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Effectiveness of Solid Waste management in Kigali City, Gasabo District, Remera Sector, Nyabisindu Cell

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Dedication

This work is dedicated to:

- ✓ To almighty God who protected us during our study
- ✓ Our parents.
- ✓ Supervisors
- ✓ All Lecturers in MSc of GI-ESD
- ✓ All our relatives and friends who supported us in any possible means towards the Completion of this work.

Declaration

This is to declare that the dissertation entitled **"Effectiveness of Solid Waste management in Kigali City, Gasabo District, Remera Sector and Nyabisindu Cell"** is my original work for MSc research and that to the best of my knowledge, it contains no material, previously published by another person nor has material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made.

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Approval

This is to certify that this work entitled *"Effectiveness of Solid Waste management in Kigali City, Gasabo District, Remera Sector, Nyabisindu Cell*" has been assessed and accepted by post-graduate coordinator team in the school of Architecture and built Environment

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ABSTRACT

This research evaluates solid waste management in Kigali City's Gasabo District, specifically focusing on Remera Sector, Nyabisindu Cell. The study aims to identify the types of waste generated, assess the collection and disposal processes, and suggest the improvement of waste management practices. The methodology used include, literature review, questionnaire surveys, and field observations. During the survey, data was collected on demographics, waste types, and management practices. In addition to the survey, qualitative data was collected. The findings indicate that most respondents were coming from the private sector. Concerning the education, the majority of respondents have primary or secondary level. Households are responsible for generation of organic waste. In terms of waste management Waste collection takes place on weekly basis by a company called CESCO Ltd. The common packaging materials are non-specified items and/or bags. While over half of the respondents didn't face any challenge, some respondents estimated that the transportation fees is very high. The study concludes that Nyabisindu Cell faces other challenges including inefficiency in waste collection, and other environmental impacts. This study recommends the service in charge should work hard to improve waste security, think about waste recycling programs, enhancement of hygiene at deposit sites, increasing of collection frequency, upgrading transportation vehicles, and fostering competition among waste management companies for a better environmental and community health outcomes.

Key Words: Solid Waste, Solid Waste management, Effectiveness.

List of abbreviations

CBOs: Community Based Organizations

CET: Central European Time

GPS: Global Positioning System

MSW: Municipal Solid Waste

PSSP: Purpose, Structure, State and Performance

SWM: Solid Waste Management

UNDP: United Nations Development Program

USEPA: United States Environmental Protection Agency.

UR : University of Rwanda

SPSS : Statistical Package for the Social Sciences

Table of Contents

List of Tables

List of Figures

Chapter One: Introduction

1.1. Background Information

Waste generation has increased massively around the world in recent decades, and there are no signs of it slowing down. More than two billion metric tons of municipal solid waste (MSW) are generated worldwide every year, and this figure is expected to increase by roughly 70 percent by 2050. With such immense volumes of waste arising, the need for authorities to provide adequate waste treatment and disposal services has become ever more important (Alves, 2023).Solid waste management is a term that is used to refer to the process of collecting and treating solid wastes. It also offers solutions for recycling items that do not belong to garbage or trash. As long as people have been living in settlements and residential areas, garbage or solid waste has been an issue. Waste management is all about how solid waste can be changed and used as a valuable resource (Spelch, 2016). Solid waste management should be embraced by each and every household including the business owners across the world (NJOGU, 2018).

One of the big challenges that today's growing cities are coping with is the delivery of effective and sustainable waste management, together with a good sanitation. Solid waste management (SWM) continues to dominate as a major societal and governance challenge, especially in urban areas overwhelmed by the high rate of population growth and garbage generation. The role of SWM in achieving sustainable development is emphasized in several international development agendas, charters, and visions. For example, sustainable SWM can help meet several United Nations' Sustainable Development Goals (Medecine, 2022).

Rwanda is expected to have generated huge volume of solid waste, as its information and communication technology infrastructure has grown significantly in the past and is expected to grow exponentially in the future. Between November 2014 and January 2015, a survey was carried out to know the status of e-waste in Rwanda (Isugi & Niu, 2016). Other types of solid waste found were plastics (4%), paper (3%), cartons (3%), glasses (2%), metal (1%), biodegradable organic wastes (75%), others (clothes, shoes, bones, hair, pampers) (14%). The organic waste was found to be more generated with 500.000 kg and 73% fractions of entire municipal solids waste in Kigali city (Nikuze, 2021).

Rwanda is no exception specifically in Kigali city where urban population growth and economic development lead to the increase of MSW generation. This growth has also increased the use of products that generate hazardous waste which contribute to the pollution and public health hazards in some localities (Kabera, 2020). As part of the decentralization process, local authorities are responsible for domestic solid waste management. Improvements in solid waste management have occurred since 2005, with the introduction of municipal by-laws prohibiting the dumping of household waste outside individual private property (Isugi & Niu, 2016). In accordance with the National Sanitation Policy Implementation Strategy, currently, the solid waste has been managed by municipality entities. These entities have limited technical and financial capacity and there is no specific strategy on approaching SWM systematically. This results in waste continuing to be managed in an ad hoc manner in most parts of the country (MININFRA, 2022).

Therefore, this study aims to identify the types of waste, assess the effectiveness of solid waste management practices, uncover the root causes of inefficiencies, and propose innovative solutions to improve solid waste management in Kigali city, specifically in Gasabo District, Remera Sector, and Nyabisindu cell. This research rationale underscores the importance of understanding the dynamics of waste management in urban settings and the necessity for sustainable solutions to address the challenges faced by rapidly growing cities like Kigali.

1.2. Problem statement

The generation of solid waste is the inevitable consequence of all processes where materials are used. Consumption, and waste management all generate waste (Yoshida & Agency, 2018). The rate of material use today is so large, with regard to the total amounts (and seen as a per capita average), that the waste generated will impact on the environmental quality and human health worldwide if it is not managed properly (Isugi & Niu, 2016).

Rwandan cities are growing day by day. Due to the population growth and the improvement of standards of life, there is a growing concern associated with waste generation (Ngwijabagabo et al., 2020). Some efforts were made to handle the urban waste, but there are still some weaknesses related to the selection of suitable sites for waste disposal. In this regards, waste disposal facilities remain inadequate in resettlements (imidugudu) in small towns and cities throughout Rwanda. In

urban areas, the local administration usually manages solid waste collection and disposes waste in open dumpsites (RUGIRAMANZI, 2013).

The challenge of solid waste management and litter in urban water bodies is still an issue of concern. One of the issues that the community and city managers face in Kigali is the presence of waste especially in terms of infrastructure and facilities. Government and public waste awareness must be raised so that Rwanda can be free of waste (Fidele Iraguha, 2022). In some instances, the local administration or a private contractor is responsible for waste collection in commercial areas, but also in residential areas when there is no CBOs, associations or private companies involved.

The collected waste is directly transported to dump sites in vehicles (RWANDA, 2015). Without waste sorting out at the household level any other system must involve machines (Manirakiza et al., 2019). Although Rwanda has a reputation for being the cleanest country in the region solid waste management and litter in urban water bodies is still an issue of concern (GGGI, 2015). This was strongly linked to the inefficiency of solid waste removal services in many areas, especially in informal settlements and slums located in urban areas. Considering these challenges, there is an urgent need to assess the efficacy of existing solid waste management strategies in Gasabo District, Remera Sector, Nyabisindu Cell. Understanding the systemic barriers, socio-economic factors, and environmental implications is essential to formulate evidence-based interventions that promote responsible waste management practices, enhance community engagement, and safeguard public health and the environment (Oteng-Ababio et al., 2018). Addressing these issues requires a multifaceted approach that integrates policy reforms, infrastructure development, community outreach, and stakeholder collaboration. Therefore, this study serves as a contribution by identifying the root causes of inefficiencies and development of innovative solutions, in the way to assist a more sustainable and resilient solid waste management system that aligns with the goals of environmental sustainability and urban development in Kigali City.

1. 3. Research Objectives

The main objective of this research is to analyze Solid Waste Management in Kigali City, Gasabo District, Remera Sector, and Nyabisindu Cell.

Specific objectives

The specific objectives are:

1. To identify the types of Solid Waste generated;
2. To investigate the effectiveness of the process of solid waste management;
3. To propose measures to improve the management of solid waste.

Our research is based on the following questions:

1. What are the types of Solid Waste generated?
2. To which extent is the solid waste management effective?
3. What are the measures to improve the management of solid waste?

Chapter 2: Literature review

2.1. Introduction

This chapter explores the literature surrounding solid waste management (SWM), a critical issue affecting both urban and rural environments. The aim is to provide a comprehensive overview of key concepts, current practices, and strategies for improvement. The chapter is divided into three primary sections: an introduction to essential terminologies and concepts, an examination of the current state of solid waste generation and management, and a discussion on measures to enhance waste management practices.

The introduction sets the stage by defining key terms and concepts related to waste and waste management. It establishes the foundation for understanding the complexity of solid waste management, including the various types of waste and the different approaches to handling them (Mugambwa, 2009). This section also outlines the scope of the review, highlighting the importance of effective waste management for environmental sustainability and public health (Sampath, 2017).

Following the introduction, the chapter delves into the current state of solid waste management, addressing the challenges faced by different regions and the variations in waste management practices (Heliyon, 2022). This includes a detailed examination of waste generation rates, the impact of socioeconomic factors, and the effectiveness of existing waste management systems. The final section of the chapter focuses on strategies for improving waste management, offering insights into best practices, technological advancements, and policy recommendations (Soysa, 2022).

2.2. Key Concepts and Terminologies

In this subsection, the concepts of interest are: Waste, Solid Waste and Solid waste management.

2.2.1. Waste

Waste refers to materials that are discarded after their primary use or deemed unusable. It includes substances that are considered worthless, defective, or surplus (Plumer, 2019). Waste can be categorized into various types, including municipal solid waste, industrial waste, and hazardous waste (Mugambwa, 2009). The definition of waste is broad and can encompass a range of

materials, from household garbage to industrial by-products. Understanding the nature of waste is crucial for developing effective waste management strategies, as it influences how materials are collected, processed, and disposed of (Gatoni, 2019).

The characterization of waste also involves distinguishing between waste products and by-products. By-products are secondary products generated during the manufacturing process, often with minor economic value. In contrast, waste products are typically considered unwanted or surplus materials that require disposal (Dvorak, 2009). Innovations in waste management can sometimes transform waste products into valuable resources, thereby improving their economic and environmental value (Wikipedia, 2020). This transformation is an essential aspect of modern waste management practices.

Effective waste management requires a thorough understanding of waste characteristics, including its composition and volume. This information helps in designing appropriate waste management systems and policies. It also aids in identifying opportunities for waste reduction, recycling, and resource recovery (Fidele, 2022). By comprehensively analyzing waste characteristics, policymakers and waste managers can develop targeted strategies to minimize waste generation and enhance waste processing efficiency.

2.2.2. Waste Management

the context of the waste source, to arrive at an appropriate management method (Samwine, 2017). Waste management encompasses a range of activities involved in handling waste materials, including collection, transportation, processing, recycling, and disposal (Mugambwa, 2009). These activities are crucial for managing waste in a manner that minimizes its impact on the environment and public health. Waste management practices vary widely between developed and developing countries, urban and rural areas, and residential and industrial settings (Samwine, 2017). These variations are influenced by factors such as waste composition, volume, and local infrastructure.

In developed countries, advanced waste management systems often include comprehensive recycling programs, waste-to-energy technologies, and strict regulations (Sampath, 2017). In contrast, many developing countries face challenges such as inadequate infrastructure, limited resources, and informal waste management practices (Heliyon, 2022). These differences highlight the need for context-specific waste management solutions that address the unique needs and

constraints of each region. Effective waste management requires a nuanced understanding of local conditions and challenges (Soysa, 2022).

Moreover, waste management practices are continually evolving in response to changing waste generation patterns and technological advancements. Innovations in waste processing and recycling technologies, as well as shifts in regulatory frameworks, contribute to improvements in waste management efficiency (Fidele, 2022). Staying abreast of these developments is essential for implementing effective waste management strategies that align with current best practices and address emerging challenges.

2.2.3. Solid waste management

Solid waste management refers to the systematic process of collecting, processing, recycling, and disposing of solid waste. It involves various strategies and techniques aimed at reducing waste generation, minimizing environmental impact, and recovering valuable resources (Dvorak, 2009). Solid waste management has evolved significantly over time, driven by changes in industrialization, urbanization, and public awareness (Sampath, 2017).

Historically, solid waste management was primarily focused on waste disposal, often through open dumping or landfilling (Mugambwa, 2009). However, modern waste management practices emphasize the importance of waste reduction, recycling, and resource recovery (Sampath, 2017). Advances in technology and increased awareness of environmental issues have led to more sustainable waste management practices. For example, recycling programs and waste-to-energy technologies have become integral components of contemporary waste management systems (Gatoni, 2019).

Effective solid waste management requires active participation from households, businesses, and governments. Public education and engagement are crucial for promoting responsible waste disposal practices and encouraging recycling (Soysa, 2022). Additionally, governments play a vital role in enforcing waste management regulations and supporting infrastructure development (Plumer, 2019). By fostering collaboration among various stakeholders, solid waste management systems can be optimized to achieve environmental and economic benefits.

2.3. Situation of solid waste generated

Managing solid waste is a challenging task all over the world and the major reason behind it is the lack of social awareness, responsibilities together with a lack of novel solutions. Globally, it is

noted that the waste generation rate increase with increasing income in other terms global urbanization paves the way for more waste generation (Heliyon, 2022). Socioeconomic development, urbanization, an uncontrollable massive population rate, and improved urban living standards increase the amount and complexity of solid waste generated. If it accumulates, it degrades the urban environment, affects natural resources, and causes health problems [1]. Solid waste management is becoming an environmental and public health concern in many countries (Fidele, 2022). Solid waste management is the one thing just about every city government provides for its residents. While service levels, environmental impacts and costs vary dramatically, solid waste management is arguably the most important municipal service and serves as a prerequisite for other municipal action (Perinaz, 2012). As you will see in this report, the world is on a trajectory where waste generation will drastically outpace population growth by more than double by 2050. Although we are seeing improvements and innovations in solid waste management globally, it is a complex issue and one that we need to take urgent action on. Solid waste management affects everyone; however, those most affected by the negative impacts of poorly managed waste are largely societies most vulnerable—losing their lives and homes from landslides of waste dumps, working in unsafe waste-picking conditions, and suffering profound health repercussions (Kaza Silpa, 2018). Knowledge in the waste generation and composition of solid waste could be considered crucial in planning and formulating continuous monitoring strategies. Dikole and Letshwenyo have examined the waste generation rate, composition and characteristics of solid waste generated in Botswana according to the income level of the households. It was revealed that the waste generation rate in low-income families' increases on the weekdays, and the rate decreases in the middle and higher-income homes on the weekdays (Soysa, 2022).

2.4. Understand the process of solid waste collection and disposal

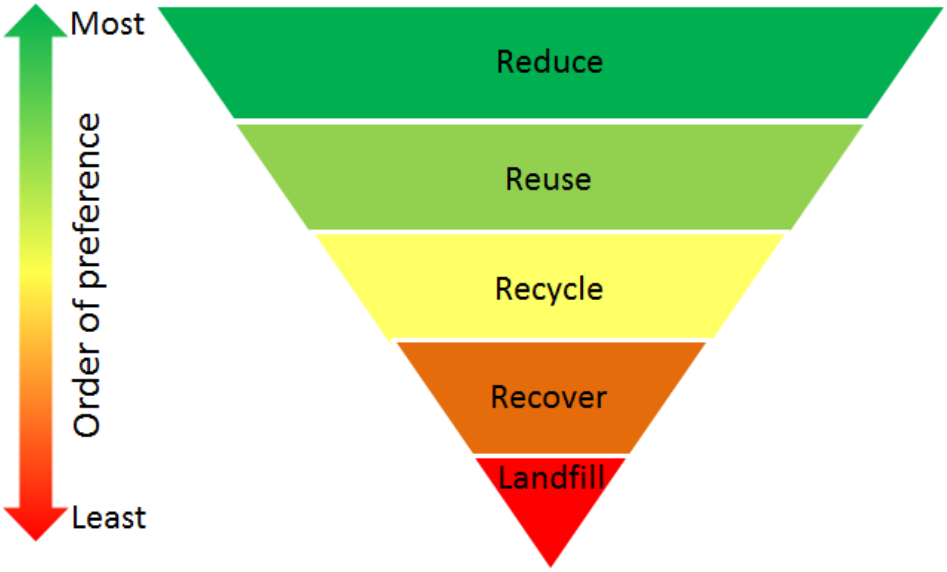
The management of waste consists of careful planning, collection, treatment (when required), and disposal. It, in addition involves, collecting reliable and valid data relating to the amount of waste generated, the factors that influence the volume of waste generated, and the predictions for future waste generation. This means that adequate waste disposal and management system is now a key driver in achieving sustainable development goals (SDGs), particularly in making cities safe, resilient, and sustainable (Titus, 2022). The disposal of waste is now largely the domain of sanitarians and public health engineers, though health professionals need to have a basic

knowledge of the subject since improper disposal of waste is a health hazard. On account of increasing populations and the changing consumption patterns of commodities, there has been a substantial increase in the generation of solid waste, both in absolute terms and in terms of per capita generation (Dwivedi, 2023). Direct impacts of waste represent a significant but comparatively small share of climate change, while resource depletion among similar effects is linked to indirect environmental impacts. This is mainly because indirect results of wastes are linked with the extraction and processing of different resources to produce different types of products while focusing on the output rather than the input in many industries. This shows how indirect impacts of incorrect management of waste can be more devastating and present the highest potential compared to its counterpart (Mubaslat, 2021). The 1994 guidance document supported regional districts in developing solid waste management plans for their region. The recommended process for developing plans for the most part remains the same, including establishing advisory committees, setting regional targets, reviewing the existing waste management system and identifying strategy options. Annual reporting and five-year effectiveness reviews are still recommended. Legislative requirements for public review and consultation on the development, amendment and final content of a plan remain the same (Environment, 2014). The term usually relates to materials produced by human activity, and the process in generally undertaken to reduce their effect on health, the environment or aesthetics. Waste management is a distinct practice from resource recovery which focuses on delaying the rate of consumption of natural resources. Resource recovery is the selective extraction of disposed materials for a specific next use, such as recycling, composting or energy generation. The aim of the resource recovery is to extract the maximum practical benefits from products, delay the consumption of virgin natural resources, and to generate the minimum amount of waste. Resource recovery differs from the management of waste by using life cycle analysis to offer alternatives to landfill disposal of discarded materials

2.4.1. The waste management hierarchy

The waste management hierarchy is a generally accepted guiding principle for prioritizing waste management practices to achieve minimum adverse environmental and health impacts from wastes. The waste management hierarchy in Figure 1 shows the preferred order of waste management practice, from most to least preferred. Source reduce, Recover, reuse, landfill and recycling are the best options for environment while landfilling is the least favored practice(Figure1)(Gatoni, 2019).

Figure1: Waste Management Hierarchy



Source: https://axil-is.com/blogs-articles/waste-management-hierarchy/

Reduce: Buy products that don't have too much packaging. Some products are wrapped in many layers of plastic and paperboard even though they don't need to be. You can also look for things that are packed in materials that don't require a lot of energy or resources to produce. Some products will put that information right on their labels (Gatoni, 2019).

Recycle: Many of the things we use every day, like paper bags, soda cans, and milk cartons, are made out of materials that can be recycled. In some towns you can leave your recyclables in bins outside your home, and a truck will come and collect them regularly. Other towns have recycling centers where you can drop off the materials you've collected. (Gatoni, 2019).

Recover: After collection, the residual waste is disposed of (either through landfill or incineration), the recyclables are remanufactured and/or energy is recovered (if energy is recovered from waste it is classified as recovery rather than disposal). To recover is a new technology that prepares and treats waste materials in order to generate energy. The energy produced by this special method is used as power. Energy can be recovered from waste either by direct waste incineration (typically mass burn incineration plants, taking unsorted waste) or by using waste as a fuel substitute (either directly or as a "refuse derived fuel"). (Dvorak, 2009).

Reuse: Bring cloth sacks to the store with you instead of taking home new paper or plastic bags. You can use these sacks again and again. You'll be saving some trees! Plastic containers and reusable lunch bags are great ways to take your lunch to school without creating waste.(Plumer, 2019).

2.4.2. An integrated strategy to waste management

The United States Environmental Protection Agency (USEPA) outlines and explains three main components in an integrated municipal waste management strategy- that is; waste prevention, recycling including composting and, combustion. In a review of these components, USEPA, categorically introduces and defines five main activities (in a hierarchy) classified under integrated waste management (waste prevention, recycling, composting, combustion and landfilling), and the similarity is noticeable between the former components and the later activities classified (Ferronato, 2019).

The importance of adequate access to solid waste management (SWM) services, one of the key components of sanitation, as a driver for moving towards a modern Rwandan household, is fully acknowledged in the National Development Agenda. By 2024, waste management systems will be developed in cities, towns and rural areas with key investments in the construction of modern landfills and improved waste treatment facilities (Government of Rwanda, 2017). Improved waste management services is regarded as a major driver of improved public health, better environmental management, and a key measure of improved quality of life for all Rwandans (Republic of Rwanda, 2022) . The Making Waste Matter: Integrated Waste Management Strategy implemented in 2015 outlined where Waste Management in Kawartha Lakes was at that time and provided clear short-term and long-term initiatives for waste management services into the future (until 2048). The Strategy stated that it would be critical to regularly review, update, and expand the document due to frequent and significant changes in waste management practices, legislation, and waste quantities in the municipality. Based on the frequency of these changes it has been determined that an update of the Strategy will occur every five years (Lakes, 2020). The world generates 2.01 billion t of municipal solid waste (MSW) annually, of which at least 33% is not managed in an environmentally safe manner. Global waste is expected to grow to 3.40 billion t by 2050. All regions worldwide generate approximately 50% or more of organic waste on average, except for Europe, Central Asia, and North America,which generate higher portions of dry waste Consequently, solid waste management is a priority of governments worldwide. The Latin

American and Caribbean (LAC) region where Mexico is located generated 231 million metric t of waste in 2016, which represents a daily per capita generation of 0.99 kg (Gerardo Bernache-Pérez 1, 2023)

2.4. 3. How the strategy of Solid waste management works

The public seems to be leaving the burden of solid waste (which they generate) to the administrative units/authorities. There is little and in some instances no indication of public concern in containing the problem and yet closer involvement/participation by the public is very important if solid waste is to be well managed (KALOKI, 2015).

The Waste Management Hierarchy is a model for sustainable waste management that aim firstly at the Reduction of waste, which is by far the most effective way to reduce waste. Secondly it encourages Reuse, repair and refurbishing of some material instead of forwarding them to a landfill. Thirdly, it encourages Recycling of waste into useful materials: "What is considered as a waste by some can be a raw material to others!" And the forth R stands for Recovery converting waste material into useable heat, electricity or fuel; for example, converting biomass waste into briquettes for cooking. The solid waste management challenge is therefore world-wide albeit at different levels in the different parts of the world (RDIS, 2018).

2.5. Measures to improve the management of solid waste management

Rwanda is facing significant challenges in relation to solid waste management; a sizeable portion of it is disposed on improper location and operated dumpsites, resulting in adverse impacts on environment and health. The country has a backlog in waste legislation enforcement as well as in coordination and promotion of existing efforts to recycle and dispose waste properly (Akimanizanye, 2020)

Currently, waste is managed under the supervision of the Ministry of Local Government, with the participation of private companies which are only in charge of waste collection. The implementation of waste management policy is carried out by a government-owned company called Water and Sanitation Corporation (WASAC) Ltd. The per capita solid waste generation rate in the city of Kigali is equal to 0.57 kg/person/day. A lot of legislations and regulations on WM are in place but their enforcement is weak. The Government of Rwanda should do more in terms of enforcing WM legislations and regulations (UNEP, 2019).

2.6. Waste Management Policy in Rwanda

Waste management in Rwanda is governed by a series of policies and strategies designed to address the challenges of solid waste generation and ensure sustainable practices across the country. These policies reflect Rwanda's commitment to improving public health, environmental sustainability, and overall quality of life through effective waste management practices.

2.6.1. National Framework and Policy Documents

Rwanda’s approach to waste management is guided by several key national policies and frameworks. The National Policy for the Environment and its accompanying strategies provide the overarching guidelines for environmental management, including waste management. The policy emphasizes the importance of minimizing waste generation, promoting recycling, and ensuring safe waste disposal practices (RWANDA, 2017). It also outlines the roles and responsibilities of various stakeholders, including government agencies, private sector actors, and the general public, in achieving the country's waste management goals.

One of the significant policy documents is the Rwanda National Waste Management Strategy, which aims to create a comprehensive waste management system that addresses both urban and rural needs. This strategy outlines specific objectives, such as reducing waste generation at the source, enhancing waste collection and recycling infrastructure, and improving public awareness and participation in waste management efforts (NIS, 2018). The strategy also sets targets for waste reduction and recycling rates, reflecting Rwanda's commitment to achieving sustainable waste management.

2.6.2. Decentralized Waste Management and District-Level Oversight

At the decentralized level, waste management responsibilities are shared among district authorities, local government bodies, and community-based organizations. District authorities play a crucial role in overseeing waste management activities within their jurisdictions. They are responsible for implementing waste management policies, coordinating with various stakeholders, and ensuring that waste management practices align with national guidelines (RWANDA, 2017).

District Plans for Elimination of Malnutrition (DPEM) serve as one of the key documents guiding district-level investments and service delivery modalities. While primarily focused on addressing malnutrition, these plans also impact waste management practices, particularly in relation to medical waste generated by health facilities. The DPEM outlines strategies for improving health services and infrastructure, which can lead to increased waste generation, particularly medical waste. To address this, districts are encouraged to develop and implement waste management plans that accommodate the additional waste streams resulting from enhanced health services (RWANDA, 2017).

2.6.3. Medical Waste Management and Health Facility Support

The management of medical waste is a critical aspect of Rwanda's waste management policy, particularly given the country's focus on improving healthcare services. The policy specifies that 7 health facilities in targeted districts will receive support to enhance access to and quality of health services. This increased support is expected to result in a higher volume of medical waste generated (RWANDA, 2017).

To manage this increased waste, the policy emphasizes the need for proper waste segregation, treatment, and disposal practices. Medical waste must be handled with special care to prevent contamination and ensure public safety. This involves using dedicated waste collection and storage facilities, implementing sterilization or incineration processes, and ensuring compliance with health and safety regulations (Gikundiro, 2021). Additionally, training and capacity-building initiatives are critical to equipping health facility staff with the necessary skills and knowledge for effective medical waste management (NISR, 2022).

2.6.4. Challenges and Opportunities

Despite the progress made in waste management policy and implementation, several challenges persist. Issues such as inadequate infrastructure, limited financial resources, and gaps in enforcement can hinder the effectiveness of waste management practices at the local level (Mubaslat, 2021). Furthermore, the growing volume of waste, particularly medical waste from improved healthcare services, requires continuous adaptation and investment in waste management systems.

Opportunities for improvement include leveraging technological advancements, enhancing community engagement, and strengthening partnerships between government agencies, private sector actors, and international organizations. For example, innovations in waste recycling technologies and waste-to-energy solutions can help manage increasing waste volumes and reduce environmental impact (Soysa, 2022). Additionally, increasing public awareness and participation in waste management initiatives can lead to more sustainable practices and better overall outcomes (Gatoni, 2019).

2.6.5. Future Directions

Looking ahead, Rwanda's waste management policy will need to adapt to evolving challenges and opportunities. Continued investment in waste management infrastructure, coupled with effective enforcement of regulations, will be crucial for achieving the country's waste management goals. Additionally, integrating waste management into broader environmental and public health strategies will help ensure a holistic approach to managing waste and promoting sustainability (Plumer, 2019).

Future policies should also address emerging issues such as electronic waste and plastic pollution, which require targeted strategies and innovative solutions. By maintaining a proactive and adaptive approach to waste management, Rwanda can continue to make strides toward a more sustainable and resilient waste management system.

2.7. Global Perspectives on Solid Waste Management

Solid waste management is a critical challenge faced by cities and countries worldwide. Different regions adopt various approaches to manage waste effectively, influenced by their unique socio-economic conditions, technological capabilities, and regulatory frameworks. This section provides an overview of solid waste management practices in different parts of the world, highlighting successful strategies and lessons learned from various studies.

2.7.1. Advanced Waste Management Practices in Developed Countries

In many developed countries, solid waste management is characterized by advanced technologies and comprehensive policies. For instance, the European Union (EU) has implemented rigorous

waste management directives aimed at reducing waste generation and promoting recycling. The EU Waste Framework Directive mandates member states to establish waste management plans that prioritize waste prevention, recycling, and recovery (European Commission, 2018). The directive also introduces the concept of the "circular economy," which aims to keep resources in use for as long as possible through recycling, reusing, and repairing (Geissdoerfer et al., 2017).

In Germany, a leader in waste management, the "Green Dot" system requires producers to take responsibility for the packaging waste they generate. This system has significantly increased recycling rates and reduced landfill use (Giegrich et al., 2020). The country also employs advanced waste-to-energy technologies, converting non-recyclable waste into energy, thus reducing landfill dependency and generating renewable energy (Kopp et al., 2021).

2.7.2. Innovations and Strategies in Developing Countries

Developing countries face different challenges in waste management, often characterized by rapid urbanization, limited infrastructure, and financial constraints. In Asia, countries like Japan and South Korea have adopted innovative waste management strategies. Japan's "Sound Material-Cycle Society" policy emphasizes waste minimization, recycling, and the use of waste as a resource. Japan has achieved high recycling rates and effective waste segregation through public awareness campaigns and stringent regulations (Tanaka, 2020).

South Korea's waste management system, known for its Pay-As-You-Throw (PAYT) policy, charges residents based on the amount of waste they generate. This approach has led to a significant reduction in waste generation and increased recycling rates (Kim et al., 2018). Additionally, South Korea has invested in advanced waste-to-energy technologies to handle residual waste efficiently (Kang et al., 2021).

2.7.3. Case Studies from Latin America and Africa

In Latin America, cities like Curitiba, Brazil, have been recognized for their innovative waste management approaches. Curitiba's "Garbage that is not Garbage" program promotes recycling by encouraging residents to exchange recyclable materials for food and other benefits. This

initiative has successfully increased recycling rates and raised public awareness about waste management (Rabinovitch & Leitmann, 1996).

In Africa, several countries are implementing strategies to tackle waste management challenges. For example, Kigali, Rwanda, has introduced a comprehensive waste management system that includes waste segregation, recycling, and composting. The city's waste management program aims to reduce landfill use and promote sustainable practices (Kagire, 2019). Additionally, in Kenya, the Nairobi City Council has partnered with private companies to improve waste collection and recycling services, demonstrating the potential of public-private partnerships in addressing waste management issues (Oduor & Karanja, 2021).

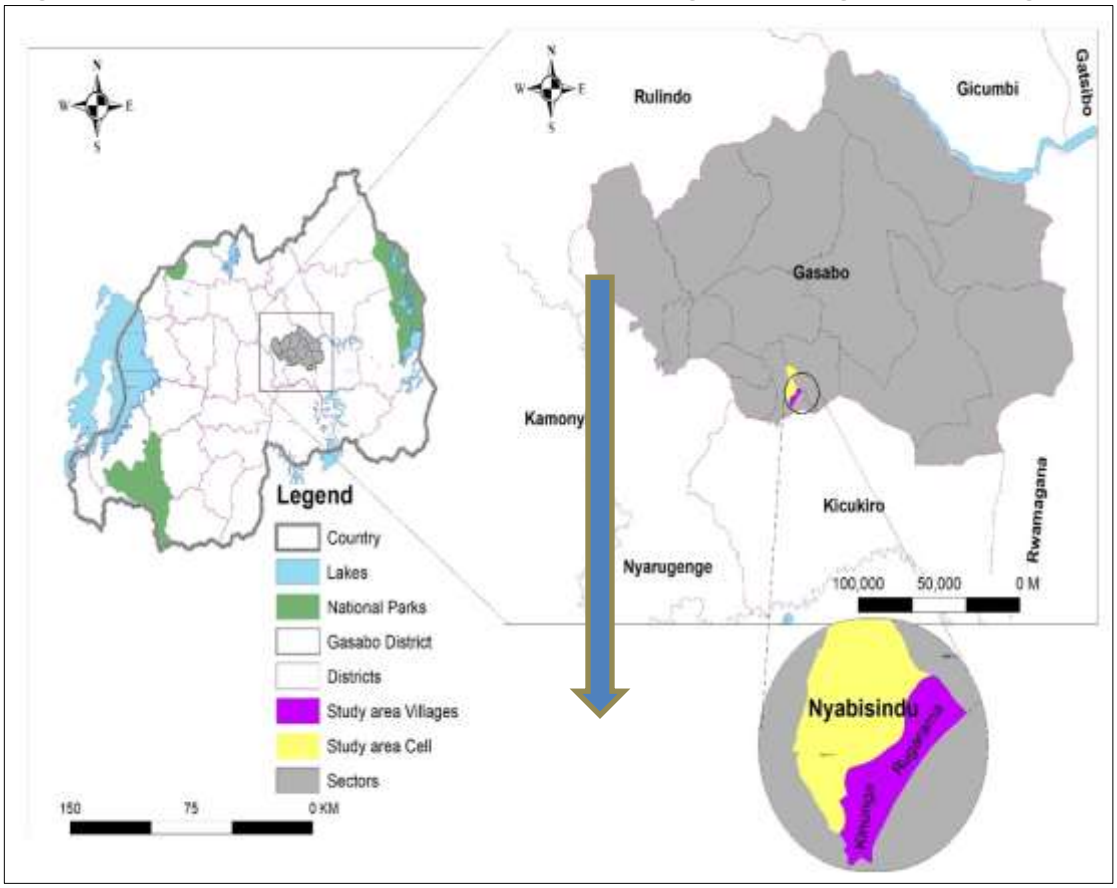
Chapter 3: Research Methodology

In our research we used different methods, tools and techniques to collect relevant information and achieve study objectives. These include the reading of literature, the questionnaire survey and field observations.

3. 1. Presentation of the study area

This research was conducted in Remera Sector. Remera Sector is one of 16 sectors which compose Gasabo District. In this sector we found Nyabisindu Cell where we focus on two villages, Rugarama and Kinunga.

Figure2: Administrative Boundaries of Kinunga and Rugarama villages



Source: Data from NISR, 2012

The Figure 2 shows the map of the administrative boundary of Gasabo district, Remera Sector, Nyabisindu Cell and Kinunga and Rugarama villages.

3.2. Study area delineation

The study, conducted in Nyabisindu Cell from 2019 to 2024, comprehensively examined trends and changes in solid waste management practices. By focusing on Rugarama and Kinunga villages, the study provided a detailed analysis of solid waste generation patterns, recognizing the variability in waste production due to the distinct economic, social, and cultural activities in each village. This extended timeframe allowed for a nuanced understanding of the factors influencing waste generation, collection and disposal.

3.3. Secondary data collection

In secondary data collection the literature review helped us to get information from published materials including books, reports, and journals. The documents were consulted in libraries or online. I visited UR library at the College of Science and Technology for the collection of information from different documents including thesis and memoires. I also exploited policy documents to check the regulations related to waste management. In addition to literature review, I used maps to understand the spatial distribution of waste in the study area.

3. 4. Primary data collection

The primary data was collected using different tools including survey questionnaire, interview and field observations. The survey was conducted among the population living in the proximity of Remera Sector, Nyabisindu Cell as well as among the authority at grassroots level.

The questionnaire survey developed had both open and closed questions.

- ✓ The open questions were used in order to have more detail information concerning the situation of solid waste generated and collected.
- ✓ The close and open questions were used to obtain direct quantitative data

3. 5. Sample size

In determining sample size, Taro Yamane formula (1985) was used: **n=N/1+N* (e)2**

n is sample size

N is the population size Rugarama and Kinunga Villages **(**households)

e is level of precision or sample error and e is estimated to be 10%.

Sample size for Rugarama Village

n=375/1+375*(0.1)2, **n=375/4.75=79**

The sample size is 79 households for Rugarama village. Respondents will be identified randomly from Nyabisindu Cell.

Sample size for Kinunga Village

n=387/1+387*(10/100)2=80

The sample size is 80 households for Kinunga village. Respondents will be identified randomly

Total Households for Questionnaire survey: 80+79=159 households

3. 6. Sampling methods

We used a random sampling method strategy. The inclusion criteria were to be over 18 years old, while the exclusion criteria were to be under 18 years of age.

3. 7. Observations

The field observations were made in order to examine how the situation on the field is. It is necessary to record data related to solid waste generated and collected in households of Kigali City and deposited to Nduba using different tools including GPS (Global Position System). Solid waste collection. Photos were taken using the digital cameras.

3.8. Data processing

Data collected from questionnaires was coded, tabulated, processed manually and edited.

3.9. Data analysis

We used Microsoft office word, Microsoft office excel and SPSS during data processing and analysis. The standard checking through editing, coding and tabulation will be used to provide the more justifications to arrive to worthwhile conclusion.

Chapter 4: Findings and Discussions

4.1. Introduction

In this part, we will present and analyze results based on primary data collection from the field where we used questionnaire survey, observations and interview. The analysis of quantitative data in this chapter will be conducted. A conclusion and recommendations will be formulated based on the findings.

4.2. Categories of respondents

Under the category of respondents, I present the occupation and level of education of the respondent

4 .2.1. Occupation of respondents

The survey done show that in Nyabisindu cell, the population has different occupations and generate different types of solid waste in line with the spending capacity.

Table 1: Occupation of respondents in Nyabisindu Cell

Occupation	Rugarama Village	Percentage (%)	Kinunga Village	Percentage (%)	Total	Total (%)
Private sector	33	41.7	19	23.7	52	32.7
Household keeper	20	25.3	31	38.7	51	32
Student	9	11.3	15	18.7	24	15
Retired	2	2.5	4	5	6	3.7
Jobless	15	18.9	5	6.2	20	12.5
Public administration	0	0	6	7.5	6	3.7
Total	79	99.7	80	99.8	159	99.6

Source: Field Survey December 2019

In both villages, respondents working in private Sector or Business present the highest number (32.7 %). This activity is the main source of their household income while respondents working as household keepers represent 32 %; Students represent 15%; Jobless residents 12.5%. Many people sell goods at the market of Nyabisindu. This activity is the main source income in this locality.

4.2.2. Level of education

The level of study help us to know capacity for households in management Solid waste. The majority of respondents representing 42.7% have attended the primary school. The population who finished secondary school represents 35.8%; those with a university degree represents 13.2%. the remaining respondents didn't attend primary school (8.1%). There is in Nyabisindu cell high number of educated population due to the influence of urbanization.

Table 2: Level of education

Level of Education	Rugarama Village	Kinunga Village	Total	Total (%)
None	10	3	13	8.1
Primary	31	37	68	42.7
Secondary	27	30	57	35.8
University	11	10	21	13.2
Total	79	80	159	99.8

Source: Field Survey December 2019

4.3. Situation of solid waste generated

Under this section, I present the types of waste produced by the households (4.3.1.), the. Collection from home (4.3.2.) and the frequency of waste collection (4.3.3.) and mode of transport from households to the landfill of Nduba.

4.3. 1.Type of waste produced at households

In Nyabisindu, it was observed that many household produce Organic waste as One types of waste.

Table 3: Type of waste produced at households

Types of solid waste	RugaramaVillage	Kinunga Village	Total	Percentage (%)
Organic waste	79	80	159	100
Plastic	0	0	0	0
Electronic waste	0	0	0	0
Metal	0	0	0	0
Total	**79**	80	159	100

Source: Field survey of 30th September 2019

4. 3. 2. Collection of solid waste from home

Every week in Nyabisindu Cell, solid waste is brought to the landfill site located in Nduba by track of CESCO ltd in collaboration with local authorities. Baskets are used for collection from home and deposition on roadside near households. Waste collection is done by the manpower that travel with the vehicle.

Figure 3: Solid waste transportation track

Source: Field survey on 22 February 2024

This lorry is the one transporting solid waste collected through households using bags. In the first place the waste is taken from households and deposed near the road in the nearby for collection. Later, the waste is put into the vehicle and transported up to Nduba dumping site by track from CESCO LTD.

Figure 4: Nduba Landfill

Source: Picture taken by Kigali City on 2019

Figure 4 shows solid waste deposited at Nduba land fill after transportation. It can be observed that the landfill is open and the local environment is exposed to different forms of pollution due to lack of proper management of waste.

4.3.3. Frequency of Solid waste collection and transportation

Solid waste is collected from households of both villages once per week and the table 5 indicates the tools used for packaging solid waste.

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Table 4: Packaging of solid waste

Means of packaging of solid waste	Rugarama Village	Kinunga Village	Total	Percentage (%)
Waste Basket	1	2	3	1.8
Carton	1	1	2	1.2
Old Basket	0	0	0	0
Sac	46	15	61	38.3
Other means of packaging	31	62	93	58,4
Total	**79**	**80**	**159**	**99.7**

Source: Field Survey of December 2019

Table 5 presents different means of packaging of solid waste by households prior to packing vehicles and transportation to Nduba Landfill. Different material non specified are used by most of respondents for packaging waste (58.4 %). in the second place, there are respondents representing 38.3 % who affirm using bags. Few respondents (1.8 %) use waste basket while 1.2 % use cartons.

Figure5: Solid waste in bags

Source: Picture taken by author on 22nd February 2024

4. 4. Use of solid waste collected

4.4.1. Recycling or deposit

In Nyabisindu Cell Solid waste collected it is brought for deposition at the Dumping Site of Nduba rather than recycling and Reuse.

Table 5: Types of use of solid waste

Types of use of solid waste	Rugarama	Kinunga Village	Total	Total (%)
Recycling and Reuse	6	8	14	8.8
Deposit	73	72	145	91.1
Total	79	80	159	99.9

Source: Field Survey of December 2019

Solid waste of households of Rugarama and Kinunga village is brought to the landfill of Nduba by Cesco ltd with 91% of Deposit and other are recycled and reused with 8.6%.

4. 4.2. Distance to Dumping site

There is a long distance between household to solid waste dumping site of Nduba. Solid Waste from the households is collected every Thursday. The distance Cesco LTD use to transport solid waste to Nduba Landfill is estimated to 15 Kilometers for reaching Landfill.

Figure 6: Distance to Dumping site

Source: Data from NISR 2012

4.4.3. Challenges in solid waste management

There are various challenges faced in solid waste management as our survey results indicate. Many households in Nyabisindu cell have challenges.

Table 6: Challenges in solid waste management

Challenges in solid waste management	Rugarama Village	Kinunga Village	Total	Total (%)
Household without challenge	40	50	89	55.97
Increasing fees for transportation to dumping site	14	2	16	10.06
Poor services by the company responsible for waste collection	9	7	16	10.06
Package of transportation	10	14	24	15.09
Limited Time for transportation	5	4	9	10.89
They don't pick more than 25kg	1	3	4	2.51

Source: Field Survey of December 2019

A high number of respondents affirms not facing any challenges (55.97 %). in terms of those facing challenges, some respondents said that they have to deal with high fee for transportation of waste (10.06 % of respondents), limited time for transportation 10.89%, Poor services (10.06%), limited quantify of waste taken not exceeding 25kg as mentioned by 2.51% of respondents, Package of transportation 16.35%. This is the reason why Rugarama and Kinunga Village have issues in solid waste management

4. 5. Measures to improve the management of solid waste

4. 5. 1. Improvement of solid waste management

The survey results from households in Nyabisindu Cell highlight several key areas for improvement in solid waste management. These suggestions, if implemented, could significantly enhance the efficiency and effectiveness of waste management in the area:

1. **Ensuring the Security of Waste Near Residential Areas**: Addressing the issue of people disseminating waste in search of fertilizers, which can be used in farming. Ensuring proper containment and security can prevent this issue.
2. **Initiating Waste Recycling and Reuse**: Establishing programs for recycling and reusing waste materials can reduce the volume of waste and promote sustainable practices.
3. **Maintaining Hygiene at Waste Deposit Sites**: Ensuring cleanliness and hygiene at waste deposit sites to prevent health hazards and improve the living conditions around these areas.
4. **Training Keepers on Waste Management**: Providing training to individuals responsible for waste management on how to handle waste while waiting for transportation to its final destination. This can improve overall waste handling and reduce mishandling.
5. **Educating Households on Waste Separation**: Training households on how to separate degradable and non-degradable waste can facilitate better waste management and recycling processes.

4.5.2. High cost for the Payment for solid waste removal

The challenge is that some households estimate that the cost paid by household for transportation of solid waste to Nduba Landfill is high and affects households differently depending on socio-economic situation. The cost for waste management is considered as high by some businessmen, household keepers, respondents working in private sector, students, jobless, Retaided and other working in administration. Some of the people affected by the high cost include those selling goods in the market. Generally, those finding waste management cost as very high are classified in third UBUDEHE Category paying about 3000rwf and below. These people have expressed the will to have a reduction of fees.

4. 5. 3. Responsibility of local administration in solid waste management

Respondents to the survey have said that local authorities have responsibility follow up the activities of solid waste management, making sure that companies in charge of transportation of work does the job regularly and professionally. The local authorities takes also the responsibility to address any conflicts between the company and the households. Households receiving the services are also requested to pay regularly on monthly basis.

4. 5. 4. The environmental impact of solid waste management

Solid waste management practices are essential component of environmental management in human settlements. These practices encompass all activities undertaken from the point of waste generation up to the final disposal. Solid waste is seriously spoiling the environmental conditions in households waste deposition area of Kinunga and Rugarama villages and to dumping site of Nduba.

Table 7: The environmental impact of Solid Waste in the study area

The environmental impact	Number of respondents	Total (%)
Diseases	4	2.51
Soil and Air pollution	16	10.06
Bad smell	26	16.35
Soil erosion	1	0.62
Lack of hygiene	3	1.88
Household without Impact	108	67.92

Source: Field survey, December 2019k

Table 7 indicates that most of respondents (67.92 %) are satisfied with the service of waste management and don't find any environmental impacts. On the other hand, there are others

estimating that there are some negative impacts including the generation of bad smells (16.35 %). On the other hand, other respondents say that solid waste is the cause of soil and air pollution (10.06 %); while others think that there is lack of hygiene due to waste generation (1.88 %). The lowest number of respondents think that waste can also cause soil erosion (0.62 %).

4. 5. 5. Proposed measures to improve solid waste management

- **Discussion Between Residents and the Waste Transportation Company**

  Resident Representative:

  "We have been facing significant challenges with the current waste management services. The high cost of waste transportation to the Nduba Landfill is particularly burdensome. Many households, especially those in the third UBUDEHE category, are struggling to afford these fees.

  Transportation Company Representative:

  "We are open to finding solutions. One option could be to negotiate with local authorities to subsidize part of the transportation costs. Additionally, if we can increase the efficiency of our operations, we might be able to reduce expenses.

- **Increase in Collection Frequency**

  Currently, waste is collected once per week. Increasing the number of collection days would prevent waste accumulation, reduce odors, and minimize health hazards. More frequent collection would also alleviate the burden on households, making waste management more efficient and responsive to residents' needs.

- **Improvement of Vehicle Quality**

  Upgrading the quality of vehicles used for waste transportation is essential. Better vehicles would ensure more reliable and efficient collection services, reduce breakdowns and delays, and enhance overall service quality. This improvement would also contribute to safer and more environmentally friendly operations.

- **Introduction of Additional Companies**

  Allowing more waste management companies to operate in the area would foster competition, potentially leading to better services and lower costs. Competition could drive innovation, efficiency, and customer satisfaction, ensuring residents receive the best possible service.

- **Ensuring Waste Security Near Residential Areas**

  Addressing the issue of waste dissemination by individuals searching for fertilizers is crucial. Proper containment and security measures can prevent unauthorized access to waste, ensuring that it remains undisturbed and reducing the risk of health hazards and environmental contamination.

- **Initiating Waste Recycling and Reuse Programs**

  Establishing recycling and reuse initiatives can significantly reduce the volume of waste sent to landfills. These programs would promote sustainable practices, conserve resources, and create economic opportunities through the sale of recycled materials. Educating the community on the benefits of recycling can further enhance participation and success.

- **Maintaining Hygiene at Waste Deposit Sites**

  Ensuring cleanliness and hygiene at waste deposit sites is vital for preventing health hazards and improving living conditions. Regular cleaning, proper waste segregation, and pest control measures can create a safer environment for residents and waste management workers alike.

- **Training Waste Management Keepers**

  Providing training to individuals responsible for waste management on proper handling techniques is essential. This training would cover best practices for waste collection,

storage, and transportation, ensuring that waste is managed efficiently and safely until it reaches its final destination.

- **Educating Households on Waste Separation**

  Training households on how to separate degradable and non-degradable waste is crucial for improving overall waste management. Proper segregation at the source can facilitate recycling efforts, reduce landfill burden, and enhance the effectiveness of waste management practices.

- **Increasing the Workforce in Solid Waste Transportation**

  Hiring more workers for waste transportation services would improve efficiency and speed up collection processes. A larger workforce can handle higher volumes of waste, reduce collection times, and ensure timely and consistent service delivery.

4. 6. Discussion

The findings of the study provide valuable insights into the dynamics of solid waste management within Nyabisindu cell. Through comprehensive primary data collection methods, including questionnaire surveys and interviews, the research delved into the multifaceted nature of waste generation and management practices. The results underscore the diverse occupational landscape within the community, with private sector/business activities and household responsibilities emerging as significant contributors to solid waste generation. This observation aligns with existing literature highlighting the correlation between urbanization, economic activities, and waste generation (Shao et al., 2021). Additionally, the educational profile of the population reveals a substantial proportion with primary and secondary education levels, indicative of the influence of urbanization on educational attainment (UNESCO, 2020; Khan et al., 2018).

Furthermore, the study reveals that municipal solid waste predominates among the types of waste generated, necessitating urgent attention to effective waste management strategies(Hoornweg & Bhada-Tata, 2012). However, challenges in solid waste collection and transportation, such as high fees and inadequate services, pose significant obstacles to efficient waste management practices. These findings corroborate previous studies highlighting the complex interplay of socio-economic

factors, infrastructure limitations, and institutional capacities in shaping solid waste management outcomes (Dladla et al., 2016).

In response to these challenges, the study recommends a multifaceted approach to improve solid waste management, encompassing measures such as revising fee structures, enhancing transportation logistics, and fostering community awareness and participation. These recommendations resonate with global efforts to promote sustainable waste management practices, as articulated in international frameworks such as the Sustainable Development Goals (SDGs) and the New Urban Agenda (United Nations, 2015; Alaloul et al., 2021).

Moreover, the environmental impacts of inadequate waste management, including diseases, pollution, and hygiene issues, underscore the urgent need for holistic and integrated waste management solutions (UNEP, 2019). By advocating for measures such as waste recycling, reuse, and improved waste segregation, the study underscores the importance of adopting a circular economy approach to solid waste management (Ellen MacArthur Foundation, 2019).

In conclusion, this study contributes to existing knowledge with valuable insights into the multifaceted challenges of solid waste management in Nyabisindu cell. By grounding its findings in existing literature, the study not only provides a nuanced understanding of the local context but also contributes to the broader discourse on effective waste management strategies.

Chapter 5: Conclusions and Recommendations

The chapter 5 presents the conclusion and recommendations in consideration of the analysis of data (results and discussion) as we saw above.

5.1. Conclusions

The study's findings illuminate the intricate dynamics surrounding solid waste management in Nyabisindu cell. Through meticulous examination of primary data derived from surveys and interviews, we have unraveled multifaceted aspects of waste generation, collection, and disposal within the community. Our research underscores the diverse occupational landscape prevalent among residents, where private sector/business engagements and household responsibilities emerge as primary drivers of solid waste generation. This diversity reflects the complex socioeconomic fabric of the community, shaped by urbanization and economic activities. Moreover, the educational profile of Nyabisindu residents mirrors the transformative effects of urbanization, with a notable portion having achieved primary and secondary education levels. This educational attainment not only reflects broader access to educational opportunities but also underscores the community's potential for adopting sustainable waste management practices through enhanced awareness and engagement.

Among the various types of waste generated, municipal solid waste emerges as the predominant category, emphasizing the critical need for comprehensive waste management strategies. However, our study brings to light a myriad of challenges impeding effective waste collection and transportation. High fees associated with waste disposal, coupled with inadequate service provision and logistical limitations, pose significant hurdles in ensuring efficient waste management practices.

Addressing these challenges requires a holistic approach encompassing policy interventions, community engagement, and infrastructural improvements. Initiatives aimed at reducing transportation costs, enhancing service quality, and optimizing waste collection mechanisms are imperative for mitigating the adverse impacts of solid waste accumulation and promoting environmental sustainability. In conclusion, our study serves as a foundational framework for

understanding the complexities inherent in solid waste management within Nyabisindu cell. By delineating key challenges and opportunities, our findings provide valuable insights for policymakers, community stakeholders, and waste management authorities to formulate targeted interventions that foster sustainable waste management practices and promote the well-being of Nyabisindu residents and the broader environment.

5. 2. Recommendations

Based on the analysis of data in Nyabisindu Cell, the following recommendations have been formulated, emphasizing the sustainability of solid waste management and the establishment of effective environmental protection measures:

1. **Revising Fee Structures**: There is a need to review the fee structures associated with waste collection and transportation, ensuring affordability and equitable access to waste management services across socio-economic groups.
2. **Enhancing Transportation Logistics:** Efforts should be made to optimize transportation logistics to improve the efficiency of waste collection and disposal processes. This may involve increasing the frequency of waste collection and deploying more efficient transportation vehicles.
3. **Fostering Community Awareness and Participation**: Community engagement and awareness campaigns play a crucial role in promoting sustainable waste management practices. It is essential to educate residents about the importance of waste reduction, segregation, and recycling, encouraging active participation in waste management initiatives.
4. **Promoting Recycling and Reuse:** Encouraging recycling and reuse of waste materials can significantly reduce the volume of waste sent to landfills. Initiatives to promote recycling facilities and create markets for recycled products should be explored.
5. **Investing in Infrastructure:** Investment in waste management infrastructure, including recycling facilities and composting sites, is essential to build a robust waste management system capable of addressing the community's needs.
6. **Policy Support and Enforcement:** Enforcing existing waste management policies and implementing new regulations where necessary can help ensure compliance and accountability among waste management stakeholders.

By implementing these recommendations in collaboration with local authorities, community leaders, and relevant stakeholders, Nyabisindu cell can move towards a more sustainable and effective solid waste management system. Through concerted efforts and collective action, we can mitigate the environmental impacts of improper waste disposal, promote public health, and create a cleaner and healthier living environment for all residents.

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Appendix

Households Questionnaire survey

Date:

A. Identification of household

1. Respondent Names:
2. Sex: Male ☐ Female ☐
3. Age:
4. Profession:
5. Level of study: None ☐ Primary ☐ Secondary ☐ University ☐
6. Cell: ……...
7. Village: …….
8. Contact: ……
9. Ownership: ……

B. Situation of Solid Waste generated

I. What type of waste produced at households?

II. Who collect solid waste from your home?

Yourself

Private company

If it is yourself, where do you put the organic waste? ……..

In case it is a private company, mention its name……...

III. How often are solid waste collected per week?

Once ……...

Twice ……

Other (Specify) ……

IV**.** How is it transported?

1. Waste Basket ☐
2. Carton ☐
3. Old Basket ☐
4. Plastic Bags ☐
5. Others (Specify)……...

Specify the type of vehicles used to carry organic waste

V**.** What happens after the transport?

Deposit to a landfill

Recycling

Others

C. Understand the process of solid waste collection and disposal.

A**.** After transport of solid waste, what happens?

1. Recycling and reuse ☐
2. Deposit ☐

II. Estimate the distance to Dumping site?

1. <100m ☐
2. 100-300m ☐
3. 300-1000m ☐
4. ☐

4. >1000 m

III. Do you have some challenges in solid waste management? Yes ☐

No ☐

A. If yes, what kinds of challenges?

D. Propose measures to improve the management of solid waste management

I. What do you think could be done to improve solid waste management?

1…….

2…….

3…….

4…….

II. How much money do people pay for the service of waste removal? Did you use this information?

……..……

……

……

III. What is the responsibility of local administration in solid waste management?

……

……....

IV. What are the main challenges in solid waste management?

……

……-

V. What are the environmental impact of solid waste management?

VI. What do you propose as measures for solid waste management?

……

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