rewards for recycling, also encouraged households to adopt more sustainable waste management practices. Moreover, education and awareness campaigns

targeted at households has shown to improve waste management knowledge, attitudes, and behaviours, leading to better waste segregation, recycling, and reduction practices.

Therefore, the IWM model as a theoretical framework for understanding the socioeconomic factors associated with household-level solid waste management practices provides a holistic and integrated approach to waste management. While it faces implementation challenges and contextual variations, the model's relevance lies in its ability to promote collaboration, address socioeconomic factors, and achieve sustainable waste management outcomes. The findings suggest that integrated waste management approaches, coupled with multi-stakeholder collaboration and education, lead to improved waste management practices at the household level.

3.0 Methodology

3.1 Study Area

This study was conducted in Morogoro Municipal, Tanzania, with a focus on three wards: Mji mkuu, Mazimbu, and Mji mpya. Morogoro Municipal serves as the regional headquarters of Morogoro Region, comprising 29 wards and 275 streets. Its projected 2022 population was approximately 440,000.

The selection of Morogoro Municipal stems from key factors. Despite its relatively modest population, the municipality generates substantial waste, suggesting unique waste management challenges requiring investigation. The area is undergoing rapid population growth, yet lacks strategic waste services, emphasizing the pressing need to address waste practices in line with increased waste production. Furthermore, its smaller population offers an opportunity for community involvement in waste management, with potential insights for tailored interventions. Therefore, by choosing Morogoro Municipal, this research addresses waste challenges in a growing municipality with limited services, exploring community engagement potential.

3.2 Research Design

The research design meticulously chosen for this study was a descriptive cross-sectional design, a strategic approach lauded for its manifold advantages. As Setia (2016) affirms, this design stands out for its adeptness in gathering precise information from respondents at a singular juncture. Renowned for its precision in encapsulating a snapshot of the research variables, it excels in achieving descriptive goals, thereby facilitating the exploration of inter-variable relationships.

Therefore, by embracing the descriptive cross-sectional design, this study sought to furnish an all-encompassing panorama of the socioeconomic underpinnings intertwined

with household-level solid waste management practices in Morogoro Municipality, Tanzania. This design harmonized perfectly with the aspiration to amass data from a diverse spectrum of households in a precise temporal frame. Such synchronization empowered the researchers to dissect the current landscape of solid waste management practices and delve into the intricate nexus between socioeconomic facets and these very practices.

3.3 Sampling procedures and sample size

The sampling procedures for this study involved the use of simple random sampling to select the wards, sub-wards, and households. This method ensured that each ward, sub-ward, and household had an equal chance of being included in the study, enhancing the representativeness of the sample. Additionally, a purposive sampling technique was utilized to select five key informants who possessed relevant expertise and knowledge in the field of solid waste management.

The sample size for the study was determined based on calculations using Nassiuma's (2000) guidelines. A total of 70 respondents were selected to participate in the study. This sample size was deemed appropriate to gather sufficient data and provide meaningful insights into the socioeconomic factors associated with household-level solid waste management practices in Morogoro Municipality, Tanzania. The selected sample size aimed to balance the need for adequate representation and feasibility of data collection within the available resources and time constraints.

$$n = (NCv^2) / (Cv^2 + (N - 1) e^2)$$

Where, n = the desired sample size,

N = Target population.

C_v = Coefficient of variation (take 0.5).

e = Tolerance at desired level of confidence (0.06) at 95% confidence level.

Where by: $n = (NCv^2) / (Cv^2 + (N - 1) e^2)$

$n = 315,866 \times 0.25 / 0.25 + (315,866 - 1) 0.06^2$

n = 70

Therefore, the sample size for the study was 70 respondents.

3.4 Data collection and analysis

The study employed a comprehensive and robust approach to data collection and analysis, integrating both quantitative and qualitative methods to gain a profound understanding of the subject matter. This combined methodological approach was crucial in offering a multifaceted view of the intricate dynamics surrounding household-level solid waste management practices.

In the realm of data collection, the study utilized two primary methods; structured questionnaire crafted amass data from households. This questionnaire encompassed a blend of closed-ended and open-ended questions, a strategy that not

only facilitated standardized data collection but also allowed participants to provide intricate insights into their waste management behaviors. This questionnaire was effectively administered through the Kobo Collect survey tool, thereby streamlining the data collection process and enhancing its overall efficiency.

In recognizing the importance of capturing nuanced perspectives, the study also incorporated qualitative data collection through key informant interviews. These interviews were conducted using a semi-structured approach guided by a carefully developed checklist of questions. This methodological choice encouraged in-depth discussions with key informants, enabling a profound exploration of solid waste management practices and the interlinked socioeconomic factors.

Subsequently, the quantitative data obtained from the study underwent a thorough analysis process. Collected data sourced from the Kobo tool underwent a rigorous data cleaning process. This critical step was taken to accurately identify and rectify any errors or inconsistencies present in the dataset, ensuring the robustness and credibility of the subsequent analysis.

The research further harnessed descriptive statistics, including frequencies and percentages, to succinctly summarize the quantitative data. This analytical approach provided a clear and concise overview of the waste management practices adopted by respondents, thereby facilitating the identification of prevailing patterns and inherent characteristics.

To assess the relationship between waste management practices and the three distinct wards, the study employed the Pearson Chi-Square Test. This statistical technique enabled the determination of whether a significant association existed between the specific ward and the prevailing waste management practices.

The study further delved into the intricate relationships between socioeconomic characteristics and specific solid waste management practices, such as re-use, landfill, burning, and dumping using binary logistic regression analysis. The outcomes of this analysis were succinctly expressed in terms of odds ratios and confidence intervals, providing valuable insights into the strength and significance of these relationships.

In tandem with the quantitative analysis, the qualitative data was subjected to a thorough assessment. The qualitative data, derived from open-ended questions and key informant interviews, underwent a comprehensive content analysis. This method involved identifying recurrent themes and patterns in the collected responses, thereby enabling researchers to glean deeper insights into the qualitative facets

of solid waste management practices and the underlying socioeconomic determinants.

Therefore, through the adept fusion of quantitative and qualitative methodologies, this study achieved a comprehensive and well-rounded understanding of the complex socioeconomic factors influencing household-level solid waste management practices in Morogoro Municipality. The use of a structured questionnaire facilitated standardized data collection and quantitative analysis, while the incorporation of key informant interviews and open-ended questions enriched the analysis with qualitative nuances. The confluence of these diverse analytical approaches offered a more nuanced and holistic exploration of the research topic, ultimately contributing to a more profound and comprehensive perspective on the multifaceted issue at hand.

4.0 Results and Discussion

4.1 Socio-demographic and economic characteristics of respondents

Understanding the socio-demographic and economic characteristics of the respondents is crucial for examining how these factors influence household-level solid waste management practices in Morogoro Municipality. By analysing the gender distribution and other relevant demographic characteristics, policymakers and waste management practitioners can tailor their strategies and interventions to address the specific needs and preferences of different groups within the community.

Table 1 presents a summary of the socio-demographic and economic characteristics of the respondents involved in solid waste management practices in Morogoro Municipality, Tanzania. The sample size consisted of 70 respondents, and their characteristics were analysed to gain insights into the demographic composition of the participants. The results indicate that out of the 70 respondents, 24 individuals, accounting for approximately 34.3% of the sample, were male. On the other hand, the majority of respondents, comprising 46 individuals, were female, constituting about 65.7% of the sample. This finding aligns with the research conducted by Christina *et al.* (2021), which also observed a higher percentage of females being responsible for waste management at the household level. This suggests that females are more involved in household duties, including environmental cleanliness, and tend to stay at home compared to males.

Table 1: Demographic characteristics of respondents under study (n=70)

Demographic variables		Frequency	Percentage
Gender	Female	46	65.7
	Male	24	34.3
Age category	18–25 years old	17	24.3
	26–35 years old	7	10.0
	36–45 years old	20	28.6
	46–60 years old	24	34.3
	Above 60 years old	2	2.9
Marital status	Married	47	67.1
	Single	14	20.0
	Widow/Widower	9	12.9
Education level	No formal education	5	7.1
	Primary school education	39	55.7
	Secondary school education	19	27.1
	Tertiary education	7	10.0
Employment status	Government Employee	5	7.1
	Self-employed	46	65.7
	Unemployment	19	27.1

The respondents in the study were categorized into five age groups. The results showed that 34.3% of the respondents fell within the age range of 46-60 years, while 28.6% were aged between 36-45 years. Additionally, 24.3% of the respondents were in the age group of 26-35 years, and 10.0% were aged between 18-25 years. The age group of 60 and above had the lowest percentage, accounting for only 2.9% of the respondents.

The findings regarding the age distribution and their involvement in waste management practices align with a study conducted by Nsimbe *et al.* (2018). Their study also revealed that a majority of the respondents responsible for waste management were mature adults aged between 45-60 years, constituting 34.8% of the sample. This suggests that mature adults possess the necessary reasoning skills and comprehension of solid waste management issues, making them more likely to take responsibility for waste management activities.

Examining the socio-demographic characteristics, such as age, is essential in understanding the dynamics of household-level solid waste management practices in Morogoro Municipality. Different age groups may have varying levels of awareness, knowledge, and capacity to engage in sustainable waste management practices. Therefore, by considering the age distribution of the respondents,



policymakers and waste management stakeholders can tailor their interventions and educational programs to target specific age groups and address their unique needs and perspectives.

The majority of the respondents in the study, accounting for 67.1%, were married. Only 20.1% of the respondents were single, while 12.1% were identified as widows or widowers. These findings are consistent with the results of a study conducted by Laor *et al.* (2018), who reported that more than half of the respondents (63.2%) were married, followed by 31.5% who were single.

The marital status of individuals can have implications for their involvement in household-level solid waste management practices. Married individuals may have additional responsibilities and shared decision-making processes within the household, which can influence their engagement in waste management activities. Singles, on the other hand, may have more autonomy and flexibility in managing their own waste. The presence of widows or widowers in the study highlights the importance of considering the specific needs and circumstances of individuals who may be managing waste on their own.

Therefore, by understanding the distribution of marital statuses among respondents, policymakers and waste management practitioners can develop targeted strategies and interventions to promote sustainable waste management practices. These strategies can take into account the different roles and responsibilities associated with various marital statuses and address the specific challenges and opportunities that arise within each category.

In terms of education, the findings reveal that a small percentage of respondents, specifically 7.1%, had informal education. The majority of respondents, accounting for 55.7%, had received primary education, while only 7.1% had attained secondary education. Those with tertiary education constituted only 10% of the sample. These results align with the findings of a study conducted by Han *et al.* (2018), which reported that 84.4% of respondents had received primary education or below, while only 15.6% had attended secondary school or above.

The level of education can significantly influence individuals' knowledge, awareness, and understanding of solid waste management practices. Higher levels of education are often associated with increased awareness of environmental issues, including the importance of proper waste management. Individuals with formal education may have access to information and resources that enable them to adopt more sustainable waste management practices.

On the other hand, individuals with limited education may face challenges in understanding the environmental and

health impacts of improper waste disposal and may be less aware of the available waste management options. They may rely more heavily on traditional or conventional waste disposal methods that are less environmentally friendly. Therefore, by considering the educational background of respondents, policymakers and stakeholders can design educational programs and campaigns tailored to different educational levels. These initiatives can aim to raise awareness, provide information on sustainable waste management practices, and promote behavior change among individuals with varying educational backgrounds.

In terms of employment status, the study found that 7.1% of the respondents were government employees, while the majority, accounting for 65.7%, were self-employed. Only 27.1% of the respondents were unemployed. These findings align with a study conducted by Abegaz *et al.* (2021), which reported that the majority of people (71%) in a similar context were self-employed, engaged in various economic activities.

The high percentage of self-employed individuals in the sample suggests that many households in Morogoro Municipality rely on their own businesses or informal economic activities for their livelihoods. Self-employment often offers flexibility and opportunities for income generation, but it can also have implications for waste management practices. Self-employed individuals may face unique challenges in managing solid waste effectively. They may have limited resources or access to waste management infrastructure and services compared to formal workplaces or government institutions. As a result, self-employed individuals may resort to informal waste disposal methods or may not prioritize proper waste management practices. Therefore, understanding the employment status of respondents is important in identifying specific socioeconomic factors that may influence household-level solid waste management practices. Policymakers and stakeholders can use this information to tailor interventions and initiatives to address the needs and circumstances of self-employed individuals, promote sustainable waste management practices within their businesses, and provide support or resources to improve waste management infrastructure in self-employed sectors. Furthermore, by addressing the waste management challenges faced by self-employed individuals, there is an opportunity to promote sustainable practices, enhance environmental consciousness, and contribute to the overall improvement of solid waste management in the Morogoro Municipality.

4.2 Solid waste management practices

Based on the findings presented in Figure 1, the most commonly used solid waste management practice among the respondents in Morogoro Municipality was dumping, accounting for 68.6% of the households. Reuse ranked

second with a prevalence of 62.9%, closely followed by burning at 55.7%, and landfill at 50%.

These findings are consistent with a study conducted by Yoda *et al.* (2014), which reported that the most common practice among households was dumping, with a prevalence rate of 61.0%. Dumping often involves households disposing of their waste at designated waste bins and having it collected by private contractors. However, it is important to note that the study's findings also highlight the negative impact of dumping as a waste management practice, including environmental degradation and the potential spread of diseases when not effectively implemented.

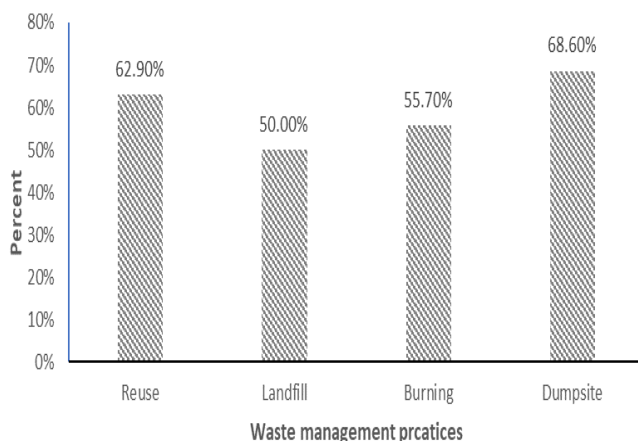


Figure 1: the overall pattern of waste management practices in percentage

The high prevalence of dumping as a waste management practice in Morogoro Municipality raises concerns about the environmental and health implications associated with improper waste disposal. Dumping can contribute to the contamination of land, water bodies, and air, posing risks to human health and ecosystems. It is crucial to address these challenges by promoting sustainable and environmentally friendly waste management practices.

The relatively high adoption of reuse as a waste management practice is encouraging, as it reflects a recognition of the value of reusing materials instead of discarding them. Reuse can contribute to waste reduction, resource conservation, and economic benefits. Efforts should be made to further promote and support reuse practices within the community.

The findings emphasize the need for comprehensive and effective solid waste management strategies that prioritize waste reduction, recycling, proper disposal, and public awareness. It is essential to educate and engage households in sustainable waste management practices, highlighting the potential environmental and health consequences of inadequate waste disposal methods. By promoting alternative practices such as recycling and composting, stakeholders can work towards mitigating the negative impacts of dumping

and burning while fostering a cleaner and healthier environment for the residents of Morogoro Municipality.

4.3 Solid waste management practices across three wards

The results presented in Table 2 indicate that there are significant differences in waste management practices among the three wards (Mazimbu, Mji Mkuu, and Mji Mpya). The table shows the frequency and percentage of respondents who reported engaging in different waste management practices, such as waste reuse, landfill use, burning waste, and waste dumping, in each ward. The "Chi-Square Tests" results indicate whether these differences in waste management practices between the wards are statistically significant or simply due to chance. A Chi-Square test is a statistical method used to determine if there is a significant association between two categorical variables, in this case, the waste management practices and the wards.

The results of the Chi-Square tests show that there is a statistically significant association between the waste management practices and the wards for each of the practices examined (waste reuse, landfill use, burning waste, and waste dumping). This means that the differences in waste management practices observed between the wards are not random but are influenced by the ward in which the respondents live. In practical terms, this means that the waste management practices are not uniform across the three wards. Each ward has its own patterns and tendencies regarding waste management. For example, one ward may have a higher proportion of people who practice waste reuse, while another ward may have more people using landfills for waste disposal. Additionally, certain waste management practices may be more prevalent or less prevalent in specific wards compared to others.



Table 2: The association between waste management practices across wards

		Ward						Total		Chi-Square Tests		
		Mazimbu		Mji Mkuu		Mji Mpya						
Waste management practices		Fr		Fre		Fre		Fre		Pearson-value	df	Sig.
	eq	Percent	q	Percent	q	Percent	q	Percent				
Reuse	No	16	61.5	5	22.7	5	22.7	26	37.1	10.544	2	0.005*
	Yes	10	38.5	17	77.3	17	77.3	44	62.9			
Landfill	No	19	73.1	7	31.8	9	40.9	35	50.0	9.175	2	0.010*
	Yes	7	26.9	15	68.2	13	59.1	35	50.0			
Burning	No	15	57.7	5	22.7	11	50.0	31	44.3	6.329	2	0.042*
	Yes	11	42.3	17	77.3	11	50.0	39	55.7			
Dumping	No	14	53.8	4	18.2	4	18.2	22	31.4	9.646	2	0.008*
	Yes	12	46.2	18	81.8	18	81.8	48	68.6			

4.3.1 Reuse

The Table 2 results show that the Chi-Square test for reuse, indicates a statistically significant association between wards and waste reuse practices (Chi-Square value = 10.544, df = 2, p-value = 0.005*). This implies that the waste reuse practices are not uniform across wards, and there is a significant difference in the proportion of people who engage in waste reuse in each ward. The highest proportion of households engaging in reuse is found in Mji Mpya and Mji Mkuu wards (77.3%), while Mazimbu ward has a lower proportion (38.5%). These differences indicate that the adoption of reuse as a waste management practice is more prevalent in Mji Mpya and Mji Mkuu wards compared to Mazimbu ward. The preference for using waste reuse as a waste management practice in specific wards can be influenced by several factors, including environmental consciousness, resource conservation efforts, economic incentives, cultural traditions, and access to creative opportunities. Studies such as Yu *et al.* (2020), Jaafarzadeh Haghighi *et al.* (2019), Kothari and Gupta (2020), and Agboh-Noameshie *et al.* (2017) have explored the drivers behind waste reuse behaviors in different communities. These studies have highlighted the role of environmental awareness and the desire to reduce waste generation, as well as the economic benefits and creative potential associated with waste reuse practices. Moreover, cultural norms and traditions can play a significant role in influencing people's inclination towards reusing waste materials. Understanding these influencing factors can aid in the development of targeted educational and policy initiatives to promote waste reuse practices in the identified wards, fostering sustainable waste management practices and resource conservation. The variation in waste reuse practices calls for targeted efforts in sustainable waste management.

4.3.2 Landfill

In landfill waste management practice, the Chi-Square test indicates a statistically significant association between wards and the use of landfills for waste disposal (Chi-Square value = 9.175, df = 2, p-value = 0.010*). This implies that the use of landfills for waste disposal varies significantly between wards, indicating differences in waste management practices. Upon examining the frequency and percentage table 2, it is evident that the proportions of households practicing landfill waste management differ across the three wards in Morogoro Municipality, Tanzania. The highest proportion of households engaging in landfill waste management practice is observed in Mji Mkuu ward (68.2%) and Mji Mpya ward (59.1%), whereas Mazimbu ward has a lower proportion (26.9%). The preference for using landfills as a waste management practice in specific wards can be influenced by a combination of factors, including the availability and accessibility of landfill facilities, the inefficiency of waste collection services, waste disposal costs, cultural attitudes and norms towards waste, environmental awareness, local policies and regulations, and perceived convenience and hygiene associated with landfill usage. Studies such as Ba-Swe *et al.* (2020), Kaza *et al.* (2018), Lee and Wong (2018), Pampaloni *et al.* (2015), Ogola *et al.* (2019), and Osibanjo and Nnorom (2011) have explored these influences in various contexts, highlighting the multifaceted nature of factors shaping people's preferences for landfill use in different communities. Variations in landfill waste management across wards necessitate considering factors like accessibility, waste collection services, and environmental awareness.

4.3.3 Burning

In Table 2, the Chi-Square test in burning waste, indicates a statistically significant association between wards and the



practice of burning waste (Chi-Square value = 6.329, df = 2, p-value = 0.042*). Implying that, there are significant differences in burning waste as a waste management practice between the different wards. The proportion of households practicing the burning waste management practice is highest in Mji Mkuu (77.3%) and Mji Mpya (50%) wards compared to Mazimbu (42.3%) ward. These findings suggest that in Mji Mkuu and Mji Mpya wards, there is a prevalent poor practice of solid waste management that is not environmentally friendly. The high percentage of households resorting to burning waste as a disposal method raises concerns about the sustainability and potential negative impacts on the environment. The preference for using burning as a waste management practice in specific wards can be influenced by several factors, including limited waste collection services and disposal infrastructure, lack of access to proper waste treatment facilities, cultural practices, economic constraints, and inadequate waste management policies. Studies such as Osmani and Hudson (2016), Phan *et al.* (2019), Rahman *et al.* (2018), and Song *et al.* (2017) have investigated the drivers behind waste burning practices in different regions. These studies have highlighted the significance of local context and socio-economic factors in shaping people's reliance on burning as a waste disposal method, as well as the implications of such practices on environmental and public health concerns. The prevalence of burning waste in Mji Mkuu and Mji Mpya wards raises concerns about the need for environmentally friendly waste management practices.

4.3.4 Dumping

The Chi-Square test indicates a statistically significant association between wards and waste dumping practices (Chi-Square value = 9.646, df = 2, p-value = 0.008*). This means that practice of dumping waste differs significantly between wards, indicating variations in waste disposal behaviors. The proportion of households practicing the dumping waste management practice is highest in Mji Mkuu (81.8%) and Mji Mpya (81.8%) wards compared to Mazimbu (46.2%) ward. The high prevalence of dumping waste raises concerns about the proper disposal of waste and the potential consequences for public health and the environment. When waste collection by the responsible organizations is delayed or inadequate, households may resort to improper dumping, leading to unsanitary conditions and an increased risk of diseases such as cholera.

The preference for using dumping as a waste management practice in specific wards can be influenced by a combination of factors, including inadequate waste collection and disposal infrastructure, limited access to formal waste disposal facilities, socio-economic constraints, lack of awareness about proper waste management practices, and cultural norms. Studies such as Das *et al.* (2020), Sujauddin *et al.* (2018), Sahid *et al.* (2019), and Uddin *et al.* (2017) have examined the drivers behind waste dumping

behaviors in various contexts. These studies have shed light on how the absence of efficient waste management systems and educational campaigns can lead to illegal dumping practices, with adverse effects on the environment, public health, and community aesthetics. Understanding these factors is essential for implementing targeted interventions to encourage proper waste disposal practices and discourage harmful dumping behaviors in the identified wards.

Therefore, the results suggest that waste management practices vary significantly across different wards. It highlights the importance of implementing tailored waste management strategies for each ward to address specific challenges and promote sustainable waste disposal practices. Understanding these differences can help policymakers and local authorities develop targeted interventions to improve waste management practices in each ward.

4.4 Factors associated with waste management practices preferences

Table 3 presents the findings of a binary logistic regression analysis conducted to examine the association between socioeconomic characteristics and solid waste management practices, including re-use, landfill, burning, and dumping. The results are reported in the form of odds ratios along with their corresponding confidence intervals. The asterisks accompanying the odds ratios indicate the level of statistical significance. Three asterisks (***) denote a significance level of $p < 0.01$, two asterisks (**) indicate a significance level of $p < 0.05$, and "ns" indicates that the variable is not statistically significant, suggesting insufficient evidence to establish an association with the outcome.

Table 3: The binary logistic regression of social economic characteristics on preference of solid waste management practices

Social economic characteristics	Re-use	Landfill	Burning	Dumping
Gender	6.641*** CI [1.679,26.261]	0.863 ns CI [0.275,2.766]	1.118 ns CI [0.327,3.586]	0.391 ns CI [0.084,1.779]
Age	2.011** CI [1.037,3.898]	2.102*** CI [1.050,3.428]	1.352 ns CI [1.007,3.459]	2.055** CI [0.584,2.547]
Marital status	0.262** CI [0.094,0.732]	0.763 ns CI [0.344,1.925]	0.729** CI [0.237,1.473]	0.654 ns CI [0.225,2.074]
Education	1.039 ns CI [0.381,2.112]	0.651 ns CI [0.307,1.442]	1.325 ns CI [0.601,3.032]	0.850 ns CI [0.398,2.053]
Employment status	2.783** CI [0.896,8.646]	2.792** CI [1.033,9.046]	3.556** CI [1.178,10.905]	0.188*** CI [0.029,0.521]
Household size	0.711 ns CI [0.429,1.158]	0.755 ns CI [0.463,1.167]	0.490*** CI [0.288,.838]	0.963 ns CI [0.474,1.793]
Time living	1.40** CI [0.646,3.033]	0.450** CI [0.207,1.118]	0.982 ns CI [0.404,2.03]	0.266*** CI [0.083,0.809]
Waste storage facility	2.153 ns CI [0.391,11.864]	1.101 ns CI [0.241,5.034]	0.534 *** CI [0.108,2.647]	3.209** CI [0.507,20.327]
Fee waste collector	0.325 ns CI [0.059,1.795]	1.761** CI [0.447,6.937]	0.250 ns CI [0.057,1.09]	8.183*** CI [1.707,39.222]
Model (Prob > chi2)	p=0.000***		p=0.012**	
	p=0.003***		p=0.000***	

Level of significance: *** meaning (p<0.01), ** meaning (p<0.05), ns meaning (not significant)

• Gender

The logistic regression analysis revealed that gender is a significant predictor of engaging in re-use behavior, with females having significantly higher odds of practicing re-use compared to males (OR = 6.641, 95% CI [1.679, 26.261]). However, gender did not show a significant association with the other waste disposal behaviors, namely landfill, burning, and dumping. These findings are consistent with a previous study by Agwu (2012) that also reported a significant association between gender and re-use behavior. It suggests that females, at the household level, exhibit greater awareness and engagement in reusing waste, particularly items such as bottles and plastic materials, demonstrating a pro-environmental attitude. Also numerous household activities, especially environmental cleaning are predominantly performed by female this tend to have a better

understanding of proper handling and care for household waste so due to that makes it easier for them to practice pro environmental practice such as reuse.

• Age

The logistic regression analysis revealed that age is a significant predictor of engaging in re-use and landfill behaviors. Older individuals have significantly higher odds of practicing re-use (OR = 2.011, 95% CI [1.037, 3.898]) and landfill (OR = 2.102, 95% CI [1.050, 3.428]) compared to younger individuals. However, age is not significantly associated with burning behaviors. The results presented in Table 4 demonstrate that age is a significant predictor for three out of four waste management practices (re-use, landfill, and dumping). This finding contradicts the findings of Nsimbe *et al.* (2018), which indicated that young people are more likely to engage in dumping waste in the dustbin. The difference in findings could be attributed to factors such as the availability of organized systems for solid waste management, which may influence waste disposal preferences among different age groups.

• Marital Status

Being married is associated with significantly lower odds of engaging in all waste disposal behaviors except burning, compared to being unmarried (OR range: 0.262 - 0.729, all p < 0.01). The results presented in Table 4 indicate that marital status is a significant predictor of two waste management practices (re-use and burning). Individuals who are married are less likely to engage in these practices compared to those who are not married. This suggests that married individuals may have a greater awareness of pro-environmental behavior, such as using re-use methods for solid waste management, which can help reduce the amount of waste generated at the household level. However, marital status was not found to be a significant predictor of landfill or dumping practices. This finding contradicts the findings of Fadhullah *et al.* (2022), which indicated that marital status has no significant association with waste management practices. This implies that whether a person is married or unmarried does not seem to influence their choices of solid waste management practices.

• Employment Status

Being employed is significantly associated with higher odds of engaging in most of the waste disposal behaviors (OR range: 2.783 - 3.556, all p < 0.01), compared to being unemployed. The results presented in Table 4 demonstrate that employment status was a significant predictor for re-use, landfill, dumping, and burning practices. Specifically, individuals who were employed were more likely to engage in re-use, landfill, and dumping practices compared to those who were unemployed. Additionally, it was observed that burning practices were relatively more common among unemployed individuals compared to those who were

employed. This finding aligns with the research conducted by Adzawla *et al.* (2019) which suggests that being employed has an influence on households' engagement in pro-environmental behavior, such as waste dumping, reuse for solid waste management and employed are able to pay amount for waste collection than unemployed. Moreover many households in Morogoro have a trees which falls leaves this attribute to practice burning for managing leaves as waste.

• **Household Size**

Smaller households have significantly higher odds of engaging in burning behavior compared to larger households (OR = 0.490, 95% CI [0.288, 0.838], $p < 0.001$). However, household size is not significantly associated with re-use, landfill, or dumping behaviors. The results presented in Table 4 indicate that household size was a significant predictor of burning practices, with individuals from smaller households being more likely to engage in burning waste than those from larger households. This finding aligns with the research conducted by Yoda *et al.* (2019), which suggests that smaller household size is a significant factor contributing to the engagement in burning waste. Smaller households tend to generate less waste, making it easier for them to burn the waste compared to larger households, which may produce a larger volume of waste.

• **Time Living**

Individuals who have resided in their current residence for a longer period of time have significantly higher odds of engaging in re-use behavior (OR = 1.40, 95% CI [0.646, 3.033], $p < 0.05$), but lower odds of engaging in dumping behavior (OR = 0.266, 95% CI [0.083, 0.809], $p < 0.01$). However, the length of time living in a residence is not significantly associated with landfill or burning behaviors. These findings suggest that individuals who have been living in an area for a longer duration are more likely to be familiar with the waste management practices prevalent in that area and are more likely to adopt pro-environmental behaviors such as re-use. On the other hand, their lower odds of engaging in dumping behaviors indicate that longer-term residents may have a better understanding of the negative consequences of improper waste disposal. This finding is consistent with the research conducted by Nanda and Berruti (2021), which emphasizes the strong relationship between the lengths of time a community has been settled and the types of waste management practices employed. Individuals who have resided in an area for a longer period of time tend to have more established waste management systems and are more aware of the importance of pro-environmental behaviors.

• **Waste collection fee**

Paying a fee for waste collection is significantly associated with lower odds of engaging in burning behavior (OR =

0.250, 95% CI [0.057, 1.09], $p < 0.01$) and higher odds of engaging in dumping behavior (OR = 8.183, 95% CI [1.707, 39.222], $p < 0.001$). However, the payment of a fee for waste collection is not significantly associated with re-use or landfill behaviors. The presence of a fee for waste collection was a significant predictor of Burning and Dumping, indicating that individuals who pay a fee for waste collection are less likely to engage in these practices compared to those who do not pay a fee. On the other hand, the payment of a fee for waste collection did not significantly predict Re-use or Landfill behaviors. These findings suggest that the cost associated with waste collection can influence waste management behavior. This result aligns with the findings of Lee *et al.* (2014), which highlight the significance of paying a fee for solid waste management in influencing the engagement in dumping practices. The collection fee collected by waste management organizations can contribute to the operational activities involved in the proper management of solid waste, such as transportation and disposal facilities.

• **Education**

Education is not significantly associated with any waste disposal behavior. This finding is in contrast to the findings of et a Mugwari *et al.* (2018); Abegaz *et al.* (2021) who reported that education level was significantly associated with various solid waste management practices, including reuse, landfill, dumping, and burning (AOR = 10.92, 95% CI = [3.12, 38.27]). According to Mugwari, et al. (2018), education plays a crucial role in raising awareness and knowledge about solid waste management. Educated individuals are more likely to have a better understanding of the importance of proper waste management and can easily be trained on effective waste management practices. This can contribute to reducing the negative impacts associated with improper solid waste management, such as the outbreak of diseases like cholera. However, in our study, education did not emerge as a significant predictor of waste disposal behaviors. This discrepancy could be due to various factors specific to the context of Morogoro Municipality, Tanzania, such as differing educational programs, cultural beliefs, or variations in waste management infrastructure. Further research is needed to explore the specific dynamics between education and waste management practices in this particular setting.

5.0 Conclusions and Recommendations

The findings of this study highlight the influence of various socio-economic factors on household-level solid waste management practices in Morogoro Municipality, Tanzania. It is evident that various factors, such as gender, age, marital status, employment status, household size, time living in the area, and paying a fee for waste collection, play a significant role in shaping waste disposal behaviors. It further evident that the current waste management practices at the household



level are inadequate, leading to potential health risks and unpleasant odors within the community. Based on these findings, several recommendations can be made to improve solid waste management practices in the municipality.

To begin with, there is a need for targeted educational programs and awareness campaigns aimed at promoting sustainable waste management practices. These initiatives should focus on raising awareness about the environmental and health impacts of improper waste disposal and provide practical solutions for waste reduction, reuse, recycling, and proper waste disposal techniques.

Furthermore, policy interventions are crucial in addressing solid waste management challenges. The government should strengthen regulations and enforcement mechanisms to discourage improper waste disposal practices such as burning and dumping. Stricter penalties for illegal dumping should be imposed to deter individuals from engaging in such behaviors.

Moreover, collaboration between the municipal council and waste management service providers should be strengthened to ensure effective waste collection and disposal services. This can be achieved by improving waste collection infrastructure, implementing regular and reliable waste collection schedules, and promoting community engagement in waste management activities.

Additionally, financial incentives or subsidies can be considered to encourage households to actively participate in sustainable waste management practices. This could include offering discounts or incentives for households that engage in recycling or waste reduction activities.

Lastly, continuous monitoring and evaluation of waste management practices should be conducted to assess the effectiveness of implemented interventions and identify areas for improvement. This can help policymakers and waste management practitioners make informed decisions and adjust strategies as needed.

In general, a comprehensive and multi-faceted approach that combines education, policy reforms, infrastructure development, community engagement, and continuous monitoring is essential to improve household-level solid waste management practices in Morogoro Municipality. By addressing the socioeconomic factors associated with waste management, the municipality can move towards a cleaner, healthier, and more sustainable environment.

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References

- Abdul-Rahaman, A., Abdul-Aziz, A. R., and Kamil, I. A. M. (2020). An investigation into solid waste management practices in the Tamale metropolis, Ghana. *Journal of Environmental Health Science and Engineering*, 18(1), 115-128.
- Abegaz, S. B., Molla, K. A., & Ali, S. E. (2021). Practices and challenges of household solid waste management in Woldia Town, northeastern Ethiopia. *Journal of Health Pollution*, 11(30),
- Adzawla, W., Tahidu, A., Mustapha, S., & Azumah, S. B. (2019). Do socioeconomic factors influence households' solid waste disposal systems? Evidence from Ghana. *Waste Management & Research*, 37(1_suppl), 51-57
- Agboh-Noameshie, A. R., Fugar, F. D. K., Fiagbe, R. P., & Nukpezah, D. (2017). Assessment of municipal solid waste management practices and challenges in developing countries: A case study of Volta Region, Ghana. *Journal of Environmental and Public Health*, 2017, 5052692.
- Agwu, M. O. (2012). Issues and challenges of solid waste management practices in port-harcourt city, Nigeria-a behavioural perspective. *American Journal of Social and Management Sciences*, 3(2), 83-92.
- Alam, P., and Ahmade, K. (2013). Impact of solid waste on health and the environment. *International Journal of Sustainable Development and Green Economics (IJSDEG)*, 2(1), 165-168.
- Allison, W. (2014). Solid Waste Management in the Pacific; Financial Arrangement. *Asian Development Bank* 2014: 1-8.
- Ba-Swe, S. N. T., Jeon, E. C., Koga, M., & Yonaha, M. (2020). Factors affecting solid waste generation and disposal practices in Hlaing Tharyar Township, Myanmar. *Environmental Development*, 36, 100545.
- Birhanu, Y., and Berisa, G. (2015). Assessment of solid waste management practices and the role of public participation in Jigjiga Town, Somali Regional State, Ethiopia. *International Journal of Environmental Protection and Policy*, 3(5), 153-168.
- Bui, T. D., Tseng, J. W., Tseng, M. L., and Lim, M. K. (2022). Opportunities and challenges for solid waste reuse and recycling in emerging economies: A hybrid analysis. *Resources, Conservation and Recycling*, 177, 105968.
- Das, A. K., Paul, D., Parida, A., & Chatterjee, R. (2020). Municipal solid waste dumping sites and their impact on surrounding environment and human health: A comprehensive review. *Journal of Environmental Management*, 262, 110326.



- Dauda, M., and Osita, O. O. (2003). Solid waste management and re-use in Maiduguri, Nigeria.
- Dlamini, S., Simatele, M. D., and Serge Kubanza, N. (2019). Municipal solid waste management in South Africa: From waste to energy recovery through waste-to-energy technologies in Johannesburg. *Local environment*, 24(3), 249-257.
- Eneje, R.C., and Abaje, I.B. (2018). Household solid waste management practices in Nigeria: Challenges and prospects. *Sustainable Cities and Society*, 42, 319-326.
- Ezeah, C., Roberts, C.L., and Byrne, J.A. (2015). A comparative analysis of the challenges and benefits of decentralized and centralized wastewater systems. *Sustainability*, 7(5), 5626-5650.
- Fadhullah, W., Imran, N. I. N., Ismail, S. N. S., Jaafar, H. M. and Abullah, H. (2022). Household solid waste management practices and perceptions among residents in the East Coast of Malaysia. *BMC Public Health* 22: 1-20.
- Fernando, R. L. S. (2019). Solid waste management of local governments in the Western Province of Sri Lanka: An implementation analysis. *Waste Management*, 84, 194-203.
- Ferronato, N., and Torretta, V. (2019). Waste mismanagement in developing countries: A review of global issues. *International journal of environmental research and public health*, 16(6), 1060.
- Fredrick, M., Oonyu, J. C., and Sentongo, J. (2018). Influence of education on the solid waste management practices of communities in Kampala city. *Journal of Environment and Waste Management*, 5(1), 261-274.
- Grossmann, I., Pearce, D.W., and Makov, T. (2019). Operationalizing sustainable waste management: A review of global practices. *Resources, Conservation and Recycling*, 150, 104431.
- Han, Z., Duan, Q., Fei, Y., Zeng, D., Shi, G., Li, H., and Hu, M. (2018). Factors that influence public awareness of domestic waste characteristics and management in rural areas. *Integrated environmental assessment and management*, 14(3), 395-406.
- Jaafarzadeh Haghighi, F., Bin Baharuddin, A. Z., Govindan, K., & Khodadadi, A. (2019). Barriers and opportunities in municipal solid waste recycling practice: A case study of Malaysia. *Journal of Cleaner Production*, 208, 1083-1095.
- Kamaruddin, M. A., Yusoff, M. S., Rui, L. M., Isa, A. M., Zawawi, M. H., and Alrozi, R. (2017). An overview of municipal solid waste management and landfill leachate treatment: Malaysia and Asian perspectives. *Environmental Science and Pollution Research*, 24, 26988-27020.
- Kaza, S., Yao, L., Bhada-Tata, P., & Van Woerden, F. (2018). What a waste 2.0: A global snapshot of solid waste management to 2050. Urban Development Series. World Bank, Washington, DC.
- Kumari, K., Kumar, S., Rajagopal, V., Khare, A., and Kumar, R. (2019). Emission from open burning of municipal solid waste in India. *Environmental technology*, 40(17), 2201-2214.
- Laor, P., Suma, Y., Keawdoungek, V., Hongtong, A., Apidechkul, T., and Pasukphun, N. (2018). Knowledge, attitude and practice of municipal solid waste management among highland residents in Northern Thailand. *Journal of Health Research*, 32(2), 123-131.210605.
- Lee, H. S., & Wong, J. W. (2018). Waste disposal behaviour of households: A case study in the Pasir Panjang district of Surabaya, Indonesia. *International Journal of Environmental Science and Technology*, 15(12), 2595-2606..
- Lee, J., Shin, H. and Lee, D. (2014). Effectiveness of the Pay-as-You-Throw (PAYT) scheme for reducing municipal solid waste in Seoul, Korea. *Waste Management*, 34(12), 2560-2568
- McAllister, J. (2015). *Factors Influencing Solid-Waste Management in the Developing World*. A Dissertation for Award of MA Degree at Utah State University. 86pp.
- Michael, O. A., Owusu, A. and Vivian, Y. (2019). Solid waste management in informal urban neighborhoods. Occupational safety and health practices among tricycle operators in Kumasi, Ghana. *International Journal of Environmental Health Research* 29(6): 702-717.
- Mugweri, F., Joseph, C. O. and John, S. (2018). Influence of education on the solid waste management practices of communities in Kampala city. *Journal of Environmental Waste Management* 5: 261-274.
- Nanda, S., and Berruti, F. (2021). Municipal solid waste management and landfilling technologies: a review. *Environmental Chemistry Letters*, 19, 1433-1456.
- Nsimbe, P., Mendoza, H., Wafula, S. T., and Ndejjo, R. (2018). Factors associated with composting of solid waste at household level in Masaka municipality, Central Uganda. *Journal of environmental and public health*, 2018.
- Nyampundu, K., Mwegoha, W. J., & Millanzi, W. C. (2020). Sustainable solid waste management Measures in Tanzania: An exploratory descriptive case study among vendors at Majengo market in Dodoma City. *BMC Public Health*, 20(1), 1-16.



- Ogola, J. S., & K'Akumu, O. A. (2019). Solid waste management policy and practice in Kenya: A case study of public technical training institutes. *Sustainable Cities and Society*, 49, 101598..
- Olukanni, D.O.; Aipoh, O.A.; Kalabo, I.H. (2018). Recycling and reuse technology: Waste to wealth initiative in a private tertiary institution, Nigeria. *Recycling*, 3, 44.
- Osmani, D., & Hudson, R. (2016). Informal waste management and its impacts on health: A case study of Dhaka City, Bangladesh. *Habitat International*, 55, 43-52.
- Othman, N.Z., and Rahman, H.A. (2019). Sustainable waste management practices: A review of solid waste minimization, recycle and reuse. *Resources, Conservation and Recycling*, 141, 235-248.
- Pariatamby, A., Tanaka, M., Islam, A., Rasul, G., Manandhar, P., Parveen, J. A., and Ahmed, N. (2014). Municipal solid waste management in Asia and the Pacific Islands. *Environmental Science, Springer, Singapore*, 201
- Phan, T. H., Ngo, H. H., Guo, W. S., Chang, S. W., Nguyen, D. D., & Nguyen, P. T. (2019). Household solid waste generation and characterization: A case study in the Can Tho City, Vietnam. *Environmental Science and Pollution Research*, 26(27), 27836-27846.
- Rahman, M. M., Ahsan, M. A., Shah, A. N. M., & Titas, M. A. A. (2018). Solid waste management practice in metropolitan Dhaka, Bangladesh: A socio-economic evaluation. *Journal of Material Cycles and Waste Management*, 20(4), 1919-1932.
- Ramadan, B. S., Rachman, I., Ikhlas, N., Kurniawan, S. B., Miftahadi, M. F., and Matsumoto, T. (2022). A comprehensive review of domestic-open waste burning: recent trends, methodology comparison, and factors assessment. *Journal of Material Cycles and Waste Management*, 24(5), 1633-1647
- Rasmeni, Z. Z., and Madyira, D. M. (2019). A review of the current municipal solid waste management practices in Johannesburg City townships. *Procedia Manufacturing*, 35, 1025-1031.
- Sahid, F. S., Shirazi, S. M., & Rahman, M. M. (2019). Assessing the social acceptance of solid waste dumping sites using a public participation GIS (PPGIS) approach. *Environmental Science and Pollution Research*, 26(20), 20827-20841.
- Sharma, K. D., and Jain, S. (2019). Overview of municipal solid waste generation, composition, and management in India. *Journal of Environmental Engineering*, 145(3), 04018143.
- Song, Q., Chen, X., Sun, X., Du, Q., & Hu, J. (2017). Incentive policies for informal recycling of electronic waste: A case study of Guiyu, China. *Environmental Science and Pollution Research*, 24(30), 23571-23582.
- Srivastava, V., Ismail, S. A., Singh, P., and Singh, R. P. (2015). Urban solid waste management in the developing world with emphasis on India: challenges and opportunities. *Reviews in Environmental Science and Bio/Technology*, 14, 317-337.
- Sujauddin, M., Huda, S. M. S., Hoque, R. R., & Ahmed, S. (2018). Solid waste management and recycling practices of residents at Dhaka city in Bangladesh. *Waste Management & Research*, 36(10), 1041-1048.
- Taghizadeh, S., and Tan, C.L. (2018). Challenges of integrated waste management in developing countries: A case study in Tehran, Iran. *Journal of Material Cycles and Waste Management*, 20(3), 1786-1795.
- Teshome, F. B. (2021). Municipal solid waste management in Ethiopia; the gaps and ways for improvement. *Journal of Material Cycles and Waste Management*, 23, 18-31.
- United Nations Environment Programme (UNEP). (2006). Integrated Solid Waste Management: A Lifecycle Inventory. Retrieved from <https://wedocs.unep.org/handle/20.500.11822/7927>
- Warunasinghe, W. A. A. I., & Yapa, P. I. (2016). A survey on household solid waste management (SWM) with special reference to a peri-urban area (Kottawa) in Colombo. *Procedia food science*, 6, 257-260.
- Wilson, D.C., Velis, C., and Cheeseman, C. (2012). Role of informal sector recycling in waste management in developing countries. *Habitat International*, 37, 1-8.
- Yoda, R. M., Chirawurah, D., and Adongo, P. B. (2014). Domestic waste disposal practice and perceptions of private sector waste management in urban Accra. *BMC public health*, 14(1), 1-10.
- Yu, X., Zhang, H., Li, Y., & Li, J. (2020). Understanding the practice of informal waste recycling by waste pickers in urban China: A case study in Shenzhen. *Journal of Cleaner Production*, 244, 118782.