Enhancing solid waste management in Kigali, Rwanda: challenges and opportunities from the perspective of waste collection companies

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Enhancing solid waste management in Kigali, Rwanda: challenges and opportunities from the perspective of waste collection companies

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Preface

The thesis report you are about to read is the result of six months of efforts made to complete my master's program at AMS Institute. Over the past two years here, I have learned a great deal, especially from my fellow students with all their different study backgrounds and nationalities.

About half of this research was carried out in Kigali, where I was welcomed with open arms by TRAIDE Rwanda. I would like to thank them for the fantastic opportunity they have given me to be able to conduct research in Kigali on such a fun topic. I would specifically like to thank Evelien, Fidela and Yanna for their help with my research, insights into the local context and providing interpretation during my interviews. I am also very grateful to them, the interviewees in this study, for the valuable information they were willing to provide. I also want to especially mention Pien, the fellow MADE student with whom I spent two months in Rwanda; I am glad that the two of us were able to embark on this adventure together.

I would like to thank my supervisors Yawei and Bas for their feedback, optimism and concern for my well-being. Finally, I would like to thank my family and friends, for their support in the process of writing this thesis, and during my time in Rwanda.

Abstract

In Kigali, Rwanda, urbanization and increased affluence will increase the amount of waste. Currently, there is no sustainable disposal of the waste, as unsorted waste is deposited in an unsanitary landfill, which is beginning to fill up. The Rwandan government aims to create a circular economy and tries to address waste management, but few developments are taking place.

As there is a need for sustainable waste management solutions, this qualitative case study examines factors affecting the effectiveness of Kigali's solid waste management (SWM) from the perspective of waste collection companies (WCCs), as these stakeholders' views have not been explored before. Data were collected by means of observations, interviews, and a literature review.

The current status of the SWM system and obstacles experienced by respondents are categorized using Wilson's Wasteaware indicators (2015). Finally, results are examined by means of the dimensions of the Modernized Mixtures Approach (MMA) (Oosterveer & Spaargaren, 2010).

Analysis shows that links within Kigali's SWM are unprepared to handle separated waste streams, inhibiting recycling. Further, there is a lack of knowledge on proper waste disposal among residents, while government educational attempts remain largely ineffective. Also, policies, issued by many different government agencies, are often contradicting. As no data are collected on the status of SWM, there is little monitoring of progress. Finally, WCCs face defaulters, leading to a weakened financial situation.

Recommendations from this research are to centralize the system, within both government and payment system. Breaking the identified 'multilevel non-separation feedback loop' may create opportunities to handle separated waste streams, thus enabling recycling. Using media to educate residents regarding source separation and a color-coding system for different waste streams is potentially successful and might break the loop. Gaining visibility into the status of the SWM, placing a weighbridge at the landfill would be a good start.

Keywords: solid waste management, waste collection companies, Wasteaware, East-Africa, Modernized Mixtures Approach

Abbreviations

CoK   City of Kigali

CPCIC   Cleaner Production and Climate Innovation Center

ISWM   Integrated solid waste management

MININFRA Ministry of Infrastructure

MMA   Modernized Mixtures Approach

MoE   Ministry of Environment

MSW   Municipal solid waste

NISWM   National Integrated Solid Waste Management Strategy

PPP   Public-private partnership

REMA   Rwanda Environment Management Authority

RURA   Rwanda Utilities Regulatory Authority

SWM   Solid waste management

WASAC   Water and Sanitation Corporation

WCC   Waste collection company

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Introduction

1.1. Introduction

Waste management is increasingly becoming a problem in cities and has attracted critical attention worldwide (Mulya et al., 2022). Global waste generation is expected to increase by 70% to 3.4 trillion tons by 2050 from 2.01 trillion tons in 2016 (Kaza et al., 2018). In low-income countries, the percentage of waste collected has traditionally been low: an average of 40% is collected, and burning and dumping waste is mostly the norm (Kabera et al., 2019). These figures, combined with the fact that the waste of 3 trillion people worldwide is burned or dumped, led experts on waste management, Wilson and Webster, to declare the situation a global waste crisis (Wilson and Webster, 2018).

Improving solid waste management (SWM) in African cities is critical for several reasons. Firstly, as the population in developing countries is still growing, and the migration from rural to urban areas is set to continue, particularly in Africa (Kabera et al., 2019), this will lead to a rapid increase in waste generation in cities, which, according to a seminal World Bank report, will soon overtake that of developed countries (Hoornweg & Bhada-Tata, 2012).

Additionally, waste per capita shows a strong positive correlation with income levels, so waste generation will increase as the country develops economically (Kabera et al., 2019; Rajashekar et al., 2019).

This is also the case in Rwanda, where industrialization, population growth, and lifestyle changes are leading to increased waste (Nikuze et al., 2021). The Rwanda Environment Management Authority (REMA) expects the amount of waste generated in Kigali to increase by 63% in 2030 compared to 2019 (REMA & UNDP, 2021). Managing municipal solid waste in developing nations can be challenging due to increased waste production, the high cost of waste management, and inadequate containment systems (Idowu et al., 2019).

In general, when the amount of waste increases and the SWM system is inadequate, local governments and city residents will often resort to unsustainable ways of SWM (Abubakar et al., 2022). The effects of such inadequate waste management on the environment are enormous: burning waste causes air pollution, landfilling causes soil contamination, and the waste can clog drains, causing flooding and the spread of infectious diseases (Van Vliet et al., 2010; D. Wilson & Webster, 2018).

1.2. Problem statement

These issues are also at play in Rwanda, as the country disposes of a sizeable portion of its waste in improper locations and dumpsites (Abubakar et al., 2022). Even though Kigali, Rwanda, is considered one of the cleanest cities in the African continent (Twahirwa, 2018), the way waste is disposed of is not very environmentally sustainable (Iraguha, Ramelan, et al., 2022; Kabera et al., 2019; Rajashekar et al., 2019; Squire & Nkurunziza, 2022). One study calls Kigali's approach in this matter the "out of sight, out of mind approach, where the emphasis is on collection and disposal, with little or no

emphasis on minimization, recovery or recycling" (Squire & Nkurunziza, page 1, 2022).

Rwandese government agencies are calling for research on feasibility studies to bring ideas for effective and efficient municipal solid waste proposals, which include options to look at each step of the municipal solid waste value chain, considering the theories of circular economy and maximum resource recovery (WASAC, 2019).

The Rwandan government recognizes the poor state of SWM and states that they have waste management high on their agenda and want to make changes in the sector (MININFRA, 2022; Rajashekar et al., 2019). This thesis examines the factors that impact the effectiveness of SWM in Kigali, Rwanda, from the perspective of waste collection companies (WCCs), as there is a need for sustainable waste management solutions.

There is uncertainty about the effectiveness of the SWM system in Kigali and a lack of available data compounds this. Moreover, the amount of waste generated in Kigali is only expected to increase (Rajashekar et al., 2019). Despite government efforts to improve the SWM system through policies and strategies, little progress seems to be made.

However, existing literature has not yet examined the specific views of WCCs regarding the challenges and opportunities within the SWM system. Gaining insights into their perspectives and

experiences is essential as they play a crucial role in the SWM system. By exploring their views, bottlenecks can be identified and possible solutions for improving the system can be explored.

1.3. Research aim & research questions
Waste in Kigali is hardly recycled and mostly disposed of in unsustainable ways. To make SWM more sustainable, something within the system will have to change. This research looks for ineffectiveness in view of sustainability but does not exclude the possibility of yielding results related to ineffectiveness that are not directly linked to sustainability.

Firstly, this research aims to examine the SWM process in Kigali, Rwanda, which involves collection, disposal, and treatment of waste, as well as policies, regulations, and stakeholders regarding waste management. When this knowledge has been gathered, the key factors influencing the effectiveness of Kigali's SWM to achieve sustainability will be identified. This will be examined from the perspective of waste collection companies and supplemented with insights from urban waste experts. By exploring their perspectives, experiences, and challenges, this study seeks to shed light on the opportunities and potential solutions for enhancing SWM practices. Through in-depth interviews and analysis, this research intends to contribute valuable knowledge about the private sector's role and its impact on the overall effectiveness of the waste management system in Kigali.

By employing the MMA's dimensions, including scale, bottom-up/top-down dynamics, degree of centralization, and degree of separation of flows, a comprehensive perspective will be gained. These dimensions serve as a critical lens through which to distill valuable insights and discern patterns within the collected information, ultimately enhancing the understanding of the subject matter.

The gathered information and insights can assist policymakers and other stakeholders in Kigali's SWM in the future in making informed decisions, resulting in a more efficient and sustainable solid waste management system for Kigali and its residents.

The main question of this study is:

What factors hinder an effectively functioning solid waste management system in Kigali, Rwanda, according to local waste collection companies and urban waste experts?

This question will be answered by means of the following three sub-questions:

- *What is the current state of affairs of Kigali's solid waste management system?*
- *What are obstacles and opportunities regarding the effectiveness of Kigali's solid waste management system, according to Kigali's waste collectors and experts?*

- *Which (combination of) large – and small scale social and technical themes regarding the effectivity of the solid waste management system can be identified?*

1.4. Scientific and societal relevance

In Rwanda, and specifically in the city of Kigali, extensive research has been conducted on the waste management system. However, despite the importance of the private sector, particularly waste collection companies, in solid waste management, there remains a knowledge gap in this area. Limited research has been dedicated to understanding the perspectives of waste collection companies, resulting in a lack of insights into their role and potential strategies for improving the solid waste situation. This research focuses on the vision of waste collection companies and breaks the existing knowledge gap.

The contemporary status of the SWM may cause negative environmental impacts and recovers limited waste streams. In addition, the way the waste is processed may cause health problems for the processors and those living near the landfill. This research hopes to use the findings to contribute to increasing the efficiency and sustainability of the Kigali SWM, thereby also contributing to the solution of the aforementioned problems. Finally, a more efficient, sustainable SWM could contribute to economic growth, as it could kickstart the recycling sector.

1.5. Outline of thesis

This study investigates the key factors influencing the sustainability of the SWM system in Kigali.

Chapter 2, theoretical framework, will discuss the theories Wasteaware and Modernized Mixtures Approach, which are used in this study. In addition, the last section provides insight into some details about the research context.

In chapter 3, methodology, the approach, and nature of the research will be explained.

In chapter 4, results, the first two sub-questions will be answered using literature, observations, and interviews.
In chapter 5, modernized mixtures, the obtained results will be analyzed through the lens of the modernized mixtures approach.

Chapter 6, discussion and limitations, will first elaborate on the results obtained and the methods used to do so. Then, the limitations of this research will be described.

In chapter 7, conclusion, the main question of the study will be answered, and the results obtained will be outlined.

2

Theoretical framework

This chapter discusses the theories used in this study. The first section provides a brief background on the formation of the Wasteaware indicators. Subsequently, the Wasteaware indicators are explained in further detail. The second section introduces the Modernized Mixtures Approach.

2.1. Integrated Sustainable Waste Management and Wasteaware indicators

In the 1980s, WASTE developed the Integrated Sustainable Waste Management approach (ISWM) (WASTE, n.d.) This approach distinguishes three dimensions within waste management: stakeholders, waste system elements, and sustainability aspects (Scheinberg et al., 2008). In the case of this approach, the word "Integrated" indicates that SWM consists of different facets, such as prevention, recycling, and composting, and the fact that it is carried out by multiple actors/stakeholders. These actors/stakeholders are all people and organizations with a stake or interest in waste management. How many different parties/individuals this involves depends on the context within which the SWM is located. For example, the stakeholders in pre-modern urban waste systems (such as in the U.S. and the Netherlands in the 1980s) tend to be the local authority, the national environment or local government ministry, and one or two private companies working under contract to the municipality, where in countries in the Global South there are often thousands of individuals connected to the waste management system in various ways (ibid). They may be living off the waste, working with it, or being duped

by it. By the ISWM, these people are called "unrecognized stakeholders."
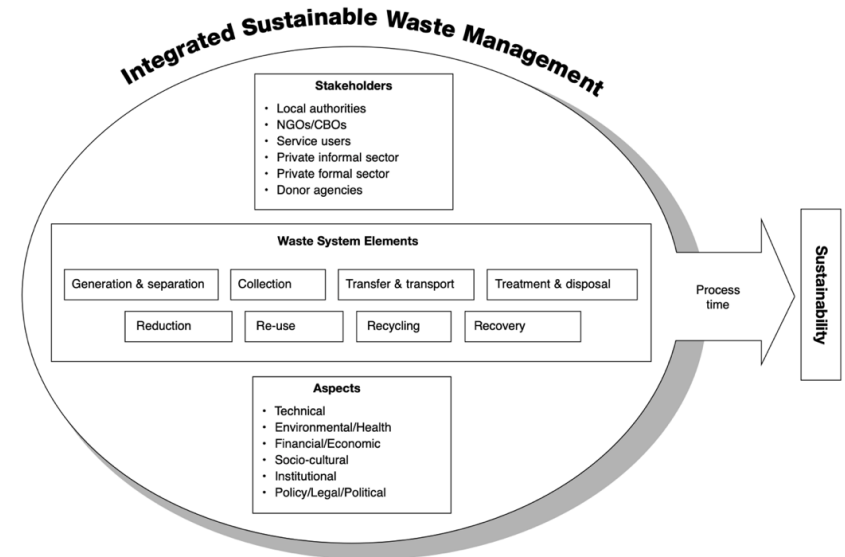
Figure 1: ISWM Assessment. Source: Anschütz et al. (2001)

The word "Integrated" also refers to the connectedness between different parts of the system and shows that this connectedness exists in technical, legal, economic, and institutional contexts. The sustainability aspects, the third dimension of the ISWM, cover various topics. For example, it looks at the sustainability of the following aspects: technical, environment/health, socio-cultural, financial/economic, institutional, and policy/legal/political (Scheinberg et al., 2008). When the system is rated "Sustainable" by

ISWM, it is robust in all aspects and is strong enough not to collapse.

For example, the degree of integration and versatility of the ISWM makes it possible to establish links between the social and institutional components of waste collection (e.g., where people should place their waste and how (often) it is collected) and the economic component (e.g., whether residents pay for this service).

The second dimension of the ISWM is the waste system elements. The purpose of this dimension is to expose the technical structures present within the SWM. However, it is not necessary for ISWM to plot the entire technical story (Scheinberg et al., 2008).

2.1.1. Wasteaware

To contribute to the global data deficit related to waste, Wilson et al. established benchmark indicators using the ISWM approach (2015). The so-called "Wasteaware" indicators consist of both quantitative and qualitative indicators, which can be used to analyze both "hard" physical components and "soft" governance aspects. These indicators have been tested through prototypes in more than 50 cities worldwide and aim to form a standard methodology to address the historical global data gap. The Wasteaware indicators are based on the ISWM methodology designed for UN-Habitat (ibid). In creating them, an effort was made to consider both the physical and governance components as broadly as possible and ensure that the indicators are applicable across different countries and income levels. The three indicators of

Wasteaware covered by the physical components are the parts of the SWM that can be physically observed and are as follows: quality of waste collection and street cleaning service, degree of environmental protection in waste treatment and disposal and quality of 3Rs – reduce, reuse, recycle – provision. The three indicators of Wasteaware covered by the governmental components are the parts of the SWM that cannot physically be observed and are as follows: degree of user and provider inclusivity, degree of financial sustainability and sound institutions and pro-active policies. These indicators are assessed using criteria, which are also established by Wilson et al. (ibid). These criteria will be explained in the following paragraphs.

(a) Physical components: waste collection and street cleaning service

To determine the effectiveness of waste collection, six criteria were identified by Wilson et al. (2016): (i) appearance of waste collection points, (ii) effectiveness of street cleaning, (iii) effectiveness of collection in low-income districts, (iv) efficiency and effectiveness of waste transport, (v) appropriateness of service planning and monitoring and (vi) health and safety of collection workers (see table 1).

Criterion	Description
Appearance of waste collection points	Presence of accumulated waste around collection points/containers
Effectiveness of street cleaning	Presence of litter and overflowing litter bins
Effectiveness of collection in low income districts	Presence of accumulated waste/illegal dumps/open burning
Efficiency and effectiveness of waste transport	Appropriate public health and environmental controls of waste transport
Appropriateness of service planning and monitoring	Appropriate service implementation, management, and supervision in place
Health and safety of collection workers	Use of appropriate personal protection equipment and supporting procedures

Table 1: Waste collection - Wasteaware criteria + descriptions (Source: Wilson et al., 2016)

(b) Physical components: degree of environmental protection in waste treatment and disposal

To determine the effectiveness of waste disposal, six criteria were identified by Wilson et al. (2016): (i) degree of control over waste reception and general site management, (ii) degree of control over waste treatment and disposal, (iii) degree of monitoring and verification of environmental controls, (iv) efficiency of energy generation and use (used for energy recovery facilities only), (v) degree of technical competence in planning, management, and operation of treatment and disposal and (vi) occupational health and safety (see table 2).

Criterion	Description
Degree of control over waste reception and general site management	Assessment of control measures at treatment and disposal sites, including the specific process being used and any potential emissions.
Degree of control over waste treatment and disposal	Evaluation of the presence of necessary technologies and operating procedures for waste treatment or disposal, considering potential emissions.
Degree of monitoring and verification of environmental controls	Assessment of the existence and implementation of environmental permitting procedures, regular record keeping, monitoring, and verification by the facility and independent regulatory bodies.
Efficiency of energy generation and use (used for energy recovery facilities only)	Assessment of the energy efficiency of facilities where energy recovery is a major purpose.
Degree of technical competence in planning, management, and operation of treatment and disposal	Evaluation of technical competence at three points: authority responsible for service provision, management of treatment and disposal facilities, and frontline operational staff.
Occupational health and safety	Assessment of the use of appropriate personal protection equipment and supporting procedures for worker safety.

Table 2 Waste disposal - Wasteaware criteria + descriptions (Source: Wilson et al., 2016)

(c) Physical components: Quality of 3Rs – reduce, reuse, recycle – provision

To determine the quality of 3Rs, six criteria were identified by Wilson et al. (2016): (i) source separation of 'dry recyclables', (ii) quality of recycled organic materials, (iii) focus on the top levels of the waste hierarchy, (iv) integration of community and/or informal recycling sector with formal SWM system, (v) environmental protection in recycling, (vi) occupational health and safety (see table 3).

Criterion	Description
Source separation of 'dry recyclables'	Assessment of the proportion of clean, source-separated materials collected for recycling compared to mixed waste, with a focus on the relative percentage of clean materials.
Quality of recycled organic materials	Qualitative assessment of the likely quality of recycled organic products, considering separation at source and quality control measures.
Focus on the top levels of the waste hierarchy	Evaluation of policy focus on promoting reduction and reuse in higher waste-generating cities, and on the 3Rs (reduce, reuse, recycle) in lower waste-generating cities.
Integration of community and/or informal recycling sector with formal SWM system	Assessment of efforts to include the informal recycling sector (in low and middle-income countries) and the community reuse and recycling sector (in higher-income countries) in formal waste management.
Environmental protection in recycling	Evaluation of environmental impacts throughout the recycling chain, from collection to separation and processing of materials.
Occupational health and safety	Assessment of the use of appropriate personal protection equipment and supporting procedures for worker safety.

Table 3: Quality of 3R's - Wasteaware criteria + descriptions (Source: Wilson et al., 2016)

(d) Governmental components: Degree of user and provider inclusivity

To gain insight into the degree of user and provider inclusivity, the indicator was split into two parts: user inclusivity, and provider inclusivity.

To gain insight into user inclusivity, six criteria were identified by Wilson et al. (2016): (i) equity of service provision, (ii) the right to be heard, (iii) level of public involvement, (iv) public feedback mechanisms, (v) public education and awareness and (vi) effectiveness in achieving behavior change (see table 4).

Criterion	Description
Equity of service provision	Evaluation of the extent to which all citizens, irrespective of income level, receive an affordable solid waste management service that meets their needs and protects public health.
The right to be heard	Assessment of whether authorities have a legal obligation to consult and involve citizens in decisions that directly affect them.
Level of public involvement	Evidence of public involvement at appropriate stages of the solid waste management decision-making, planning, and implementation process.
Public feedback mechanisms	Existence and use of public feedback mechanisms on solid waste management services.
Public education and awareness	Implementation of comprehensive, culturally appropriate public education and awareness raising programs.
Effectiveness in achieving behavior change	Assessment of the effectiveness of education and awareness programs in changing waste management practices and behaviors.

Table 4: Degree of user inclusivity - Wasteaware criteria + descriptions (Source: Wilson et al., 2016)

To gain insight into provider inclusivity, six criteria were identified by Wilson et al. (2016): (i) legal framework, (ii) representation of the private sector, (iii) role of the 'informal' and community sector, (iv) the balance of public vs. private sector interests in delivering services and (v) bid processes (see table 5).

Criterion	Description
Legal framework	Evaluation of the presence and implementation of laws or legal instruments that enable both public and private sectors to deliver solid waste management services effectively.
Representation of the private sector	Assessment of the presence of organizations or structures representing the private waste sector actively participating in waste management planning forums, committees, etc.
Role of the 'informal' and community sector	Recognition and acknowledgement of the role of the organized 'informal' and community sectors within the formal solid waste management system.
The balance of public vs. private sector interests in delivering services	Evaluation of checks and balances to ensure mutually beneficial waste service delivery by the public and private sectors.
Bid processes	Assessment of the openness, transparency, and accountability of bid processes in solid waste management service procurement.

Table 5: Degree of provider inclusivity - Wasteaware criteria + descriptions (Source: Wilson et al., 2016)

(e) Governmental components: Degree of financial sustainability
To gain insight into the degree of financial sustainability, six criteria were identified by Wilson et al. (2016): (i) cost accounting, (ii) coverage of the available budget, (iii) local cost recovery – from households, (iv) affordability of user charges, (v) pricing of disposal and (vi) access to capital for investments (see table 6).

Criterion	Description
Cost accounting	Extent to which the solid waste management accounts reflect accurately the full costs of providing the service and the relative costs of the different activities within solid waste management; and whether the accounts are open to public scrutiny
Coverage of the available budget	Is the annual budget adequate to cover the full costs of providing the service?
Local cost recovery – from households	Percentage of the total number of households both using and paying for primary waste collection service. The focus here is on the number of households, NOT on the percentage of the total costs which they pay
Affordability of user charges	Are practices or procedures in place to support charges for those who can least afford to pay?
Pricing of disposal	Degree to which all the wastes coming to the final (treatment or) disposal site(s) are charged at a rate that covers (at least) the operating costs of (treatment or) disposal
Access to capital for investments	Has adequate provision been made for necessary capital investments, both to extend collection coverage to any un-served areas; to upgrade standards of waste disposal; and to replace existing vehicles, equipment and sites at the end of their life?

Table 6: Degree of financial sustainability - Wasteaware criteria + descriptions (Source: Wilson et al., 2016)

(f) Governmental components: Sound institutions and pro-active policies

To gain insight into the sound institutions and pro-active policies the indicator was split into two parts: adequacy of national framework for SWM and degree of local institutional coherence.

To gain insight into the adequacy of national framework for SWM six criteria were identified by Wilson et al. (2016): (i) legislation and regulations, (ii) strategy/policy, (iii) guidelines and implementation procedures, (iv) national institution responsible for implementing SWM policy, (v) regulatory control/enforcement, (vi) Extended Producer Responsibility (EPR) or Product Stewardship (PS) (see table 7).

To gain insight into the degree of local institutional coherence, six criteria were identified by Wilson et al. (2016): (i) organizational structure/coherence, (ii) institutional capacity, (iii) city-wide SWM strategy and plan, (iv) availability and quality of SWM data, (v) management, control, and supervision of service delivery and (vi) inter-municipal (or regional) cooperation (see table 8).

Criterion	Description
Legislation and regulations	Existence of comprehensive national laws addressing solid waste management requirements, including regulations that have been put in place.
Strategy/policy	Existence of an approved and recent national strategy for solid waste management, as well as clear policies that are implemented.
Guidelines and implementation procedures	Presence of clear guidelines for local authorities on implementing laws and strategy, along with effective mechanisms for facility siting.
National institution responsible for implementing SWM policy	Presence of a single institution at the national level responsible for implementing or coordinating the implementation of solid waste management strategy/policy.
Regulatory control/ enforcement	Presence of a well-organized and adequately resourced environmental regulatory agency that enforces legislation to ensure a level playing field.
Extended producer responsibility (EPR) or Product Stewardship (PS)	Engagement with national and international companies to share costs of waste management service and/or recycling for products they produce.

Table 7: Adequacy of national framework - Wasteaware criteria + descriptions (Source: Wilson et al., 2016)

Criterion	Description
Organizational structure/ coherence	Degree to which solid waste management responsibilities are concentrated in a single organization or department that can be held accountable for performance.
Institutional capacity	Assessment of the organizational strength and capacity of the department(s) responsible for solid waste management.
City-wide SWM strategy and plan	Existence and implementation of a recent strategy or plan at the city or regional level for solid waste management.
Availability and quality of SWM data	Existence of a management information system (MIS) and regular measurement, collection, and monitoring of data related to solid waste management.
Management, control, and supervision of service delivery	Measure of the strength of control by the city as the client for solid waste management over the delivery of services by the private or public sector.
Inter-municipal (or regional) cooperation	Evaluation of the effectiveness of waste collection at the local level and the cooperation required for treatment and disposal at the city-wide or regional level.

Table 8: Degree of local institutional coherence - Wasteaware criteria + descriptions (Source: Wilson et al., 2016)

2.2. Modernized Mixtures Approach

The theory of the Modernized Mixtures Approach (MMA) emerged as a response to the false dichotomy between two paradigms that separates large-scale, centralized, high-tech approaches (referred to as 'centralized systems') on the one hand, and small-scale,

decentralized, convenient, and low-cost technological approaches on the other (referred to as 'decentralized systems') (see figure 2 and 3) (Oosterveer & Spaargaren, 2010). In their theory of MMA, Oosterveer and Spaargaren suggest combining the strengths of both paradigms: a successful MMA embraces the strengths of both paradigms through the dimensions of scale, degree of participation, degree of centralization, and degree of separation of flows.
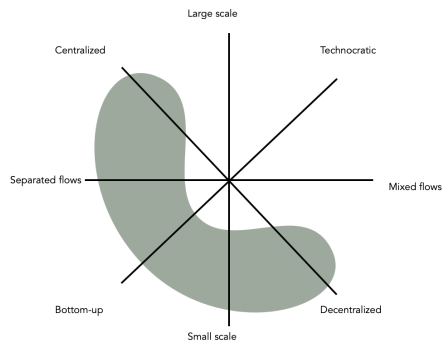
Figure 2: Decentralized System (adapted from Spaargaren et al., 2006)
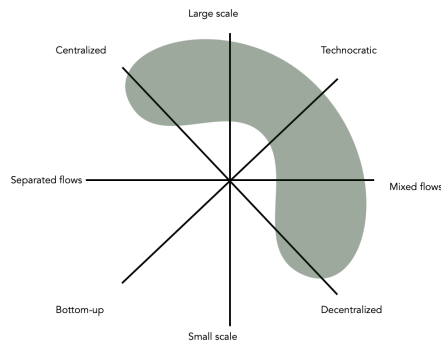
Figure 3: Centralized System (adapted from Spaargaren et al., 2006).

In seeking a middle ground between opposing paradigms, the MMA represents a new approach to building SWM systems, rather than building on the grid-based, centralized systems in the developed world or the decentralized on-site systems common in developing countries (Hendriksen et al., 2012). Each city or location necessitates a unique combination of technologies and governance arrangements based on the aforementioned principles. The MMA enables this flexibility by rejecting the notion

of a universal solution for urban environmental infrastructure (van Vliet, van Buuren, Oosterveer, et al., 2013).

To ensure effective configurations, the MMA must encompass the following conditions:

> *ecological and institutional sustainability*,
>
> *accessibility* (especially for marginalized communities),
> *technical flexibility*,
>
> *resilience*,
>
> *robustness* (Oosterveer & Spaargaren, 2010, p. 16).

It is crucial to recognize that the interpretation of these conditions varies depending on the specific context.

Ecological or environmental sustainability involves minimizing pollution and resource consumption. In the context of SWM, it entails reducing landfill waste and promoting recycling to minimize resource utilization (e.g., materials, energy) (van Vliet et al., 2013). Recycling can contribute to resource conservation as well.

Institutional sustainability encompasses sociopolitical and cultural aspects at both local and national levels, influencing the integration of a new system within existing urban infrastructure, such as SWM, and enhancing its performance (van Vliet et al., 2013). It focuses on embedding the new system into the social fabric and governance structures of the particular setting.

Accessibility pertains to ensuring that disadvantaged populations have equitable access to sanitary infrastructure,

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regardless of financial, sociocultural, or physical barriers. It aims to prevent marginalization and ensure equal opportunities for all members of society (Hendriksen et al., 2012)).

Technical flexibility refers to the ability of urban

infrastructure to withstand economic, political, and climate-related uncertainties and adapt accordingly. It ensures that the system remains functional and efficient despite changing conditions and challenges (Hendriksen et al., 2012).

The MMA can also be used as an assessment tool. The different dimensions are used as a lens and allow for an integrated perspective through which both social and technical dimensions of SWM can be assessed (van Vliet, van Buuren, & Mgana, 2013). It is also possible to observe combinations of small- and large-scale features through use of the dimensions.

This study uses two of the three methods discussed, Wasteaware and MMA. The Wasteaware method is derived from the ISWM; the two methods are very similar. The Wasteaware method provides a good structure for this research and covers all the facets that the ISWM provides. Wasteaware will be used as a method to highlight the features of the SWM and structure the results obtained. The chapter structured by Wasteaware will address the first two sub-questions; the current state of affairs of the SWM in Kigali and the factors that hinder its efficiency, according to WCCs and urban waste experts. The MMA will be used in a separate chapter in which the results of the first two sub-questions will be analyzed using this method.

3 Methods

This section begins by restating the research objective, research design, and research questions. Subsequently, the methodology employed in this research will be elaborated upon and justified. This will include a discussion of the respondents, data collection and -analysis as well as considerations of ethics and consent.

3.1. Research design

The research design used for this study is a single case study approach. Case studies offer a thorough understanding of a specific phenomenon within its real-life context (Bryman, 2016) and are appropriate for in-depth research to uncover contextual factors and underlying mechanisms (Flyvbjerg, 2006). In this research, by focusing on Kigali's SWM; complexities, and dynamics involved in waste management (including practices, policies, and stakeholder interactions) can be explored in great detail.

In this qualitative case study multiple sources of evidence were gathered by means of interviews, observations, and literature study in order to gather information for a rich and nuanced understanding of the phenomenon under study (Yin, 2018). Actively engaging with stakeholders and capturing their perspectives makes it possible to understand the multiple perspectives and meanings inherent in the phenomenon under investigation (Stake, 2005).

The main emphasis of this research is centered on the waste collection companies within Kigali's SWM system, particularly those responsible for collecting household waste.

Finally, the use of multiple data sources enables the triangulation of findings, which contributes to the reliability and validity of the research.

3.2. Respondents

The following organizations and individuals were engaged as respondents in this research study (see table 9):

a) Waste collection companies

To gain insights into the challenges and opportunities encountered by WCCs in Kigali regarding waste management, interviews were conducted with four such companies. The companies were recruited as follows.
Out of a total of 13 WCCs, contact information for 9 companies was discovered online. Phone calls were made to these companies, and 6 of them agreed to participate. This included 5 WCCs responsible for household waste collection (referred to as WCC A-E), and 1 waste company involved in collecting waste from businesses where source separation is already implemented (referred to as WCC F).

b) Urban waste experts

To gain a comprehensive understanding of the current state of waste collection in Kigali, discussions were held with Prof. Telesphore Kabera, Associate Professor of Environmental Engineering at the College of Science and Technology of the University of Rwanda.

In order to better comprehend the dynamics of waste collection in the city, Mr. Manirakiza from Urban Dynamics in Kigali was interviewed.

To assess the utilization of government support by waste management companies, an employee from the Cleaner Production and Climate Innovation Center (CPCIC), a green growth fund supported by the government, was consulted.

To gain more information on the workings of the SWM system and its dynamics, an interview was conducted with an employee of a development aid organization, one of whom specializes in circularity in Rwanda.

Lastly, an entrepreneur and owner of multiple startups in plastic recycling in East Africa was interviewed to gain further insight into the waste management chains in Rwanda.

3.3. Data collection and analysis
For this research, the following data were collected.

a) Literature

In order to provide a good understanding of the current SWM system in Kigali, a literature study was conducted. Outcomes of this study, especially those of the study by Kabera et al. (2019), served as a basis for the collection of empirical data (e.g., interview schedule) and its subsequent analysis (code set). MMA was used as a lens during the interviews (probing).

Interviewee	Date	Duration
WCC A	03-05-2022	0:51:02 hrs
WCC B	11-05-2023	1:01:50 hrs
WCC C	12-05-2023	0:41:19 hrs
WCC D	05-05-2023	0:45:43 hrs
WCC E	27-05-2023	0:20:23 hrs
WCC F	22-05-2023	1:06:08 hrs
Employee CPCIC	11-05-2023	0:39:10 hrs
Dr. Vincent Manirakiza	12-05-2023	0:40:50 hrs
Dr. Telesphore Kabera	20-05-2023	0:26:21 hrs
Employee development aid organization	18-05-2023	1:27:43 hrs
Entrepreneur in recycling sector East-Africa	02-05-2023	0:49:43 hrs

Table 9: List of interviewees

b) Fieldwork

In order to maximize understanding of the local context and SWM, fieldwork was conducted in Kigali, Rwanda (2 months).
By conducting on-site fieldwork rather than relying exclusively on remote research methods, the researcher can benefit from the following advantages and added value:

- Experience and observation*:*

    By being part of everyday life in a given context, it is possible to understand the context and specific situations better.

- Local perspectives*:*

    By being on-site, it is easier to connect with stakeholders, as well as other residents of the city.

- Data collection*:*

    On-site, real-life data collection has several advantages. In the case of interviews, the physical presence of the interviewer allows for the observation and response to nonverbal communication, leading to a deeper level of engagement and understanding during the interview process.

During field work, the following data were collected by means of observations, interviews and the keeping of a research diary.

Observations
The following situations and processes were observed on site:
• Waste collection on the streets varies across different neighborhoods based on socio-economic status, both in the formal sector (garbage trucks, workers) and the informal sector (people collecting and selling plastic to middlemen).
• Women who sweep the streets and maintain clean borders, with their waste being collected by the garbage trucks.
• The process of waste collection by WCCs, including how residents package household waste before disposal and how the waste is collected.
• The overall perception of the city's cleanliness.
These situations were photographed as well as documented in the research journal.
To avoid observation bias, joint observations were conducted with an independent researcher who is well-versed in the field of urban sustainability. Observations were compared and discussed in order to identify any gaps or make necessary additions.

Interviews
The purpose of the interviews was to gather the perspective of WCCs on their envisioned future and progress regarding SWM in Kigali, as well as their potential influence in this regard. The primary goal was to identify the obstacles that impede the sector's sustainability and devise a solution.
Hereto, semi-structured interviews were conducted with employees of waste collection companies, focusing on those involved in household waste collection.

Instead of directing specific questions on particular subjects, the interviews followed a format of posing four open-ended questions to all participants. This approach was adopted to allow respondents the opportunity to steer clear of politically sensitive

matters. Probing questions were only introduced if participants voluntarily raised such issues, inviting them to elaborate further on the topic.

Interviews were audiotaped and transcribed verbatim (see appendix I).

Not all interviewees had a proficient command of the English language. In order to preserve the interviewees' intended meaning, all grammatically incorrect or awkward sentences were kept intact.

Two of the interviews were conducted with the help of a translator, who was a project officer at TRAIDE and thus well-versed in the subject matter. Translation of research interviews may include the risk of (unconcious) translation bias due to cultural and linguistic issues in collecting data in one language, and reporting in another (Kirkpatrick & Van Teijlingen, 2009). In their article, Kirkpatrick and van Teijlingen emphasize the importance of being aware of the possible pitfalls in translation and interpretation issues, as this helps both researchers and interpreters to minimize them. They propose this process should be explicit in the planning and reporting of any research carried out in a cross-cultural setting using translators. Translators' work must be made visible and clearly reported (Kirkpatrick and van Teijlingen, 2009). Therefore, to minimize the risk of translation bias and ensure research quality, once transcribed, the interviews were shared with the translator, and together, their accuracy was verified by cross-checking with the respective interviewees.

The interviews were analyzed using Atlas.ti 22, with relevant sections grouped according to Kabera et al.'s (2019) six indicators and corresponding subcategories of Wasteaware. Thematic analysis was then applied to these groups, extracting core themes. These themes include the problems and potential solutions related to each indicator within the SWM system. This led to an initial code set. To ensure inter rater reliability this code set was checked with an independent researcher. Hereto, one interview was coded by the researcher with the initial code set. The same interview was then coded by the independent researcher, using the same code set. Similarities and differences were discussed, resulting in the modification of one code: within the indicator 'User inclusivity', the criteria 'public education' and 'awareness and effectiveness' did not adequately address how people perceive waste as a concept before receiving education. Therefore, the code 'Public image of waste' was added.

Research diary
The research diary contains a record of the progress of the investigation, as well as reflections on changes in research design and any resulting amendments. It comprises 36 entries entered between March and June 2023.

3.4. Context
The SWM system under study is located in Kigali, Rwanda. A brief explanation of the country, its people, and the city of Kigali will be given to give more meaning to the study.

Rwanda is a landlocked country in East Africa, just below the equator. The country is also dubbed 'the country of 1000 hills.

Kigali, the capital, is situated at an altitude of about 1.5 km. There is relatively little talk of seasons, but one has to deal with the rainy season. When it rains, water from the hills above washes into the valleys. It can be fertile and muddy in low-lying areas, but as you go lower, the likelihood of waterlogging increases.

Rwanda is a densely populated country with 13,2 million inhabitants in 2022 on 26.338 km2. The country is organized into provinces, which in turn are divided into districts. These districts are then divided into sectors, and within each sector, there are several cells. These cells are called 'Imidugudu'. Kigali is divided into three districts, each containing 35 sectors. In total, there are 161 cells and 1183 'Imidugudu' in the city.

3.5. Consent
Participants were aware they could withdraw from the study for any reason at any time and gave informed consent for the collection and anonymized use of data gained from audio recorded interviews.

3.6. Ethical consideration
This research was conducted by a white researcher from the Global North. As a researcher with such background, one must be wary of the possibility of perpetuating colonial power dynamics and reinforcing neocolonial narratives (Shohat & Stam, 2014). During the research, the information I get from local people is the primary source of information for this study. Western knowledge about SWM, among others, may not be applicable to every topic.

Therefore, literature from both the Global North and the Global South was used, and the accuracy of the research in this context was critically examined.

Another ethical obstacle was the possibility of inadvertently exploiting local participants and their knowledge for personal gain, without appropriate compensation or recognition. Likewise, consideration was given to those who precisely do not want to receive recognition, and rather want to remain in anonymity. Therefore, necessary steps were taken to protect both the researcher and the people involved in the research from these risks. Hereto, locals were only approached under guidance of other locals or people familiar with the research area. Additionally, the intentions, expectations and motivation for the research were clearly stated at the start of interaction.

4

Results

This chapter describes the results obtained in the research on the key factors influencing the sustainability of the SWM system in Kigali. The data for this study were obtained through literature review, observations, and ten semi-structured interviews. Of these eleven interviews, six were conducted with WCCs, and the other five with urban waste experts. For ethical concerns, some of the personal data is anonymized. Thus, WCCs are referred to WCC A-F. More information on the interview methods can be found in chapters 3.3. and 3.4.

The chapter is structured using the six Wasteaware indicators by Wilson et al. (2016), with each indicator forming a separate paragraph (waste collection, waste disposal, 3 R's, user & provider inclusivity, financial sustainability, and sound institutions and pro-active policies).

4.1. Quality of the waste collection and street cleaning service

Appearance of waste collection points

Households store their waste indoors for a week, after which the responsible WCC picks it up (Iraguha et al., 2022). In the public space, trash cans can also be found (image 1). Putting trash on the street on days other than the collection day can result in a fine of 10,000 to 100,000 Rwf (€9,50 - €95) (Rwanda National Police, 2017). Proper waste collection is especially important during the rainy season because all waste that is not collected in containers is washed away to lower-lying areas, where it has a chance of ending up in open water or clogging pipes. The latter is cited as one of

the reasons for regular flooding in the Nyabugogo area, which can also lead to the disruption of two busy roads connecting Kigali to the north and south (Kabera et al., 2019). Additionally, it is important to have all waste containerized as it can prevent vermin and decrease health risks.

The waste collection points function well for households, as they adhere to the weekly collecting of municipal solid waste (MSW) (Rajashekar et al., 2019; observations). Also, hardly any waste is observed around these points. However, the way waste is packaged before it is delivered to the collection points can be improved. Many households do not store their waste in bins or bags but use old packaging materials such as rice bags, paper bags, or cartons (Victoire et al., 2020; observations). This method of storage is unsanitary and can lead to health risks. Also, it is more likely to be washed away prior to waste collection in case of heavy rainfall. According to a WCC, 'effective' waste storage (closed off, and possibly to ensure separated streams) requires the right tools, such as a dustbin or bags (WCC B, personal communication, May 11, 2023). He adds here that there is an affordability problem regarding these bins. Moreover, no designated, enclosed areas where the waste can be kept on the day it is due for pickup have been observed in the public realm. This can also cause waste to wash away during heavy rains.

Taking into account the above, it can be concluded that waste is effectively collected weekly and there is virtually no street waste according to literature and observations. However, inadequate

storage by households can be unsanitary and also result in waste being washed away during heavy rainfall.

Effectiveness of street cleaning

The effectiveness of street cleaning is considered high. The author's site observation confirms what previous research has shown; hardly any waste is observed on the streets in the city (Kabera et al., 2019; Rajashekar et al., 2019). To reduce street trash, streets are swept daily, and waste is containerized as much as possible by households inside or on the street in garbage cans (Victoire et al., 2020).

A slight difference is noticeable between urban and rural areas; where in urban areas virtually no waste was seen (picture 1), this was somewhat more the case in rural areas (pictures 2 and 3). The streets are swept by women employed by WCCs, and the greenery along the roads is maintained. One way to enhance street cleanliness, as discussed in the previous section, is to improve waste storage through bins/bags to ensure that loose waste cannot be washed away by rain.

Effectiveness of collection (in low-income areas)

Several WCCs are responsible for waste collection in various neighborhoods. Households pay a monthly fee directly to the WCCs, which ensures that their MSW is collected weekly. WCCs are obligated to collect all waste from the neighborhood for which they are responsible.

Picture 1: Clean street and trashcan in urban Kigali
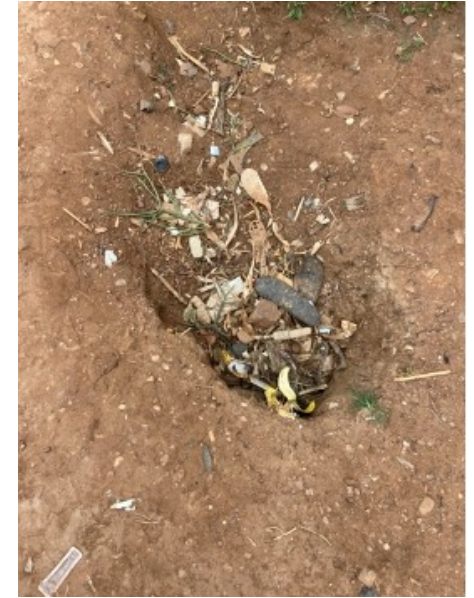
Picture 2: Waste pit in rural Kigali

Picture 3: Waste observed in rural Kigali

Exactly how much waste is collected by WCCs is unclear, due to a lack of data. There exists ambiguity in the literature about the percentage of waste collected throughout the whole city (see Table 10). Kabera explains that the data they used are focused only on the urban areas of Kigali, whereas Rajashekar et al. have studied the entire city (personal communication, May 22, 2023). This indicates that waste collection coverage is lower in rural areas than in urban areas. Rajashekar et al. state that around 35,8% of the city's waste is brought to Nduba – which forms a 10% difference with the amount of waste the article states is collected (2019). The reasons they give for the difference between these numbers are a possible waste diversion to recyclers or illegal dumping to avoid landfill fees.

In addition, there is uncertainty about the total amount of waste generated due to the lack of data collection (Table 11 shows an overview of these different numbers). The lack of these data also contributes to a lack of understanding about the current amount of waste collected in Kigali; there is no visibility on the amount of waste that is collected or generated, which in turn means that there is also no visibility on the amount that is not collected. The waste collection taking place seems to be successful, as little waste is observed in the streets. However, due to the lack of data regarding waste generation and waste collection coverage, it is not possible to ascertain what portion of the generated waste is captured by waste collection services.

In spite of the lack of data, it is safe to say that the system seems to be working reasonably well. Waste is collected regularly, and streets are relatively clean, but not all households participate in the official

Author	Waste collection coverage
Kabera et al., 2019	88%
Rajashekar et al., 2019	49%
Iraguha et al., 2022	88.72%
Squire & Nkurunziza, 2022	Highly Efficient'

Table 10: Different numbers on waste collection coverage

Author	UNEP GWMO/ EICV5 (2018)	Rapid Planning 20 (2018)	Wilson, Kabera (2017)	WASAC (2016)	Auditor General (2015)	Kigali Master Plan (2013)	Mucyo (2013)	SWM Strategic Plan for Kigali 21 (2012)
Per Capita (kg)	0.49	0.50	0.57	-	0.60	0.60	0.60	0.47
Province-wide (tons)	800	808	638	500	-	640	450	408

Table 11: Different numbers on waste generation (adapted from Rajashekar et al., 2019)

waste collection system. Despite regular waste collection throughout the city, some people dispose of their waste in other ways, such as dumping it in public spaces (Victoire et al., 2020; Iraguha et al., 2022). By doing so, residents avoid paying collection fees. Especially in low-income communities, people dump their waste in empty lots, water channels, rivers, creeks, or other public spaces (Iraguha et al., 2022; observations). Others burn their waste in their backyards. An interviewed professor of urban dynamics mentions that the level of waste collection is not equal in all places; he states that low-income neighborhoods often have worse accessibility (for garbage trucks) which leads to the quality of waste collection being not as good (Manirakiza, V., personal communication, May 12, 2023). It is also mentioned that waste in low-income areas is spread on fields, as citizens often lack knowledge about waste and see this as a cheap way to get rid of their waste. (Manirakiza, V., personal communication, May 12, 2023; Kabera, T. personal communication, May 22, 2023).

Another way households do not participate in the official waste collection system is by not paying the waste collection fee. As will be elaborated on in the fifth sub-paragraph, many WCCs suffer from defaulters within the neighborhoods in which they operate. The City of Kigali (CoK) requires collectors to collect all waste in the area they are responsible for despite defaulters (WCC A, personal communication, May 3, 2023). Regardless of these rules, WCC A states that although the government wants them to collect all the waste, they usually do not collect everything because not all households have paid their fees (ibid). WCC C adds that the

government promises to help them get people to pay the fees, but that they never help them enough (personal communication, May 12, 2023).

Efficiency and effectiveness of waste transport
The waste is collected at a central point by employees, from where it is loaded onto a waste truck. This waste truck then takes the waste to the Nduba landfill.

Recent legislation has made waste collection in waste collection trucks more efficient and safer. All interviewed WCCs mention that a ruling has been made requiring companies to own at least three compressor waste trucks for each sector they operate. WCC A explains that before purchasing these new trucks, his company used vessels not made explicitly for garbage collection. In the old type of truck, the waste must be loaded from above, the waste is not covered, and it has less capacity since the waste is not compressed (see picture 4, p. 29). Another WCC explains that the new trucks are safer for his employees because they no longer have to be in or on the truck. The truck is automated and puts the waste in the vessel "by itself (WCC D, personal communication, May 2, 2023). He also mentions that this truck allows for faster waste collection, has a larger capacity, and looks more professional. Therefore, due to the new policy, the efficiency and effectiveness of waste transportation is improving.

Appropriateness of service planning and monitoring

Waste is picked up in each neighborhood by the WCC in charge, on an appointed day (Kabera et al., 2019). Waste collection proceeds well and is usually on time (ibid). Several people are at work during collection; the work is divided into collecting, monitoring, and handling the waste (observations).

Health and safety of collection workers

WCCs are required by Rwanda Utilities Regulatory Authority (RURA) legislation to provide their staff with materials and equipment for effective waste collection and employee safety (RURA, 2021). For example, waste collectors must wear work clothes (including gloves and boots), and they are not allowed to stand in garbage trucks.

Picture 4: Waste collectors standing among waste

Many of the WCCs report that the new policy has resulted in improvements in the safety of their workers. However, there is room for improvement with respect to the safety of workers, as waste collectors do not always wear their safety gear or adhere to all safety measures (WCC B, personal communication, May 11, 2023; observations) (see picture 5). As a solution to this, WCC B would like to make the concept of safety and purchasing safety gear more accessible to (his) employees by setting up a training center where they can learn about safety measures and regulations. He thus attributes the disregard for safety measures to a lack of knowledge among his employees.

Picture 5: Waste collectors standing on a moving truck

Additionally, it has been noted that jobs in the waste sector are underrated and underpaid (employee CPCIC, personal communication, May 11, 2023). The low status and income of the profession can put pressure on the mental well-being of employees.

Recent governmental measures by RURA have somewhat increased the level of health and safety for waste collectors. However, the non-adherence to health measures, ignorance of employees regarding their risks, and the low social status of the labor, result in the health and safety of workers being low to medium.

4.2. Environmental control - disposal
Degree of control over waste reception and general site management

The unseparated waste collected by the various WCCs is taken to Kigali's only landfill: Nduba (Rajashekar et al., 2019). When Nduba, first opened its doors in 2012, the landfill covered 15 ha of land, whereas two years later, this had already increased to 28.6 ha in active use, 24 ha for future use, and 18 ha which is used as a buffer zone (WASAC, 2014). Nduba was built near housing, which causes health risks to the inhabitants (Victoire et al., 2020). This has resulted in 821 residents being relocated from the area so far since 2012 (Top Africa News, 2023). Recognizing environmental degradation, the government has made several attempts to transform Nduba, however without success (Rajashekar et al., 2019).

The landfill is owned and operated by the CoK and the Water and Sanitation Corporation (WASAC), which are both governmental agencies. Garbage trucks pay a set amount to dump the waste at Nduba.

The CoK is the daily, administrative government of Kigali.

The CoK is not authorized to issue legislation but is allowed to issue guidelines. In addition to these guidelines, the CoK uses social media to reach residents, where they often use media campaigns to draw attention to keeping the city clean, safe, and green (Squire & Nkurunziza, 2022). It also monitors various issues, such as investment activities, execution of budgets, and economic development.

WASAC is the body in charge of water and sanitation. In addition, WASAC deals with some issues related to waste management. As such, they are concerned with ensuring sustainable waste management practices through prevention, reduction, reuse, composting, recycling, energy recovery, and safe disposal of waste in the country (Squire & Nkurunziza, 2022). In addition, they also deal with regulations related to waste management, such as introducing price and quality agreements between WCCs and their customers (ibid). Finally, WASAC is the agency that contracts workers on behalf of the CoK, which manages the Nduba landfill.

The accessibility of Nduba is rated as poor, due to accessibility and security problems. Several WCCs report problems regarding accessibility to Nduba, as the road that provides access is in poor condition. WCC F described the road is very bad and hilly,

destroying the waste collectors' trucks (personal communication, May 17, 2023). He also mentions that sometimes street kids are (violently) making waste trucks stop when they are on their way to Nduba. When the trucks stop, the children climb into the truck to collect any valuable materials. There is no supervision or security on the roads, posing a safety risk to truck drivers. As a solution, he proposes the authorities should put law enforcers along the road, to make sure people do not interfere with their operations (ibid).

Degree of control over waste treatment and disposal

The waste is disposed of at the site by the WCC-owned garbage trucks, and then handled by Nduba employees (Rajashekar et al., 2019). The waste is then dumped and covered daily with soil to reduce bad odors and prevent fires.

The degree of control over waste treatment and disposal is low. First, there is little control over the waste that comes in, as the waste is delivered unsorted, leaving no insight into its composition (WCC B, personal communication, May 11, 2023). Secondly, there are no adequate measuring instruments to determine how much waste is received (Rajashekar et al., 2019; Kabera et al., 2019). However, the weight is estimated based on the number of garbage trucks and the average weight of waste they bring in. Moreover, there is little talk of waste treatment, as the unsorted waste is dumped, and covered with soil (Rajashekar et al., 2019). Due to mismanagement, for example, stockpiled garbage and poor upkeep, several management changes have taken place over the years. Since 2018, according to Rajashekar et al., Nduba has been better maintained; since a management change, leachate diversion channels have been created, garbage is covered with gravel more often, and stockpiled waste has been repositioned (ibid). Despite, they state Nduba is still an open-air dumping site which causes several environmental and health issues. These consist of the following (ibid):

- Failure to prevent leachate with high pollution potential from seeping into ground and surface water.
- Pest- and fly nuisance.
- Spontaneous combustion due to the build-up of landfill gas (consisting of combustible methane) because of inadequate coverage of the waste with soil.
- Three-quarters of the site is nearly full.

Rajashekar et al. also note that Nduba may still be managed by unskilled workers with little equipment to oversee daily operations (2019).

Interviewed WCCs mention that the way waste is currently disposed of at Nduba is not sustainable, as no recycling or composting takes place. WCC C mentions his company submitted a plan to the CoK several years ago to install a waste separation machine in Nduba, which would enable the recycling of waste streams. The plan was rejected by the municipality at the time, as they did not deem the plan feasible due to the large amounts of waste that arrive daily:

"You can have a recycling plant here (*read: Nduba*), but you need a lot of investment to be able to treat at the speed that people push you to have. (…) It's not easy to treat the waste because of the huge amounts." 3:16 ¶ 114 – 122 (WCC C, personal communication, May 12, 2023)

Nevertheless, he argues that organizing Nduba into different areas where a particular waste stream can be deposited is a viable solution to decrease the amount of waste that ends up at the landfill and to enable recycling and composting (ibid). This is concurred by another waste collector (WCC E, personal communication, May 27, 2023).

WCC B and WCC C say that the CoK has issued an international tender regarding the redevelopment of Nduba, intending to enable on-site separation and express their views on the tender:

"In Kigali, we are collecting much waste and maybe they (*read: the government*) think we will not be able to treat it properly. Our country is a country that just wants to higher the standards. So, when you present a project, they want it to be at the highest level. And in African culture, we think that maybe people from outside Africa, are better than what we have inside. That is the big problem that we have, maybe…" 3:3 ¶ 25 – 30 (WCC C, personal communication, May 12, 2023)

"The investor has to make money out of that waste. To make money, the waste should be in a state he wants, and that state is sorted, which can't be guaranteed by the city of Kigali. (…) But now these investors, I think they are struggling: 'Can it make a viable business case? I can't unless they bring me sorted waste.'" 4:32 ¶ 265 – 269 (WCC B, personal communication, May 11, 2023)

WCC B later explains that he believes working with local companies that start small initiatives is a more sustainable solution (personal communication, May 11, 2023). He adds that the government prefers to work with large, international companies because of the considerable investment required to convert the entire site into a sanitary landfill.

There is uncertainty about the future of Nduba and the current state of the landfill. However, the government seems to want to attract ideas and investment to create a sanitary landfill. WCCs identify several obstacles, such as the unsorted status in which the waste is delivered which may result in no willingness to invest (due to uncertainty of success), the large amount of waste delivered daily, the large amount of investment required to create a sanitary landfill and the somewhat idealistic approach of the government regarding the end result.

Degree of monitoring and verification of environmental controls
The Nduba landfill opened after the previous landfill, Nyanza, closed. Nyanza began experiencing problems in 2003 when waste collection systems were privatized, and the amount of waste

collected increased (Rajashekar et al, 2019). At the time, there were several reasons for Nyanza's closure, such as leachate leakage into nearby communities, unpleasant odors, pests, and spontaneous methane gas explosions – problems that also occur at Nduba. In 2019 - several years after the Nyanza landfill was closed - there were still problems in the area (Rajashekar et al., 2019). For example, landslides and cracks in the surface still occur, increasing the likelihood of water flowing through the landfill and making the site unstable.

Various government agencies are discussing the state and future of Nduba. However, these statements differ from each other, so no clear picture can be formed about the status of Nduba.

For example, WASAC states that plans are made to begin a feasibility studies on the transformation towards a sanitary landfill from 2020 on, including the remediation of Nduba (2019). This document does not clarify the current state of the landfill and what changes they want to make. In 2022, the Ministry of Infrastructure announces that the Nduba landfill was recently operationally improved; it would now be considered a controlled landfill, (MININFRA, 2022).

An interviewed professor says that he, along with two companies, just heard that they won a tender to redesign Nduba (Kabera, T. personal communication, May 22, 2023). Kabera explains that the waste will be sorted manually by 15 workers and that separate places will be designated where the waste streams will be put. The professor does not appear to have been fully informed of Nduba's environmental status. He explains that no additional environmental measures will be taken at Nduba, since an environmental impact assessment took place when Nduba was first opened, and thus no changes will be made regarding the environmental impacts of the landfill. However, in a performance audit conducted three years after Nduba opened, it became clear that several guidelines established by RURA, such as conducting an environmental impact assessment and preventing leachate from the unsanitary landfill, had not been met (OAG, 2016). Lastly, the professor mentions that there are issues of leachate at the dumpsite, however, he adds that there are no plans to ensure that leachates are prevented (Kabera, T. personal communication, May 22, 2023).

Reporting on the future of Nduba, however, has not been uniform; a national newspaper reported in early 2023 that Nduba would close to make way for a "modern" landfill (Nkurunziza, 2023). The CoK states that Nduba was intended to be a temporary landfill, to be used before a new, more suitable site could be found (CoK, 2020; CoK, 2018). This is also reflected in the Kigali Master Plan 2050 set the goal that this new landfill site would be far from the population, away from water sources and well-sealed to prevent leachate (ibid).

There is uncertainty about the extent of environmental monitoring at Nduba. RURA's report shows that monitoring of the area does take place (OAG, 2016). What else is done with this information is unclear, as various government agencies report other plans for the future, and not everyone seems to be aware of the outcome of the

monitoring (Kabera, T. personal communication, May 22, 2023). However, the aforementioned problems indicate that little follow-up action is being taken to address the problems found. The same problems are identified at Nduba as at the previous landfill that caused its closure at the time. Also, there are different views from government agencies about the current status of the landfill and its management in the near future.

4.3. Quality of 3Rs - reduce, reuse, recycle - provision
Source separation of 'dry recyclables'
In 2012, the government attempted to introduce waste separation to the public; households were trained to separate and collect organic waste (MoE, 2022). However, this was unsuccessful due to lax guidelines at the landfills - the collectors could not systematically unload the waste, leading to contaminated organic waste, according to the ministry. Most recent government reports state that separation at the source is still lagging, contributing to low recycling rates (MININFRA, 2022). The government still encourages source separation. It does this through "sensitization" (WCC A, personal communication, May 3, 2023). Sensitization means imparting knowledge about waste (including source separation) to residents during neighborhood meet-ups or through media and will be further explained in paragraph 4.4.1 - *Public education and awareness*. The use of source separation makes it easier to recycle the waste later because this way the waste stays clean, and the different streams are already sorted.

Source separation is considered an important prerequisite for recycling. By separating waste prior to collection, the waste remains relatively clean, so the future recycled material will be of better quality (WCC C, personal communication, May 12, 2023). Separating waste, preferably at the source, is commonly cited as a starting point for recycling (employee CPCIC, personal communication, May 11, 2023; employee development aid organization, personal communication, May 18, 2023; WCC A, personal communication, May 3, 2023).

The overall SWM system in Kigali is unprepared to handle separated waste streams. At the household level, source separation hardly takes place - and when it does, it is pointless as all (separated) waste goes into the same garbage truck (WCC B, personal communication, May 11, 2023; observations). Subsequently, it is mentioned that the landfill, which is managed by the government agencies CoK and WASAC, does not currently have segregated facilities to dispose of the separated waste streams (WCC B, personal communication, May 11, 2023; WCC C, personal communication, May 12, 2023).

Making source separation mandatory seems effective to WCC B (personal communication, May 11, 2023). However, he argues that because of the lack of facilities at the state-owned landfill, the government cannot enforce source separation on households or waste collectors.

Despite the fact that the system is not yet prepared for separated flows, source separation is still seen as a goal by both WCCs and

governments (more on this in Section 4.6.). Due to the fact that the system is not yet prepared, it is meaningless for the separate parties to start acting separately. For example, WCC C states that it will not start separate collection if it cannot do anything with the separated materials:

"To collect the waste separately, you need to have a day of, let's say, organic waste and another day of nonorganic waste. This means it is double work. (…) That just increases the cost." 3:22 ¶ 142 – 148 (WCC C, personal communication, May 12, 2023)

Attempts are also being made at the landfill to prepare the area to receive separated waste streams. The government is trying to attract investors to create a sanitary landfill where waste is separated but is running into several problems in this undertaking (this will be elaborated on in section 4.6.).

Some challenges also still exist for residents to engage in source separation. For example, residents still have too little knowledge about waste. Iraguha et al. state that citizens in Kigali have a limited understanding of proper waste management and its consequences and lack awareness and information (2022). Through sensitization, WCCs and governments are trying to educate residents about source separation. They do this mainly through the sensitization of households, which will be further discussed in paragraph 4.4.1: *Public education and awareness*. One respondent has been sensitizing for some time. The method his staff uses is going door to door to ask people to separate their waste (WCC A, personal communication, May 3, 2023). WCC A says that very few households separate their waste and that he has also not noticed any changes in the rate of separation recently.

Iraguha et al. identify three factors that lead people to start separating waste at the household level (2022):
1. Individuals who care about the environment.
2. Households being paid by recyclers to separate their waste.
3. The feeling of shared responsibility for the city's waste management system.

The employee of a development aid organization states that he envisions people needing a financial incentive to get source separation off the ground, such as halving the collection fee and starting up this system neighborhood by neighborhood. Once this system is rolled out citywide, he suggests the government make it mandatory.

In addition to imparting knowledge to get source separation off the ground, a WCC has conducted pilots in other, smaller cities to get households to separate their waste (WCC B, personal communication, May 11, 2023). The method he uses for source separation is color-coding; each waste stream has its color. In these pilots, colored bags were distributed to households and colored bins were used at businesses. He explains that he gave a waste guide to users, from which users can identify which waste belongs to which waste stream (/color). He calls the results of this pilot successful. WCC F, which serves the private sector, also indicates the successful use of a color-coding system (WCC F, personal communication, May 17, 2023). Still, WCC B foresees problems in

rolling out this system across Kigali, including the lack of a system that is used the same by all WCCs, the number of WCCs operating in the city, and the large amount of waste generated in Kigali. Moreover, WCC B noted the absence of a comprehensive system or software specifically designed to manage the waste sector (personal communication, May 11, 2023). In contrast to other sectors like transportation, which have their own software systems, the waste sector lacks a similar infrastructure for efficient management.

Focus on the top levels of the waste hierarchy

In terms of reduction, reusing, and recycling policy and practical action (considered the top levels of the waste hierarchy by Wilson et al. (2015)), the government has undertaken some action. In 2008, the Rwandan government banned the use and production of plastic bags. In 2019, this law was revised to ban all single-use plastic (GGGI, 2021). Besides these rules, there is no other legislation that requires either residents or businesses to reduce, reuse or recycle waste.

The focus on the top levels of the waste hierarchy is considered sufficient to low. Government policy on banning single-use plastic is very progressive. However, otherwise little (policy regarding) recycling takes place, and no waste minimization strategies exist. Studies adopt different numbers regarding the occurrence of recycling/composting (see Table 12). The lack of data collection could explain the difference in these percentages. Also, some studies do not give numbers because they are unknown to them.

	Recycling Before Collection	Composting at Landfill
Kabera et al., 2019	10%	Insignificant
Iraguha et al., 2022	2.02%	35.5%
Rajashekar et al., 2019	-	Small extent

Table 12: Different numbers regarding recycling/composting

The Ministry of Infrastructure (MININFRA) acknowledges that recycling is still at a very early stage in Rwanda and names the lack of separation at source, high input costs, and low market demand as major challenges (MININFRA, 2022). The absence of small-scale recycling of materials at present is confirmed by the WCCs interviewed. However, the companies do show ambition to engage in recycling in the future.

Interviewed WCCs indicate that they too have not yet encountered regulations related to reduce, reuse and recycle policies that affect their operations. None of the WCCs interviewed have concrete plans to start their own recycling facility: some have thought about it but see various obstacles in doing so:

> "To do anything in Kigali, you need permission. (…) You need a place that is appointed for industrial work, and there are not many, or they are expensive. The second thing is that when your area is far from where you are collecting waste, it increases travel costs." 3:17 ¶ 123 – 130 (WCC C, personal communication, May 12, 2023)

Two other respondents mention that they mainly face financial obstacles in starting a recycling facility. WCC A says they expect starting up a recycling facility to be easy if they can find a well-suited location and if households deliver their waste separately (personal communication, May 3, 2023). When asked if the company has enough money to finance this or if they would have to take a loan, the response is that that limits them. A respondent mentions that Rwanda is an excellent country to start a business in because getting a license is easy and quick (waste entrepreneur, personal communication, May 2, 2023). However, he does note that funding your company is more difficult because many banks charge an interest rate of 20%. WCC F also sees financial obstacles but adds that having its own recycling facility will provide a profit because the raw materials are free (personal communication, May 17, 2023).

One respondent mentions that sustainability as a phenomenon is not yet very popular in the entrepreneurial community in Rwanda (waste entrepreneur, personal communication, May 2, 2023). As a means of raising awareness, he mentions an online platform where entrepreneurs can meet and learn about sustainability. In addition, he notes that issuing grants would be a good incentive for companies to get started in sustainability.

A respondent working for a government-backed company that deals with "eco-innovation", among other things, says they are working on finding opportunities for industrial symbiosis, where some streams can be captured separately by waste collectors and then easily reused or transformed (employee CPCIC, personal communication, May 11, 2023). Examples of this also exist in Kigali. She explains that WCCs have yet to contact them for collaboration.

The CPCIC employee also mentions that awareness about recycled products is fundamental. She states that consumers should be informed about the choice of recycled or non-recycled products and that, otherwise, this business has no future. Another respondent states that the market for recycled products in Rwanda is quite large, but the country is too small to set up a profitable recycling facility (employee development aid organization, personal communication, May 18, 2023). He also cites the instability of (ties with) neighboring countries as a dilemma, which creates uncertainty about markets. He is not optimistic about the recycled products now on the market in Rwanda, such as pavers (sidewalk tiles made from remelted plastic mixed with sand), because of the short lifespan of the products and the inability to recycle these products again. He argues that these companies sometimes lack vision.

Companies, therefore, seem keen to expand in the sustainability sector. To promote this, networks in which companies can learn from each other could work well, and companies that drive connection could also play a role in this. Funds are commonly cited as the biggest obstacle for companies to expand, for example in securing a suitable location or seeking a loan. Starting a business is considered easy in Rwanda by several respondents.

Integration of community and/or informal recycling sector with the formal SWM system

The existence of the informal sector is recognized and understood by MININFRA (2022). They elaborate that this system consists of three components: first, informal waste collectors collect recyclable materials from household waste and/or public trash cans, then the materials are purchased by informal collectors, and as a final step, these materials are resold to recyclers, who turn them into new products. Furthermore, they neither endorse nor criticize this sector.

The informal sector is not integrated with the formal SWM system. All WCCs interviewed acknowledge the existence of the informal sector that collects waste from the streets. Even though WCCs have an exclusive right to collect the waste within a certain area, some individuals collect for example plastic (see picture 9). On days when the waste is taken out, these people often come before the WCCs arrive, to separate plastic from the waste. The researcher has heard about people collecting other materials besides plastic, such as paper and glass. However, this part of the informal sector was not observed within the field research period. Sub-paragraph 4.4.2. will expand on the relationship between WCCs and the informal sector.

4.4. Inclusivity – user and provider

This subchapter will be divided into two. First, user inclusivity, and second provider inclusivity will be discussed.

4.4.1. User inclusivity

Equity of service provision

Each neighborhood in Kigali is served by a designated WCC. WCCs visit households to collect fees for services. All households should be financially able to receive waste collection services as the service cost is linked to income level (Kabera et al., 2019). The payment system is further explained in the sub-paragraph *financial sustainability (4.5.)*. Equity of service provision is rated as very good, as all residents have access to waste collection services.

Level of public involvement

According to Kabera et al., citizens can make their voices regarding waste management heard through environmental committees, during monthly meetings with sector officials, or at the (mandatory) monthly community clean-up day, called Umuganda (2019). Iraguha et al. concur that Umuganda functions as a platform to communicate with WCCs and add that some citizens contact the WCCs directly (2022).

WCCs and governments state that they attend these public events to teach residents about waste, and therefore connect with residents in this way. However, according to Rajashekar et al., residents mention that no clear channels exist to report their complaints regarding the WCCs (2019).

Public education and awareness

To teach residents about proper waste management, the CoK and WCCs engage in 'sensitization'. Sensitization refers to both the oral transmission of information about sustainable waste management

and the dissemination of knowledge through media. In the case of Kigali, this mainly involves the proper storage of waste, putting it out on the right days and separating the waste (WCC B, personal communication, May 11, 2023). Iraguha et al. state that citizens in Kigali have a limited understanding of proper waste management and its consequences and lack awareness and information (2022). WCC E explains that they provide information through their fee collector, who goes door-to-door to collect the fees (personal communication, May 27, 2023). He explains that this fee collector explains the relevance of waste separation and requests households to implement it. In addition, his company disseminates information during Umuganda and through the district's WhatsApp group.

The current approach to sensitization does not seem to have the desired effect. First, it is mentioned that public meetups are not always well attended:

> Interviewee:
> "In weekly local meetings (…) We have agents who operate, they're also the ones who go and sensitize, or maybe someone from the office should go to sensitize."
> Fidela:
> "I have one question about those weekly meetings; how many people attend those?"

> Interviewee:
> *laughter of agreement – insinuating: not many* "We suggested to the city of Kigali to publish, make articles in the newspapers or advertisements and radio."
> Fidela:
> "Actually, it's that one that would work.." 2:24 ¶ 243 – 259 (WCC A, personal communication, May 3, 2023)

In conversations with people in the neighborhood during the weekly meetings, one respondent also said that there should be a distinction in which people should be reached:

> "You don't need to train the owner of the house. No. You need to train their workers. (…) They are the ones who implement this. So, they need to be trained, right?" 3:25 ¶ 162 – 166 (WCC C, personal communication, May 12, 2023)

Next to sensitizing residents during meetings, the government also tries to reach out to residents through media, such as tv or the papers (WCC B, personal communication, May 11, 2023). The respondent adds that previous awareness campaigns consisted of six months of intensive campaigns, after which they ended. He emphasizes that the campaigns must be part of a continuous process in order to be effective.

One respondent names the importance of spreading awareness regarding the image of (recycled) waste (employee CPCIC, personal communication, May 11, 2023). She names awareness about waste as a resource as one of the most important

means to improve all-round effectivity in the sector. She proposes to spread awareness via social media, TV, and journals, for which they will publish case studies explaining for example why recycled products are relevant. She elaborates that no campaigns have been launched yet.

To promote sensitization, the media seems a good means of reaching people, provided there is an ongoing process, not just short-term campaigns. In addition, campaigns should be targeted at those responsible for the household's waste. To accomplish this, WCC B proposes that the government could specifically designate companies to specialize in educating the public on this matter. While there are currently 11 WCCs, the government could narrow down the selection to three companies solely focused on providing education and awareness regarding waste separation.

Effectiveness of achieving behavior change
The degree of effectiveness of achieving behavior change will be assessed on the basis of attempts to bring about source separation among the population, as this has been initiated by several parties for quite some time.

Kabera et al. state that awareness of the importance of separating waste at source is high among households. The reasoning for the high state of awareness is not further explained in their article. Regardless of the high level of awareness, they argue households do not separate their waste because they do not trust WCCs (2019). Iraguha et al. contradict their statement on awareness,

stating that residents have a limited understanding of proper waste management and its consequences, citing a lack of information as a reason for this (2022). Their research found that 98% of citizens do not separate their waste. The legislation for WCCs specifies the education of residents about waste separation as an obligation (RURA, 2020).

A lack of awareness and knowledge among the population still results in little source separation. Moreover, not separating waste does not have consequences for residents.

Several WCCs also indicate that work is still needed to achieve behavior change. The sensitization strategies have not yet had the desired effect. When sensitization is discussed during the interviews, the topic of how the public perceives waste as a phenomenon often comes up among respondents:

> "How can you explain to the citizens of Kigali how to do it (*read: sustainable waste management*)? To do it, a lot of pressure, polishing, and the image are needed here." 4:27 ¶ 240 (WCC B, personal communication, May 11, 2023).

> "You see, with this waste collection or waste management, you know. In Africa, maybe I might say that people, or the society, have not yet gotten to understand it well. You know, you might find that they take garbage as just garbage. They don't take it as a resource." 7:6 ¶ 61 (WCC F, personal communication, May 17, 2023)

> "People just need to understand that it (*read: source separation*) is useful and it's to protect the environment. So, the mindset that people have is the first problem. They need to just understand that they need to separate the waste for their well-being and their environment." 2:44 ¶ 407 – 409 (WCC A, personal communication, May 3, 2023)

Whereas the previous interviewees mention that a change in residents' perceptions of waste could help create source separation, one respondent states that it could also help collect fees for waste collection, as it would change 'the culture of not paying for waste' (WCC A, personal communication, May 3, 2023).

4.4.2 Provider inclusivity
Legal framework
WCCs are given responsibility over an area when they have won the area's tender, which is issued by the municipality (Rajashekar et al., 2019). After winning the tender, they receive a license valid for five years.

Three different licenses give WCCs the right to collect waste, mainly related to where the waste collector is allowed to work. A first-category license is required to collect municipal waste in Kigali, a second-category license is required to collect waste from individuals (such as big companies or embassies), and a third-category license is required to collect waste in rural areas (anywhere but Kigali) (RURA, 2021). The latter two licenses have different terms and are cheaper than the first category license. For the first-category license, companies have to respond to a tender

written out by the sector, in which they have to submit a viable business plan, demonstrate the ability to collect waste weekly, prove that they own at least three garbage trucks with a capacity of 5 tons and pay an application fee of 100.000 Rwf (€90) (Rajashekar et al., 2019). Companies that win the tender for waste collection in a particular sector will pay RURA 2.5 million Rwf for the permit, on top of the Rwf 100,000 application fee, and must cede 0.3% of their quarterly turnover to the government. The license is valid for five years, giving them the exclusive right to collect all MSW in a sector. After one to five years (depending on the sector), they must renew this license and re-enter the bidding process (ibid). The same research names that the length of the contracts is a source of irritation for WCCs, whereas they have difficulties with obtaining loans (for investments in high-quality equipment) on shorter contracts and have to undergo extensive negotiations for the renewal of contracts (ibid).

WCCs state that they have an exclusive right to operate in certain areas and that this division is effective. WCC B states that the duration of the contract is relatively short to recoup the investments that companies must make, this is expanded on in the next subsection: *financial sustainability* (personal communication, May 11, 2023).

Several governmental institutions create regulations that WCCs are required to follow while doing their work (more on this in sub-paragraph 4.6.). Government regulations may include safety, investment or working methods of WCCs. All WCCs indicated in the

interviews that to communicate new policies, governments call them by phone, after which all WCCs are informed of the content of the new regulations during a meeting. One respondent also mentioned that the government sometimes organizes training sessions (WCC D, personal communication, May 2, 2023).

Representation of the private sector
Nothing was found in the literature about private sector representation. However, the author's research shows that the private sector is not represented sufficiently. First of all, efforts at uniting the WCCs of Kigali to make their voices heard by the government haven't succeeded yet. This is shown by one of the respondents, who mentions that an organization was set up not too long ago, bringing together WCCs, which is called Wasteman (WCC A, personal communication, May 3, 2023). At Wasteman meetings, he says, the companies meet to discuss their shared issues.

 However, this advocacy organization is still in the start-up phase; and it is not yet officially recognized by the government and is therefore not invited to meetings where their voices could be heard (employee development aid organization, personal communication, May 18, 2023). He also says the government is setting up a union for the WCCs arranged by RURA. It does not yet exist because RURA is understaffed, he says. His organization has offered financial resources and workforce, but RURA has thus far not taken them up on their offer.

 In another interview, a respondent is less positive about the cooperation between different companies:

"The service providers with different knowledge, different visions, different understanding, and different capacities in terms of physical capacity and intellectual capacity, all these factors contribute. It's not 1 system that can work in one place. OK in theory one system, but in practice different." 4:14 ¶ 168 – 172 (WCC B, personal communication, May 11, 2023).

Besides contact with the government, the WCCs indicated they have contact with each other. The respondent did mention that this is to a certain extent, as the companies are also competitors:

"Yeah, but don't forget that we are competitors. (…) We are now trying to have some instructions, some regulations that can help us to work, to live together. And one who is given this task of drawing those texts you see to help people to live together without fighting without today." 3:12 ¶ 90 – 96 (WCC C, personal communication, May 12, 2023)

 This is agreed upon in another interview, which also adds that the company is primarily concerned with its operations and is, therefore, unaware of the situation at other companies (WCC F, personal communication, May 17, 2023). According to the same respondent, there exists a group chat that includes the responsible individuals from all WCCs operating in Kigali, along with representatives from certain government agencies. The interviewee describes this group as highly active. They mention that the CoK, all WCCs, REMA (Rwanda Environment Management Authority), and a representative from RURA are part of this chat. The purpose of the

group is to create awareness about waste management issues and address urgent matters. The interviewee provides an example by showing a picture of a pile of trash in a market area, pointing out that such incidents can be brought to the attention of the group to raise awareness and prompt action. The group chat has a controlling function regarding the quality of waste collection. The group chat does not, however, contribute to the collaboration between companies, nor does it serve as a means to make the voices of the WCCs heard.

Uniting WCCs to make their voices heard is progressing but is not yet a solid organization. The association created by the WCCs themselves (Wasteman) does not yet have a seat at the table, and the association created by the government is not yet taking shape. Also, competition causes companies to want to cooperate only to a limited extent. Therefore, the representation of the private sector is not sufficient yet.

Role of the informal sector
In paragraph 3.1: '*Integration of community and/or informal recycling sector with the formal SWM sector*' outlined the extent to which there is an informal sector present within Kigali's SWM. It is presented that there is an informal sector separating materials both during waste collection and at the disposal site.

Kabera et al. say little about the informal sector, only that the sector's lack of recognition by the formal sector forms a weakness (2019). Rajashekar et al. state that informal waste pickers at landfills are actively discouraged as per various policy documents and cite that landfill operators say they strictly enforce these rules (2019). Moreover, they do not mention the existence of informal waste collectors who gather waste pre-collection.

All WCCs interviewed acknowledge the existence of the informal sector that collects waste from the streets; this has also been observed by the researcher. Even though WCCs have an exclusive right to collect the waste within a certain area, some individuals collect for example plastic (see picture 6). On days when the waste is taken out, these people often come before the WCCs arrive, to separate for plastic from the waste. Since materials are not separated from waste anywhere else in the system, it is interesting for this sector to collect the materials and make money by selling them.

Picture 6: Plastic waste collected by an informal waste collector

None of the interviewed WCCs indicates partnering up with the informal sector. The following respondent states he would like to get rid of the informal sector that is active within their working areas:

"Normally, they (*read: informal waste collectors*) are not supposed to go there (*read: in their appointed sectors*) to collect. So, we are dealing with the authorities to just capture them and then put them maybe in prison, when possible. Yeah, because they do bad things. They can come here, on your door - it's not the day of collecting your waste. But they just tell you to take out the waste (…) And this makes us in trouble with authorities, saying: 'Someone was just putting their waste out there, and you didn't collect?'. No, it's not the day! And after some time, we see that there is someone behind that." 3:14 ¶ 103 – 112 (WCC C, personal communication, May 12, 2023)

He adds that collecting and selling plastic separately is not a problem - it results in his company collecting less waste, which will save on costs (WCC C, personal communication, May 12, 2023). He suggests that householders can keep the plastic separate themselves and either sell it themselves or hand it off to informal waste collectors.

Another WCC sees a future in integrating the informal sector into the SWM and says they should be considered and organized, and not pushed out (WCC B, personal communication, May 11, 2023). A respondent argues that it is difficult to involve the informal sector in the formal sector because it employs too many

people to organize properly (Kabera, T. personal communication, May 22, 2023).

The informal sector is active both before collection by WCCs and after collection at the Nduba landfill. The informal sector separates waste streams and resells them. Some argue that the work of informal waste collection interferes with the quality of formal SWM, while others see potential in the work of the informal sector.

The balance of public vs. private sector interests in delivering services

Through a public-private partnership (PPP), the private and public sectors work together in SWM. Companies selected by the government are responsible for waste collection and carry it out through rules established by various governments (more on this in sub-paragraph 4.6). In turn, the government is responsible for waste disposal at Nduba.

When asked whether WCCs are allowed to express their views on the regulations and to what extent this feedback is considered, the answers vary. One respondent says that during meetings, it is said that the WCCs will work together with the government. Still, the ideas pitched in meetings with government agencies usually take a very long time to be executed (WCC A, personal communication, May 3, 2023). Later in the interview, he mentions that the government says they will offer them support, but in the end, there is not much intellectual support or connection between them and the government.

Another respondent also mentioned that his company's ideas are not always included in decision-making:

> "Even the ideas that you provide, when you have this opportunity to meet them (*read: the government*), even the ideas that you are providing; it's not really 100% that they are going to be taken into consideration. You see, it's like, they are formulating their things. You are not there... And then you are the one who will go to implement this." 3:7 ¶ 54 – 56 (WCC C, personal communication, May 12, 2023)

Later in the interview, WCC C gives an example of a situation where the government responds to feedback from the private sector regarding the length of the contract under which the WCCs work. The WCCs had told the government that a one-year license was too short to return their investments. After these complaints, the government extended the license to five years. None of the interviews further provided a concrete example of collaboration with the government or outlined a situation where the government works with feedback from the private sector. Lastly, one respondent indicated working hand-in-hand with the government.

> "We work hand in hand with the authorities because even the dumping site, it belongs to the authorities. So, we do work hand in hand. For example, occasionally we do have meetings conducted by the government and the body, given the mandate to regulate us, we are being regulated, yeah." 7:18 ¶ 225 – 227 (WCC F, personal communication, May 17, 2023)

Cooperation exists between the private and public sectors, but the degree to which both interests are balanced against each other seems uneven. For example, WCCs are sometimes asked to give their input on topics and are personally briefed on new policies in group meetings with all stakeholders. In addition, all stakeholders (various central government bodies, CoK and all WCCs) have a group chat in which SWM is discussed (more on this in paragraph 4.6.1.). Despite these collaborations, feedback from WCCs is not always, or very slowly, incorporated into government decision-making and regulations.

4.5. Financial sustainability
Cost accounting
The cost of waste collection is borne by households; they pay the WCCs for providing this service (Kabera et al., 2019). In turn, the WCCs pay a fee for dumping waste at Nduba. Part of the cost of running the landfill lies with the government.

WCCs report running into several financial obstacles, including fee levels and the mandatory purchase of expensive equipment. The regulations drafted by RURA in 2012 regarding the fee that households must pay for waste collection are still in effect anno 2023, and WCCs call it a fee in dire need of an increase. The main reason they name the need to increase the fee for users is the recent gasoline price increase (WCC F, personal communication, May 17, 2023; WCC A, personal communication, May 3, 2023; WCC C, personal communication, May 12, 2023). WCC C adds that despite inflation over the years, fees have not increased (personal

communication, May 12, 2023). One respondent refutes the opinion of the WCCs regarding the, in their view, too low fee, stating that there is competition and that this is only possible if the companies do well (Kabera, T. personal communication, May 22, 2023). Iraguha et al. also state WCCs call fee amounts insufficient (2022). Yet, according to the same study, they continue to generate revenue.

In addition to dissatisfaction with the rates, some WCCs have also run into financial difficulties due to another measure taken by the government, namely the mandatory purchase of new trucks (WCC D, personal communication, May 2, 2023). WCC D notes that it was able to purchase the trucks, but that it was a financial hit. Additionally, he says he is aware that the purchase was a financial burden for other WCCs as well. WCC C adds that all the trucks had to come from abroad, so many taxes had to be paid (personal communication, May 12, 2023). WCC F adds that the spare parts needed for the maintenance of trucks are costly (personal communication, May 17, 2023).

Lastly, in paragraph 4.4., it was mentioned that all companies would like to educate residents to increase awareness regarding source separation and paying fees. WCC B says this also requires a budget, as education does not generate much direct income (personal communication, May 11, 2023). Part of the purpose of education is to obtain more income and to ensure that households separate their waste. Achieving source separation also has a for-profit purpose; when the WCCs are supplied with separated streams, the waste is worth more, since they are clean and pre-sorted, and thus can be more easily reused.

As a possible solution to the aforementioned problems, WCC A mentions that the government could help them with financial matters (personal communication, May 3, 2023). WCC F agrees and adds that civic education might help people understand the need to pay the fees (personal communication, May 17, 2023).

Coverage of the available budget
The budget made available for SWM from the city is used to operate the Nduba landfill. Disposal fees paid by the WCCs also contribute to this (Kabera et al., 2019). Moreover, WCCs have to pay regulatory fees to the government, which are set by the regulatory board of RURA (RURA, 2021). These are part of the obligations that come with having a license. The WCCs also pay to take their waste to Nduba, the revenue from which also goes to the government (Rajashekar, 2019). The government does not contribute financially to waste collection services, as this part of the SWM system has been privatized.

Local cost recovery – from households
Kabera et al. state that the fee collection rate in Kigali is high; 95% of households adhere to the payment scheme (2019). The reason they give for this high rate is that the fee for waste collection is often tied to fees paid by residents to neighborhood security control, which residents are glad to pay for. This rate is contradicted by Rajashekar et al. who state that, mainly by middle- and low-income households, payments are often not made, thereby explaining that despite rates being kept artificially low, they are often still too high for low-income households (2019).

Interviews reveal that the payment rate is low. All interviewed WCCs indicate that they are facing defaults for waste collection:

> "I don't have the exact numbers, but how recently we were giving cards to people who pay. And out of 5300, we gave cards to 1900, so.." 2:30 ¶ 315 – 319 (WCC A, personal communication, May 3, 2023)

> "We are paid (*read: by households*) at, let's say, 60%. (…) Normally, we make a list of them (*read: the defaulters*). We are supposed to pass it on to the authorities, but to get what..? Let's say I have a list of 1000 people in a sector, but there is no one in office of the sector allocated to help me to go house to house to make everyone pay. (…) They tell us: please go take the rubbish, we'll help you to make those people pay. But they never help enough." 3:10 ¶ 67 – 78 (WCC C, personal communication, May 12, 2023)

WCC A, which operates in a low-income neighborhood, argues that the amount of people's income has no bearing on whether they pay the fees or not. He states that it is a problem that occurs in all areas and at different WCCs (personal communication, May 3, 2023).

In addition to not paying the fees, households also try to bribe the staff of the WCCs to pay a lower fee this way:

> "These guys, colleagues, will go with the house, they give them like 300 RwF (€0,23) and then they just take it (*read: the waste*). Because we still collect a lot of garbage - with less payers." 2:35 ¶ 353 – 355 (WCC A, personal communication, May 3, 2023)

WCC C would like to involve the government in fee payments and presents an idea for implementation. The respondent suggests integrating waste collection fees with other essential services, such as water, which are centrally regulated and managed. By linking waste collection payment with the centralized payment system for essential services like water, individuals would better understand the importance of waste collection and be more inclined to comply with the fees (WCC C, personal communication, May 12, 2023).

Addressing the SWM system starts with finance, a respondent says (employee development aid organization, personal communication, May 18, 2023). He, too, suggests linking waste collection fees to the water bill, thus ensuring more revenue for waste collectors, who, in turn, can innovate. He cites the perception of waste in society as one of the reasons why people do not pay the collection fee.

Affordability of user charges

The cost of waste collection services is linked to income level (Kabera et al., 2019). The system, called 'Ubudehe', is comprised of 4 categories. The first category is meant for people with the lowest income; this group is exempt from the fee. The second category pays 1000 Rwf (€0,90) per month and the fourth category pays 4000 Rwf (€3,60) per month. The third category pays an amount that lies

between these categories and varies per WCC (Kabera et al., 2019; Iraguha et al., 2022). If households do not sign up for these services or refuse to pay, they risk a fine of Rwf 10,000 (Kabera et al., 2019).

Because of the Ubudehe system that links fee levels to income levels, user chargers are regarded as affordable.

Access to capital for investment
To perform waste collection services, you must make some significant investments, states one respondent (WCC C, personal communication, May 12, 2023). As explained in paragraph 4.3, WCCs are struggling to find capital to purchase high-quality equipment and sustainable expansions of their enterprises, such as setting up a recycling facility.
Obtaining loans in Rwanda is pricey, banks charge high interest rates. This discourages companies from taking out loans (WCC A, personal communication, May 3, 2023). To get investment for 'green activities' in Rwanda, an interviewee refers to the Rwanda Green Fund (WCC B, personal communication, May 11, 2023). The Green Fund's goal is to mobilize finance to support the green economy. Moreover, their website states that 'Alternative Waste' is one of their 'Key Priority Sectors.' However, upon inquiry via email, it becomes clear that they have not (yet) participated in any project in the waste sector (FONERWA, personal communication, n.d.).

Finances are also an obstacle to implementing policies, one respondent mentions (WCC A, personal communication, May 3,

2023). He cites this as the main reason that, in his view, implementing policies takes a long time. An example of this is the lack of investment and capital also plays a major role in attempts by the government to create a sanitary landfill, as will be further explained in section 4.6. Rajashekar et al. argue that the CoK has no budget in the short- or medium-term for improving SWM (2019).

In order to get investment, Rwanda is looking for alternative ways to attract people and capital. Fulfilling the government's ambitions often requires additional outside investment, mentions an interviewed professor, as the country does not have the financial capacity to make all the investments itself. He argues that the government wants to shift to a service economy. In order to achieve this, people and capital must be attracted, which he says requires a clean, organized society:

"When you see the region here and the countries surrounding. Their resources, they are rich, they are big. But then you see in Rwanda, a small country? Not many, right? There is also that we have many people. That's why the government is shifting from the primary sector to the tertiary sector, of services. So, if you want to develop the service economy, the first thing to do is to attract people. Attract tourists, attract business. If you want to build that component of dualism, improve the clean and organizations, the clean city, the clean society, an organized society, and security." 3:4 ¶ 104 – 108 (Manirakiza, V., personal communication, May 12, 2023)

4.6. Sound institutions & proactive policies

This paragraph will be divided into two; first, the adequacy of the national framework for SWM will be discussed, then, the degree of local institutional coherence will be discussed.

4.6.1. Adequacy of national framework for solid waste management

Legislation and regulation, strategy/policy

Policies related to waste have emerged over the past 15 years (Rajashekar et al., 2019; MININFRA, 2022; Iraguha et al., 2022). Before 2010, no framework existed that unified all waste regulations, relating to all different stakeholders. Before then, all SWM, including waste collection, was the responsibility of the CoK, but this service was privatized in 2003 (Rajashekar et al., 2019).

National policies to manage and regulate SWM have been in place for some time. Strategies to make the entire SWM sector more sustainable have been released fairly recently. Before 2022, all policies related to waste collection found their background in the 2005 Organic Law Determining the Modalities of Protection, Conservation, and Promotion of the Environment in Rwanda (Rajashekar et al., 2019). From 2010, the policy slowly evolved as rapid urbanization took place, various government institutions were established, and environmental emergencies surfaced. These developments helped shape the waste policy (ibid).

The National Sanitation Policy and Implementation Policy was the first policy document to look at the waste sector as a whole, or in conjunction with the handling of liquid waste (sewerage) (see appendix II). However, the policy document was mainly focused on water-related issues and focused on SWM only in a four-page long subchapter. Consequently, comparatively little attention went to SWM in the 48-page document. In the subchapter on SWM, the Waste Hierarchy (see figure 4) is seen as guiding the future of SWM, which at the time focused on waste minimization (MININFRA, 2016). In the strategy, the government sets a goal of disposing 60% of domestic waste 'properly' by 2019/2020, and 80% of it by 2029/2030. In this context, disposing "properly" means that the waste is either recycled, reused, or disposed of at a designated site. In addition, the plan states that 30% of non-organic waste should be recycled by 2019/2020, and 40% of it by 2029/2030 (ibid). The plan does not contain any further concrete plans to achieve this, only several targets regarding the percentage of waste.

Figure 4: Waste hierarchy (adapted from MININFRA, 2016)

According to Rajashekar et al., the goals set in the National Sanitation Policy and Implementation Policy have not been met (2019).

MININFRA retrospectively called the National Sanitation Policy and Implementation Policy an umbrella policy, providing direction for the future of SWM (2022). In 2022, the National Integrated Solid Waste Management Strategy (NISWM) was released by MININFRA, a strategy in which the waste sector across

the country was assigned a multi-year plan. NISWM is regarded as progressive and is in line with the circular economy roadmap. The strategy focuses on waste minimization, sustainable access to waste collection services, environmental protection, and growing the waste sector's contribution to the green economy. The pillars of the strategy are supported by specific actions and enablers. NISWM promotes public-private partnerships and innovative financing to attract private investment and ensure sustainable funding for the waste sector. This policy sees WCCs as a target audience that they would like to reach through newspaper and radio - nothing is mentioned about direct contact or cooperation with WCCs.

The strategy emphasizes expanding waste collection services, optimizing system logistics, supporting private sector-led initiatives, and infrastructural support for waste beneficiation. According to NISWM, waste collection coverage should already have increased to 50-95% in the short term (2022-2024). Accordingly, WASAC recently stated that solid waste treatment and management is one of their priorities (2019). They proclaim the following:

'Rwanda has committed itself to reach very ambitious targets in sanitation, with the vision to attain 100% service coverage by 2024 according to seven-year government program. The importance of adequate sanitation services as drivers for social and economic development, poverty reduction and public health is fully recognized in Rwanda's flagship policy documents and political goals. ' (WASAC, 2019, p. 1).

However, according to WCCs, no new policies have been introduced specifically to this end, and collection coverage appears unchanged. Besides the expansion of waste collection, other goals in the NISWM that should have already been set in motion have not yet been met. It is mentioned that policy integration can be a stumbling block in Rwanda; many policies and strategies are written that are often not implemented within the intended time frame, or not yet addressed at all (employee development aid organization, personal communication, May 18, 2023). The reason the respondent gives for this is that policy is seen as a starting point - if someone wants to do something and there is no policy for it yet, it will not be undertaken.

A respondent was asked about the feasibility of certain policy implementation goals, such as the aim to reuse or recycle 80% of all waste in Kigali by the end of 2024. In response, he expressed uncertainty and stated that he was not sure about the feasibility of achieving this target within the given timeframe. He stated that some of the goals set by the government are rather ambitious (WCC B, personal communication, May 11, 2023).

Policies are often set with little input from WCCs as outlined in paragraph 4.4: *The balance of public vs. private sector interests in delivering services*. WCCs are informed of the new policy at a meeting, as of when they must implement the policy. Strategies such as the NISWM are very progressive and contain concrete plans. However, implementing these plans requires a lot of time and money, which requires investments. Sometimes the purpose of

writing policy is to provide guidance for the future, and no immediate action is required.

Guidelines and implementation procedures

No literature exists on how policies are implemented, and how they are communicated to the private sector. Interviewed WCCs explain that they are told about new policies through meetings (WCC A, personal communication, May 3, 2023). A respondent says:

> "It is a face-to-face meeting. Yeah. Now if it is for waste collection companies, they call upon all companies. They all come. Show up. Officials will make a meeting. We agree on things. We go out and implement." 4:47 ¶ 347 – 353 (WCC B, personal communication, May 11, 2023)

WCC B argues that the use of guidelines is insufficient to change SWM, but that mandatory measures would be effective (personal communication, May 11, 2023). He adds that residents of Rwanda firmly obey the law.

> "They just inform; they don't engage. To me, engagement is like a forced engagement. Like for example, if they can say: from now on, no truck will enter the dumpsite with mixed waste. That is, engage. They engage us to make a change in our logistics and operations." 4:45 ¶ 335 – 341 (WCC B, personal communication, May 11, 2023)

Sometimes, development assistance agencies like GGGI are involved in introducing WCCs to particular policies, according to WCC A (personal communication, May 3, 2023). When governmental institutions contact a WCC regarding new legislation, they sometimes ask for feedback, says another respondent (WCC C, personal communication, May 12, 2023). WCC C also mentions that often nothing is done with this feedback but did give a concrete example of when this did happen.

National institution responsible for implementing solid waste management policy

SWM in Rwanda is composed of national entities that make policies (MININFRA, MoE), as well as a mixture of national and local implementation organizations and regulatory bodies (Rajashekar et al., 2019). The rules that govern how all implementation activities are carried out must be established by RURA and REMA; WASAC also implements SWM through its involvement in landfill management. Finally, districts and sector officials are responsible for managing contracts with waste management businesses and maintaining environmental protection with assistance from CoK.

RURA is tasked with regulating public utilities such as telecommunications, postal services, water, removal of waste products from premises, etc. (RURA, n.d.). In addition, RURA has a statutory duty to provide fair competition among service providers while promoting and protecting the rights and interests of consumers in regulated sectors (Squire & Nkurunziza, 2022). The institution plays a central role in communication between

policymakers and licensed service providers. For example, the RURA writes regulations and guidelines such as Governing Solid Waste Collection and Transportation Services (2021). This document outlines, among other things, the rules related to issuing and maintaining licenses, technical conditions for waste collection, and penalties.

REMA is the authority dedicated to protecting, conserving, and promoting the national environment (REMA, 2021). Their mission is to protect natural resources in a climate-friendly way through decentralized structures of governance. They also mention the well-being of Rwandans as being a core part of their policy. REMA does not deal directly with waste, but it is, for example, the agency that initiated the ban on the production, import, sale, and use of single-use plastics (Squire & Nkurunziza, 2022). In addition, REMA has a department dedicated to environmental education, which includes, for example, working to promote awareness of the importance of safe waste management practices in the educational curriculum.

Policy	Implementation	Regulation
Ministry of Infrastructure (MININFRA)	City of Kigali (CoK)	Rwanda Environment Management Authority (REMA)
Ministry of Environment (MoE)	Water and Sanitation Cooperation (WASAC)	Rwanda Utilities Regulatory Authority (RURA)

Table 13: Overview of responsibilities institutions

The responsibilities of WASAC and CoK are discussed in paragraph 4.2. – *Degree of control over waste reception and general site management.*

The fact that the SWM system is regulated by many different government agencies is not viewed very positively by WCCs. The WCCs interviewed often discuss "the government" in a general sense, without specifying the particular agency involved. This lack of distinction becomes apparent when companies have to interact with multiple agencies. WCC B indicated that the number of different people in charge leads to confusion and inefficiency and stressed the need for a centralized entity or one-stop center that can coordinate with different institutions (personal communication, May 11, 2023). They suggested the establishment of an office dedicated to waste management, which could be located within the CoK, REMA, or the ministry. He expressed the inconvenience of dealing with different entities such as RURA and the city, as each may have different messages and requirements. This fragmented approach was deemed counterproductive by the interviewee.

In addition to the contact, WCCs have with the agencies, it is mentioned that policies also have to go past several agencies before they can eventually be implemented:

> "Policy needs to be approved by many people, like it has to come from RURA and REMA and then it goes to Ministry of Environment, it's a long process." 2:20 ¶ 214 (WCC A, personal communication, May 3, 2023)

A respondent also notes that there can be policy incoherence among different government agencies due to a lack of communication and aligned views (employee development aid organization, personal communication, May 18, 2023). Moreover, he discusses the difficulty of getting in touch with government agencies. He cites the bureaucracy that precedes arranging an interview as a good indication of how it is for WCCs to get in touch with governments.

On the composition and effectiveness of different governments, one respondent says that the government in Rwanda often consists of qualified people, but there is an issue of understaffing (employee development aid organization, personal communication, May 18, 2023). He also states that the people who work for the government are generally very competent, only that this decreases with the scale of government (national/local) and the locality (urban/rural).

Regulatory control/enforcement
RURA and REMA have a monitoring function in SWM (Kabera et al., 2019). For example, RURA is responsible for overseeing the bidding process for licenses (ibid). REMA monitors the implementation of issued policies (REMA, 2009). In addition, the quality of waste collection is monitored by both governments and WCCs through a group chat that includes all stakeholders (WCC F, personal communication, May 17, 2023).

4.6.2. Degree of local institutional coherence
Organizational structure/coherence
The CoK handles various aspects of waste management, including strategic planning, capacity building, outreach campaigns for waste separation, waste beneficiation, and zoning for waste management industries (Rajashekar et al., 2019). Additionally, the CoK, in collaboration with WASAC, manages Nduba. However, the CoK faces challenges in terms of resource allocation and coordination capacity to effectively implement new strategies and projects (ibid).

Through PPPs, the CoK relinquishes the control of waste collection to private companies (WCCs), as they decide which WCC gets licensed. A respondent states that the government chose a PPP structure for waste collection because quality is more guaranteed in the private sector than in the public sector (Kabera, T. personal communication, May 22, 2023). The amount of waste that is collected since the service was privatized has increased (Rajashekar et al, 2019). The reason he cites for this is that the public sector pays their employees anyway, regardless of the quality of the service provided.

WCC B suggests that, since waste collection was privatized, too many WCCs operate in the city (personal communication, May 11, 2023). He also mentions that the city is divided into too many sub-areas with different companies responsible for them. He adds that WCCs vary significantly in intellectual and physical capacity. He envisions waste being collected per district (a total of 3) by one responsible company.

Citywide strategy and plan

For the future of Kigali, there is the Kigali Master Plan 2050, which outlines all urban challenges and plans (CoK, 2018). The Master Plan does not yet have many concrete plans related to SWM. However, the Kigali Master Plan 2050 urgently calls for making a new plan for SWM and building a new landfill.

A respondent says the government issues public tenders for some problems because it does not have the proper resources to deal with a particular issue (employee development aid organization, personal communication, May 18, 2023). He goes on to address the fact that these tenders are often poorly constructed; he states that there have been instances when a tender was won and the winners were allowed to start work, only to withdraw upon arrival because the project turned out not to be feasible as the tender was flawed (ibid).

Availability and quality of solid waste management data

To gain insight into the status of waste generation and waste treatment, information systems can be used to collect data.

No data are kept in Kigali's SWM system (Kabera et al., 2019; Rajashekar et al., 2019). This is concurred by the following respondent:

"There are no waste data here. To have data, you need a system. At the dump site you need a weighbridge. Or when we collect, for example. Management of our customers, billing, and payment, and the waste data collected. There is no system." 4:8 ¶ 80 – 89 (WCC B, personal communication, May 11, 2023)

WCC B adds that all figures used in reports and articles are based on estimates (personal communication, May 11, 2023). WCC B further explains that he has developed a system that can be utilized by other WCCs, which he believes would simplify fee collection and data acquisition processes. He intends to integrate this system with government institutions, enabling the sharing of data and generating interest in his company. He clarifies that, under terms and conditions, other WCCs can make use of his system. However, he has not yet made the system available to them, as he plans to present it to the government first.

The lack of data in Kigali's SWM emerged as an obstacle earlier in the study. For example, it is not possible to monitor how much waste is generated, collected, and disposed. It also does not track what proportion of waste collected is recycled.

Management & control of service delivery

WCC F indicated that the government sometimes controls its operations (personal communication, May 17, 2023). For example, he says they sometimes stop by their office to check "the general things" and pull over a garbage truck about twice a year to verify workers' compliance with safety regulations. He emphasizes the

latter, adding that the government feels that worker safety is a priority. He explains that when a company fails to comply with rules, a fine is first issued, but the license is revoked if frequent repetition occurs.

Management control & supervision on SWM is rated poorly by Kabera et al. (2019). For example, a vehicle was purchased for each district to measure waste activity, only it was not observed that waste activity was measured in 2019. In addition, there is little (good quality) data available on the amount of waste that is disposed of, as Nduba does not have measuring equipment (Iraguha et al., 2022; Rajashekar et al., 2019). Several areas in the city indicated no regular control of the quality of service at WCCs (Rajashekar et al., 2019).

Overall, therefore, there is little government control over the services provided. Only compliance with safety guidelines is checked - the quality of waste collection is not monitored throughout the whole city.

5

Modernized Mixtures Approach

This chapter will analyze the results from the perspective of the MMA. The following paragraphs will discuss dimensions of scale, centralization, bottom-up/technocratic, and flows. The chapter concludes with an indication of how the entire SWM, upon recommendation from the interviewees, would shift within the MMA spectrum in the future. Most of the recommendations are made from the viewpoint of WCCs, although there are instances where the recommendations come from other stakeholders' perspectives when they are in line with the same trend within the dimension as indicated by the WCCs.

5.1. Scale
The ways in which "scale" emerged in the interviews are: the scale of city-wide operations, the possible expansion of WCCs' operations, and the scale of waste processing in Nduba.

The current approach to SWM consists of waste collection by various WCCs operating under a citywide PPP model. However, it is mentioned in the interviews that the quality of waste collection can vary per neighborhood. Possible reasons for this are: 1) different approaches of WCCs to the existence of defaulters (collecting or not collecting the waste), or 2) possible imbalances in the capacities of WCCs. Both governments and WCCs are committed to increasing collection coverage within Kigali. A proposed solution to address these challenges is to consolidate the number of WCCs and their associated neighborhoods,

enabling each WCC to operate on a larger scale and enhance efficiency.

Additionally, some WCCs aim to expand their operations by incorporating recycling facilities, contributing to sustainable waste management practices, and envisioning a future with significantly increased SWM scale in Kigali.

Furthermore, the CoK seems to favor a large-scale operation to redevelop Nduba over accepting several small-scale initiatives to redevelop sections of Nduba.

In both waste collection and disposal, there seems to be a call, both from WCCs and the government, for an approach on a larger scale (see figure 5). On the WCCs' side, this increase in scale has to do with both the amount of waste collected and the scale of operations, to which the recycling of materials is added. On the
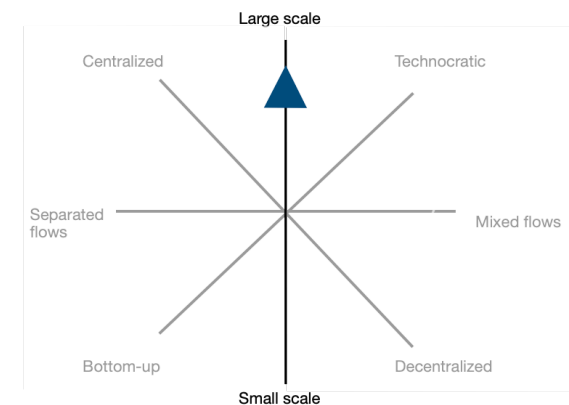

Figure 5: MMA figuration: call for larger scales (developed by author)

government side, it has to do with the scaling up of the areas in which WCCs operate, as well as increasing landfill capacity and technological developments.

5.2. Centralization

The topics in which the centralization dimension arose in the interviews relate to responsibility over SWM at government agencies, and how collection fees are collected from residents.

The SWM system in Rwanda is primarily shaped at the national level, by various legislative and executive bodies, which establish regulations and frameworks for waste collection. The policies apply across the country, whereas practical implementation and regulation take place at the municipal level. However, interviews with WCCs suggest a need for an even more centralized approach to address problems arising from conflicting policies and unclear responsibilities among different government agencies. The creation of a single, central government agency responsible for all SWM tasks has been proposed to promote integration and effectiveness and ensure consistent standards and guidelines. Through centralization within the government, decision-making will be uniform and clear, both within the government and in communication with WCCs.

WCCs have also expressed a desire for a centralized payment system, linking collection costs to essential services such as water supply, which they believe would improve collection rates.

Moreover, from the perspective of the CoK, there also seems to be a focus on centralization, particularly in developing

key projects such as the Nduba redevelopment, where large investors (ensuring waste disposal is conducted by one party) are favored over smaller-scale initiatives.

From the WCCs, there seems to be a desire for a government, and a payment system that is centralized to a greater degree (see figure 6).
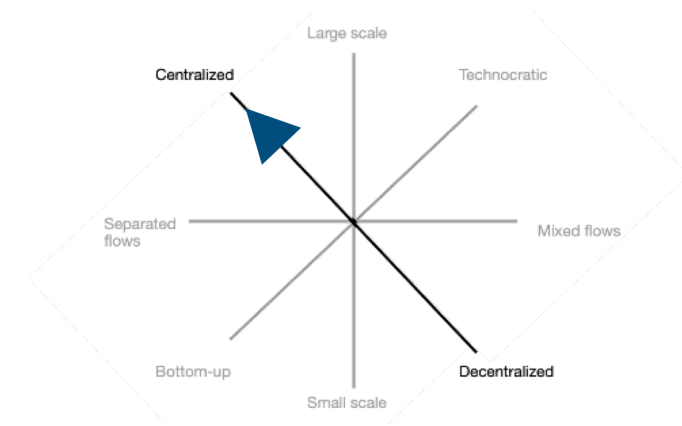

Figure 6: MMA figuration: pleas for centralization (developed by author)

5.3. Bottom-up/technocratic

The way the bottom-up/technocratic dimension can be found in the interviews is mainly related to feedback on the wishes of integration in governments.

SWM in Kigali seems to follow a predominantly technocratic rather than a bottom-up approach. Policy is initiated by the national government and implemented and controlled by the municipality, with little involvement of the private sector.

As indicated in the previous section, there is also a demand for a more centralized government that issues policy for the sector. Therefore, the technocratic nature of the system should be maintained. However, the desire of WCCs to have more say in policy is seen in this dimension as a desire for lean toward a somewhat more bottom-up policy (see figure 7).
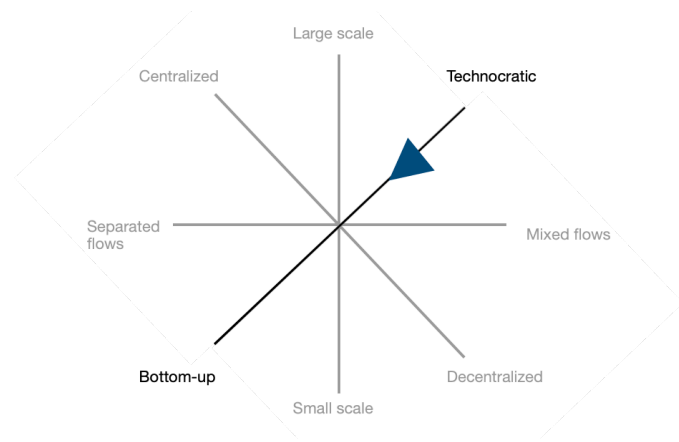

Figure 7: MMA figuration: calls for bottom-up approach (developed by author)

5.4. Flows
The flows dimension refers to the degree of separation of waste streams.

Based on the gathered data, it becomes clear that waste separation by households in Kigali, or any other stakeholder within the formal SWM, is minimal to nonexistent. A lack of knowledge among residents about the benefits of source separation is cited as one of the main reasons why waste is not currently separated. In addition, WCCs do not collect waste separately, further reducing efforts to separate waste at the source.

All interviews and policies reveal a desire on the part of both WCCs and the government to create separate flows of waste in order to facilitate recycling. The primary reason cited by WCCs for not implementing waste separation practices (yet) is the unavailability of waste disposal facilities for separate collection. This is particularly evident in Nduba, where a combination of indiscriminate waste collection and insufficient financial resources appears to hinder the establishment of a proper sanitary landfill.

Both governments and WCCs seem to have a desire to separate waste streams throughout the SWM chain (see figure 8). As outlined in the multilevel non-separation feedback loop, sorting waste at one of the links will create a chain reaction, allowing the handling of separated streams to take off. When residents deliver their waste separately, WCCs can collect it separately and the streams can be treated separately.
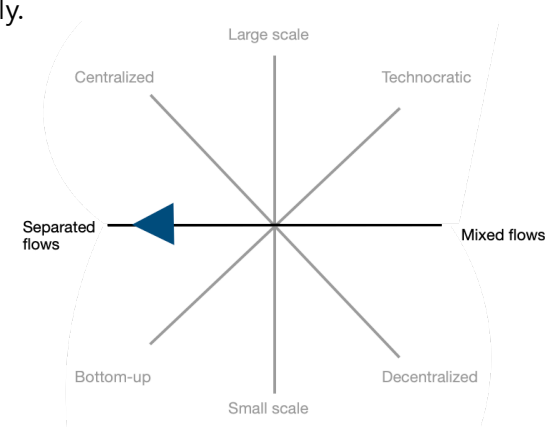

Figure 8: MMA figuration: calls for separated flows (developed by author)

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5.5. MMA configuration

Based on the changes in dimensions interpreted from the interviews, the SWM system would shift within the structure of the MMA (see figure 9). The greatest change occurs in the flows dimension, where the system should move to the other end of the spectrum. The degree of centralization and scale should be increased, as compared to the current system. Lastly, the system will retain its technocratic character, shifting slightly more towards bottom-up as more account needs to be taken of the opinions of the WCCs.
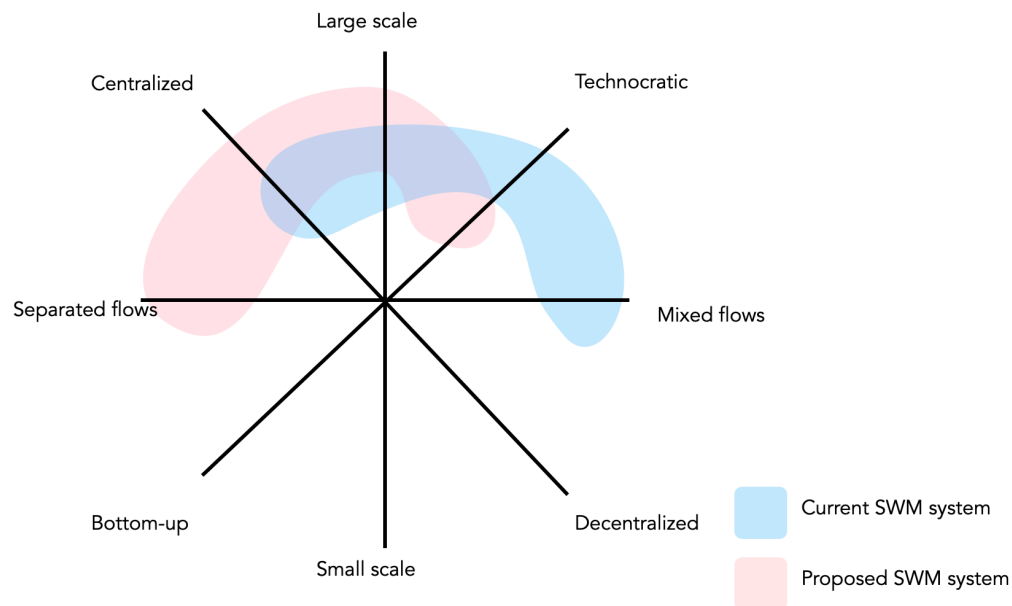

Figure 9: MMA figurations: present and future of Kigali's SWM according to MMA analysis (developed by author)

6

Discussion and limitations

This thesis reported on the SWM system of Kigali and aimed to uncover possible challenges and opportunities related to increasing its effectiveness. In the first paragraph, first, the results will be discussed. Subsequently, the theoretical approaches used in the research will be reflected upon. This second paragraph, highlights the limitations that occurred during the research process and provides insight into how these limitations may have affected the outcomes of the study. It also gives recommendations for future research on how to avoid certain problems.

6.1.1. Discussion of results

In order to increase the effectiveness of the SWM, several challenges are addressed that are in need of solutions. Recycling is seen as the most effective method of waste treatment, since as many materials as possible are given a new function, and as little waste as possible ends up in the landfill and thus does not cause pollution. This research shows that waste is not currently separated, which is identified by interviewees as a prerequisite for recycling. More specifically, interviewees name source separation as the most effective method of creating clean, separated waste streams.

Respondents gave several reasons for the current lack of waste separation: the fact that no link in the SWM is prepared for segregated waste streams (the by the author established multi-level non-separation feedback loop), financial difficulties, and a lack of motivation and knowledge about waste separation among households.

As delivering waste in separated streams can make money for WCCs, as they are the building materials for, say, recycled plastic or compost, they would financially benefit from getting source separation off the ground. Iraguha et al. argue that a financial incentive may be a motivation for households to separate their waste (2022). This is also suggested by the development aid agency employee; he suggests offering people discounts on their waste collection fee in case they separate their waste. Despite the fact that the amount of the fee is determined by income level, and thus would be affordable, it is thought that this method will be effective. Combined with the color-coding method proven effective by a WCC, it is an option to start source separation in this way.

In the scenario where source separation has taken off, the multi-level non-separation feedback loop has been broken, and the rest of the SWM system can adapt to the separately delivered streams. This will result in different waste streams being collected by separate trucks. Now that there is a supply of waste streams ready for recycling, WCCs, or other companies, will start up recycling facilities to reuse the streams and make money from them.

Another possibility is for the government to create a sanitary landfill where either the separated waste can be processed, or the waste can be sorted and processed after collection.

Lastly, it would also be possible to opt for post-sorting and involve the informal sector in this. The sector has a lot of experience regarding waste separation and has connections with companies that can process the sorted streams. WCCs and governments could benefit from this working method, knowledge and connections.

Two respondents suggested linking the waste collection fees to the water bill as a possible solution to combat defaulters. This is seen as a good solution to improve payments, as it becomes practically impossible not to pay the fee. This will lead to less waste being illegally disposed of and will therefore reduce negative impacts on the environment. However, in the event that one does not have the financial means to pay for the waste collection fee, this would automatically cause them to also be deprived of water, which I consider unethical. Arranging payments for waste collection through official institutions is seen as a good solution, provided low-income groups are taken into account.

The defaulters faced by WCCs do not seem to pay their fees for the following reasons, according to respondents. For one, they have too little knowledge about waste, which results in them not knowing the consequences of dumping or incineration. In addition, waste has a bad image - some people see waste as a worthless product and therefore do not understand why they should pay for handling something that is worthless. Imparting knowledge about waste should be able to address these issues. Current initiatives to teach people knowledge about waste have had little success. Reasons given for this include using the wrong channels, not targeting the right people, and media campaigns being too short in duration. The (long-term, targeted) use of media campaigns is seen as an effective strategy.

Another phenomenon observed is the government's desire not to take any half-measures. An example of this is the sanitation of Nduba. WCCs reveal that the government does not accept initiatives addressing only a small part of the landfill. The government wants to take a large-scale approach regarding the conversion of the landfill. The government's desire to tackle things big and centralized is also evident in the mobile payment network, within which one can pay at stores, as well as for credit, internet, electricity, and water. It is possible that government aspirations are holding back innovation, as several small initiatives could already contribute to solving the problem.

The government publishes many policies related to innovative waste management strategies. These describe targets such as waste-to-energy facilities and achieving a circular economy (as read in NISWM, see appendix II). Looking at the current status of the SWM, these goals seem far from in sight. Yet, money and time are being put into creating these extensive plans. Trying to attract foreign investors, Rwanda is working on its image. Therefore, it is possible that one of the reasons the policy is being published is to create a progressive and sustainable image for the country. The study identifies a number of problems that underlie the achievement of these goals. Therefore, it seems more urgent to address these problems than to write policies for goals that are a long way from being achieved.

Having many different government agencies involved brings some adverse effects. For example, in WCCs, it leads to confusion about

what responsibilities lie with which agency, and it is unclear which party is the deciding factor in making plans. One example is the ambiguity surrounding the future of the landfill. Where one authority talks about redeveloping Nduba, another states that Nduba is only an interim solution before a new, sanitary landfill will be built at another location. To avoid such miscommunications and ambiguities, one WCC suggests creating a separate government body to deal with SWM. Communication between stakeholders and the government would be easier and faster if one party is aware of everything going on within the sector. Because the body is aware of all aspects of SWM, it is able to look at problems with a holistic view, and thus make decisions that benefit SWM.

There is currently a significant lack of data in all parts of the SWM system, as indicated by literature and interviews. All waste figures are based on estimates. In order to make improvements in the SWM system, it is important to understand the current state of affairs. During attempts to make changes to the waste management system, this way it is possible to measure whether the adjustments are effective. The simplest first step is to place a weighbridge at the landfill to accurately measure how much waste is coming in. With this data, it is then in turn possible to see how much waste is collected per neighborhood, and by which companies.

In general, Kigali has a waste collection system that is effective in the sense that much waste is collected, services are regular and streets are clean. The way waste is disposed of may be effective in

that the collected waste is taken to a single point, but it has negative impacts on the environment. Therefore, the "*out of sight, out of mind*" mentality, mentioned in the introduction, has been observed in Kigali. All in all, there are many opportunities to increase effectiveness and create a sustainable waste management system.

6.1.2. Discussion of methodology
Two theoretical frameworks were used in this research: the Wasteaware indicators and the MMA. In using these theories, in light of this research, some obstacles were encountered.

a) Wasteaware research
In this thesis, a partial replication of the research conducted by Kabera et al. (2019) was undertaken. Findings of the current study reveal new insights and information that differ from outcomes described in Kabera et al. their research. For example, this study shows that WCCs have a high default rate, while Kabera et al. state that there is a 95% collection rate. They also state that households have a high awareness of separating waste. The finding that waste is rarely delivered separately is demonstrated in this study. Based on this information, it cannot be said to what extent households are knowledgeable about separating waste, only that most households do not currently do it. These findings indicate the need for further investigation of Kigali's SWM using the Wasteaware method. Engaging in further research that incorporates the utilization of these indicators may enhance our understanding of waste management and capture any additional nuances that may arise.

b) Modernized Mixtures Approach

In this research, by applying the MMA to the vision of the WCCs, insights into their perception of the future of the SWM system were obtained. Using this lens provided insight into the SWM as a whole; its scale, degree of centralization, degree of separation of flows and the either technocratic or bottom-up nature of the system. By examining the SWM as it is now, and as desired by WCCs through the lens of MMA, it is made clear, at a higher, more abstract level, what changes need to be made. Using the desired changes named by WCCs, an analysis of how the SWM system should adapt within the dimensions of MMA was made. Categorizing the WCCs' desires within the dimensions of MMA helped to understand the structure of their needs.

It is important to recognize that different stakeholders involved in SWM in Kigali, such as governments, the private sector, and residents, may have varying priorities that may not necessarily align with the values attributed to an effective modernized mixture configuration. The specific conditions necessary for an effective MMA configuration are ecological and institutional sustainability, technical flexibility, and resilience. For example, WCCs may benefit financially if residents separate their waste but do not compost it individually, as this allows the WCCs to generate profits from the waste. On the other hand, from an ecological sustainability standpoint, it would be more favorable for households to compost their waste themselves, thereby avoiding the transportation of waste to a composting facility.

Therefore, it could be argued that in order to create an effective modernized mixture configuration, the stakeholders responsible for shaping the SWM system should align their values and priorities. For example, joint goals could be set regarding sustainability, financial health of the institutions and a corresponding division of labor for citizens, business, and government.

The MMA configuration is presently located in the top-right corner, while the proposed MMA configuration is located in the top-left corner. The biggest change occurs in the area of mixed flows; where waste is currently collected unsorted, in the desired SWM all flows are separated. The dimensions centralized and large scale are amplified. In the proposed configuration, control of the SWM is centralized within the government, and the scale of the operation increases, as more people will participate in the formal SWM. Finally, the degree of technocracy will decrease slightly, as the opinions of WCCs will count more in the decision-making process.

6.2. Limitations

Firstly, the use of Wasteaware indicators may not be the most suitable method for identifying specific problems in the SWM system. The indicators primarily serve as a means to present the current state of SWM rather than pinpoint specific issues. When applying the indicators to identify problems, the criteria can sometimes be too narrow in scope. An example of this, regarding the waste disposal indicator, there is only one criterion where disposal in Kigali's SWM needs explanation; the other criteria are only applicable to disposal sites that are more technically or

analytically advanced. For this reason, while coding, most of the information on disposal in Kigali was categorized under the criterion 'Degree of control over waste reception and general site management', with a broad description stating that it applies to all treatment and disposal sites regardless of the specific processes involved. This criterion is considered lacking in specificity to identify problems in the SWM, such as that of illegal disposal.

Moreover, it was observed that the Wasteaware framework is more suitable for well-developed SWM systems in terms of technology and sustainability. The criteria align better with such systems, while indicators for measuring the degree of underdevelopment in a system are relatively scarce.

The addition of the MMA to the research methods was, therefore, of added value in this study. The MMA added value to the study by using its dimensions to probe the interviews and analyze them, allowing for a deeper exploration of the issues within the SWM system. This approach provided a broader perspective and highlighted additional problems that may not have been captured solely through the use of Wasteaware indicators. While the Wasteaware indicators ask for information about, for example, some aspect of government or policy, the dimensions of MMA provide insight into this, for example, by looking at the degree of centralization of a system, or its size. Applying this combined approach revealed, for example, that all stakeholders would like to see the SWM system more centralized, as a more centralized system would offer, among other things, more clarity in policies and companies, and a larger scale approach. The extent to which the system is currently insufficiently centralized was revealed

through the use of the MMA and would not have been revealed with the use of Wasteaware alone.

For example, there may be problems within different indicators of Wasteaware that can be summarized under the same dimension within the MMA. By looking at the outlined problems, discovered using Wasteaware, within a SWM with this lens, and grouping the problems under the MMA dimensions, it can likewise aid in finding a solution to said problems.

Future studies may explore alternative methodologies that better capture the complexity of less developed SWM systems or use a combination of Wasteaware indicators and the MMA. This combination may provide a more nuanced understanding of issues specific to system design and the role that governments and other stakeholders play in it. For example, there may be issues within different Wasteaware indicators that can be grouped together under the same dimension within the MMA. By looking at the outlined problems within a SWM with this lens and grouping the problems under the dimensions of the MMA, it can help identify the issue and find a solution to these problems.

Secondly, it should be noted that conducting interviews with government agencies in Rwanda requires researchers to obtain a permit from the government, which can be time-consuming. Unfortunately, due to the constraints of the study's timeframe, the researcher was unable to obtain the necessary permit for interviewing government agencies. Therefore, the insights and

perspectives of these key stakeholders were not included in the study, which could have provided valuable information and a more comprehensive understanding of the SWM system in Kigali. For example, it could have contributed to the understanding of how different governmental organizations are (internally) coordinated. It also would have given more insight into the status and future of Nduba. There is also the possibility that interviewees would have had more confidence in the study (and the researcher) if the researcher had obtained a permit, and thus, approval from the government. Obtaining a permit might also have caused current respondents to disclose more information.

Thirdly, despite the researcher's attempts to maintain objectivity, it is important to acknowledge that the researcher's Western perspective may have inadvertently influenced the conduct of the study and the interpretation of the data.

Lastly, time and resource constraints in the study may have impacted the amount and variety of data collected. The limited number of interviews conducted and the specific focus on certain aspects of the SWM system may have overlooked other important factors. Additionally, the number of interviews with WCCs may have limitations in representing all WCCs in Kigali, affecting the generalizability of the findings.

7

Conclusion

The aim of the present research was to explore the obstacles and opportunities related to the effective functioning of SWM from the WCCs' point of view and to better understand the current state of SWM. The research employed a single case study. The overall research question for this study was:

What factors hinder an effectively functioning solid waste management system in Kigali, Rwanda, according to local waste collection companies and urban waste experts?
To answer this research question, three sub-questions were formulated, being:

1. What is the current state of affairs of Kigali's solid waste management system?

2. What are obstacles and opportunities regarding the effectiveness of Kigali's solid waste management system, according to Kigali's waste collectors and experts?

3. Which (combination of) large – and small scale social and technical themes regarding the effectivity of the solid waste management system can be identified?

This chapter is structured on the basis of the above-mentioned sub-questions.
Hereto, firstly, the current state of Kigali's SWM will be discussed. Subsequently, the obstacles and opportunities of the SWM system according to waste collectors and experts will be presented. Finally, when answering the third sub-question, the identified social and technical problems will be discussed.

7.1. Sub-question 1: What is the current state of affairs of Kigali's solid waste management system?

By assessing Kigali's waste management system using the Wasteaware indicators, the following characteristics could be recognized:

(a) Waste collection by WCC's

Data collected on-site showed that waste is collected on schedule by WCC's, and streets are generally clean. However, there is a slight difference between higher urban areas and lower rural parts of the city, where slightly more litter is visible. This may be due to inadequate waste storage, as this can cause litter to wash away into lower (rural) areas and rivers during heavy rainfall. Moreover, the waste collection coverage is higher in urban areas compared to rural areas. Residents in rural areas, who do not take part in formal waste collection, dispose of waste by other means, which negatively impacts the environment. Residents' knowledge and perception of waste influence their willingness to pay for proper waste management.

(b) Costs

The cost of waste collection is borne by households, who pay a monthly fee to the responsible WCC. All households theoretically have access to waste collection services, since costs are linked to income level. However, according to the WCC's, regardless of the affordability of the fee, problems appear to exist concerning fee payment, something that will be explained further in paragraph 4.2.

(c) Policy changes

Recent policy changes have made waste collection more effective and safer. WCCs were mandated to acquire new waste collection trucks and adhere to stricter safety regulations for waste collectors. All waste collected by WCC's in Kigali is disposed of at the Nduba landfill, the management of which is the responsibility of the government. Due to the lack of a weighbridge, only estimates are available for the amount of waste entering Nduba. This landfill, however, poses risks to the environment and the health of local residents and Nduba's workers as it produces leachate; a substance that is harmful to local residents and workers, as these people may not have sufficient knowledge to handle the waste safely. Furthermore, it appears that waste is not separated, neither before nor after collection. This results in low existence of recycling, reusing, and reduction in the formal SWM sector. In the informal sector, however, some materials are collected and reused.

(d) Government regulations

Regulations related to SWM are issued by various national governments and Kigali's municipality. Specific SWM-focused policies are relatively new in Kigali, as previous policies tended to be more oriented toward sanitation, with SWM being a secondary concern. Kigali's new policy contains big plans for innovating its SWM. However, some of these plans proved to be too ambitious and were ultimately not met, e.g., increasing Kigali's waste collection coverage.

7.2. Subquestion 2: What are obstacles and opportunities regarding the effectiveness of Kigali's solid waste management system, according to Kigali's waste collectors and experts?

By means of interviews with Kigali's waste collectors and waste management experts, insights were gained into what they believe are the obstacles and opportunities for Kigali's SWM.

1. Obstacles

With regard to the obstacles experienced by waste collection companies and experts, the following insights emerged:

(a) Limited effectiveness of sensitization strategies

Initiatives aiming to engage households in waste separation efforts, struggle due to the lack of waste awareness among people, resulting in attempts to evade waste collection fees and a negative perception of the waste sector. Attempts have been made by both governments and WCC's to educate residents through community meetings and media (sensitization), but effectiveness was limited because the duration of media strategies is often too short and attendance at meetings is too small.

Solutions suggested by the WCC's to improve awareness include primarily the use of media to reach the population, and to ensure that education becomes a long-term project. In addition, WCC's and experts argue that financial incentives may also encourage residents to separate their waste.

(b) Lack of recycling infrastructure

WCC's see source separation as the best method to separate waste, as this provides the cleanest separated waste streams, which are best suited for reuse. Achieving source separation therefore, is an important step in initiating recycling. However, various bottlenecks, such as a lack of knowledge amongst citizens, inadequate storage facilities, financial constraints, and a lack of a structure for handling separated waste throughout the entire SWM chain, hinder the initiation of waste separation by waste producers, collectors, and disposers. This lack of initiation of separation leads to a reinforcing effect, which I termed the '*multi-level non-separation feedback loop*'.

Apart from the effective collection of recyclable materials, a well-developed recycling infrastructure is also vital for resource recovery. Some WCC's indicate they would like to start their own recycling facility, but encounter obstacles, such as finding suitable locations and obtaining loans.

(c) Financial constraints

WCC's face financial constraints due to outdated fee structures, mandatory investments in new equipment, and problems with defaulters. The fee amount, set by the government, has remained unchanged for years despite inflation and recent increases in fuel prices. Even though fee prices are kept artificially low, some households avoid fee payment by illegally dumping their waste. In this respect, both literature and interviews with WCC's show that non-payment is influenced by a lack of waste knowledge, rather than by the fee amount. Financial constraints impede investments in infrastructure development, in waste separation facilities, and in advanced equipment.

(d) Little involvement of WCCs in decision-making processes

Many WCC's desire greater involvement in decision-making processes, as they feel that policy implementation is often imposed upon them without adequate consideration of their insights and challenges. Since input from WCC's is not included in the decision-making process, important insights may be omitted, even though this stakeholder brings insights from the field and will ultimately have to implement any regulations made.

The extent to which WCC's feel they can express their views on regulations and the incorporation of their feedback into government decision-making, varies. Some WCC's claim that their feedback is not fully considered. Others state that it is, but interestingly enough, despite probing in the interviews, concrete examples of such collaboration did not come forward.

In order to gain a stronger voice in decision-making, WCC's are working to form a union. However, the lack of government recognition of such a union limits their current influence. In addition to the establishment of the union by the WCC's, RURA also aims to establish a union for WCC's, but it is taking them time to get it off the ground.

(e) Ambiguity from the government

With respect to the extent of environmental regulations, there is ambiguity among different parties, as written policies have proven to not guarantee implementation. For example, the government aims to establish a sanitary landfill for waste separation, recycling, and composting, but the timing and existence of this new landfill remain uncertain. The large daily influx of waste requires a sizeable sanitary landfill for processing, making the issue more challenging.

Furthermore, a large number of government agencies are involved in SWM, leading to policy fragmentation and unclear responsibilities - both internally (according to literature), and externally (according to WCC's). To avoid such ambiguities, several respondents (both a WCC and an expert) suggested the idea of having one responsible organization within the government which is responsible for SWM. The centralized government would then enhance both internal coordination and coordination between waste collectors and the government.

(f)   Lack of data

Literature, WCC's, and experts all state that the lack of data on waste generation, collection, and disposal contributes to uncertainty about the current status and future of Kigali's waste management system.

2.   Opportunities

In the interviews, the following opportunities were mentioned by waste collector companies and experts:

Integration of formal and informal waste collection

Despite the exclusive rights of WCC's to collect waste in certain areas, the informal sector also collects specific materials from the waste, such as plastic. The formal and informal sectors do not co-operate, on the contrary: the informal sector currently disrupts the operation of formal waste services, according to WCC's. According to literature and some WCC's, there are opportunities for integrating these two sectors, especially when it comes to waste separation, as the informal sector has experience in separating and reselling materials.

Break the 'multi-level non-separation feedback loop'

When the multi-level non-separation feedback loop is broken, and one of the stakeholders starts working with separated waste streams, this may pave the way for the rest of the chain to do the same, enabling the reuse of waste streams.

7.3. Sub-question 3: Which (combination of) large – and small scale social and technical themes regarding the effectivity of the solid waste management system can be identified?

This sub-question was answered using the Modernized Mixtures Approach (MMA), through which large- and small-scale social and technical issues could be identified. The four dimensions of the MMA shed a light on the findings obtained in the first two sub-questions, thereby contributing to the identification of challenges and solutions within the SWM.

Figuration 1: Greater degree of centralization

In terms of centralization, it has become clear that WCC's would like to see SWM centralized to a greater degree. A potential solution would be to work with one central government body responsible for SWM, rather than the current, fragmented form. Another solution would be to centralize the operating areas more, with fewer WCC's operating, in larger areas.

Figuration 2: Separated flows

To enable the reuse of materials, all stakeholders want to get (source) separation off the ground, and therefore aim for as many separate flows as possible. Two methods of waste separation are currently in use, namely: 1) source separation through color coding,

and 2) subsequent separation of waste (by the informal sector). The options differ in terms of, among other things, the quality of the sorted waste and the required degree of citizen participation. Both, or a combination of the two, can eventually contribute to the effective separation of waste.

Figuration 3: Larger scale
WCC's would like to increase the scale of the SWM: on the one hand, they want to collect more waste by increasing collection coverage, on the other hand, they want to increase their operations by recycling raw materials from waste. Both goals are hampered by financial issues. Getting more people to pay for waste collection services through a payment system, for example, would give WCC's the resources to scale up.

Figuration 4: Less top-down decision making
The current decision-making process allows limited input from WCC's, making this process top-down. WCC's would like to have more say in the decision-making process, making the system more bottom-up. This could be achieved by formalizing the union(s).

The combination of these challenges and solutions within MMA's dimensions shows that from the WCCs point of view there is a desire for a more centralized, large-scale system, within which the government makes policy for SWM with the participation of WCCs. One of the biggest changes WCCs would like to see is the separate handling of waste streams.

8
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