Association between Waste Management Practices, Demographic Factors and Household Disease Prevalence in Tanzania

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Abstract: Waste management is becoming a critical issue in Tanzania, especially in squatter settlements where 70–80% of the urban population lives without adequate infrastructure and services. This study, utilizing secondary data from the Tanzania Household Budget Survey 2017–2018, examined the relationship between waste management practices, demographic factors and household disease prevalence. Employing a binary logistic regression model, the study investigated how different waste disposal methods influence health outcomes among the households. Key findings indicate that age, sex and family size significantly impact disease risks while effective waste management practices such as recycling, selling waste to collectors, burning and composting significantly reduce disease prevalence. These results highlight the urgent need for government interventions to improve waste management systems. Moreover, the study recommends for the promotion of safer waste disposal methods, enhancing recycling efforts and implementing stricter regulations to mitigate health hazards and improve overall community well-being in Tanzanian urban areas.

Keyword: Waste management; public health; diseases prevalence; poverty.

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Introduction

Waste management poses a global challenge that affects individuals, families, societies, and governments by contributing to environmental degradation, public health issues, and economic strain (Fadhullah et al., 2022). Improper waste disposal leads to pollution, which can contaminate water sources and soil, causing health problems for individuals and families. Societies face increased healthcare costs and reduced quality of life due to the spread of diseases linked to poor waste management. Governments are burdened with the need to invest in infrastructure, enforce regulations, and manage waste sustainably, which requires substantial financial resources and coordination efforts (Kitole & Utouh, 2023; Theodory & Kitole, 2024). Poorly managed waste leads to hundreds of thousands of preventable deaths each year in developing countries, which hinders their advancement in public health and economic development (Deeney et al., 2022; Folarin, 2022). This situation complicates efforts to establish integrated solid waste management systems, as the immediate health crises and limited resources make long-term planning and implementation challenging (Folarin, 2022; Shafer, 2020).

A study of Fadhullah et al. (2022) indicated high level of awareness of health risks associated with poor waste management, with 95.9% of respondents acknowledging its link to illnesses like malaria and diarrhea in East Coast of Malaysia. Moreover, Folarin et al., (2022) suggested that over 2.5 billion people in developing countries lack access to clean water. This critical situation exacerbates the spread of pathogenic microorganisms through wastewater, significantly impacting public health

and environmental quality (UNESCO, 2023; Shayo et al., 2023; Theodory & Kitole, 2024). In Sub-Saharan Africa, the problem is particularly acute, with inadequate waste management systems contributing to water contamination and increased disease prevalence (UNESCO, 2023). Addressing these issues in developing countries, including those in Sub-Saharan Africa, requires comprehensive strategies to improve waste management infrastructure, enforce regulations, and ensure access to clean water for all communities (UNICEF, 2019.

In Tanzania, waste management is increasingly becoming a pressing issue, particularly in highly populated communities where basic amenities are lacking (Biswas & Singh, 2021). Water and sanitation-related diseases account for more than 70% of medical cases nationwide, highlighting the public health implications of inadequate waste management systems (UNICEF, 2019). A study by Nyampundu et al. (2020) in Dodoma, Tanzania, showed that lack of awareness and sustainable waste management practices among merchants resulted in an increased prevalence of diseases, including typhoid, malaria, diarrhea and measles. Despite ongoing efforts by the government and various organizations to improve waste management infrastructure and services, Tanzania still faces significant challenges (UNICEF, 2019; Theodory & Kitole, 2024). These efforts include waste management awareness campaigns and education, the implementation of waste management bylaws, subsidizing waste management fees for poor households and improving dumpsite areas (Nyampundu et al., 2020). However, over 10,000 tonnes of municipal solid waste are generated daily, and limited access to sewer systems exacerbates waterborne disease incidences (UNESCO, 2023; Folarin, 2022).

Despite concerted governmental efforts in Tanzania, waste management challenges still persist, thwarting disease prevention and impeding public health enhancement (Nyampundu et al., 2020; Kagonji & Manyele, 2016; Kuchibanda and Mayo, 2015). The persisting challenges stem from inadequate infrastructure, knowledge gaps, and low awareness levels among households (Nyampundu et al., 2020). These deficiencies in waste management practices exacerbate the prevalence of diseases.

Effective waste disposal practices, such as recycling, composting and proper waste segregation remain a challenge in many communities (Kitole & Utouh, 2023). Furthermore, inaccessibility to clean water exacerbates the health hazards posed by inadequate waste management practices (UNESCO, 2023). Wastewater, often contaminated with pathogenic microorganisms, serves as a primary medium for the transmission of waterborne diseases in these regions (Shayo et al., 2023). The correlation between contaminated water sources and diseases like diarrhea underscores the urgent need for improved waste management strategies to safeguard public health (World Health Organization, 2014; Deeney et al., 2022). While studies have consistently demonstrated the role of proper waste management in disease prevention, there remains a gap in understanding the prevailing impact of waste management practices on disease prevalence in Tanzania, necessitating further investigation (World Health Organization, 2018).

These deficiencies in waste management practices may exacerbate diseases, necessitating further studies to establish the link between waste management and health outcomes in Tanzania. Thus, this study sought to shed light on the relationship between waste management practices and disease prevalence, thereby informing effective policy interventions and public health strategies.

Theoretical framework

The theoretical foundation of the study draws upon the Health Belief Model (HBM) as its guiding framework. Developed by social psychologists Hochbaum, Rosenstock and Kegels in the 1950s, the HBM posits that health-related behaviors are shaped by individuals' perceptions of susceptibility to health threats, the severity of these threats, the perceived benefits of preventive actions and barriers to taking such actions (Addo et al., 2017). Additionally, cues to action and self-efficacy play pivotal roles in determining individuals' engagement in health-promoting behaviors (Kitole et al., 2023a).

In the context of this study, the HBM provides a comprehensive lens through which one can examine the relationship between household waste management practices and disease prevalence. The HBM theory elucidates that individuals' perceptions of susceptibility to diseases arising from poor waste management, their understanding of the severity of the associated health threats, and their beliefs regarding the benefits and barriers of adopting proper waste management behaviors influence their health-related decisions (Biswas & Singh, 2021).

Furthermore, the model emphasizes the importance of external cues, such as health education campaigns, in motivating individuals to take preventive action, as well as the significance of self-efficacy in shaping individuals' confidence in their ability to manage household waste effectively (Anuar et al., 2020).

Figure 1: Health Belief Model
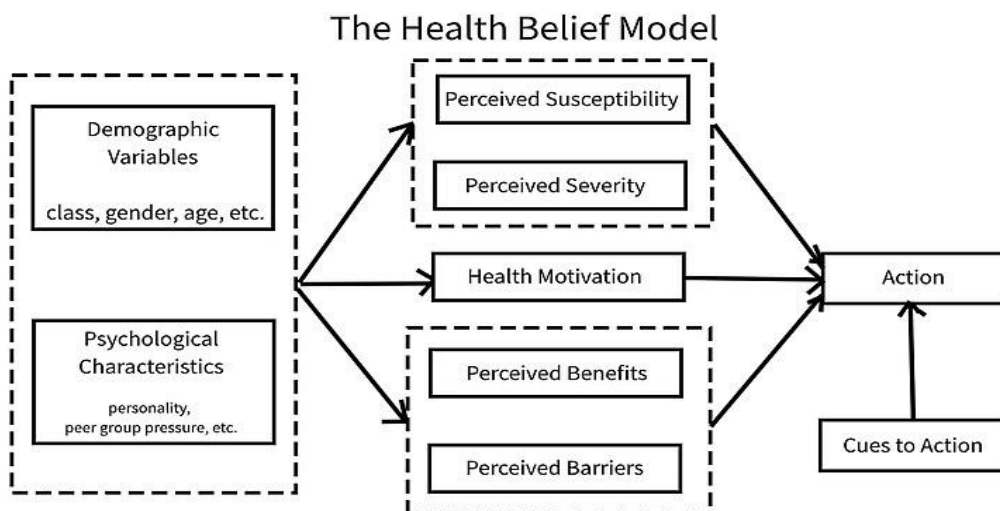
HBM proposes that individuals are more likely to engage in health-promoting behaviors if they perceive benefits of the behavior as outweighing the barriers and feel confident in their ability to take action (Anuar et al., 2020). In this context, this study possess deeper insights into the psychological factors driving THE household waste management practices and their impact on disease prevalence. This approach enables a nuanced understanding of the underlying mechanisms shaping health-related behaviors, thereby informing targeted interventions aimed at promoting proper waste management and improving public health outcomes in Tanzania.

Methodology

Research Design
The study used a cross-sectional survey design, which involves collecting data at a single point in time from various respondent groups. This method allows researchers to analyze data from a snapshot perspective, providing insights into the current state of variables of interest. Unique features of this design include its efficiency in gathering information from a large sample quickly and cost-effectively. Additionally, it enables the comparison of different population groups at a single time, offering a broad understanding of trends, relationships and differences among the groups. However, it is important to note that while cross-sectional surveys can establish correlations, they do not provide causal relationships due to the lack of temporal data.

Population and Sampling
The survey employed a two-stage cluster sampling approach. In the first stage, enumerator areas (primary sampling units or PSUs) were selected from the 2012 population and housing census frame. A total of 796 primary sampling units were chosen, including 69 from Dar es Salaam, 167 from other cities and 560 from rural areas. This sampling method ensures that the data accurately reflect the diverse demographic and geographic distribution of the Tanzanian population, providing a robust basis for examining the relationship between waste management practices and disease prevalence.

Source of Data
This study analyzed the effect of waste management on disease prevalence in Tanzanian households using secondary data from the 2017 to 2018 Tanzania Household Budget Survey (HBS), collected by the National Bureau of Statistics. The survey comprised a nationally representative sample of 9,552 households, covering Tanzania's 26 mainland regions.

Analytical Modelling
The logistic regression model estimated the effect of waste management practices on households' disease prevalence in Tanzania. The choice of the model based on its ability to explain probabilities

rather than provision of raw interpretations (Kitole et al. 2023b). The use of the sigmoid function or the logistic function helps to model the relationship between explanatory variables and the likelihood of the outcome variable. The general equation of the model is as follows:

$$P_r = \left(y_i = \frac{1}{x_i\beta_i}\right) = 1 - F(x_i\beta_i),\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\ (1)$$

These are continuous growing functions that take a real value and return a value between 0 and 1, where F (.) is the cumulative distribution function. As a result, the likelihood of seeing zero is

$$P_r = \left(y_i = \frac{0}{x_i\beta_i}\right) = F(-x_i\beta_i)\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\ (2)$$

One can estimate the model using the maximum likelihood estimation approach, based on the provided specification. The dependent variable y_i is an unobserved latent variable, linearly related to the equation:

$$y_i = \beta_i x_i + \mu_i$$

Where μ_i a random disturbance is is the term and x_i is an independent variable associated with disease prevalence among the households. The dependent variable y_i can be observed if y > 0, which signifies households' risk to disease and y=0 households signifying no risks to diseases.

$$y = \begin{cases} 1, & If \text{ households have risk to disease} \\ 0, & if \text{ households dont have risk to disease} \end{cases} \dots\dots\dots\dots\dots\dots\dots\dots\ (3)$$

The logit model examined the data and the empirical model appears as follows:

$$y = \frac{e^{\beta_0+\beta_1 X_1+\dots\dots\dots+\beta_P X_{iP}}}{1+e^{\beta_0+\beta_1 X_1+\dots\dots\dots+\beta_P X_{Xi}}} = \frac{1}{1+e^{-(\beta_0+\beta_1 X_1+\dots\dots\dots+\beta_P X_{iP})}}\dots\dots\dots\dots\dots\dots\dots\ (4)$$

The logarithmic transformation of the equation in the logistic regression model results in a linear relationship between the independent and dependent variables. Next, the logit transformation appears here:

$$logit(y) = log\frac{P(y)}{1-P(y)} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots\dots\dots\dots\dots + \beta_P X_{iP}\dots\dots\dots\dots\ (5)$$

Table 1 presents the array of variables incorporated in the analysis. Each variable is meticulously defined and expounded upon to elucidate its conceptualization and measurement within the research framework. Through detailed descriptions, the table delineates the nature of each variable, including its type and anticipated impact on the outcome variable. By systematically outlining the measurement process and expected signs of influence, the table offers a transparent and thorough overview of the analytical constructs employed in the study.

Results and Discussion

Demographics of Respondents
Table 2 indicates demographic characteristics of the households included in the study. The results reveal a slightly higher representation of females (55.12%) compared to males (44.88%). Furthermore, a significant majority of the households (70.57%) resided in rural areas while the remaining 29.43% lived in urban locales. The educational attainment of the participants varied, with the largest proportion having completed secondary education (29.16%), followed by primary education (23.20%). A smaller percentage had received college or vocational training (19.41%) and the fewest had attained a university education (8.27%). Regarding marital status, the sample appears between married (48.13%) and single (51.87%) individuals. These demographic insights provide a comprehensive understanding of the composition of the study population, offering a valuable context for the interpretation of the research findings.

Table 1: Description of Variables and Measurements

Variable name	How its measured	Variable type	Sign
Households' disease prevalence	1= household have risk to disease 0= households don't have risk to disease	Dummy	
Age	Time elapsed between date of birth and a specific point in time	Continuous	**-**
Sex	Sex of the head of the head of household 0= male 1=female	Dummy	**+/-**
Households size	Total number of family members in a household	Continuous	**_**
Education level	It is measured in terms of the highest class of an individual has attained	Categorical	**+**
Households Income	It is measured in terms of TZS	Continuous	**+**
Separating wastes	If households use the practice or not	Dummy	**_**
Recycling packing materials	If households use the practice or not	Dummy	**+**
Composting organic waste	If households use the practice or not	Dummy	**+**
Selling waste to waste collector	If households use the practice or not	Dummy	**+**
Burning waste	If households use the practice or not	Dummy	**+**
Waste management campaigns	If households attended waste management campaigns nor not	Dummy	**+**

Table 2: Household Demographic characteristics

Variable	Attributes	Frequency	Percentage
Sex	Male	4287	44.88%
	Female	5,265	55.12%
	Total	**9,552**	**100.00%**
Residence	Rural	6741	70.57%
	Urban	2,811	29.43%
	Total	**9,552**	**100.00%**
Level of education	No schooling	1,907	19.96%
	Primary education	2,216	23.20%
	Secondary education	2,785	29.16%
	College and Vocational training	1,854	19.41%
	University	790	8.27%
	Total	**9,552**	**100.00%**
Marital status	Married	4,597	48.13%
	Single	4,955	51.87%
	Total	**9,552**	**100.00%**

Research Question 1: What is the level of waste management practices by households in Tanzania?
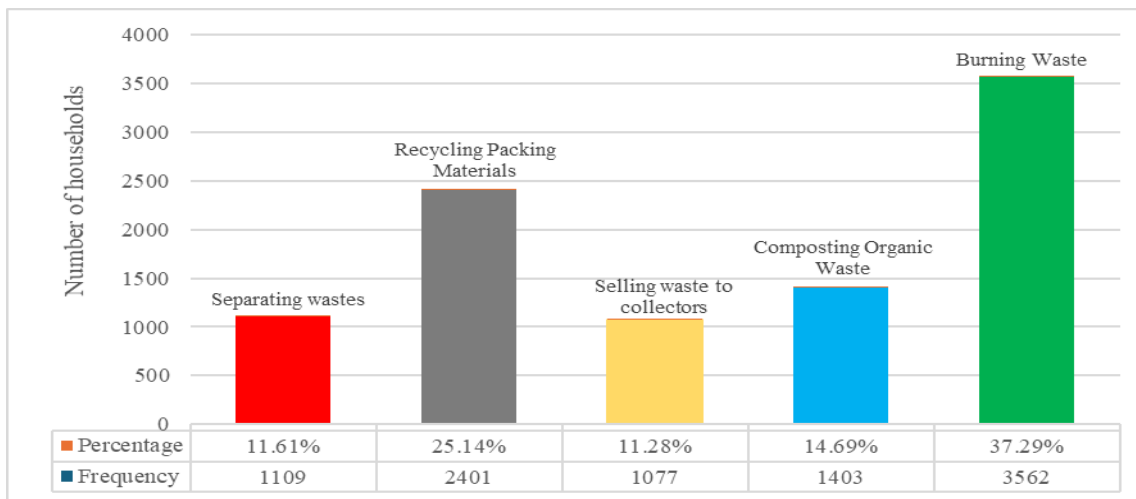
The waste management practices detailed in Figure 2 demonstrate a mix of methods employed by households to manage waste. Notably, 37.29% of households resort to burning waste, a practice that, while common, is criticized for environmental drawbacks including air pollution (Shayo et al. 2023). Recycling, particularly of packing materials, is embraced by 25.14% of households, echoing broader environmental initiatives that emphasize resource conservation and landfill reduction (Shafer,

2020). Additionally, 14.69% engage in composting organic waste, aligning with United Nations Environment Program advocacy for this method as a sustainable waste solution (UNICEF, 2019; WHO, 2018). By selling waste, households can generate income, turning what would otherwise be a disposal cost into a financial opportunity. This economic aspect is significant as it not only helps households financially but also creates a market for waste as a resource, contributing to the circular economy. This approach is supported by the findings of Kiyasudeen et al. (2016), who emphasize the economic potential of waste when effectively collected and reused.

Figure 2: The household usage of waste management practices in Tanzania

	Separating wastes	Recycling Packing Materials	Selling waste to collectors	Composting Organic Waste	Burning Waste
■ Percentage	11.61%	25.14%	11.28%	14.69%	37.29%
■ Frequency	1109	2401	1077	1403	3562

Table 3: Effects of waste management on household's disease prevalence in Tanzania

Disease Prevalence	Odds Ratios	Robust St. Err.	t-value	p-value	[95% Conf	Interval]
Age	-0.055	0.031	-1.78	0.075*	-0.115	0.006
Sex (Male)	2.463	1.098	2.24	0.025**	0.311	4.616
Households size	1.42	0.629	2.26	0.024**	0.187	2.654
Primary education	0.517	1.739	0.30	0.766	-2.892	3.925
Secondary education	-2.03	1.672	-1.21	0.225	-5.306	1.246
Higher education	-3.699	1.701	-2.17	0.030**	0.366	7.032
lnINCOME	0.091	0.654	0.14	0.889	-1.191	1.373
Separating wastes	-1.42	0.629	-2.26	0.024**	0.187	2.654
Recycling packing materials	-0.226	0.59	-0.38	0.002***	-1.383	0.931
Composting organic waste	1.289	0.701	1.84	0.066*	-0.084	2.662
Selling waste to waste collector	0.786	0.5	1.57	0.006**	-0.193	1.766
Burning waste	-0.065	0.47	-0.14	0.000***	-0.985	0.855
Waste management campaigns	-0.75	0.45	-1.67	0.095*	-0.131	1.631
Constant	-5.488	9.083	-0.60	0.546	-23.29	12.314
Pseudo r-squared	0.4585		Number of obs		9,552	
Wald Chi-square	54.41		Prob > chi2		0.000	
Log pseudolikelihood	-73.422486					

Furthermore, 11.61% of households practice waste separation, a crucial step that enhances the efficiency of recycling processes. Efficient separation ensures that recyclable materials are not contaminated, thereby improving the quality and value of the recycled end products. This method is vital for effective recycling programs, as emphasized by Deeney et al. (2022).

Research Question 2: What is the effect of waste management practices on household diseases prevalence?

Findings in Table 3 provide insights into the relationship between waste management practices and household disease prevalence.

Regarding age, there is a positive association with disease prevalence, suggesting a potential trend of

increased susceptibility to diseases with increasing age (p = 0.075). This result implies that older individuals are more likely to experience higher chances of disease prevalence compared to younger individuals. This trend could be attributed to the aging immune system and increased vulnerability to infections and diseases as people grow older. Fadhullah et al. (2022) reported similar findings, observing a slight increase in disease susceptibility with advancing age in their study on household health behaviors in rural communities in Sub-Saharan Africa. These findings align with those of Nyampundu et al. (2020), which also suggest that older age groups tending to have higher disease prevalence, possibly due to the cumulative effects of environmental and health-related factors over time. These studies emphasize the importance of age as a factor in understanding disease prevalence and highlight the need for targeted health interventions to address the specific vulnerabilities of older populations.

Household size demonstrates a significant positive association with disease prevalence, implying that larger households are more susceptible to experiencing diseases compared to smaller ones. In other words, members of larger households are more likely to experience diseases compared to members of smaller households, holding all other factors constant. This finding aligns with the results by Kiyasudeen et al. (2016) in their study conducted in India. Their study identified household size as a significant predictor of disease prevalence, suggesting that this relationship is consistent across different populations and contexts. Additionally, larger families may face greater challenges in maintaining optimal hygiene and sanitation practices, further increasing the risk of disease outbreaks. Socioeconomic factors, such as access to healthcare and resources may also play a role in mediating this relationship.

Moreover, individuals with higher education levels demonstrated a significantly lower likelihood of experiencing diseases compared to those with lower education levels. The odds ratio of -3.699 (p = 0.030) indicates that individuals with higher education levels are approximately 3.7 times less likely to experience diseases than their counterparts with lower education levels. This finding suggests that there is a notable inverse association between higher education and disease susceptibility. The observed trend of lower disease prevalence among individuals with higher education levels may be influenced by various factors. One possible explanation is that individuals with higher education levels may have greater access to health information, leading to better health literacy and more informed health decisions.

Additionally, higher education levels could be associated with improved socioeconomic status, which in turn may provide better access to healthcare resources, healthier living conditions, and a reduced exposure to environmental risk factors. These advantages may contribute to a lower likelihood of disease occurrence among individuals with higher education levels. Consistent with these findings, previous studies by Shayo et al. (2023) in Tanzania and Addo et al. (2017) in Ghana have also reported negative associations between higher education levels and disease prevalence. These studies provide further support for the notion that higher education can serve as a protective factor against diseases, potentially due to the increased health awareness, better living conditions, and improved access to healthcare that often accompany higher educational attainment.

Furthermore, various waste management practices examined in this study demonstrated differing associations with disease prevalence. Separating wastes into different categories exhibited a significant negative association, with an odds ratio of -1.42 (p = 0.024), suggesting that individuals who engage in waste separation are less likely to experience diseases compared to those who do not. This negative association implies that waste separation can serve as a protective factor against disease occurrence.

Similarly, selling waste to designated waste collectors was associated with an odds ratio of -0.786 (p = 0.006), indicating that individuals who sell their waste are approximately 78.6% less likely to experience diseases than those who do not. These findings suggest that proper waste separation and selling waste to collectors may contribute to a reduction in disease prevalence. Recycling packing materials and burning waste also demonstrated significant negative associations with disease prevalence, with odds ratios of -0.226 (p = 0.002) and -0.065 (p < 0.001), respectively. These findings imply that recycling packing materials and burning waste may have protective effects against disease prevalence. The negative associations observed between these waste management practices and

disease prevalence indicate that they can serve as protective factors against disease occurrence.

Moreover, results show that participating in waste management campaigns and composting organic waste are practices significantly linked to lower disease prevalence in households, as indicated by the findings with coefficients of -1.289 (p=0.066) and -0.750 (p=0.006), respectively. These practices are effective in reducing the likelihood of diseases, supporting the results of similar studies. For instance, Shafer (2020) and Kitole et al. (2024) have both documented that proactive waste management can decrease disease prevalence. Consistent with these findings, Kiyasudeen et al. (2016), Shayo et al. (2023), and Dimoso and Andrew (2021) have identified waste management as a crucial factor in reducing disease rates, highlighting the critical role of proper waste disposal and handling in promoting a healthy environment.

Conclusion and Recommendations

The study shed light on the complex relationship between waste management practices and household disease prevalence in Tanzania. The study revealed significant associations between certain waste management practices and disease prevalence, highlighting the importance of adopting sustainable waste management strategies to safeguard public health. In this case, therefore, policymakers should prioritize promoting the adoption of environmentally sustainable waste management practices, such as recycling and composting, through awareness campaigns and educational programs.

Encouraging households to separate wastes and engage in composting organic waste can help reduce the accumulation of harmful pollutants and pathogens, thereby lowering the risk of disease transmission within communities. Additionally, incentivizing the recycling of packing materials and discouraging the burning of waste can contribute to improving environmental health outcomes and reducing disease prevalence.

Encouraging households to separate their waste into different categories, such as organic, recyclable and hazardous materials can improve the efficiency of waste management systems. By separating waste, it becomes easier to process and dispose each type of waste appropriately, reducing the risk of contamination and environmental pollution. Governments should provide clear guidelines and

support for waste separation, including distribution of color-coded bins and bags.

Establishing regular and reliable waste collection services can help ensure that waste is removed from communities in a timely manner. This may reduce the risk of waste accumulation, which can lead to the breeding of disease-carrying pests and the contamination of water sources. Governments should work with private sector partners and community-based organizations to develop cost-effective and sustainable waste collection systems that meet the needs of diverse communities.

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