Evaluation of Challenges Associated with Solid Waste Management in the City of Kigali, Rwanda

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Abstract

Increasing environmental pollution is caused by various factors, including an increase in the human population, which increases the amount of waste disposed of. One of the issues that the community and city managers face in Kigali is the presence of garbage. Individual behavior, attitudes, and public perceptions play a role in waste management as obstacles. This study aims to identify, understand, and evaluate the challenges faced in managing solid waste in Kigali. This study used a mixed-method approach. Data were collected through field observation, questionnaires, and interviews to analyze the challenges associated with solid waste management. The data were analyzed by using Jamovi software. The results showed a low community behavior and attitudes toward waste management; ignoring waste management harms the environment and public health. Hostile community behavior, such as throwing trash in illegal dumping, causes waste to accumulate and other problems. The results indicated that WM laws and regulations have not been appropriately implemented and lack awareness and a limited understanding of solid waste management. Kigali city does not recover energy from waste, and Kigali city lacks proper waste management facilities and treatment skills.

Introduction

Garbage is a global issue that is affecting the entire world today. Approximately 5 million tons of waste are generated daily, approximately half of which is a non-organic waste(Bergesen et al., 2019). The waste problem has not been adequately addressed, particularly in various regions of Rwanda(Iraguha et al., 2022). Every year, the amount of waste produced increases(Kabera et al., 2019). Increasing environmental pollution is caused by various factors, including an increase in the human population, which increases the amount of garbage disposed of(Anirudh Rajashekar et al., 2019). It is exacerbated by inadequate waste disposal facilities, a lack of community awareness and willingness to manage and dispose of waste, and a lack of public understanding of the benefits of garbage. The community is reluctant to reuse trash because waste is considered dirty and must be discarded or lose prestige(Isugi et al,. 2016)(Manaf et al., 2009). Improperly managed garbage can pollute the environment and cause river silting, leading to flooding(Mbuligwe, 2013). Furthermore, garbage can contribute to the spread of disease, pungent odors, and other issues that interfere with comfort and health(Savino et al., 2019). These various factors contribute to decreased environmental quality and negatively impact the community.

The rapid growth of the population in Kigali is inextricably linked to various advances in transportation, technology, and other facilities(World Bank Group, 2018). It is a fact that the city of Kigali is the most efficient and effective location for productive activities(Iraguha et al., 2022). Population growth, consumption patterns, and lifestyle changes have increased waste characteristics' amount, types, and diversity (Sundaranar et al., 2011)(Byamba & Ishikawa, 2017). Increased purchasing power for various types of basic materials and technological products, as well as increased businesses or activities supporting a region's economic growth, all contribute significantly to the quantity and quality of waste produced(Wainberg, 2017). One of the issues that the community and city managers face in Kigali is the

presence of waste(Kabera et al., 2019)(Study et al., 2018). Especially in terms of infrastructure and facilities. Government and public waste awareness must be investigated so Rwanda can be free of waste problems(Iraguha et al., 2022).

Materials And Methods

This study employs a mixed method to understand better Kigali City's waste management system and challenges. Distributing questionnaires to respondents, community interviews, contacting waste collection and recycling companies and government agencies, and other sources such as national reports were used to gather information. Systematic random sampling was used to select households. The study had no intention of generalizing to the entire population. It looked at the city of Kigali and tried to capture the attitudes, behaviors, and challenges associated with solid waste management practices in a small sample size. The Jamovi software was used to analyze statistical data for this study.

Results And Discussion

Waste generation

Solid wastes in Kigali City rapidly increase in quantity and quality as the city's population and economic activities grow, while disposal land becomes scarce. Composting and landfill methodologies are the most viable alternatives for managing solid waste in Kigali City. However, no single strategy will effectively control the waste problem as a successful program that relies on varied solutions for various conditions. Direct citizen participation is essential.

Table 1
Kigali City's waste generation, population density, and GDP per capita per year.

Year	Waste generated per day(Tons)	Waste generated by capita/day(Kg/day)	Population density(/Km)	GDP per capita(USD)
2012	408	0.47	1,213	725.16
2014	450	0.6	1,391	743.56
2018	808	1.6	1,402	783.63
2022	823	2.09	1,552	832.57

The results show that waste generation was 2.09 kg per capita per day (the maximum amount), as presented in Table 1. The amount of waste generated exceeded the 1 kilogram per person per day limit, placing the city in the category of a "higher waste generating" city.

Table 2
The generated solid waste and collected in selected districts of the city of Kigali

District	Waste generated/day	Waste collected/day		Waste left uncollected	
	Tonnes(Ton)	Tonnes(Ton)	%	Tonnes(Ton)	%
Gasabo	371	311		60	
Kicukiro	210	198		12	
Nyarugenge	242	209		33	
Total	823	718	87,2	105	12,8

The results show that only 87.2% of solid waste was collected, with the remaining 12.8% left uncorrected (Table 2), implying that some households dump their waste in illegal dumpsites.

The results showed that the City of Kigali generates more organic waste. The results in Fig. 1 show that Organic waste accounts for 78 percent of waste generated in Kigali, with food (20.6%), garden (379%), and wood (7.8%) accounting for the remaining 6.6 percent (paper and cardboards (9 percent. Plastic makes up 3.7 percent of non-organic waste, followed by metal (1.6 percent), glass (1.1 percent), and metal (1.6 percent).

Kigali municipal solid waste treatment method

Citizens are expected to collect household waste in sacks or other temporary containers and hand it to private waste collectors. Figure 2 shows different methods households use to manage temporary waste.

In Kigali, 7.24 percent of waste was burned without energy recovery, as shown in Fig. 3. Kigali lacks waste treatment due to low citizen participation, weak policymaking, and poor private sector performance.

Waste Management and Disposal (Environmental Control)

The results indicated that 87.2 percent of waste collected for treatment or disposal was disposed of at the Nduba regulated disposal site; Fig. 11 depicted the Nduba landfill, the only landfill in the City of Kigali. It lacks proper automobile access to the site via paved roads. The Nduba landfill lacks a weighbridge, making it difficult to keep accurate records of all entering garbage information, including waste volumes, weights, and

types. This site has not been subjected to an Environmental Impact Assessment. The site is not operating at full environmental control capacity (see the score for 2C.3). Table 8 summarizes the preceding points.

Table 3
General information at Nduba disposal site.

Description	Evaluation(Nduba Landfill)
Amount of waste received	87.2% (718Tons)
Paved roads(Vehicle accessibility)	–
Nduba landfill security	✓
Unloading of waste	±
Control of fires	±
Waste treatment and disposal	Medium level
Environmental Impact Assessment	–
Volume, weights, and categories of incoming waste	✓
Control of odor, emission(GHG)	–
Leachate	–

✓Denotes the presence of practices; – indicates inadequate standards, the absence of practices or very low quality; and ± denotes the existence of records that have not been updated.

Significant progress has been made in some technical areas; however, the sites are not following the standards. Operators lack technical training. Moreover, their vehicles and equipment are outdated and insufficient (see the score for 2C.5). Currently, no waste-to-energy is generated. Some safe operating procedures exist but are not followed. There were no health checks for the disposal workers. No effort has been made to consider the conditions of heavy machinery operators or workers directly on the landfill site in hazardous working conditions (hence the variable 2C.6 was scored low). Table 3 shows the evaluation results of the reference indicators and the factors that comprise them for Environmental Control. The qualitative indicator (2C) obtained a 50 percent score.

Table 4
Environmental control assessment, using reference indicators of 2C (qualitative) and 2(quantitative)

Indicator	Description	Observations
2	Control of waste management or disposal (%)	50%
2C.1	Control over waste collected and general site management	Medium
2C.2	Degree of control over waste treatment and disposal	Medium
2C.3	Degree of verification and monitoring of environmental controls	Medium compliance
2C.4	Waste to energy generation(Energy recovery)	NA
2C.5	Degree of technical expertise in the management, planning, operation, and disposal	Medium compliance
2C.6	Workplace health and safety	Low compliance
2C	Environmental protection level in waste treatment and protection	Medium ((Total score 50%)

The findings in Table 4 show the evaluation of the reference indicators and associated environmental control variables. Due to the above facts, we rate the qualitative indication (3A) at 25%. There is inadequate information about the informal recycling sector. Therefore, more emphasis should be placed on this issue.

The Community Perceptions, Awareness, Attitudes, and Behaviors in Solid Waste Management

Community Knowledge and awareness of solid waste separation

Table 5
Waste separation status in Kigali city

Waste separation status			
No		Frequency	Percentage
1	Yes	5	2%
2	No	199	98%
	Total	204	100

Table 5 shows that 98% of respondents don't separate solid waste. Citizens lack knowledge about waste management and its effects. Environmental education and knowledge are key to raising public awareness of environmental issues.

Table 6
The reason why citizens do not separate solid waste

	The reason why I do not separate waste		
No		Frequency	Percentage
1	Ignorance	31	20,5%
2	Laziness	30	19,9%
3	I don't think it is necessary to sort out	14	9,3
4	Waste collection companies are responsible, not citizens	71	47
5	I don't have any knowledge of sorting out	5	3,3
	Total	151	100

In Table 6, the study looked at factors that can affect waste segregation at the household level. The lack of waste sorting equipment affects the performance of waste sorting programs and the lack of public awareness of environmental problems.

The Community Perceptions, Attitudes, and Behaviors in Solid Waste Management

The results show that 83% of households have solid waste disposing of the container and 17% do not (Fig. 4). They dump their solid waste at inappropriate places and in their backyard.

Community and SWM Payment Services

The private-public partnership works on average, and households pay a reasonable charge based on their categorization of social class (Ubudehe). Fees range from 1000 Rwf (USD1.2) to 5000 Rwf (USD6) monthly. Category 1 (poor people) is exonerated. Private garbage collection companies continue to generate revenue despite complaints that the garbage collection fee is insufficient.

The citizens are expected to pay a waste collection fee. However, some households fail to pay waste collection fees due to poverty or ignorance; they dump their waste on illegal dumpsites. The results showed that 14.7% of citizens do not pay solid waste collection fees (Fig. 5).

The legal and regulatory framework

Table 7
Benchmark indication (6F) qualitative evaluation for SWM framework.

Indicator	Description	Observations
6F.1	Regulations and legislation	Medium compliance
6F.2	Policy and Strategy	Medium compliance
6F.3	Procedures for implementation and guidelines	Medium compliance
6F.4	National institution responsible for SWM implementation policy	Medium compliance
6F.5	Regulation control	Medium compliance
6F	Adequate the national framework for SWM	Total score 46%

Municipal governments have guidelines for the laws and strategies implementation; however, existing approaches to MSW-related concerns are insufficiently holistic. The baseline studies are insufficient; the Ministry of Environment is the national agency in charge of policymaking, although it is not in charge of policy implementation or coordination. The municipal government implements the regulations (see scores for 6F.3, 6F.4, and 6F.5). Based on these facts, the qualitative indicator (6F) score is 46 percent (Table 7).

Conclusions

This study shows the challenges associated with the management of solid waste in Kigali city; Citizens have a poor understanding of waste management practices and their consequences, as well as insufficient knowledge and awareness. Kigali city lacks proper waste management facilities and treatment skills. People who live near the Nyabugogo watershed dump their garbage with low community behavior and attitudes toward waste management. Some citizens fail to pay waste collection fees due to poverty or ignorance and dump their garbage in the water channel and other illegal dumpsites. During the rainy season, this trash is carried toward the watershed, polluting the water, hurting aquatic species, and causing eutrophication.

WM laws and regulations have not been properly implemented; they burned waste without recovery energy. Its actions and strategic plans did not mention solid waste management public awareness campaigns.

Declarations

Conflict of interest.

We declare that there are no conflicts of interest of any nature.

Ethical approval.

All the co-authors have studied and agree with the contents of the manuscript and there is no financial interest to report

References

Anirudh Rajashekar, Aiden Bowers, & Alexis Sebarenzi Gatoni. (2019). Assessing waste management services in Kigali. *International Growth Centre*, *July*, 73.

Bergesen, H. O., Parmann, G., & Thommessen, O. B. (2019). Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel Convention). *Yearbook of International Cooperation on Environment and Development 1998–99*, 87–89. https://doi.org/10.4324/9781315066547-15

Byamba, B., & Ishikawa, M. (2017). Municipal solid waste management in Ulaanbaatar, Mongolia: Systems Analysis. *Sustainability (Switzerland)*, *9*(6). https://doi.org/10.3390/su9060896

Iraguha, F., Handono Ramelan, A., & Setyono, P. (2022). Assessment of current solid waste management practices, community perceptions, and contributions in the City of Kigali, Rwanda. *IOP Conference Series: Earth and Environmental Science*, *1016*(1), 012056. https://doi.org/10.1088/1755-1315/1016/1/012056

Isugi, J., & Niu, D. (2016). Research on Landfill and Composting Guidelines in Kigali City, Rwanda Based on China's Experience. *International Proceedings of Chemical, Biological and Environmental Engineering*, *32*(1), 12–16. https://doi.org/10.7763/IPCBEE

Kabera, T., Wilson, D. C., & Nishimwe, H. (2019). Benchmarking performance of solid waste management and recycling systems in East Africa: Comparing Kigali Rwanda with other major cities. *Waste Management and Research*, *37*(1_suppl), 58–72. https://doi.org/10.1177/0734242X18819752

Manaf, L. A., Samah, M. A. A., & Zukki, N. I. M. (2009). Municipal solid waste management in Malaysia: Practices and challenges. *Waste Management*, *29*(11), 2902–2906. https://doi.org/10.1016/j.wasman.2008.07.015

Mbuligwe, S. E. (2013). *Solid Waste Management Assessment Within Urban Settings in Burundi , Rwanda ,*.

Savino, A. A., & de Titto, E. (2019). *Sustainable Waste Management Challenges in Argentina: Vol. i*. https://doi.org/10.4018/978-1-7998-0198-6.ch001

Study, C., Nairobi, O. F., & In, K. (2018). *Technology WJERT SUSTAINABLE SOLID WASTE MANAGEMENT IN URBAN AREAS A*. *4*(4), 389–399.

Sundaranar, M., Nadu, T., & Breeding, T. (2011). *Municipal Solid Waste (MSW) production and management in Kovilpatti Municipality*. *1*(5), 307–311.

Wainberg, R. (2017). Solid waste management. *Water*, *26*(1), 28–29.

World Bank Group. (2018). What a Waste 2.0 Introduction -"Snapshot of Solid Waste Management to 2050." Overview booklet. *Urban Development Series*, 1–38. https://openknowledge.worldbank.org/handle/10986/30317

Figures

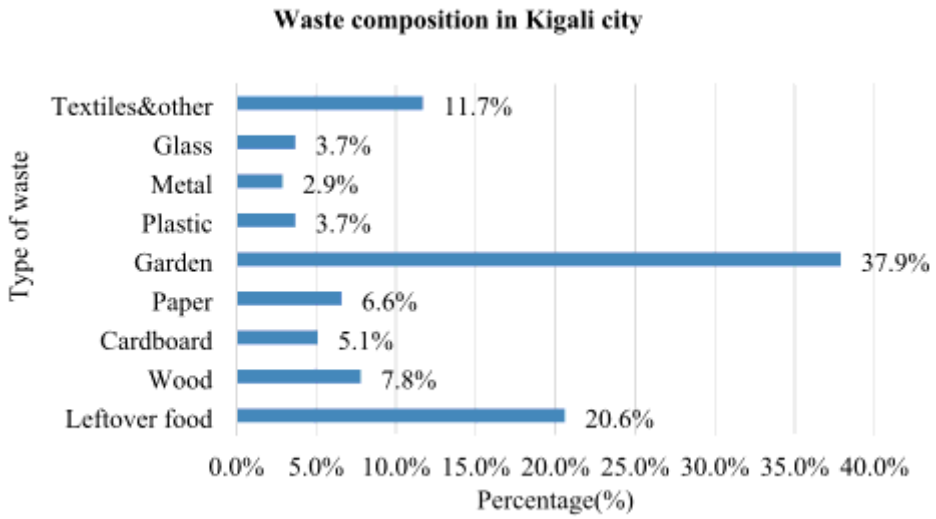

Figure 1

Waste composition in Kigali City

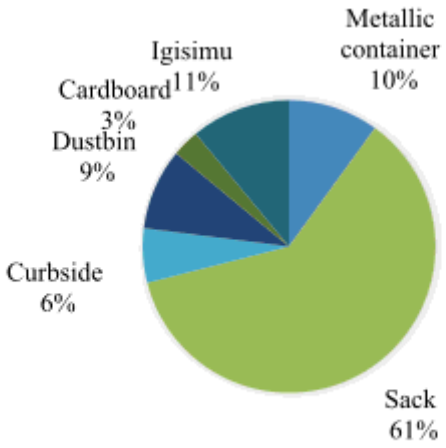

Figure 2

Household solid waste collection methods

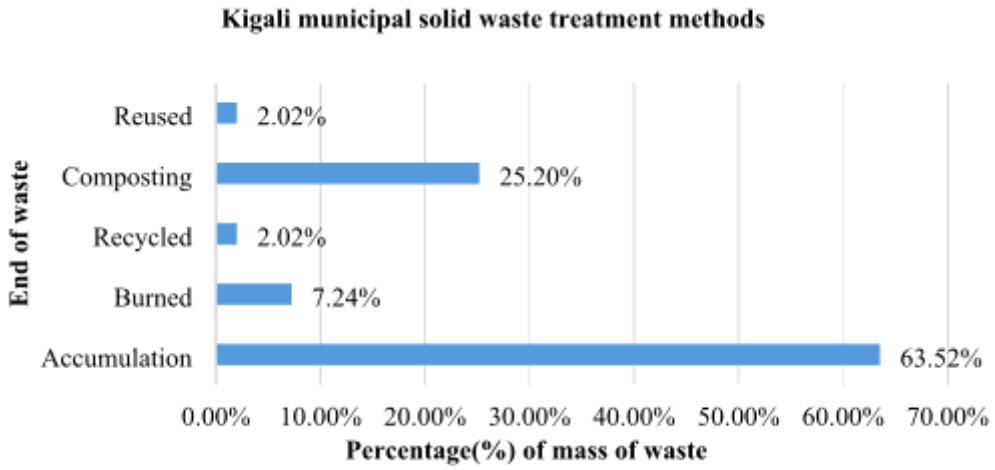

Figure 3

Kigali municipal solid waste treatment methods

Figure 4

Households with a solid waste disposal container

Figure 5

Status of solid waste collection fee payment