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Household Solid Waste Generation Patterns and Collection Systems in Urban Tanzania: A Case Study of Morogoro Municipality

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Abstract

This paper examines household solid waste generation patterns and collection systems in Morogoro Municipality, Tanzania, utilizing a mixed research design combining quantitative and qualitative methods. A sample of 380 heads of households was randomly selected, and data were collected through surveys, in-depth interviews, and field observation. Quantitative data were analysed using SPSS, with Chi-square analyses revealing relationships between waste quantities and socio-demographic characteristics. Qualitative data were analysed through content analysis. The results indicate that food waste constitutes 66% of total waste, with compound sweepings and papers trailing at 20%. Most households (60%) generate 1–3kg of waste daily, yet face significant inconsistencies (74%) in waste collection schedules. Despite the common use of sacks (97%) for waste storage, an underperforming collection system results in uncertainty among residents, leading to roadside dumping. Notably, homeowners produce significantly higher quantities of waste ($p<0.001$), and larger family household sizes correlate with increased waste generation ($p<0.000$). The study unveils challenges in waste collection due to inadequate infrastructure and technology, resulting in environmental and health risks from waste accumulation in public areas. Recommendations include: investing in infrastructure and technology to enhance waste collection efficiency, increasing financial allocations through partnerships and grants, and launching public awareness campaigns for improved waste segregation, and adherence to collection schedules. Additionally, promoting sustainable recycling and composting practices is advised.

Key words: *urbanization, sustainability, waste, environment, population*

1. Introduction

One of the defining features shaping the global waste landscape is the dual phenomenon of rapid urbanization and population increase. As an increasing number of individuals are pulled by urban life, the volume of waste generated experiences a corresponding and significant increase (Sarbassov et al., 2019). Remarkably, urban centres tend to produce more waste per capita compared to rural areas, primarily due to intensified consumption patterns and shifts

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in lifestyle (Amasuomo & Baird, 2016). Although Africa is the least urbanized continent according to the African Policy Circle (APC, 2020), it faces unique challenges driven by the speed of its urban growth. This rapid urbanization has substantial implications for achieving sustainable urban development goals (Akmal & Jamil, 2021). While urbanization in developed countries often correlates with economic growth, the same is not consistently observed in developing countries (WB, 2019). The expansion of cities in developing countries commonly reveals a low capacity to address the complex demands of urbanization, including waste management (Guerrero et al., 2013; Saghir & Santoro, 2018).

It is an unquestionable fact that waste management is among the many problems experienced across most African nations (Dlamini et al., 2019; Justice Kofi Debrah; Vidal & Dinis, 2021). This issue is particularly noticeable within the Sub-Saharan African (SSA) region, where the complexities of waste management are greater than before (Nahman & Godfrey, 2010). Research efforts have been undertaken across the region to establish the true extent of this problem, and have revealed alarming findings. For instance, in the year 2016, the continent of Africa generated waste accumulating up to 2bn tons. Out of that, only half of this was formally collected (WB, 2019). The accumulation of uncollected waste in the streets is one of the most noticeable features in African cities (Mihai et al., 2019). Unattended waste not only ruins the visual appearance of the surroundings, but also poses severe environmental and public health risks (Mukama et al., 2016; Rajashekar, 2019). Frequent foul smells emanating from waste accumulated heaps create a highly contaminated and hostile living environment (Nyampundu et al., 2020). Moreover, uncollected waste obstructs water-courses and drainage systems, leading to blockages that exacerbate flooding during rainy seasons. Stagnant waters due to floods and waste drains become breeding grounds for disease vectors such as mosquitoes, cockroaches and rats, further endangering the health and well-being of urban dwellers (Kanhai et al., 2021).

In Tanzania, the pursuit of economic growth has led to a growing urban population. Consequently, there is an unprecedented increase in waste generation. The country's urban population has surged remarkably, from about 15m people in 2012 to approximately 24m people in 2022 (URT, 2022). Regrettably, the population increase and accelerated urbanization in Tanzania have strained the provision of essential social services, including waste management. It is estimated that the amount of municipal solid waste (MSW) generated in the country is about 12.1–17.4m tonnes per year, equating to 0.66–0.95kg per capita per day. On average, the report shows each person produces 241–347kg of waste annually (Biswas & Singh, 2021).

Waste is broadly classified based on its nature and properties, encompassing solid, liquid, and gaseous forms. Solid waste, in particular, exhibits heterogeneity with a mixture of organic and inorganic matter (Abdel-Shafy & Mansour, 2018). Waste can further be categorized according to its source of generation and type, including municipal waste, agricultural waste, biomedical waste, e-waste, among others (Harilal et al., 2011). Solid waste is often referred to as refuse, and includes various materials such as waste tires, scrap metal, latex paints, furniture, toys, garbage, appliances, vehicles, oil, anti-freeze, empty aerosol cans, paint cans, compressed gas cylinders, construction and demolition debris, asbestos, plastics, containers, bottles, and more (Rincón et al., 2016). The management of solid waste is crucial to avoid environmental and health hazards (Aryampa et al., 2019; Fadhullah et al., 2022).

Household waste constitutes a significant portion of municipal waste, and forms the largest fraction of waste in developing countries. Between 50 to 80% of the total municipal waste generated constitute household waste (Nwachukwu et al., 2018). Over recent decades, shifts in production and consumption patterns have led to a diverse mix of waste components, including e-waste and hazardous waste, primarily generated by household consumption, and secondarily by related livelihood activities (Ncube et al., 2021). Effective management of household waste is crucial for maintaining urban quality of life, as poor waste management practices are associated with a range of health issues, including respiratory, gastrointestinal, and vector-borne diseases (Kwailane et al., 2016). The rapid rise in household waste generation rates and changes in waste composition present significant challenges, particularly in developing and rapidly urbanizing cities. Due to their nature and composition, household waste requires ongoing research and monitoring. It is essential to determine the fractional composition, management practices, and challenges faced (Adzawla et al., 2019; Fadhullah et al., 2022). Waste characterization is a crucial component of any waste management system, as it significantly influences treatment processes, enhances performance, and informs policy-making. It also provides the necessary data for developing relevant community and national activities to address waste management issues effectively.

Waste generation is fundamentally initiated at the point where individuals make decisions regarding materials they deem unusable, and therefore in need of disposal. According to Coffey and Coad (2013), this marks the inception of the waste management process. The volume of waste destined for disposal is significantly influenced by the effectiveness of waste segregation/separation practices at the source. In the context of developing countries, the situation is further complicated by the limited capacity of local recycling industries to manage and process segregated waste. Despite efforts to separate waste at the source, the inadequate infrastructure for recycling means that much of this

waste is not absorbed back into productive use. This insufficiency in recycling capacity exacerbates the problem, leading to an unrestrained increase in the overall waste generation. As noted by Kibria et al. (2023), the escalation in waste generation poses significant challenges to waste management systems in these regions.

Waste collection is another key stage in waste management (Amasuomo & Baird, 2016). It involves gathering waste from its point of origin and transporting it for processing or disposal. In urban settings, waste collection faces challenges due to the widespread generation of solid waste and recyclables from various sources, leading to increased complexity and costs (Kain et al., 2022). Effective planning and management are essential to optimize waste collection processes and reduce expenses, which typically account for 50 to 70 percent of total waste management costs (Coffey & Adrian Coad, 2013). Three primary components characterize waste collection: collection points, frequency, and type of storage containers (Singh et al., 2016; Laurieri et al., 2020). Collection points are located in residential, commercial, or industrial areas. Moreover, collection frequency varies based on population size, lifestyle, and climatic conditions. However, urban areas require more frequent collection (Adedara et al., 2023). Storage containers—selected based on durability, ease of handling, and resistance to environmental factors—play a crucial role in collection efficiency (Abubakar et al., 2022).

A number of studies on solid waste have been conducted in Tanzania; and these have been mainly on the challenges and prospects of private sector participation in solid waste management (Kirama & Mayo, 2016); waste segregation potentials (Kihila et al., 2021); characterization of market solid wastes (Nyampundu et al., 2020); public opinion about waste management (Cheng & Urpelainen, 2015); income and value chain activities in informal solid waste collection (Mushi et al., 2022); and assessment on the awareness, knowledge, attitude and practice of the community towards solid waste disposal (Alfred Chengula et al., 2015). While extensive research has been conducted on various dimensions of solid waste management, analysis specifically targeting household solid waste generation patterns and collection systems remains insufficient. Existing studies predominantly focus on broader issues or different sectors, thereby neglecting the specific dynamics at the household level. Therefore, this paper aims to uncover household solid waste generation patterns, and the performance of waste collection systems.

2. Theoretical Literature Review

This paper is grounded in two key theoretical frameworks that provide a robust conceptual foundation for analysis. The first is the Environmental Kuznets Curve (EKC), initially introduced by Panayotou in 1993 (Mahmoodi &

Dahmardeh, 2022). The EKC posits an inverted U-shaped relationship between environmental degradation and economic development, suggesting that waste generation may initially increase with economic growth, but eventually decrease as income levels and environmental awareness rise. This theory helps to explain the influence of various socio-economic factors on household waste generation patterns, offering insights into how economic development stages impact waste production and management. The second theoretical framework is the theory of planned behaviour (TPB), proposed by Ajzen in 1991 (Bosnjak et al., 2020). The TPB is instrumental in understanding the determinants of individual behaviour, particularly the intention to engage in specific actions. It postulates that behaviour is driven by attitudes, subjective norms, and perceived behavioural control. In the context of this study, the TPB is crucial for investigating how individual behaviours can be influenced to enhance awareness and practices related to solid waste management. By examining attitudes towards waste management, social pressures, and individuals' confidence in their ability to manage waste effectively, this theory provides a comprehensive lens to explore behavioural change. Therefore, this dual-theoretical approach provides a comprehensive basis for analysing the complexities of household waste management, and developing strategies to promote sustainable practices.

3. Context and Methods

This study was carried out in Morogoro municipality in Tanzania, lying between 6° 35´S and 6° 57´S; and 37° 33´E and 37° 50´E; at the base of the Uluguru Mountains. The Morogoro municipal covers 260km² (100sq miles); bordered to the east and south by the Morogoro Rural District, and to the north and west by Mvomero District. The study was carried out between August and September 2022. Five streets (Mbuyuni, Mji Mkuu, Boma, Mazimbu, and Sultan), as shown in Figure 1, were purposively selected for the study. These streets are also served with waste collection services.

The Morogoro municipal constitutes 19 administrative wards. Based on the 2012 national census, the total population of the municipal was 315,866; whereby 151,700 were males and 164,166 were females, making an average household size of 4.1. The population increased to 471,409; where 226,817 were males, 244,592 females. The increase indicates 4.1% annual population change, while an average of household size is 3.5 (URT, 2022). The area is distinctly tropical and is characterized by high summer temperatures; and low but variable rainfall between September and March. It is one of the hottest areas in the country during summer. About 200 metric tons of solid waste is generated daily in the municipality, but the municipal authority can only collect and dispose less than 35% of the generated waste. About 35% of the uncollected waste is disposed of in refuse pits; while 30% is dumped in streets, streams and rivers (Shimba et al., 2021).

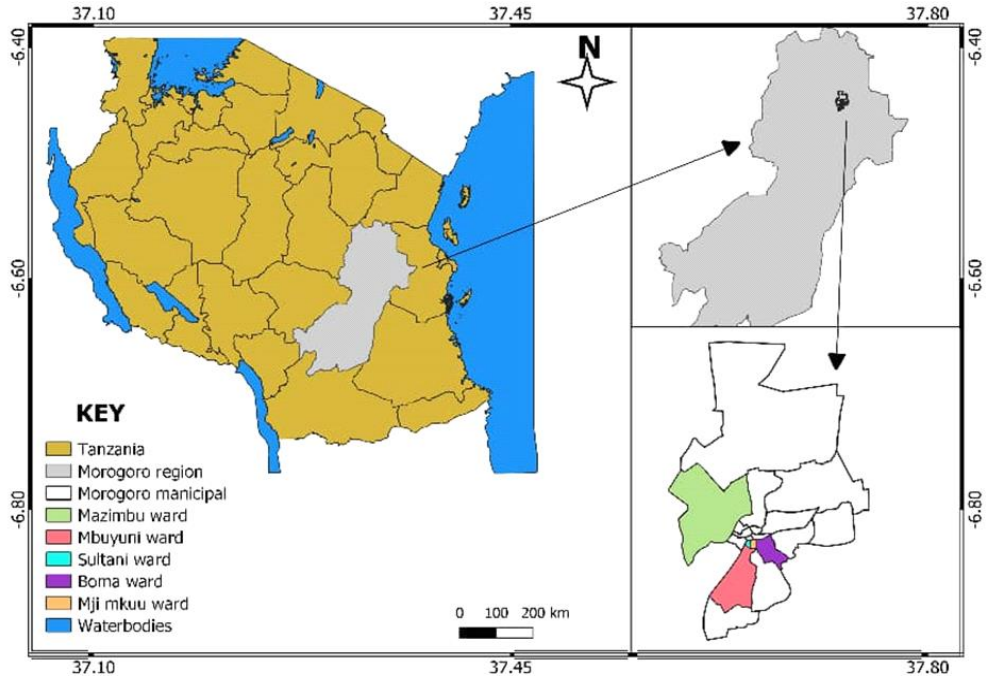

Figure 1: **Location of the Study Area**
Source: URT (2022)

The study yielding this paper adopted a mixed research design, where both quantitative and qualitative methods were employed. A sample of 380 heads of households were randomly selected for the study; and these were involved in a household survey. These were selected for the reason that they are the ones making decisions in most family matters, including waste management aspects. The sample was determined by the Yamane formula (1967): (n) for a given population size (N) with the margin error (e).

$$n = \frac{N}{1 + N * (e)^2}$$

Given:

Population size (N) = 7600
The margin of error e (0.05 for a 95% confidence level).

Hence:

$$n = \frac{7600}{20} = 380$$

So, the sample size for this study was 380 households.

This study used both primary and secondary data sources. Secondary data were collected through reading different published and unpublished literature, obtained from various sources of information. The sources comprised of papers published online by scientific and peer-reviewed journals, books, and unpublished documents from local government offices. Also, visits were made to the main Library of the University of Dar es Salaam and the Morogoro Municipal authority environment section to get insights on environmental issues. Primary data were collected through a household survey, in-depth interviews and field observation. A household survey involved a semi-structured questionnaire, which had both open-ended and close-ended questions. This was used to collect data from household heads. The heads of household in each street were requested to provide information administered by the researcher. This was used to collect information on socio-demographic characteristics of the respondents, waste generation patterns, and waste collection manner. Moreover, field observations were conducted using structured checklists to assess the effectiveness of the waste collection systems on the ground.

Quantitative data collected from the household survey were coded, processed and analysed using the Statistical Package for Social Sciences (SPSS IBM, version 20). Descriptive analysis was executed to uncover essential insights into waste generation patterns among households. Cross-tabulations and chi-square analyses were conducted to uncover relationships between waste quantities and socio-demographic characteristics of households. Microsoft Excel was employed to generate graphs for visual data presentation. Qualitative data from interviews with key informants and FDGs were analysed through content analysis, and presented through descriptive statements and direct quotations. Results for quantitative data were presented by using figures and tables.

4 Results and Discussion

4.1 Socio-economic Characteristics of Respondents

All the 380 sampled households responded to the survey questionnaire. A majority of the respondents were in between ages 18–54 by more than 70%. There were more females (55%) than male (45%); the composition fitting well with the study as women are the ones who engage more in cleaning activities and environmental aspects at large. The majority of the respondents were married (63%), followed by about 18% of unmarried ones. The respondents had attained mostly primary education qualification (41%), followed by secondary education (39%). Most of the respondents engaged in self-activities that involved more than 70%, and the remaining fraction was employed. Also, they were largely found to live in rental houses (55%), with 45% owning their homes. Moreover, the majority of the households (57%) had between 1–5 members on average; while the remaining percentage (43%) had up to 6 and more members (Table 1).

Table 1: Characteristics of the Respondents

Variable	Category	Frequency (n= 380)	Percent (%)
Age	18-35	142	37.4
	36-53	138	36.3
	54^{+}	100	26.3
	Total	**380**	**100.0**
Sex	Male	171	45.0
	Female	209	55
	Total	**380**	**100.0**
Marital status	Married	240	63.2
	Widowed	50	13.2
	Divorced	19	5.0
	Unmarried	71	18.7
	Total	**380**	**100.0**
Education	Primary	158	41.6
	Secondary	149	39.2
	Tertiary	73	19.2
	Total	**380**	**100.0**
Occupation	Employee	96	25.3
	Self- employed	284	74.7
	Total	**380**	**100.0**
House ownership	Own	318	45.5
	Rent	209	55.0
	Total	**380**	**100.0**
Family size	1-5	217	57.1
	6^{+}	163	42.9
	Total	**380**	**100.0**

Source: Field Data (2022)

4.2 Waste Generation and Composition

4.2.1 Waste Composition

Figure 2 provides a detailed analysis of the composition of household solid waste generated by respondents within the study area. The data reveal a significant variation in the types of waste produced, with several key findings emerging: Food-related waste is the predominant category, constituting a substantial 65% of the total household waste. Compound sweepings and paper waste, though representing smaller proportions, are also significant. Specifically, compound sweepings account for 11% of the total waste, while paper waste contributes 92%. Other waste categories include plastic waste at 7%, textiles at 3%, wood waste at 2%, and miscellaneous waste types, including metal and glass, collectively accounting for 2%. Understanding the composition of waste generated is a key aspect of waste management planning. In this study, the predominant waste type generated by households was food waste. Though most of the food waste is not hazardous, managing food waste presents a unique challenge due to its high moisture content, which can attract disease vectors such as houseflies and cockroaches.

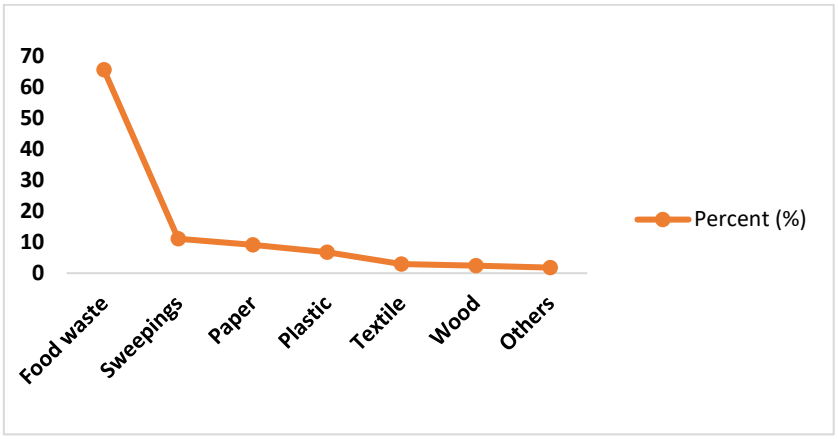

Figure 2: Types of Household Solid Waste Generated
Source: Field Data (2022)

Additionally, small animals like mice and rats are drawn to improperly managed food waste, contributing to hygiene issues, foul odours, and environmental contamination. These results tally with the results emanating from interview sessions with key informants. For example, one interviewee (KI 3) from waste collection service providers was quoted saying:

> *"Apart from foul odours produced by food waste, the drainage from food waste leads to corrosion on the metal components of our waste vehicles, resulting in unending maintenance costs."*

Photo 1: Uncollected Waste Draining Water
Source: Field Data (2022)

The narratives and observations show the challenge associated with handling food and related waste. However, proper waste management strategies can be applied to transform food waste into valuable resources. For instance, food waste can be collected and converted into an energy source; and it can also be used as animal feed for livestock such as chicken and pigs. Furthermore, food waste can be converted into compost manure that can be used to enrich soil for plant cultivation. This approach not only minimizes the budget allocated to waste management, but also contributes to environmental conservation. Numerous studies—including Giavini and van den Berg (2017), and Saleh and Koller (2019)—have highlighted the prevalence of biodegradable materials, particularly food waste, in municipal solid waste, especially in urban areas. This underscores the importance of developing effective strategies for managing organic waste, which forms a significant portion of the waste stream in many African countries. These findings underscore the importance of addressing food waste management as a critical component of overall waste management strategies. Managing food waste not only mitigates environmental and health risks, but also presents opportunities for resource recovery and sustainability.

4.2.2 Waste Quantity

To better understand the daily waste generation patterns among households within the study area, an analysis categorized households into two distinct groups based on the average amount of waste generated per day. The first category comprises households generating 1–3kg of waste per day; and the second category includes households generating more than 4kg of waste per day. The analysis revealed that a majority of households, accounting for a substantial 60%, fell into the first category, generating between 1 to 3kg of waste per day (Figure 3).

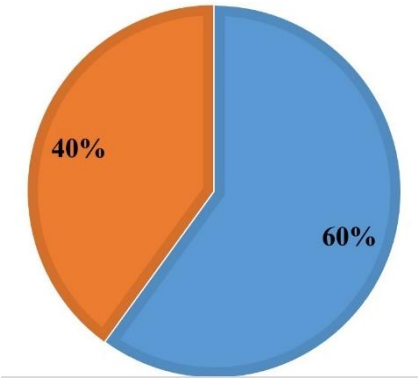

Figure 3: Average Amount of Waste Generated
Source: Field Data (2022)

The study revealed that families with a smaller number of members generated less waste. This is likely because smaller households prepare smaller meals, resulting in less food waste. Another contributing factor could be the lower purchasing power of these households, as most surveyed families reside in low-income areas. These findings are consistent with previous studies, which indicate that the amount of solid waste generated depends on the household size and income level (Mfinanga et al., 2018; Ezeudu et al., 2019).

4.2.3 Factors Influencing Waste Quantities

The study revealed the influential role of socio-demographic attributes in shaping household waste generation. Notably, age emerged as a vital determinant, with households headed by individuals aged 46 and above exhibiting markedly higher waste quantities (73%) with statistically significant p-value ($p<0.000$), underscoring that older households tend to generate more waste compared to younger counterparts. Additionally, tenure status was found to be a significant factor, as households residing in owned properties generated a substantially higher quantity of waste (82.0%) compared to those in rented accommodations ($p<0.001$). Furthermore, there was an association between family household size and waste quantity (61%) ($p<0.000$) (Table 2).

Table 2: Factors Influencing Waste Quantities

Variable	Category	Waste 1-3kg		Waste 4⁺kg			
		Freq.	*%*	*Freq.*	*%*	*Total*	*P-value*
Age	18-45	97	45.5	45	26.9	142	
	46+	116	54.5	122	73.1	238	**.000**
	Total	**213**	**100.0**	**167**	**100.0**	**380**	
Sex	Male	105	49.3	66	43.4	171	
	Female	108	50.7	101	56.5	209	**.057**
	Total	**213**	**100.0**	**152**	**100.0**	**380**	
Marital status	In marriage	131	61.5	95	56.9	226	
	Not in marriage	82	38.5	72	43.1	154	**.363**
	Total	**213**	**100.0**	**167**	**100.0**	**380**	
Education level	Primary	201	94.4	153	91.6	354	**.292**
	Secondary	12	5.6	14	8.4	26	
	Total	**213**	**100.0**	**167**	**100.0**	**380**	
House ownership	Own	181	85.0	137	82.0	318	**.001**
	Rent	32	15.0	30	18.0	62	
	Total	**213**	**100.0**	**167**	**100.0**	**380**	
Family size	1-5	157	73.7	60	35.9	217	
	6^{+}	56	26.3	107	64.1	163	**.000**
	Total	**213**	**100.0**	**167**	**100**	**380**	
Occupation	Employed	158	74.2	126	75.4	284	
	Self Employed	55	25.8	41	24.5	96	**.777**
	Total	**213**	**100.0**	**167**	**100.0**	**380**	

Source: Field Data (2022)

The study revealed a correlation between the age of household heads, family size, and the quantity of waste generated, particularly concerning food waste. Older household heads, often overseeing larger families due to having more children and grandchildren, were associated with increased food waste generation. This aligns with observations by Adzawla et al. (2019) and Noufal et al. (2020), indicating that larger households tend to produce greater amounts of solid waste. Conversely, smaller family sizes were linked to reduced food waste generation, as limited family sizes typically result in smaller meal portions and, consequently, less waste production. While no significant associations were found between factors such as gender, educational level, marital status, and the activities of household heads and waste generation quantities, the influence of population size and household income levels on solid waste generation was consistent with previous research (Mfinanga et al., 2018; Ezeudu et al., 2019).

4.2.4 Waste Segregation at Source

Observations revealed that households engaged in minimal sustainable waste management practices such as segregation, sorting, and recycling. When asked why they were not actively sorting waste, one FGD member (FDG No. 5) said:

> *"Segregating waste presents a challenge for me because I lack the means to afford separate waste containers. Furthermore, even if I were to segregate the waste, there are no designated facilities or locations to take the segregated waste, as all waste is ultimately disposed of at the same dump site."*

In their respective studies, Nyampundu et al. (2020) and Kihila et al. (2021) verified the limited or non-existent waste segregation practices in Tanzania. Despite the presence of environmental policies, acts, and regulations that emphasize waste segregation, the actual implementation of these measures significantly lags behind.

4.3 Waste Collection System

4.3.1 Collection Points

Approximately 27% of the households utilized the street-side collection system, whereby waste is deposited in designated areas along specific pathways for later collection. This method is favoured for its convenience in certain urban settings. In contrast, the door-to-door collection system was the least utilized, accounting for only 10% of the waste collection methods employed by households (Photo 2).

It was observed that despite the presence of waste collection systems, instances of improper waste disposal persist. These include illegal dumping in various open spaces such as cemetery areas, backyards, along streets and main roads, near river streams, and in proximity to homesteads. This phenomenon aligns with findings from other research, which indicate a common prevalence of illegal or unregulated dumpsites across African countries.

Photo 3: Waste Waiting for Door-to-door Collection
Source: Field Data (2022)

The literature underscores the significant environmental challenges posed by illegal dumpsites. These challenges encompass the obstruction of drains and sewers (Ejaz et al., 2010), the release of toxic substances (leachates) into the soil, and subsequent environmental heavy metal contamination (Bartkowiak et al., 2016). Furthermore, the inefficiency of waste collection systems has been correlated with various health issues. Specifically, inadequate waste management has been linked to respiratory problems, infectious diseases, and gastrointestinal ailments (Gutberlet & Uddin, 2017).

4.3.2 Waste Collection Frequency

The analysis revealed that the frequency of waste collection was significantly inconsistent across the surveyed area, with 74% of the respondents reporting irregular collection schedules. Only 17% of the respondents indicated that waste collection occurred once a week. Notably, there were no instances of waste being collected three times a week as scheduled (Table 3). Observations confirmed that these infrequent collections resulted in the accumulation of waste in residential areas, posing potential health and environmental hazards.

Table 3: Waste Collection Frequency

Responses	Frequency	Percentage
Inconsistent	280	73.7
Once a week	65	17.1
Twice a week	35	9.2
Three times a week	0	0
Total	**380**	**100**

Source: Field Data (2022)

Frequent waste collection enhances environmental health by minimizing unpleasant odours, and reducing the potential for littering and illegal dumping. This not only improves the aesthetic appeal of communities, but also makes them more pleasant and healthier places to live. Additionally, regular collection schedules are essential for effective recycling and waste management practices, ensuring timely collection of recyclable materials, and promoting environmental sustainability. Moreover, frequent waste collection services significantly improve residents' quality of life by ensuring a cleaner, safer, and more sanitary living environment. Research indicates that infrequent waste collection is prevalent in developing countries, exacerbating public health and environmental issues (Ahsan et al., 2014; Nyampundu et al., 2020; Adedara et al., 2023).

4.3.3 Storage Containers

The study revealed a predominant reliance on sacks for waste storage, with 95% of the respondents indicating sacks as their primary waste storage container. The study also identified a minimal use of other container types, including plastic buckets, cartons, drums, and woven baskets (Table 4).

Table 4: Waste storage containers

Type	Frequency	Percentage
Plastic buckets	10	2.6
Metal buckets	1	0.3
Cartons	5	1.3
Sacks	360	94.7
Drums	1	0.3
Woven baskets	3	0.8
Total	**380**	**100**

Source: Field Data (2022)

Proper waste storage is crucial for maintaining public health and environmental quality. The type and condition of waste storage containers have a direct impact on the sanitation of residential areas, the efficiency of waste collection services, and the prevention of environmental contamination. The prevalent use of sacks for waste storage raises several significant concerns. Despite being convenient and inexpensive, sacks often fall short in providing sanitary and effective waste containment. Also, sacks are prone to tearing, which leads to spillage and increased exposure to pests. The limited adoption of more durable and secure containers, such as plastic buckets and drums, suggests a gap in the access to, or awareness of, better waste storage options. The research findings of Ryogo (2015), Wekisa and Majale (2020), and Nevrlý et al. (2021), highlight the substandard use of waste storage containers among households in developing countries. These studies collectively emphasize the need for improved waste management infrastructure, and increased public awareness to address the health and environmental risks associated with inadequate waste storage solutions.

Photos 5 & 6: Observed Waste Storage Facilities
Source: Field Data (2022)

4.3.4 Waste Collection Efficiency

Interviews with representatives from the municipal authority's environmental section highlighted numerous challenges associated with waste collection. Foremost among these challenges is the critical shortage of funds needed for procuring essential transport facilities. This funding deficit for vital transport infrastructure significantly impacts waste collection services. Insufficient transportation resources hinder municipalities from effectively gathering and transporting waste from residential areas to disposal sites. For instance, the research conducted by Chamwali et al. (2022) in Morogoro revealed that municipal officials could only collect and dispose of less than 35% of the 200 tons of solid waste generated daily. This situation underscores a pervasive issue of low municipal waste collection efficiency, not only in Tanzania but also more broadly in developing countries, as noted by Guerrero et al. (2013), Joshi & Ahmed (2016), Lema et al. (2019), and Biswas and Singh (2021).

6. Conclusion and Recommendations

This study revealed significant findings regarding household waste generation patterns and collection systems in Morogoro municipality. The study found that households consistently generate various types of waste, including food waste, compound sweepings, papers, and plastics, with negligible seasonal variations. However, the existing waste collection systems in Morogoro face numerous challenges. The frequency and efficiency of waste collection services are inadequate, primarily due to the lack of infrastructure and resources. These deficiencies lead to the accumulation of waste in public areas, increasing the risk of environmental pollution and disease transmission. The study underscores the urgent need for more reliable waste collection services to prevent waste accumulation and its associated risks. Addressing the inconsistencies in waste collection schedules should be a priority to improve

urban sanitation and public health. Additionally, the study highlighted the influence of socio-demographic factors on waste generation patterns within the municipality. As Morogoro experiences rapid growth, waste management issues are escalating, posing a significant hurdle to achieving environmental sustainability. The municipality's struggle to manage generated waste can largely be attributed to financial constraints, emphasizing the need for enhanced funding and infrastructure development to support effective waste collection and management.

Based on the significant findings of this study, the following recommendations are proposed to address the challenges associated with household waste generation and collection in Morogoro municipality. First, significant investment in infrastructure, such as additional waste collection vehicles and advanced technology is crucial to enhance the frequency and efficiency of services. Increasing financial allocations through alternative funding sources, including enhanced public-private partnerships and grants, can mitigate the existing financial constraints. Moreover, comprehensive public awareness campaigns and community involvement initiatives are crucial to improving waste segregation practices, and ensuring adherence to collection schedules. Strengthening and promoting sustainable practices such as recycling and composting will further support effective waste management.

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