Solid Waste Management Practices and Community Livelihoods in Kicukiro District, Rwanda

Charles Nsengiyumva[1], Felicien Irafasha[2]*, Martin Vincent Nsanzumukiza[3]

[1] Environmental economics and natural resource management Department, Factulty of Environmental; Rwanda; e-mail: nsengicha@gmail.com

[2] Environmental Health Science Department, School of Public Health, University of Rwanda

[3] Environmental economics and natural resource management Department, Faculty of Environmental; Rwanda

***Corresponding author:** Felicien Irafasha; Tel.: +250785539140; E-mail: f.irafasha@ur.ac.rw

Abstract

Objective: This study examined solid waste management (SWM)[1] practices, community livelihood status, and the relationship between them in Kicukiro District, Rwanda.

Methodology: A descriptive cross-sectional design was used. Structured questionnaires were administered to 414 respondents: 384 households selected by multistage and systematic random sampling and 30 key stakeholders (waste collection companies, recyclable-material collectors, and sector officials) included by census. Data were analyzed with descriptive statistics and multiple linear regression in Stata 17.

Findings: Participation in SWM was high: 75.1% of households separated waste at source, 90.1% had proper storage containers, 94.4% paid for collection, and 88.1% reused waste materials. However, only 33.1% had earned money from waste, whereas 62.3% agreed that waste management creates employment and 70.1% that it has improved cleanliness; 64.5% had a high livelihood level. SWM practices explained 35.8% of the variation in livelihood scores ($R^2 = 0.358$; $p < 0.001$). Lack of knowledge of proper waste management was the strongest negative predictor ($\beta = -0.175$; $p = 0.001$), whereas reuse and recycling was positively associated with livelihood ($p = 0.020$).

Conclusion: SWM in Kicukiro improves environmental cleanliness and supports employment, but its contribution to household income remains modest. Strengthening recycling value chains, public awareness, and waste-based enterprises could increase these benefits.

Keywords: Solid waste management; Community livelihoods; Recycling; Environmental sanitation; Kicukiro District; Rwanda

[1]Abbreviations: SWM, solid waste management; RWF, Rwandan franc; UNILAK, University of Lay Adventists of Kigali; B, unstandardised regression coefficient; β, standardised regression coefficient; SE, standard error; SD, standard deviation.

1. Introduction

Solid waste management has become a pressing environmental, social, and economic issue worldwide because of population growth, urbanisation, industrialisation, and changing consumption patterns. The world generates about 2.01 billion tonnes of municipal solid waste each year, and this is projected to reach 3.40 billion tonnes by 2050 if current trends continue (Kaza et al., 2018). Open dumping, uncontrolled burning, and improper disposal contribute to environmental pollution, climate change, and public health problems (Wilson, 2015). Integrated systems covering waste reduction, segregation, recycling, composting, collection, and safe disposal are therefore essential for sustainable urban development (Hoornweg & Bhada-Tata, 2012; Wilson, 2015).

In Africa, rapid urban growth, limited finance, and inadequate infrastructure make SWM a major challenge. Urban areas on the continent generate an estimated 125 million tonnes of municipal solid waste annually (Komakech et al., 2014), and waste generation in Sub-Saharan Africa is expected to more than triple by 2050 (Kaza et al., 2018). Much of this waste is dumped in open sites or burned in residential areas (Nzeadibe & Ajaero, 2011), while weak institutional capacity and low community participation limit the effectiveness of municipal systems (Ogwueleka, 2009). East African cities such as Nairobi, Kampala, and Dar es Salaam face similar problems of inefficient collection, inadequate landfills, and limited recycling (Okot-Okumu, 2012). Yet waste collection, recycling, composting, and resource recovery can also create income and employment, particularly for informal workers and small entrepreneurs (Wilson et al., 2006).

In Rwanda, SWM has received growing attention, especially in the City of Kigali, which generates an estimated 300–400 tonnes of solid waste per day, mostly from households and commercial establishments (Rajashekar et al., 2019). Organic material accounts for about 64–74% of municipal solid waste (GIZ, 2022), and average household generation in Kigali is about

0.56 kg per capita per day (GGGI, 2023). Nevertheless, segregation at source remains limited and the national recycling rate is estimated to be below 4% (GIZ, 2022). Kicukiro District, one of the three districts of Kigali, has experienced rapid residential, commercial, and institutional expansion that has increased waste generation (Rajashekar et al., 2019). Although private companies provide collection services in the district, waste is often disposed of without its economic value being recovered, limiting its potential contribution to livelihoods.

This study draws on two complementary theories. The Sustainable Livelihoods Framework (Chambers & Conway, 1992; DFID, 1999) holds that households sustain their livelihoods through access to human, social, financial, physical, and natural capital. SWM can strengthen these assets by improving health (human capital), generating income from waste-related activities (financial capital), encouraging community participation (social capital), providing infrastructure (physical capital), and protecting the environment (natural capital). The waste management hierarchy ranks strategies in descending order of preference as reduce, reuse, recycle, recover, and dispose (Surendra et al., 2025), and provides the basis for assessing how far households move beyond disposal towards resource recovery.

Previous studies in Rwanda and elsewhere have documented SWM practices, collection performance, and the role of the informal recycling sector (Iraguha et al., 2022; Kabera et al., 2019; Makwara & Magudu, 2013; Yasmin, 2017). Others have shown that waste-related activities can provide income and that poor waste management undermines health and productivity (Ogunwale et al., 2024; Oteng-Ababio et al., 2023; Temeh, 2025; Velis et al., 2012). However, most of this work focused on environmental sanitation, infrastructure, governance, or informal recyclers, and few studies have quantified how household SWM practices relate to livelihood outcomes such as income, employment, and environmental cleanliness at district level in urban Rwanda. Temeh (2025), for example, examined communities around the Nduba landfill in Gasabo District but did not cover Kicukiro.

This study therefore aimed to (i) assess the SWM practices implemented in Kicukiro District, (ii) evaluate the community livelihood status in the district, and (iii) determine the relationship between SWM practices and community livelihoods. The conceptual framework guiding the study (Fig. 1) treats SWM practices as the independent variable and community livelihoods as the dependent variable, with infrastructure, policy enforcement, and community awareness as intervening variables.

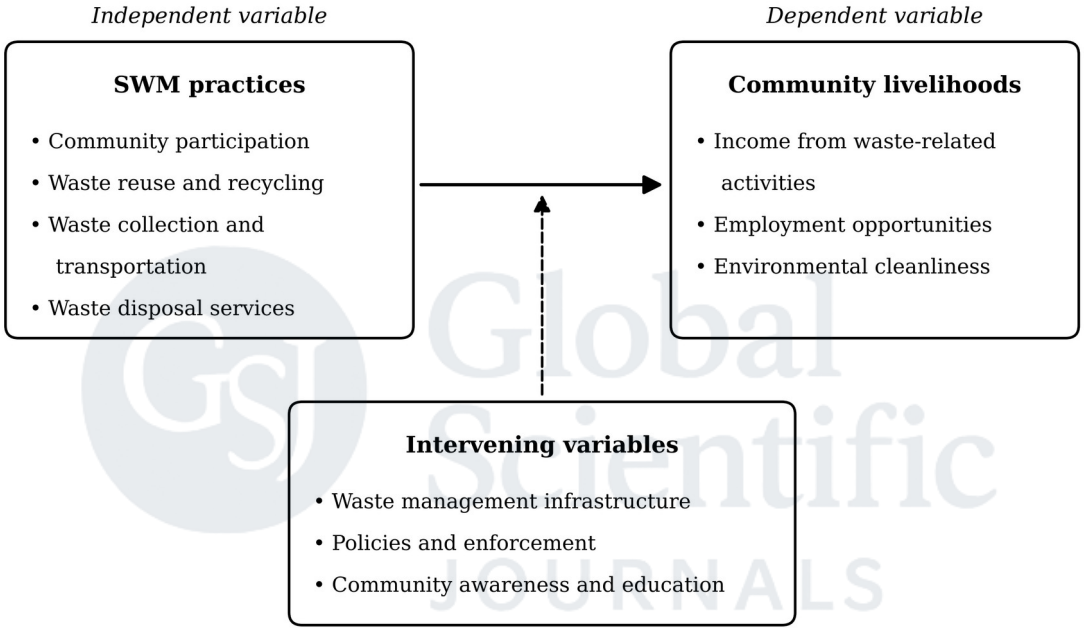

Fig. 1. Conceptual framework of the study. SWM practices (independent variable) are expected to influence community livelihoods (dependent variable); the relationship may be affected by intervening variables (dashed arrow). SWM: solid waste management.

2. Methodology

2.1. Study area

The study was conducted in Kicukiro District, one of the three districts of the City of Kigali (Fig. 2). The district lies in the southern part of Kigali and borders Gasabo District to the north, Nyarugenge District to the north-west, and Bugesera District to the east. It comprises ten sectors: Gahanga, Gatenga, Gikondo, Kagarama, Kanombe, Kicukiro, Kigarama, Masaka, Niboye, and Nyarugunga. Kicukiro was selected because it is one of the fastest-growing urban districts in Rwanda, with diverse socio-economic activities and both high- and low-income

communities, which allows variation in waste management practices and livelihoods to be assessed.

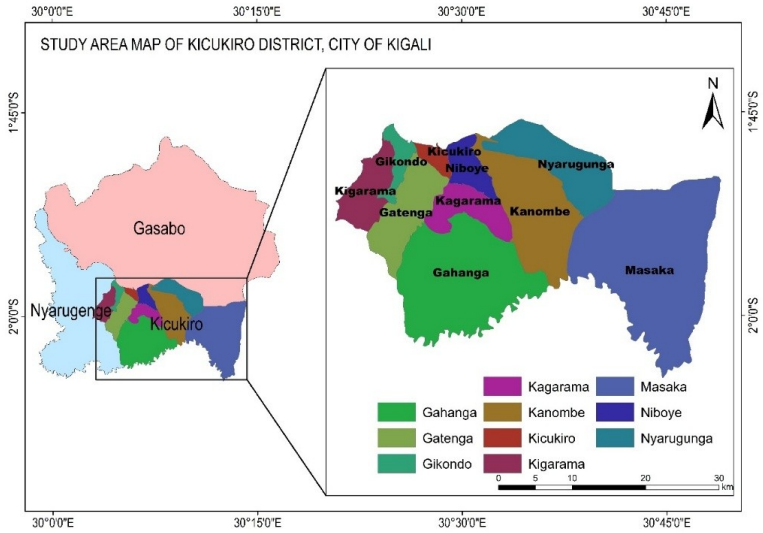

Fig. 2. Administrative map of Kicukiro District showing its ten sectors. Map produced in ArcGIS.

2.2. Research design

A descriptive cross-sectional design with a quantitative approach was used. This design allows data to be collected at a single point in time to describe existing waste management practices and livelihood conditions and to examine relationships among variables without manipulating the study environment (Cohen et al., 2018).

2.3. Study population and sample size

The study population comprised households, waste collection companies, formal recyclable-material collectors, and sector officials responsible for waste management in Kicukiro District. Households were included as the primary generators of municipal solid waste; collection companies because they collect, transport, and dispose of household waste; recyclable-material collectors because they drive reuse and recycling; and sector officials because they organise collection services, enforce hygiene regulations, and mobilise community participation.

The household sample size was calculated using Cochran's formula (Eq. 1):

$$n = Z^2 P(1 - P)/D^2 \quad (1)$$

where n is the sample size, $Z = 1.96$ is the standard normal value for a 95% confidence level, $P = 0.5$ is the assumed proportion of households with adequate sanitation and waste management practices, and $D = 0.05$ is the desired precision. This gave $n = (1.96^2 \times 0.5 \times 0.5)/0.05^2 \approx 384$ households. In addition, all 5 waste collection companies, all 15 formal recyclable-material collectors, and all 10 sector officials were included by census because their numbers were small, giving a total sample of 414 respondents.

2.4. Sampling procedure

Households were selected by multistage sampling. In the first stage, all ten sectors were included and the 384 households were allocated to sectors using probability proportional to size (Table 1). In the second stage, households were selected within each sector by systematic random sampling from administrative household lists: the sampling interval k was obtained by dividing the number of households in the sector by its allocated sample, the first household was selected at random, and every kth household was then included until the sector quota was reached. Key stakeholders were enumerated by census.

Table 1. Proportional allocation of the household sample by sector.

No.	Sector	Households (N)	Sample (n)
1	Gahanga	22,883	65
2	Gatenga	19,073	54
3	Gikondo	4,618	13
4	Kagarama	5,404	15
5	Kanombe	19,939	57
6	Kicukiro	4,497	13
7	Kigarama	17,691	50
8	Masaka	21,341	61
9	Niboye	7,579	22
10	Nyarugunga	12,438	35
	Subtotal (households)	135,463	384
11	Key stakeholders[a]	30	30
	Total	**135,493**	**414**

[a] 5 waste collection companies, 15 formal recyclable-material collectors, and 10 sector officials, all included by census.

2.5. Data collection

Primary data were collected using structured questionnaires administered to households, recyclable-material collectors, representatives of waste collection companies, and sector hygiene and sanitation officers, supplemented by a field observation checklist. The questionnaire comprised closed-ended, multiple-choice, multiple-response, and five-point Likert-scale items (1 = strongly disagree to 5 = strongly agree). It covered SWM practices (community participation, reuse and recycling, collection, transportation, and disposal) and livelihood outcomes (income from waste-related activities, employment opportunities, and environmental cleanliness).

2.6. Data analysis

Data were entered, cleaned, and analysed in Stata version 17. Frequencies, percentages, means, and standard deviations were used to describe respondents' characteristics, SWM practices, and livelihood indicators. A composite livelihood score was computed from the livelihood items, and respondents were classified as having a high or low livelihood level based on their composite score. The relationship between SWM practices and the livelihood score was estimated using multiple linear regression (Eq. 2):

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_9 X_9 + \varepsilon \quad (2)$$

where Y is the community livelihood score; β_0 is the intercept; β_1–β_9 are regression coefficients; X_1–X_9 are, respectively, waste separation, lack of knowledge as a barrier, reuse and recycling, storage, availability of collection services, payment for collection and transportation, satisfaction with services, availability of equipment, and awareness of waste management regulations; and ε is the error term. Unstandardised (B) and standardised (β) coefficients were used to describe the direction and relative strength of associations, and statistical significance was set at $p < 0.05$.

2.7. Ethical considerations

Ethical clearance was obtained from the Institutional Review Board of the University of Lay Adventists of Kigali. Participation was voluntary, the objectives of the study were explained to all participants, and written informed consent was obtained before data collection. Respondents' identities were kept confidential.

3. Results

3.1. Socio-demographic characteristics of respondents

Of the 412 respondents who reported socio-demographic information, 58.5% were female (Table 2). Secondary education was the most common level (34.2%), whereas 20.4% had no

formal education. Most respondents were economically active, mainly self-employed (34.2%) or employed (34.0%), and only 6.6% were unemployed. Incomes were mostly low to middle: 44.7% earned 100,000–250,000 RWF per month and 38.8% earned less than 100,000 RWF.

Table 2. Socio-demographic characteristics of respondents (n = 412).

Variable	Category	Frequency	%
Gender			
	Male	171	41.5
	Female	241	58.5
Education level			
	No formal education	84	20.4
	Primary	105	25.5
	Secondary	141	34.2
	University	82	19.9
Occupation			
	Employed	140	34.0
	Self-employed	141	34.2
	Casual labour	104	25.2
	Unemployed	27	6.6
Monthly income (RWF)			
	< 100,000	160	38.8
	100,000–250,000	184	44.7
	250,001–500,000	56	13.6
	> 500,000	14	3.4

RWF: Rwandan franc.

3.2. Solid waste management practices

Household participation in SWM was high (Table 3). Three-quarters of households (75.1%) separated waste at source, 90.1% had a proper storage container, 94.4% paid for collection, and 88.1% reused waste materials, mostly plastic containers (64.3%). Biodegradable waste was the fraction most often separated (48.4%), followed by plastics (25.7%). Recyclable-material collectors were present in the area of 88.4% of households, and 95.9% reported that collection and transportation services were available, mostly weekly (80.0%). Although 90.6% were

satisfied with these services, 87.7% reported waste management challenges, chiefly poor collection and transportation (49.6%) and high service fees (34.5%).

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Table 3. Household participation and practices in solid waste management in Kicukiro District.

Variable	Category	n	%
Separates waste at source	Yes	311	75.1
	No	102	24.6
	No response	1	0.2
Has proper waste storage container	Yes	372	90.1
	No	41	9.9
Pays for waste collection	Yes	391	94.4
	No	23	5.6
Types of waste separated[a]	Biodegradable	162	48.4
	Plastic	86	25.7
	All types	43	12.8
	Metals	23	6.9
	Paper	21	6.3
Reuses waste materials	Yes	364	88.1
	No	49	11.9
Materials reused[a]	Plastic containers	250	64.3
	Paper containers	73	18.8
	Glass bottles	56	14.4
	Other	10	2.6
Recyclable-material collectors present in area	Yes	366	88.4
	No	48	11.6
Collection and transportation services available	Yes	397	95.9
	No	17	4.1
Collection frequency	Weekly	331	80.0
	Daily	61	14.7
	Monthly	14	3.4
Satisfied with collection services	Yes	375	90.6
	No	39	9.4
Experiences waste management challenges	Yes	363	87.7
	No	51	12.3
Main challenge reported[a]	Poor collection/transportation	184	49.6
	High service fees	128	34.5
	Lack of knowledge	30	8.1
	Inadequate equipment	29	7.8

[a] Percentages are calculated among households that responded to the item.

3.3. Community livelihood status

Respondents perceived the economic potential of waste to be high but the direct household benefit to be limited (Table 4). More than half (58.7%) agreed or strongly agreed that recycling generates income, but only 34.7% reported that their household sells recyclable materials, 33.1% that it has earned money from waste, and 33.8% that waste income contributes to household livelihood; about half disagreed with each of these statements. Community-level benefits were more widely recognised: 62.3% agreed that waste management creates employment, 70.1% that it has improved cleanliness, and 66.2% that it has reduced scattered waste and illegal dumping. Overall, 64.5% of respondents had a high livelihood level and 35.5% a low level (Fig. 3).

Table 4. Respondents' perceptions of the economic, employment, and environmental benefits of solid waste management, *n* (%).

Statement	SD	D	N	A	SA	Mean	SD[a]
Economic benefits							
Recycling bottles, metals, plastics and paper generates income	75 (18.1)	32 (7.7)	64 (15.5)	142 (34.3)	101 (24.4)	3.39	1.41
My household sells recyclable waste materials	133 (32.1)	69 (16.7)	68 (16.4)	102 (24.6)	42 (10.1)	2.64	1.41
Our household has earned money from waste materials	140 (33.8)	75 (18.1)	62 (15.0)	86 (20.8)	51 (12.3)	2.64	1.41
Income from waste contributes to household livelihood	138 (33.3)	70 (16.9)	66 (15.9)	85 (20.5)	55 (13.3)	2.66	1.44
Employment creation							
Waste management creates employment in the community	68 (16.4)	34 (8.2)	54 (13.0)	142 (34.3)	116 (28.0)	3.40	1.40
Waste collection, sorting and recycling create jobs	71 (17.1)	28 (6.8)	63 (15.2)	135 (32.6)	117 (28.3)	3.40	1.41
Environmental benefits							
Waste management has improved cleanliness in the area	63 (15.2)	13 (3.1)	48 (11.6)	132 (31.9)	158 (38.2)	3.75	1.39
Waste management has reduced scattered waste and illegal dumping	66 (15.9)	19 (4.6)	55 (13.3)	127 (30.7)	147 (35.5)	3.65	1.41

SD: strongly disagree (1); D: disagree (2); N: neutral (3); A: agree (4); SA: strongly agree (5). [a] Standard deviation.

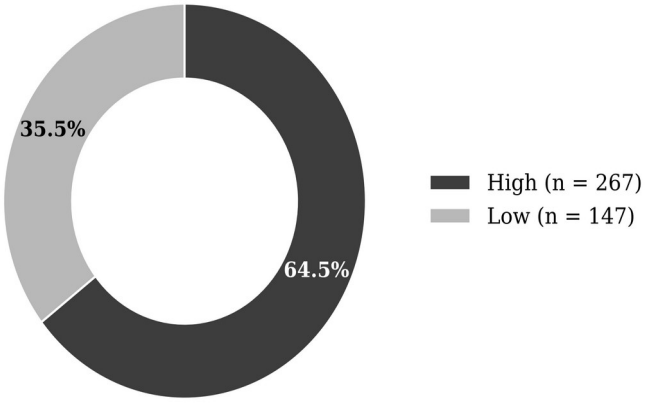

Fig. 3. Community livelihood level of respondents (n = 414). Respondents were classified as having a high or low livelihood level based on their composite livelihood score.

3.4. Relationship between SWM practices and community livelihoods

The regression model was statistically significant ($F(20, 382) = 10.65$, $p < 0.001$) and explained 35.8% of the variation in livelihood scores (R = 0.598; $R^2 = 0.358$; adjusted $R^2 = 0.324$) (Table 5). Lack of knowledge of proper waste management had the strongest, negative association with livelihood (B = −3.549; β = −0.175; p = 0.001). Reuse and recycling was positively associated with livelihood (B = 1.067; β = 0.033; p = 0.020). Satisfaction with collection services was negatively associated with livelihood (B = −2.598; β = −0.127; p = 0.040). Waste separation (B = −2.153; p = 0.050) and awareness of waste management regulations (B = 3.789; p = 0.050) were borderline. Storage, availability of collection services, payment for collection, and equipment availability were not significant.

Table 5. Multiple linear regression of community livelihood score on solid waste management practices.

Predictor	B	SE	*β*	*t*	*p*
Waste separation	−2.153	1.133	−0.092	−1.90	0.050
Lack of knowledge (barrier)	−3.549	1.073	−0.175	−3.31	0.001
Reuse and recycling	1.067	1.580	0.033	2.52	0.020
Storage	1.274	2.081	0.041	0.62	0.535
Collection services available	−1.092	2.809	−0.023	−0.39	0.697
Payment for collection and transportation	0.134	2.662	0.004	0.05	0.957
Satisfaction with services	−2.598	2.048	−0.127	−2.10	0.040
Equipment availability	0.339	1.543	0.014	0.22	0.828
Awareness of waste management regulations	3.789	1.959	0.115	1.93	0.050

Dependent variable: community livelihood score. B: unstandardised coefficient; SE: standard error; *β*: standardised coefficient. Model summary: $R = 0.598$; $R^2 = 0.358$; adjusted $R^2 = 0.324$; standard error of the estimate = 8.289; $F(20, 382) = 10.65$; $p < 0.001$.

4. Discussion

4.1. Solid waste management practices

Household participation in SWM in Kicukiro was high, particularly for source separation, storage, and payment for collection. The 75.1% separation rate is consistent with Mbiba (2014), who found source separation and informal recovery to be common in Eastern and Southern African cities, but higher than in Kampala, where Banga (2011) reported limited household separation despite awareness. Proper storage (90.1%) was also slightly higher than the 85.8% reported in a Kampala slum (Ssemugabo et al., 2020). These differences may reflect Kigali's better-organised collection system, access to recyclable-material collectors, community sensitisation, and local enforcement; Kabera et al. (2019) similarly identified Kigali as having comparatively strong collection coverage and fee payment within East Africa.

The predominance of biodegradable waste among separated materials agrees with the high organic share of municipal waste in African cities (GIZ, 2022; Mbiba, 2014), whereas the low separation of paper and metals suggests limited markets or incentives for these materials. Widespread reuse and the presence of recyclable-material collectors indicate that formal and informal actors work together in resource recovery, as highlighted by Wilson et al. (2006).

However, high access to and satisfaction with collection coexisted with frequent complaints about service reliability and fees, revealing a gap between coverage and quality that is common in cities of the Global South (Kaza et al., 2018). Improvements should therefore target service reliability, affordability, and recycling infrastructure, not only coverage.

4.2. Community livelihoods

Respondents recognised the income potential of recycling, yet only about one-third reported earning money from waste. The economic value of recovered materials therefore accrues mainly to collectors and recyclers rather than to households, a pattern also observed where the informal recycling sector dominates value chains (Velis et al., 2012; Wilson et al., 2006). The broad agreement that waste management creates jobs is consistent with the ILO (2013), which emphasises the potential of waste management to generate decent green jobs. The strongest perceived benefit was environmental: improved cleanliness and reduced illegal dumping, which are closely linked to public health and environmental sustainability (Kaza et al., 2018; Wilson, 2015).

4.3. Relationship between SWM practices and livelihoods

SWM practices jointly explained about one-third of the variation in livelihood scores, indicating a moderate relationship. Lack of knowledge was the strongest negative predictor, suggesting that environmental education can improve both waste-handling behaviour and the economic benefits households obtain from waste (Wilson et al., 2006). The positive association of reuse and recycling with livelihood suggests that these activities provide income or cost savings, and the borderline positive association with awareness of regulations points to the role of governance and enforcement in improving sanitation and wellbeing (Wilson, 2015).

The negative coefficients for waste separation and service satisfaction were unexpected. One possible explanation is that lower-income households separate waste as a coping strategy to

recover saleable materials, so that separation is a marker of economic vulnerability rather than its cause (Wilson et al., 2006). Because the design is cross-sectional, these associations should not be interpreted causally. The study is also limited by its reliance on self-reported data and perception-based livelihood measures.

5. Conclusion

Households in Kicukiro District participate widely in solid waste management, including source separation, proper storage, reuse, and payment for collection. These practices are perceived to improve environmental cleanliness and to create employment, but direct income from waste reaches only about one-third of households. SWM practices are moderately associated with livelihood: lack of knowledge is the main negative factor, whereas reuse and recycling is positively associated with livelihood. SWM therefore supports, but is not yet a primary driver of, household livelihood improvement. Strengthening recycling value chains, expanding waste management infrastructure, improving service reliability and affordability, intensifying environmental education, and promoting waste-based enterprises would increase the socio-economic benefits of SWM in Kicukiro and similar urban districts in Rwanda.

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