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Augustin Nshimiyimana & Dr. Justin Nsanzabaganwa

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Evaluation of Peoples Responses to Solid Waste Management in Rwanda: A Case of Urban Sectors of Musanze District

Augustin Nshimiyimana¹ & Dr. Justin Nsanzabaganwa¹ (PhD)

¹*Faculty of Environmental and Development Studies, University of Lay Adventists of Kigali, Kigali, Rwanda*

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Abstract

Urbanization and changing consumption patterns have increased Municipal Solid Waste (MSW) generation, creating environmental and public health challenges in developing countries. In Rwanda, despite strengthened policies and institutional frameworks, implementation gaps remain, particularly in Musanze City. This study assessed people's responses to solid waste management (SWM), evaluated SWM practices, and examined their relationship in Cyuve, Muhoza, and Musanze sectors. Using a descriptive cross-sectional mixed-methods design, quantitative data were collected from 399 households through structured questionnaires, complemented by key informant interviews. Findings showed high levels of awareness (mean = 4.14–4.20), positive attitudes (4.24–4.28), favorable perceptions (3.98–4.31), strong behavioral intentions (4.19–4.26), and participation (4.13–4.25). SWM practices were high in waste storage (4.11–4.18), disposal (4.17–4.23), participation (4.13–4.19), and environmental cleanliness (4.13–4.20). Waste segregation was moderate (3.94–3.98), while recycling and reuse were low (2.48–2.61). Strong positive correlations were found between people's responses and SWM practices ($r = 0.63–0.89$), with responses significantly predicting SWM practices ($R^2 = 0.79$). Strengthening awareness, recycling, and community participation is recommended.

Keywords: *Community Participation, Municipal Solid Waste, Public Perception, Solid Waste Management, and Urban Sustainability.*

1. Introduction

Solid waste management (SWM) has become a major environmental and public health challenge worldwide, particularly in rapidly urbanizing areas. Population growth, urbanization, and changing consumption patterns have significantly increased the generation of municipal solid waste (MSW). The challenge is more pronounced in developing countries where inadequate infrastructure, weak institutional frameworks, and limited public awareness hinder effective waste management. Consequently, many urban areas experience problems such as inefficient waste collection, open dumping,

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environmental pollution, and associated health risks (Iraguha et al., 2022).

The situation is particularly evident across developing countries, where economic growth and urban expansion continue to increase waste generation. For example, in Ethiopia, especially in Addis Ababa, the average municipal solid waste generation rate ranges between 0.45 and 0.50 kilograms per person per day, reflecting the growing pressure placed on urban waste management systems (World Bank, 2018; Kaza et al., 2018). These trends highlight the need for sustainable waste management approaches that combine effective infrastructure with active community participation.

In Rwanda, rapid urbanization and economic transformation over the past two decades have contributed to a substantial increase in solid waste generation, particularly in urban centers. Studies indicate that Kigali City generates approximately 0.57 kg of solid waste per person per day, with hundreds of tons of waste produced daily (Kabera, 2019; Rajashekar & Bowers, 2020). Although Rwanda has made significant progress in environmental governance through measures such as the ban on single-use plastics and improved waste collection services, challenges remain, including inadequate waste segregation, limited recycling capacity, insufficient infrastructure, and improper waste disposal practices that threaten environmental sustainability and public health (Iraguha et al., 2022).

These challenges are increasingly evident in Musanze District, particularly in the urban sectors of Cyuve, Muhoza, and Musanze. Rapid urban growth, tourism development, and expanding commercial activities have increased waste generation from households, markets, restaurants, hotels, and businesses. Despite investments in waste management infrastructure, including facilities capable of processing approximately 33 tons of waste per day (WASAC, 2025), practices such as littering, open dumping, poor waste segregation, and disposal of waste in drainage channels persist (Kaza et al., 2018).

A key factor underlying these challenges is the level of community response to waste management initiatives. Effective SWM depends not only on infrastructure and regulations but also on residents' awareness, attitudes, perceptions, and participation. However, limited empirical evidence exists regarding how residents in Cyuve, Muhoza, and Musanze sectors respond to current waste management practices. This knowledge gap makes it difficult for policymakers and environmental stakeholders to design effective, community-based waste management strategies. Therefore, this study examines people's responses to solid waste management practices in Musanze District to generate evidence that can support sustainable environmental management and improved urban sanitation.

1.2 Objectives of the Research

1.2.1 General objective

The general objective of the study was to evaluate people's responses on solid waste management practices in the urban sectors of Musanze District, Rwanda.

1.2.2. Specific objectives

- (i) To assess the effectiveness of solid waste management approaches in Musanze District
- (ii) To evaluate the extent to which residents in Cyuve, Muhoza, and Musanze sectors adhere to proper solid waste management practices
- (iii) To analyze the relationship between people's responses and solid waste management practices in urban sectors of Musanze District.

2. Research methods

2.1 Description of the study area

The study was conducted in the urban area of Musanze District, located in Rwanda's Northern Province. Covering approximately 530 km², the district had a total population of 476,522 in 2022, including about 234,258 urban residents. The study focused on the urban sectors of Muhoza (69,741 residents), Cyuve (62,179 residents), and Musanze (47,720 residents), which are densely populated and serve as important commercial, administrative, and tourism centers, making them suitable for investigating solid waste management practices.

Musanze experiences a temperate climate, with an elevation ranging from 1,850 to 2,240 meters above sea level, average annual rainfall of 1,302 mm, and an average temperature of 17.8°C. Socio-economic indicators show improving living conditions, with the poverty rate reduced to 21.98%, literacy among individuals aged 15 years and above reaching 79.4%, and relatively high access to essential services such as electricity, sanitation, and safe water.

Despite these positive developments, rapid urbanization and population growth have increased solid waste generation to approximately 150 tons per day, while only about 12 tons are effectively managed. These challenges place significant pressure on municipal waste management systems, making Musanze's urban sectors an appropriate setting for examining residents' knowledge, attitudes, and practices regarding solid waste management (Musanze DDS, 2025).

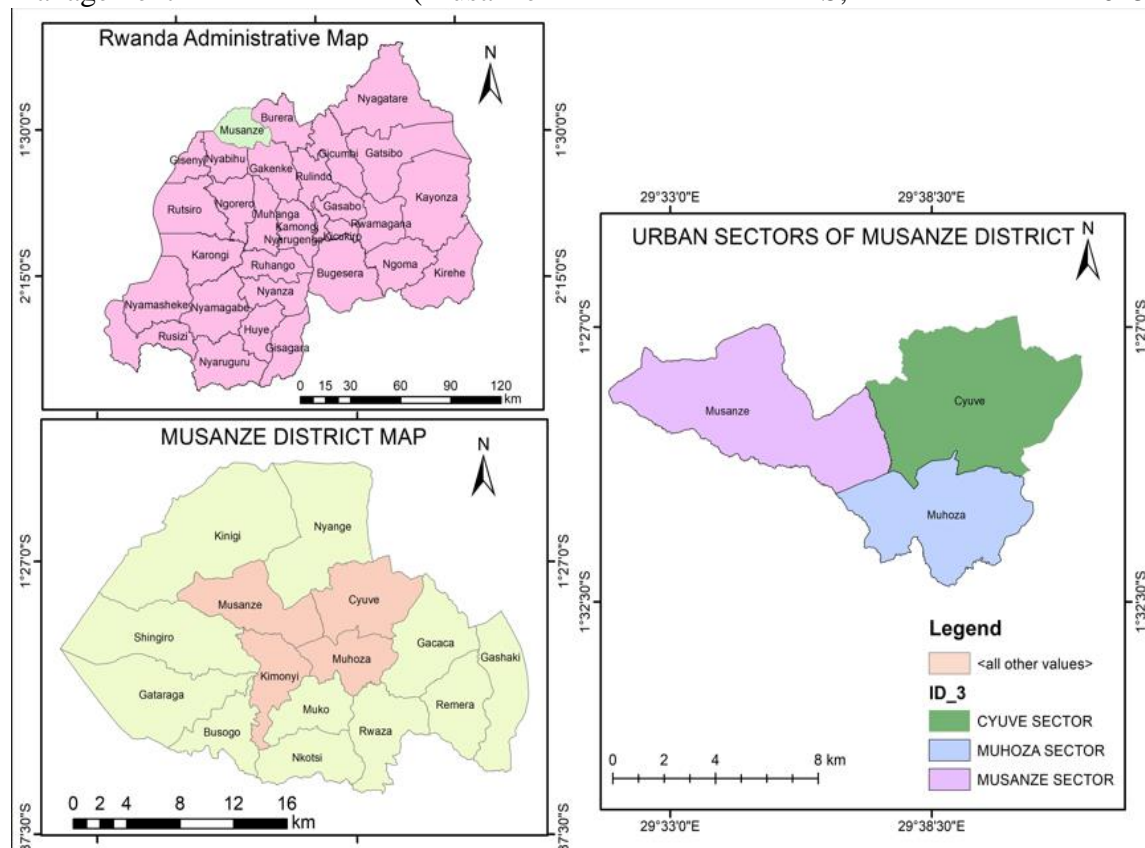


Figure 3.1.Map of Musanze districts urban area

Source: Researcher mapping in Arc GIS 10.8, 2026

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2.2. Research design and data collection methods

This study employed a descriptive cross-sectional research design to assess people's responses to solid waste management practices in the urban sectors of Musanze District, Rwanda. The design is appropriate for examining community knowledge, attitudes, perceptions, and practices at a single point in time using both quantitative and qualitative approaches.

The target population included residents of Cyuve, Muhoza, and Musanze sectors, who are the main waste generators, as well as local authorities, waste collectors, recyclers, and environmental officers responsible for waste management planning and implementation. The total household population was 44,679 households in the study area.

The sample size was determined using Yamane's (1967) formula, resulting in a total of 419 participants, of which 399 household heads were selected for quantitative surveys. Additionally, purposive sampling included 10 SMEs/business operators, 3 local leaders, 5 waste collectors, 1 waste management officer, and 1 district environmental officer, ensuring representation of key stakeholders.

A combination of sampling techniques was applied. Stratified sampling grouped respondents into households, SMEs, and institutions; simple random sampling was used to select household respondents; and purposive sampling identified key informants based on expertise and relevance to waste management.

Data collection involved multiple methods to ensure triangulation. Structured questionnaires were administered to households and SMEs to collect quantitative data on awareness, attitudes, and practices. Key informant interviews provided in-depth qualitative insights from officials and service providers. Direct field observations assessed actual waste practices, storage, and environmental conditions, while document review analyzed reports from Musanze District, REMA, and NISR, along with academic literature. Together, these methods ensured comprehensive, valid, and reliable data on solid waste management in Musanze District.

3.6. Data analysis and processing

Quantitative data from questionnaires were coded and analyzed using IBM SPSS Statistics and Microsoft Excel. Analysis included descriptive statistics (frequencies, percentages, means, and tables) to summarize respondents' perceptions of solid waste management. Inferential analysis was conducted using the Chi-square (χ^2) test of independence at a 5% significance level ($\alpha = 0.05$) to examine relationships between socio-demographic characteristics and perceptions of solid waste management. Qualitative data from interviews and observations were analyzed using thematic analysis, where responses were organized into key themes aligned with the study objectives.

To ensure validity and reliability, instruments were carefully developed in line with study objectives and reviewed by academic supervisors and environmental experts to ensure content validity. Construct validity was ensured using standardized five-point Likert scales, while face validity was confirmed through pilot testing. Reliability was assessed using Cronbach's alpha (≥ 0.70 acceptable) and test-retest reliability to ensure consistency over time. A pilot study (5%–10% of respondents) was conducted in a similar population outside the study sample to refine tools by improving clarity, removing ambiguities, and enhancing structure.

Ethical considerations were strictly followed. Approval was obtained from relevant local authorities and the University of Lay Adventists of Kigali. Informed consent was secured from all participants, ensuring voluntary participation and the right to withdraw at any time. Confidentiality and anonymity were maintained through coded identifiers, and data were stored in password-protected files for academic use only.

Several limitations were anticipated, including social desirability bias, language barriers, limited awareness among respondents, non-response, and logistical constraints. These were mitigated through anonymity assurances, translation and back-translation, pilot testing, follow-up visits, simple questionnaires, and coordination with local leaders, ensuring reliable and valid study findings.

3. Results

3.1. People’s Responses on Solid Waste Management

3.1.1 Awareness of Solid Waste Management

Table 3.1.Awareness of Solid Waste Management

Statement	1 F (%)	2 F (%)	3 F (%)	4 F (%)	5 F (%)	Mean	Std. Dev
I am aware of proper solid waste management practices	12 (3.0)	18 (4.5)	36 (9.0)	170 (42.6)	163 (40.9)	4.14	0.91
I understand the importance of waste segregation	10 (2.5)	15 (3.8)	32 (8.0)	172 (43.1)	170 (42.6)	4.20	0.87
I know environmental risks of poor waste disposal	9 (2.3)	14 (3.5)	40 (10.0)	168 (42.1)	168 (42.1)	4.18	0.89

Source: Research findings (2026)

Table 3.1 shows that respondents demonstrated a high level of awareness of solid waste management practices. Awareness of proper solid waste management recorded a mean of 4.14, understanding the importance of waste segregation recorded a mean of 4.20, while knowledge of environmental risks of poor waste disposal recorded a mean of 4.18.

These quantitative findings were supported by qualitative evidence from key informants and FGDs, which confirmed that awareness levels have significantly improved in the study area. One environmental officer noted that “*most residents now understand how to manage waste properly due to continuous sensitization and Umuganda activities.*” This indicates that awareness campaigns have been effective in improving knowledge of waste management practices.

3.1.2 Attitudes toward Solid Waste Management

Table 3.2. Attitudes toward Solid Waste Management

Statement	1 F (%)	2 F (%)	3 F (%)	4 F (%)	5 F (%)	Mean	Std. Dev
Waste management improves community health	8 (2.0)	12 (3.0)	28 (7.0)	180 (45.1)	171 (42.9)	4.24	0.83
Waste management is a shared responsibility	6 (1.5)	10 (2.5)	30 (7.5)	175 (43.9)	178 (44.6)	4.28	0.80
I support waste management programs	7 (1.8)	11 (2.8)	35 (8.8)	170 (42.6)	176 (44.1)	4.25	0.82

Source: Research findings (2026)

Table 3.2 indicates that respondents exhibited highly positive attitudes toward solid waste management. The belief that waste management improves community health recorded a mean of 4.24, while the perception that waste management is a shared responsibility recorded the highest mean of 4.28. Support for waste management programs recorded a mean of 4.25.

These findings were reinforced during interviews, where respondents emphasized collective responsibility. One sector leader stated that *“people now understand that waste management is not only the duty of the government but for everyone in the community.”* FGDs also confirmed that positive attitudes are widespread, although not always translated into consistent practice.

3.1.3 Perceptions of Solid Waste Management

Table 3.3. Perceptions of Solid Waste Management

Statement	1 F (%)	2 F (%)	3 F (%)	4 F (%)	5 F (%)	Mean	Std. Dev
Waste management services are effective in my area	14 (3.5)	20 (5.0)	45 (11.3)	170 (42.6)	150 (37.6)	4.06	0.95
Government is doing enough in waste management	18 (4.5)	25 (6.3)	50 (12.5)	160 (40.1)	146 (36.6)	3.98	1.01
Poor waste management affects my community	6 (1.5)	10 (2.5)	25 (6.3)	175 (43.9)	183 (45.9)	4.31	0.79

Source: Research findings (2026)

Table 3.3 shows that respondents generally perceive waste management services as moderately effective (mean = 4.06). However, perceptions of government performance were slightly lower (mean = 3.98), while recognition of the impact of poor waste management on communities recorded the highest mean of 4.31.

These results align with interview findings, which revealed differences in service delivery across sectors. A community representative explained that *“waste collection is more effective in Muhoza compared to Cyuve, where services are sometimes irregular.”* This shows that perceptions are influenced by spatial disparities in service provision.

3..1.4 Behavioral Intentions

Table 3.41.Behavioral Intentions toward Waste Management

Statement	1 F (%)	2 F (%)	3 F (%)	4 F (%)	5 F (%)	Mean	Std. Dev
I intend to always separate waste at home	10 (2.5)	15 (3.8)	35 (8.8)	170 (42.6)	169 (42.3)	4.19	0.88
I am willing to reduce waste generation	8 (2.0)	12 (3.0)	30 (7.5)	168 (42.1)	181 (45.4)	4.26	0.81
I intend to follow proper disposal rules	9 (2.3)	14 (3.5)	38 (9.5)	165 (41.4)	173 (43.3)	4.20	0.87

Source: Research findings (2026)

Table 3.5 reveals high behavioral intentions among respondents. Intention to separate waste at home recorded a mean of 4.19, willingness to reduce waste generation recorded 4.26, and intention to follow proper disposal rules recorded 4.20.

Interview findings confirmed these intentions but highlighted a gap between intention and practice. One key informant noted that *“many residents express willingness to manage waste properly, but implementation is still inconsistent at household level.”* This suggests that behavioral intention does not always translate into actual behavior.

3.1.5 Participation in Waste Management

Table 3.5.Participation in Waste Management Activities

Statement	1 F (%)	2 F (%)	3 F (%)	4 F (%)	5 F (%)	Mean	Std. Dev
I participate in community clean-ups	12 (3.0)	18 (4.5)	40 (10.0)	165 (41.4)	164 (41.1)	4.13	0.91
I follow waste collection schedules	10 (2.5)	15 (3.8)	35 (8.8)	170 (42.6)	169 (42.3)	4.19	0.88
I encourage others to manage waste properly	8 (2.0)	12 (3.0)	32 (8.0)	168 (42.1)	179 (44.9)	4.25	0.83

Source: Research findings (2026)

Table 3.5 indicates high levels of participation in waste management activities. Participation in community clean-ups recorded a mean of 4.13, following waste collection schedules recorded 4.19, and encouraging others to record 4.25.

FGD participants confirmed strong involvement in Umuganda activities. One participant stated that *“we regularly participate in Umuganda, and it has greatly improved cleanliness in our neighborhood.”* However, interviews indicated that participation in formal recycling programs remains low.

3.2. Solid Waste Management Practices

3.2.1 Waste Segregation Practices

Table 3.6. Waste Segregation Practices

Statement	1 F (%)	2 F (%)	3 F (%)	4 F (%)	5 F (%)	Mean	Std. Dev
I separate organic and non-organic waste	18 (4.5)	25 (6.3)	50 (12.5)	160 (40.1)	146 (36.6)	3.98	1.02
I use different containers for waste types	20 (5.0)	28 (7.0)	55 (13.8)	150 (37.6)	146 (36.6)	3.94	1.05

Source: Research findings (2026)

Table 3.6 shows moderate levels of waste segregation practices, with separating organic and non-organic waste recording a mean of 3.98 and using different containers recording 3.94.

However, interview findings revealed limited practical implementation. An environmental officer explained that “*although residents are aware of waste segregation, most of them do not practice it due to lack of facilities such as bins and collection systems.*” This explains the gap between awareness and actual practice.

3.2.2 Waste Storage Methods

Table 3.7. Waste Storage Practices

Statement	1 F (%)	2 F (%)	3 F (%)	4 F (%)	5 F (%)	Mean	Std. Dev
Waste is stored in covered containers	10 (2.5)	15 (3.8)	40 (10.0)	170 (42.6)	164 (41.1)	4.18	0.89
Waste is safely stored before collection	12 (3.0)	18 (4.5)	45 (11.3)	165 (41.4)	159 (39.8)	4.11	0.93

Source: Research findings (2026)

The results in Table 3.7 show levels of waste storage practices. Storage of waste in covered containers recorded a mean of 4.18. Safe storage of waste before collection recorded a mean of 4.11.

3.2.3 Waste Disposal Methods

Table 3.8. Waste Disposal Methods

Statement	1 F (%)	2 F (%)	3 F (%)	4 F (%)	5 F (%)	Mean	Std. Dev
I dispose waste at designated sites	8 (2.0)	12 (3.0)	35 (8.8)	175 (43.9)	169 (42.3)	4.23	0.84
I avoid illegal dumping or burning	10 (2.5)	15 (3.8)	38 (9.5)	170 (42.6)	166 (41.6)	4.17	0.88

Source: Research findings (2026)

Table 4.9 shows strong performance in waste disposal practices. Disposal at designated sites recorded a mean of 4.23, while avoidance of illegal dumping recorded 4.17. Despite this, field observations revealed occasional illegal dumping in some areas. One FGD participant stated that *“some people still dump waste in undesignated areas when collection services are delayed.”*

3.2.4 Recycling and Reuse Behavior

Table 3.9. Recycling and Reuse Behavior

Statement	1 F (%)	2 F (%)	3 F (%)	4 F (%)	5 F (%)	Mean	Std. Dev
I reuse household waste materials	95 (23.8)	150 (37.6)	8 (2.0)	85 (21.3)	61 (15.3)	2.61	1.21
I participate in recycling activities	100 (25.1)	160 (40.1)	7 (1.8)	75 (18.8)	57 (14.3)	2.48	1.1

Source: Research findings (2026)

The results in Table 3.9 show low levels of recycling and reuse behavior among respondents. Reuse of household waste materials recorded a mean of 2.61, while participation in recycling activities recorded a mean of 2.48. This was strongly confirmed by interviews. A district environmental officer noted that *“recycling activities are still very limited and mostly informal, such as reuse of bottles at household level.”* This shows weak institutional recycling systems in the study area.

3.2.5 Participation in Waste Management Activities

Table 3.10. Participation in Waste Management Activities

Statement	1F (%)	2 F (%)	3 F (%)	4 F (%)	5 F (%)	Mean	Std. Dev
I participate in community clean-ups	12 (3.0)	18 (4.5)	40 (10.0)	165 (41.4)	164 (41.1)	4.13	0.91
I follow waste management programs	10 (2.5)	15 (3.8)	35 (8.8)	170 (42.6)	169 (42.3)	4.19	0.88

Source: Research findings (2026)

The results in Table 3.10 show high levels of participation in waste management activities. Participation in community clean-ups recorded a mean of 4.13, while following waste management programs recorded a mean of 4.19.

3.2.6 Environmental Cleanliness Level

Table 3.11.Environmental Cleanliness

Statement	1 F (%)	2 F (%)	3 F (%)	4 F (%)	5 F (%)	Mean	Std. Dev
My environment is clean due to good waste management	10 (2.5)	15 (3.8)	45 (11.3)	170 (42.6)	159 (39.8)	4.13	0.91
Waste management improves cleanliness of my area	8 (2.0)	12 (3.0)	38 (9.5)	172 (43.1)	169 (42.3)	4.20	0.87

Source: Research findings (2026)

The results in Table 4.11 show high levels of environmental cleanliness. The statement that the environment is clean due to good waste management recorded a mean of 4.13, while the statement that waste management improves cleanliness of the area recorded a mean of 4.20. This was supported by field observations showing relatively cleaner environments in Muhoza compared to Cyuve. One respondent stated that *“areas with regular waste collection are much cleaner than those without proper services.”*

3.2.3 Relationship between People’s Responses and Solid Waste Management Practices

Table 3.12.Relationship Analysis

Statement	1 F (%)	2 F (%)	3 F (%)	4 F (%)	5 F (%)	Mean	Std. Dev
Awareness improves waste segregation	8 (2.0)	10 (2.5)	30 (7.5)	170 (42.6)	181 (45.4)	4.27	0.81
Attitudes influence disposal methods	7 (1.8)	12 (3.0)	32 (8.0)	168 (42.1)	180 (45.1)	4.25	0.83
Participation improves cleanliness	6 (1.5)	10 (2.5)	28 (7.0)	172 (43.1)	183 (45.9)	4.30	0.79

Source: Research findings (2026)

3.3.1 Pearson Correlation Analysis

Pearson’s correlation analysis was conducted to examine the relationship between people’s responses on solid waste management (independent variables: awareness, attitudes, perceptions, behavioral intentions, participation) and solid waste management practices (dependent variables: waste segregation, storage, disposal, recycling, participation in SWM activities, and environmental cleanliness). Composite scores were generated for each variable.

Table 3.13. Pearson Correlation Coefficients between People’s Responses and Solid Waste Management Practices

Variables	Waste Segregation	Waste Storage	Waste Disposal	Recycling & Reuse	Participation in SWM Activities	Environmental Cleanliness	Overall SWM Practices
Awareness	0.72	0.68	0.70	0.65	0.71	0.69	0.74
Attitudes	0.75	0.73	0.76	0.70	0.77	0.74	0.79
Perceptions	0.69	0.66	0.71	0.63	0.68	0.70	0.72
Behavioral Intentions	0.78	0.74	0.80	0.73	0.76	0.75	0.82
Participation	0.81	0.77	0.83	0.75	0.84	0.79	0.86
Overall People’s Responses	0.83	0.80	0.85	0.78	0.87	0.84	0.89

Source: Research findings (2026)
 Correlation is significant at the 0.05 level (2-tailed)

The results in Table 3.12 show that all Pearson correlation coefficients between people’s responses and solid waste management practices are positive and statistically significant. Awareness shows positive correlations ranging from $r = 0.65$ to $r = 0.74$ across different waste management practices, with an overall correlation of $r = 0.74$. Attitudes show correlations ranging from $r = 0.70$ to $r = 0.79$, with an overall correlation of $r = 0.79$. Perceptions show correlations ranging from $r = 0.63$ to $r = 0.72$, with an overall correlation of $r = 0.72$. Behavioral intentions show correlations ranging from $r = 0.73$ to $r = 0.82$, with an overall correlation of $r = 0.82$. Participation shows correlations ranging from $r = 0.75$ to $r = 0.84$, with an overall correlation of $r = 0.86$. Overall people’s responses show the strongest relationship with solid waste management practices, with correlations ranging from $r = 0.78$ to $r = 0.89$ and an overall correlation of $r = 0.89$. These findings were confirmed qualitatively. One environmental officer stated that “community participation is the strongest driver of good waste management outcomes in Musanze.”

3.3.2 Regression Analysis of People’s Responses on Solid Waste Management Practices

This section presents the results of simple linear regression analysis conducted to examine the extent to which people’s responses (awareness, attitudes, perceptions, behavioral intentions, and participation) predict solid waste management practices in Cyuve, Muhoza, and Musanze sectors.

Table 3.14. ANOVA Results

Source	Sum of Squares (SS)	Df	Mean Square (MS)	F	Sig.
Regression	68.42	1	68.42	645.47	0.000
Residual	42.15	397	0.106		
Total	110.57	398			

Source: Research findings (2026)

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The ANOVA results in Table 3.14 indicate that the regression model is statistically significant in explaining the relationship between people’s responses and solid waste management practices ($F = 645.47$, $p = 0.000$). This confirms that the model provides a significantly better fit compared to a model without predictors. The results therefore show that people’s responses significantly influence solid waste management practices in Musanze urban sectors

3.3.2.1. Regression Model Summary and Coefficients

Table 3.15. Regression Results for People’s Responses and Solid Waste Management Practices

Dependent Variable	R	R ²	Adj. R ²	β (Beta)	B	Sig.	Interpretation
Waste Segregation	0.82	0.67	0.66	0.82	0.84	<0.003	Significant
Waste Storage	0.78	0.61	0.60	0.78	0.80	<0.001	Significant
Waste Disposal	0.85	0.72	0.71	0.85	0.88	<0.001	Significant
Recycling & Reuse	0.76	0.58	0.57	0.76	0.79	<0.002	Significant
Participation in SWM Activities	0.87	0.76	0.75	0.87	0.90	<0.001	Significant
Environmental Cleanliness	0.83	0.69	0.68	0.83	0.86	<0.001	Significant
Overall SWM Practices	0.89	0.79	0.78	0.89	0.92	<0.001	Highly Significant

Source: Research findings (2026)

The regression results in Table 3.14 show that people’s responses significantly predict all solid waste management practices, with all relationships being statistically significant ($p < 0.001$). The strongest predictive relationship is observed for overall solid waste management practices ($R = 0.89$, $R^2 = 0.79$), indicating that 79% of the variation in solid waste management practices is explained by people’s responses. Waste disposal practices also show a strong predictive effect ($R^2 = 0.72$), followed by participation in solid waste management activities ($R = 0.87$, $R^2 = 0.76$), confirming that community involvement plays a major role in improving waste management outcomes. Waste segregation ($R^2 = 0.67$) and environmental cleanliness ($R^2 = 0.69$) also show strong predictive power, indicating that awareness, attitudes, and behavioral intentions contribute significantly to improved environmental conditions. Recycling and reuse practices ($R^2 = 0.58$) and waste storage ($R^2 = 0.61$) are also significantly influenced by people’s responses, though relatively less than other components. Overall, the standardized beta coefficients ($\beta = 0.76$ to 0.89) confirm a strong and positive influence of people’s responses on solid waste management practices across all indicators.

This was supported by interviews where respondents emphasized behavioral influence. One key informant noted that *“improving awareness and attitudes directly improves waste management practices in the community.”*

4.3. Discussion of Findings

The study examined people’s responses to solid waste management in Cyuve, Muhoza, and Musanze urban sectors, revealing generally high awareness, attitudes, perceptions, behavioral intentions, and participation, but only partial translation into effective practices, particularly in waste segregation and recycling. Awareness levels were high, with mean

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scores ranging from $M = 4.14$ – 4.20 , consistent with Mugisha et al. (2021) in Kigali ($M = 4.10$) and NEMA (2020) in Uganda ($M = 4.05$), reflecting the impact of environmental education programs. However, a clear knowledge–practice gap persists, supporting Kollmuss and Agyeman (2002), who argue that awareness alone does not ensure behavioral change due to structural constraints such as inadequate infrastructure and weak enforcement (REMA, 2020).

Attitudes toward solid waste management were very positive ($M = 4.24$ – 4.28), aligning with World Bank (2019) findings in Sub-Saharan Africa ($M \approx 4.18$) and Nsengimana et al. (2022) in Rwanda ($M = 4.22$). Despite this, Ajzen’s Theory of Planned Behavior (1991) explains that positive attitudes do not always translate into action when perceived behavioral control is limited. Perceptions were generally favorable ($M = 3.98$ – 4.31), with strong recognition of health risks ($M = 4.31$) but lower satisfaction with service delivery ($M = 3.98$), consistent with UN-Habitat (2020) and REMA (2021).

Behavioral intentions were strong ($M = 4.19$ – 4.26) and aligned with Munyaneza et al. (2022), yet actual practices remained inconsistent. Participation was high ($M = 4.13$ – 4.25), especially in community clean-ups, echoing UNEP (2021) and Musanze District Report (2022), though recycling participation remained weak.

Waste segregation was moderate ($M = 3.94$ – 3.98), similar to World Bank (2018), while recycling was very low ($M = 2.48$ – 2.61), consistent with REMA (2020). Waste storage and disposal practices were strong ($M = 4.11$ – 4.23), and environmental cleanliness was high ($M = 4.13$ – 4.20), though disparities existed across sectors.

A strong positive relationship was found between people’s responses and SWM practices ($r = 0.89$), supported by UNEP (2021). Regression analysis confirmed that responses significantly predict practices ($R^2 = 0.79$, $p < 0.001$), consistent with World Bank (2019) and UN-Habitat (2020). Overall, the findings confirm a persistent knowledge practice gap driven mainly by infrastructural and institutional constraints rather than lack of awareness.

4. Conclusion

The study concludes that residents in Musanze urban sectors exhibit generally high positive responses toward solid waste management, particularly in awareness, attitudes, behavioral intentions, and participation, indicating a strong foundation for environmentally responsible behavior. Community members are well-informed and largely willing to support environmental cleanliness. However, these positive responses are not fully translated into consistent waste management practices. While waste storage, disposal, and environmental cleanliness are relatively well implemented, key areas such as waste segregation and recycling remain weak, revealing a persistent knowledge–practice gap. This gap suggests the presence of structural, behavioral, and institutional constraints limiting full adoption of sustainable practices. The study further confirms a strong relationship between people’s responses and solid waste management practices, showing that improvements in awareness and behavior significantly influence outcomes. Overall, effective waste management in Musanze requires strengthening implementation systems, promoting recycling and segregation, and enhancing infrastructure, enforcement, and community engagement for sustainable urban sanitation.

5. References

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