TOWARDS RESOURCE RECOVERY, REUSE, REDUCING AND RECYCLING OF SOLID WASTE IN NAIROBI COUNTY: A CASE STUDY OF ROYSAMBU SUB-COUNTY

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DECLARATION

This thesis is my original work and has not been presented in whole or part of award degree in this or any other university.

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ABSTRACT

Solid waste management practices such as resource recovery, reduction; reuse and recycling (4R's) have emerged mainly to minimize the negative impacts to the environment. These practices have faced various challenges despite the written support provided in policies and laws of Kenya. Using Roysambu sub-county as case study, the study sought to examine impediments to 4R's. The research was based on survey design which targeted households, garbage collecting companies and the county government. The study adopted stratified random sampling technique to arrive at a sample population of 383 respondents, which was determined by calculating the target population of 127,519 with 95% confidence level and error of 0.05. The specific objectives were to determine factors impeding sorting of solid waste at household level, to establish the willingness of garbage collectors in engaging in 4R's promotion and to determine gaps in policy and institutional arrangements that hinder successful adoption of 4R's in Roysambu Sub-county. To achieve this, the researcher undertook household surveys, key informants and focus group discussions. The study found that unavailability of waste sorting facilities (24%), limited knowledge (20%) and incentives in waste sorting (21%), irresponsibility to sorting waste (18%) and lack of understanding the value of waste as a resource (17%) were the key factors causing inability to practice waste sorting at household level. Results further revealed that the county government does not explicitly promote garbage collectors engaged in 4R's because it does not consider the garbage collectors capacity in waste handling. Compounded by lack infrastructure, existing policy and institutional loopholes have resulted to weak enforcement strategies that hinder 4R's. Nonetheless, the study found that incentives such as reduction in cost of garbage collection fees can be mainstreamed into policy if markets for waste resources are made available. In view of this, the study recommends increased public participation, education and awareness, more importantly focusing on how to sort waste, value of waste and available markets where recovered waste can be sold. License acquisition should be more stringent in a manner that would allow garbage collectors to only operate if 4R's are incorporated as a key component of their activities.

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Because of you, I have thrived.
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DEDICATION

This scholarly work is dedicated to my parents, Mr. And Mrs. Stephen Mbaki for their invaluable parental role through my formative period to my current status.

My sisters,

My brother,

My nieces and nephew

My best friends

Everyone who cares for our environment

And myself

For prayers, moral and spiritual support, encouragement and financial support. I am forever grateful.

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LIST OF ABBREVIATIONS/ACRONYMS

4R's	Reduce, recovery, reuse and recycle
CED	Compliance and Enforcement Department
CWM	Conventional Waste management
EM	Ecological modernization
EMCA	Environment Management and Coordination Act
EMT	Ecological Modernization Theory
FDG	Focus group discussions
GHG	Green House Gas
ISWM	Integrated Solid Waste Management
ISWP	Integrated Solid Waste Management Plan
NAMA	Nationally Appropriate Mitigation Action
NCCAP	National Climate Change Action Plan
NCG	Nairobi County Government
CG	County Government
NEMA	National Environment Management Authority
NEP	The National Environment Policy
PET	Polyethylene terephthalate
RGCA	Roysambu Garbage Collectors Association
SWM	Solid Waste Management

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

As urbanization and consumption rates are on the rise, the result is an increase in amount of solid waste generated (McAllister, 2015). Currently, over 1.3billion tones of solid waste is generated per year within urban cities and is predicted to rise to 2.2 billion tones in 2025 with rates of waste generation doubling in lower income countries (Hoonwerg *et al*, 2012). According to UNHABITAT 2010, despite the increasing generation of solid waste per capita in lower income countries, waste collection services are still grossly inadequate. Unfortunately, this increase in waste generation has not been accompanied by an equivalent increased capacity by authorities to deal with the situation, more so in developing countries (Tacoli, 2012). Furthermore, the rapid urban development in low income countries has immensely implied pressure on the authority's capacity to deal with the menace.

This has become a growing concern compounded by poor planning, conflicts in establishing landfills which has resulted to heaps of waste within cities. Dangers of dumps include production of toxic gases through burning of waste, which has impacted on human health. The solid waste also produces leachate which percolates through to ground water reserves. Dump sites also form breeding grounds for insects and disease vectors like mosquitoes and flies. The impact on climate change cannot be ignored, methane gas produced from solid waste decomposition greatly impacts global warming. As at 2005, the waste management industry was one of the largest contributor to emission of non- CO_2 greenhouse gases from land-filling and waste water, accounting for 13% of the total emissions (Ministry of Environment and Forestry, 2016).

This necessitates a paradigm shift to integrated solid waste management (ISWM) which provides impetus to 4R's. Reduction in GHG emissions from landfills through proper waste management systems will mitigate climate change and have significant economic, environmental and social

benefits such as revenue generation through waste to energy programs, natural resource conservation, development of green technologies and thus, increased youth employment. The emergence of proper waste management practices strongly influence the tone of development in countries around the world. For instance, high technological capacities, advanced environmental regulations and enforcement authorities in Central Asia and Europe have resulted to reduction in waste disposal in landfills by up to 75% (Kaza, Yao & Woerden, 2018). This resulted to high rates of waste recovery of materials such as paper, metal, glass and organic materials with only minimal waste ending up in landfills.

Sub-Saharan countries have experienced substantial growth and modernization by shifting the focus to construction of sustainable disposal sites, improving collection and disposal services and increasing environmental awareness for the public. Nonetheless, institutional and regulatory frameworks are not clearly defined (World Bank, 2018). This lack of clarity impedes the role of local governments in delivering proper waste management services, thus resulting to adoption of conventional waste management practices. This undermines the general global trends in achieving sustainable waste management, with developing countries being faced by challenges such as overuse of landfills and disposal facilities even after exceeding full capacity, conflicts in establishing landfills and land scarcity (Kaza *et al,* 2018).

While Kenya is committed to increase economic growth, the increase in GDP has resulted to environmental degradation through poor waste management and sanitation systems, and industrial pollution (Ministry of Environment and Forestry, 2018). Unsustainable consumption and production patterns have resulted to increased waste generation which undermines the quality of air, waste and land. Despite efforts to encourage 4R's, the amount and composition of waste generated in Kenya remains high. Oguge, 2019 pointsF out the fact that Kenya currently lacks any national or county policy framework specific to plastics. Additionally, no specific

policy on e-waste exists in Kenya, with lack of segregating phone batteries posing a threat to human health and the environment (Anyango & Munyugi, 2018)

According to the Ministry of Environment and Forestry (2018) despite waste management being a devolved responsibility under the Kenyan constitution, most counties still lack adequate infrastructure, funding and governance mechanisms for effective waste management. The ministry further adds that all counties in Kenya currently have uncontrolled dump sites, with a number of communities faced with the challenge of acquiring affordable waste management services. According to National Environment Management Authority (NEMA), Nairobi County alone generates up to 2,400 tons of waste per day with 80% being collected, 20% uncollected. Collected waste is taken to the Dandora dump site where resident living around make do with waste recovery and reusing. The Ministry of Environment and Natural Resources (2016) found that despite the fact that up to 93% of the waste is potentially recyclable and reusable, only 5% is recovered for recycling and composting. Majority of the waste is thus disposed on illegal dump-sites which in most cases, are operating in unsanitary and unplanned manner. This results to increased air, water and soil pollution which pose significant environmental and health problems. Most of these problems are experienced in low income and slum areas of Nairobi, aggravated by increased population density, lack of garbage collection services and poor infrastructure (Ministry of Environment and Natural Resources, 2016).

Over time, formal and informal entrepreneurs dealing with income generation through waste recovery have arisen (Ruby, 2016). Waste resource recovery has provided a good source of employment with positive impacts on environmental and economic sectors. Several micro and small enterprises are involved in recovering of waste and selling to industries that recycle waste (Ondieki, 2014). Resource recovery, reuse and recycling has given value to otherwise worthless waste and has become a more practical option towards achieving sustainable solid waste management.

1.2 Statement of the Problem

While Article 42 of the Kenyan Constitution 2010 provides that every person is entitled to a clean and healthy environment, solid waste management remains to be one of Nairobi's most visible environmental problems, characterized by heaps of waste and uncollected garbage (Haregu *et al* 2016). The National Environment Policy 2013 provides a framework that addresses urbanization, waste management and pollution, providing that the government shall promote facilities and incentives for waste recovery, reuse and recycling. Article 6 of the Waste Management Regulations 2006, mandates the waste producer to minimize, recover and recycle waste. Section 87(4) of EMCA (2015) mandates every person generating waste to employ minimization measures. The National Sold waste Management Strategy Plan (2015) recommends an 80% waste recovery rate by 2030 and only 20% of waste sent to landfills. The plan guided by Zero waste principle, views waste as a resource that can be harnessed to create employment and reduce pollution. It also advocates for waste segregation at source. Additionally, Kenya's development blueprint Vision 2030 acknowledges the need for efficient and sustainable solid waste management practices as the country develops into an industrialized state.

However, these regulations are not fully implemented since integrated solid waste management cannot be upheld with the current system of waste collection and disposal on the ground, whereby waste sorting from the source is hardly applied. Most of the practices involve only collection and disposal, irregardless of whether the resources are recyclable or not (Kasozi 2010). Ondieki (2014) adds that waste recycling enterprises still lack capacities to optimize their productivity and often operate without support from the county government. This can perhaps be attributed to the fact that institutional and implementation mechanisms are weak. It could also be caused by negative attitude of the public towards waste collection and disposal, and the general perception that waste management is the sole responsibility of the county government.

This study therefore sought to investigate factors impeding best waste management practices. It established why waste sorting has not yet been embraced in Roysambu sub-county, and find ways of making it a reality. The results and recommendations will be used to inform policy makers and relevant institutions in making decisions that facilitate 4R's.

1.3 Research Questions

The overall question is what are the impediments to 4R's in Roysambu Sub-county?

Specific questions

1. What factors impede sorting of solid waste at household level in Roysambu Sub-county?
2. What is the willingness of garbage collectors in engaging in 4R's promotion in Roysambu Sub-county?
3. What gaps exist in policies and institutional arrangements that hinder adoption of 4R's in Roysambu Sub-county?

1.4 Research Objectives

The overall objective is to investigate impediments to 4R's in Roysambu Sub-county.

Specific objectives

1. To determine factors impeding sorting of solid waste at household level in Roysambu Sub-county.

2. To establish the willingness of garbage collectors in engaging in 4R's promotion in Roysambu Sub-county.

3. To determine gaps in policy and institutional arrangements that hinder successful adoption of 4R's in Roysambu Sub-county.

1.5 Scope and Limitations of the Study

The study attempted to understand the challenges and opportunities for implementing 4R's in Roysambu Sub-county. Solid waste management involves many stakeholders but the researcher chose to dwell on households and garbage collecting companies because they are directly involved in solid waste management at source. The study investigated policy and institutional gaps that impede 4R's in Roysambu sub-county.

1.6 Significance of the study

Environmental protection and management provides a vital foundation that anchors human rights, such as the right to a clean and healthy environment for all. Reducing, recovering, reusing and recycling of solid waste provide environmental, social and economic benefits which can be harnessed to improve human and environmental well-being. The study addresses issues that impede successful adoption of 4R's, which view solid waste as a resource that can be sustainably managed for both present and future generations. Based on the fact that implementation strategies in 4R's are weak, the study provides opportunity to bridge these policy gaps by prioritizing best practices in planning and management of waste, enhancing the knowledge base as well as inform policy makers on strategies that promote 4R's.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter provides an overview of relevant literature specifically focusing on 4R's. Global, regional and local perspective of the problem area is discussed in this section. Case studies of best practices were reviewed to inform the policies regarding 4R's.

2.2 Waste as a Resource

Traditionally, waste is thought of having little, if any or no value. Conventional waste management (CWM) emphasizes heavily on waste collection and disposal at landfills (Rhyna *et al* 1995). Only minimal attempts are made to incorporate waste reduction, recovery and reuse. Rhyna adds that the main focus of CWM to provide an end-of-pipe solution, which result to local institutions investing a significant amount in revenue for waste collection and disposal, regardless of whether the material is recyclable or not. Landfills are a major source of Methane (CH_4) which as a greenhouse gas, has impacted heavily on global warming, leading countries to spend billions of dollars in recovering what could have otherwise been prevented (Wilson *et al,* 2015). Consequentially, developing countries face health and environmental risks, as well as losing economic opportunities in waste recovery and reuse (Troschinetz & Mihelcic, 2009). Unless sustainable waste management is practiced, the value of waste resources cannot be realized.

A paradigm shift to integrated solid waste management (ISWM) provides impetus to embracing 4R's as a vital component in waste management. Opportunities in turning waste into a resource include economic benefits such as waste to energy technologies, revenue generation as well as reduction of overall cost of pollution and waste management. It also provides environmental benefits such as climate change mitigation, reduced pollution and landfills. Viewing waste as a

resource provides numerous social benefits including improved health and increased employment opportunities (De Feo *et al,* 2019)

2.3 Circular Economy and Waste Management.

Shifting from the perception of 'waste as a problem' to viewing 'waste as a resource' has to be rooted to a wider framework of a circular economy, which propels economic developments towards a sustainable future. Consumption and production patterns have for a long time been based on linear models, where resources are extracted, processed, used and finally discarded as waste (MacArthur, 2014). In contrast, the circular economy model ensures that the value of a material is kept as high and for as long as possible. Ultimately, the need to input more energy and material significantly reduces, resulting to minimal environmental pressure emanating from life cycle of products from extraction through to end-of-life.

The concept of circular economy revolves around 4R's since its core focus is turning waste back into a resource. R_1 entails reduction and prevention of waste which can be achieved through legislative arrangements, product design and local initiatives to separate reusable resources from the waste (Peprah *et al,* 2015). Laws and policies oblige manufacturers to adapt standards in product design or limit production activities. Increased public awareness and education also intensifies reduction of waste. In Kenya, a complete plastic ban was upheld in August 2017, a measure that was set to minimize production and use of plastic bags (GoK, 2017). R_2 entails reusing either part or whole of the waste material. A good example is in soft drink companies where bottles are returned to bottling plants for cleaning and refilling. According to Fewtrell, 2012), reusing is best achieved through segregation at source. R_3 is applied where waste materials are recycled. The material may not be reused directly, but undergoes processing to a new product e.g. used papers can be converted into files or cards. Finally, R_4 entails waste recovery, which is achieved through incineration of materials resulting to energy recovery.

Ideally, the goal of the 4R concept is to minimize waste volumes, reduce reliance on landfills, reduce cost in waste management, mitigate climate change and improve human well-being. Therefore, transitioning from linear to circular models requires high levels of cooperation between the state, citizens and businesses in waste management (Lee *et al*, 2017). High quality waste streams for 4R's requires effective infrastructural developments and citizen participation, which is essential in achieving sustainable waste management. Coherent and holistic approaches in waste prevention, such as circular economy models are thus paramount in ensuring 4R's are taken into account at all levels of product life cycle. A circular economy not only reduces the negative implications of linear economy but rather, builds long term environmental resilience while at the same time, increasing economic opportunities.

2.4 Global Engagement in 4R's Promotion

The degree of waste recycling and recovery varies greatly from a global perspective. The use of advanced management techniques in developed countries has proven to have positive impacts in suppressing the waste menace. For example in Germany, the Enhance Resolution Mobile Sorting system increased the level of recycling by 62% in 2010. It banned land-filling which resulted to almost zero landfills at the same time (Reichel *et al*, 2013). Another study done in Mauritius on PET (Polyethylene terephthalate) bottles recovery and recycling, the then Ministry of environment promulgated a regulation that Bottling companies were required to establish a deposit-refund system that would encourage return of maximum number of PET bottles. Up to 59 bins were placed at strategic spots where consumers deposited the bottles for recycling. This system succeeded in creating opportunities for local residents who got additional income by selling the PET bottles (Seebaluck *et al*, 2009).

Integrated solid waste management can be achieved by corporation between the communities and local governments, who are responsible for regulating and controlling their

activities. A study done in Pune India indicated positive results in formalizing informal sector through trade unions and rag picker corporates. Informal waste pickers were widespread among slum residents, with women and children waste pickers often socially discriminated for the nature of activity they depended on for livelihoods. A convention of waste-pickers was developed to serve as a platform that identified the interests of rag pickers. It later formed a registered trade union to fight for the rights of waste pickers and increase job opportunities (Chikarmane *et al*, 2005). The then Pune city government became the first authority to officially register waste-pickers in recognition of their contribution to municipal solid waste management. This study shows how community mobilization can effectively contribute to improving livelihoods of waste pickers by legally recognizing them. It shows that if local authorities work together with informal sectors, a mutually beneficial relationship will exist and lead to positive realization of integrated solid waste management.

2.5 Engagement of 4R's in Nairobi, Kenya

According to Ondieki (2014), there are over 150 private operators involved in recycling and recovery of waste in Nairobi. But despite the contribution by these recycling enterprises, there still lacks policy frameworks that facilitate partnerships with recycling enterprises in Nairobi. Section 57 of Environment Management and Coordination Act (EMCA) provides for development of instruments that protect the environment such as tax and fiscal incentives that can be used to encourage good practices. However, despite these provisions, few instruments have since been developed to promote 4R's and implementation of these instruments has been unsuccessful (Kibwage, 2002). There lacks fiscal incentives or infrastructure from the government that support services provided by these enterprises. Solid waste management in Kenya heavily relies on command and control strategies, which have proven to be futile since heaps of waste and illegal dump sites are still frequent in Nairobi (Ndugire *et al*, 2005).

Engaging in 4R's has provided a good source of employment with positive impacts on environmental and economic sectors. In Nairobi, several Micro and Small Enterprises are involved in recovering of waste and selling to industries that recycle waste (Ondieki, 2014). Some engage in this business informally, meaning that their activities lack any form of regulations or protection from the government (NAMA, 2016). The government is yet to introduce fiscal incentives/tax for source separation and infrastructure to foster waste minimization, recovery and recycling (Palfreman *et al*, 2015). Small and large waste recyclers are also constrained by strict licensing requirements and high utility costs for water and electricity. Ondieki (2014) adds that these entrepreneurs also suffer harassment by government agencies and undeveloped markets for recovered waste. This ambiguity in these provisions can arguably be attributed to negligence among public authorities.

2.5.1 4R's at Dandora Dumpsite

Majority of waste recovery activities are perceived to be done at Dandora dumpsite, which hosts about 3000 individuals recovering waste, and have engaged in the waste recovery activity for more than 30 years (Gumbihi, 2017). These individuals are organized into groups registered under Ministry of Youth and Gender Affairs and County Department of Environment. Leah (2017) adds that there however lacks information on how much waste is recovered from these waste streams because the county has not managed to register them in totality. Groups which have been registered and attained formal acknowledgment pay a license fee of ksh10, 000 annually, but their impact cannot go unnoticed since they recover up to 500 tons of plastic waste per day (Leah, 2017).

2.5.2 Non-State Actors engaged in 4R's promotion

Taka Taka Solutions has positively impacted Nairobi's waste problem by committing itself to collection and recovering of waste. It has employed thirty individuals who earn approximately

Ksh850 per day. Due to the nature of activities, the company has provided training and protective gears to workers in order to prevent accidents and infections. Additionally, all waste received is sorted, recovered and the residuals transported to Dandora dumpsite. The recovered material is then sold to different clients based within and outside Nairobi. This has boosted the company's profit margins, created employment and minimized the total amount of waste ending up in Dandora dump site. Nonetheless, the company faces challenges brought about by compliance license from NEMA and the County Government , as well as manual sorting and negative attitude from the public (Leah, 2017).

2.6 Policy and Intuitional Frameworks facilitating 4R's in Kenya

2.6.1 Constitution of Kenya (2010)

The Constitution of Kenya 2010 lays down profound implications for environmental management, both at national and county levels. It provides a basis for which laws, institutions and policies shape the practice of environmental governance, including waste management. The Constitution preamble acknowledges the environment as our national heritage and outlines provisions for protection and sustainable development. The right to a clean and healthy environment is enshrined in Article 42 of the Constitution. The bill of rights entitles all citizens to have the environment protected to benefit both present and future generations through measures articulated in Article 69 (1), which outlines the states responsibility to ensure sustainable exploitation, utilization, management and conservation of natural resources; To encourage public participation in protection, conservation and management of natural resources; to eliminate processes and activities that damage the environment. The constitution thus gives powers to the state to intervene in promoting 4R's at both local and national level. Additionally, the Fourth Schedule (Part 2) of the Constitution outlines responsibilities to the county government including removal of refuse, dumps and disposal of solid waste. The constitution

thus anchors these roles by bestowing powers to the county government to establish ways of promoting 4R's.

2.6.2 National Environment Policy, 2013 (Sessional Paper No. 10)

The National Environment Policy (NEP), 2013 acts as a framework that guides efforts in addressing environmental problems associated with solid waste management. The aims of this policy is to better quality of life for present and future generations through sustainable management and use of the environment and natural resources. Regarding solid waste management, the policy seeks to promote establishments of incentives and facilities for cleaner production, waste recovery, reuse and recycling. It also advocates for use of economic incentives that will promote engagement in 4R's.

In addition to NEP, the draft National Sustainable Waste Management Bill 2018, acts as a framework that creates the necessary policy and regulatory environment to enable Kenya effectively tackle the waste menace, through systematic collection of sorted waste from the source, as well as facilitating activities aimed at promoting 4R's and energy recovery. Relevant to the study is addressing 4R's upon which it calls for immediate action to addressing waste management by incentivizing and facilitating establishment of multiple links in the waste value chain which currently lack in Kenya. Such links include affordable waste collection services in all neighborhoods, sorting posts where waste will be sorted for recycling, composting facilities for organic waste and waste to energy facilities. The policy addresses the problems related to 4R's by stipulating full implementation of the principle of zero waste and circular economy whose core goal is to minimize volume of waste ending up in landfills or incineration plants.

2.6.3 Waste Management Regulations, 2006

The Waste Management Regulations offer legal provisions in streamlining waste handling, transportation and disposal. Waste is categorized into industrial, hazardous and toxic waste, pesticides and toxic substances, biomedical and radioactive waste. These regulations provide a framework for handling, storing, transporting and disposal of waste according to categories provided therein.

2.6.4 The Environmental Management and Coordination Act, 1999 (amended), 2015 (EMCA)

EMCA is the primary legislative act that provides a framework on matters concerning the environment and anchors NEMA's responsibilities in promoting 4R's. Section 70 of EMCA establishes a standard review and enforcement committee whose role, together with NEMA and other agencies, includes identifying materials that pose a threat to human and environmental health such as solid waste. Section 87 of EMCA bars disposal of waste in a way that would pollute the environment or harm any human. Section 87(4) further obligates every individual whose activities generate waste to adopt measures that reduce pollution through practices such as recycling and treatment. These provisions however fall short because they do not address the social dynamics and fundamental problems associated with waste sorting at source.

2.7 Institutional Frameworks Governing Waste Management in Kenya

2.7.1 County Government (CG)

Waste management is a devolved function under the Kenyan Constitution and hence, the CG has a key role to play in implementing 4R's. The Fourth schedule (Part 2) of the constitution outlines responsibilities to the CG including removal of refuse, dumps and disposal of solid waste. The CG is thus responsible for implementing these devolved functions in accordance with national and county policies, laws, regulations and standards. It is also mandated to establish financial

and operational conditions necessary to effectively carry out removal of refuse and dumps in a manner that promotes 4R's. Although it is yet to be passed, the draft National Sustainable Waste Management bill, 2018 further outlines responsibilities of the CG including allocation of at least 20 acres of land as designated sites for setting up material recovery and recycling facilities, as well as sanitary landfills for secure disposal of unrecoverable waste. Other responsibilities include incentivizing collection and separation of waste at source in neighborhoods and informal settlements.

2.7.2 National Environment Management Authority (NEMA)

NEMA was established under EMCA as the principle government instrument responsible for implementation of all policies related to the environment, and to exercise general supervision and coordination over all matters relating to the environment NEMA has the primary responsibility to implement environmental safeguards in Kenya while collaborating with other actors such as private firms, civil society and development banks which finance infrastructure. The authority is charged with enforcing EMCA's provisions together with other subsidiary legislations touching on water quality, waste management, biodiversity protection and impact assessment. In this regard, NEMA's core task is to review and issue out licenses to proponents that plan to engage in waste management. EMCA also grants NEMA powers to complete any authority or ministry to comply with existing environmental regulations. Nonetheless, the authority has over time suffered from inadequate funding, corruption, lack of community participation as well as duplication of roles among national and local government entities (Barczewski, 2013).

2.8 Theoretical Framework

2.8.1 Theory of Environmentally Responsible Behavior (ERB)

The ERB was proposed by Hines, Hungerford and Tomera in 1987 and has over the years attracted attention by policy makers and scholars. ERB states that intention to act, attitudes, locus of control (internalized sense of personal control over events of one's own life), sense of individual responsibility and knowledge have an impact on whether a person would adopt a behavior or not. The model comprises of variables that play a vital role in adoption of ERB, such as the control center which has a substantial impact on an individual's intention of acting. The theory of ERB suggests that there exists a relationship between the control center, individual attitudes and intention to act. Hines, Hungerford and Tomera argued that the control center directly affects an individual's attitude which can result to improved intention of acting and thus, improved behavior. This theory focuses more on interactions between parameters that influence a person's behavior than one singular impact of a single variable.

With regard to waste management, there lacks one single factor responsible for current behavior or capable of initiating behavioral change (Akintunde, 2017). For instance, despite the various policy and legal provisions in waste management that prohibit such acts, people still dump waste in streets and illegal dump because they see others doing it. With regards to promoting 4R's, knowledge alone is insufficient in promoting responsible acts of proper waste management. However, knowledge about importance of 4R's combined with its regulations and enforcement could potentially prompt people to have a positive attitude, which translates to good intentions to act. This implies that uniting constructs of attitude, control center and intention of acting become a base on which responsibilities of pro-environmental behaviors are formed. The theory will be useful for the study as it attempts to identify how public attitudes can be transformed to create an environmentally sensitive society.

2.9 Conceptual Framework

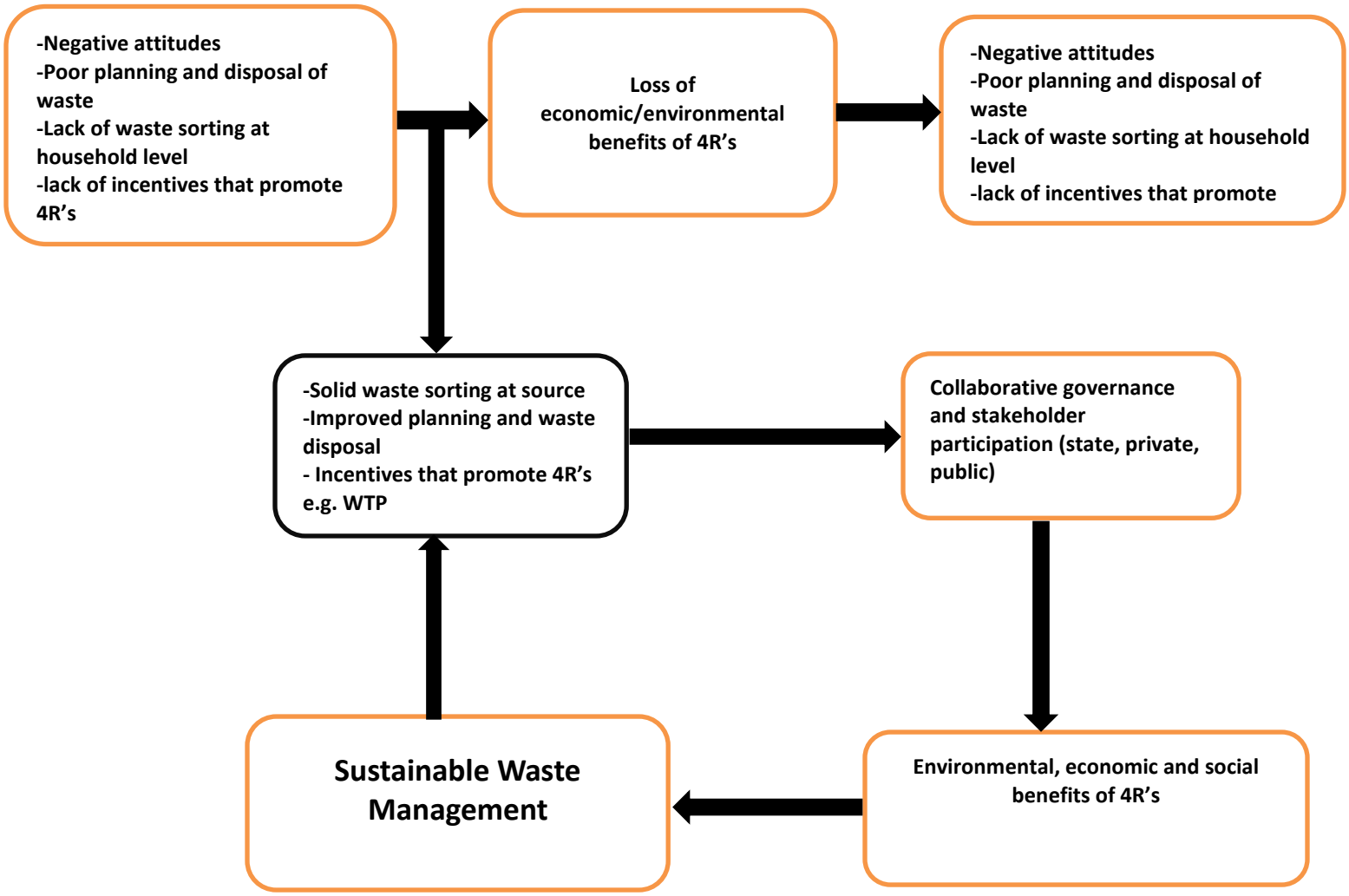

Figure 1 Conceptual Framework

Source: Author, 2019

Lack of waste sorting from the source is closely linked with negative attitude towards waste management. This is compounded by poor planning and disposal of waste in illegal dumpsites, which pose a threat to human and environmental health. Consequently, benefits of 4R's such as; climate change mitigation, reduction in landfills, revenue generation through waste to energy recovery and employment opportunities are not realized. Hence, shifting from unsustainable waste management requires change of attitude, adoption of waste sorting practices from the source, willingness of garbage collectors to engage in 4R's as well as collaborative governance between the states, public and private stakeholders. Such practices are backed up by robust policy and institutional arrangements that support implementation of sustainable strategies that facilitate 4R's. An integrated policy and institutional framework for 4R's will enable development of incentives that promote 4R's, as well as increased partnerships between the government and garbage collectors involved in 4R's. The long term implications will be sustainable waste management which will ensure environmental and economic benefits of 4R's are enjoyed. This is illustrated on figure 1.

2.10 Knowledge Gaps

Despite the existence of policy and institutional frameworks governing solid waste management, knowledge gaps in promoting 4R's engagement has been evident. For instance, the environmental laws and policies in Kenya have faced a number of lapses during implementation. Illegal dumping is still rampant with 4R's being practiced informally and at small scale. Mwinzi, 2017 notes that these lapses have been aggravated by lack of political will, of which coupled with lack of planning of informal settlements, has resulted to insufficient mechanisms in dealing with urbanization as well as waste management.

The study identifies gaps in discussions revolving around public attitudes and awareness of environmentally sound practices. Gaps in behaviors- attitude often arise due to lack of public participation, societal habits as well as lack of knowledge about effective techniques that promote 4R's. Central to behavior- attitude gap exists inconsistencies between an individual's values and actions. Such inconsistencies are noted where citizens are aware of the damages but lack concern about environmental harm brought about by poor waste management practices. This is compounded by lack of will and limited action by these same citizens in reducing waste or engaging in pro-environmental behavior. The government has been reluctant in studying public behaviors and attitude in promoting 4R's since policies discuss on the need to improve public awareness and education, but lack guidelines on how to do so. Additionally, none of the reviewed literature has studied factors impeding 4R's in Roysambu, hence the need for further research at local and regional levels that would bridge these gaps.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Study Area

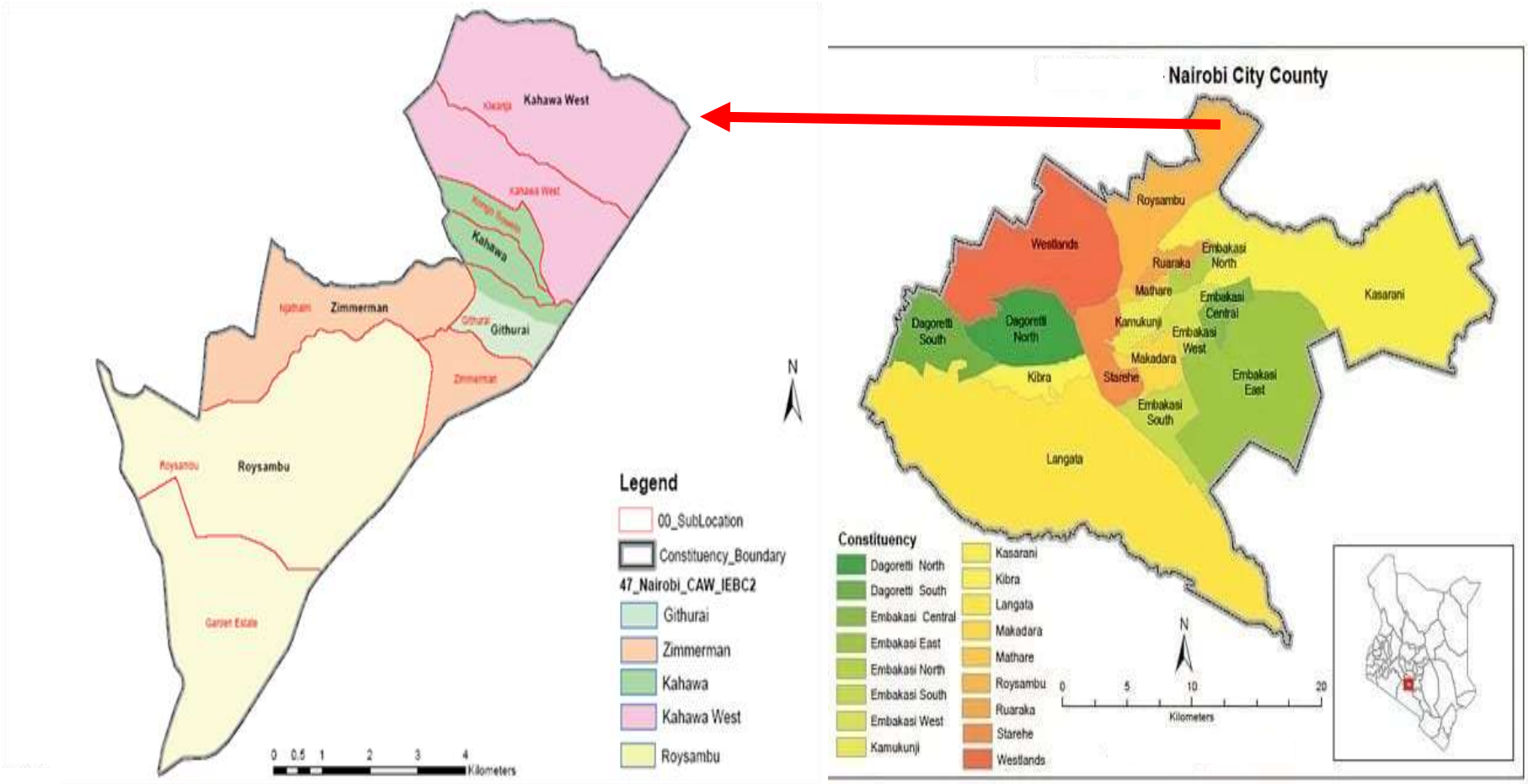

Figure 2 Map showing location of Roysambu Sub-county in Nairobi Source: IEBC 2012

The study was carried out in Roysambu Sub-county, found in Nairobi County on latitudes and longitudes 1°13'01.8"S 36°53'12.0"E. It covers an area of 48.80 Km^2 and is subdivided into 5 assembly wards namely Zimmerman, Kahawa west, Kahawa, Roysambu and Githurai. It has a population of 208,280 with manufacturing, trade, real estate, tourism and hospitality as the main economic activity (KNBS, 2010). The sub county experiences temperate tropical climate with two rainy seasons. It receives high rainfall between March and April with short rainy season occurring between November and December. Annual rainfall ranges between 850mm-1050mm with mean daily temperatures ranging between 12^0C- 26^0C. July and August are the coldest months with January and February being the hottest (KNBS, 2010).

3.2 Research Design

The study adopted both qualitative and quantitative methods which involved combining elements of both qualitative and quantitative approaches in a single study for the broad purpose of understanding the research problem, rather than using either approach alone. (Johnson *et al,* 2007). It involves collecting, analyzing and interpreting data by observing what people do and say (Schoonenboom & Johnson, 2017). Qualitative data was collected through in depth interviews and focus group discussions (FDG's) with government and garbage collectors respectively. Quantitative data adopted descriptive method which involved observing Roysambu households without intervening. Therefore, combining both methods was best fit for this study as it ensured that factors hindering waste sorting at source, willingness to engage in 4R's, policy and institutional gaps were interrogated fully.

3.3 Sampling and Sample Size Determination

Roysambu Sub County consists of Zimmerman, Kahawa west, Kahawa, Roysambu and Githurai wards. The population in these wards formed the sampling frame of the study.

Table 1: Roysambu Ward Population

Ward	**Population**
Zimmerman	38,912
Kahawa west	39,994
Kahawa	35,853
Roysambu	40,331
Githurai	47194
Total	202,280

Source: IEBC 2012

To get to the individual sampling unit (household), the sub county was stratified according to incidence of poverty i.e. high and middle income wards with incidence of poverty between 25% and 49% respectively, and lower income wards where incidence of poverty is more than 50%. (KNBS, 2013). Roysambu and Zimmerman are regarded as high income wards, Kahawa West and Kahawa ward are regarded as middle income, while Githurai is regarded as low income. Using random sampling, one ward was selected representing high income (Roysambu) and middle income households (Kahawa West). Purposive sampling was done to select Githurai since it was the only low income ward in Roysambu. This was followed by systematic household sampling within the selected wards. The subsets of the strata was then combined to represent the total sample population.

$$n_0 = (Z^2 pq)/e^2$$

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}}$$

Where, n is sample size, Z is selected critical value of desired confidence level (z score); p is estimated proportion of an attribute that is present in the population (0.5) ; $q = (1 - p)$; e is desired level of precision, and N is population size of the three wards (127,519). This method obtained a sample size of 383 respondents which was spread through representative wards using:

$(Ward\ X\ population)\ /\ Total\ Ward\ Population\ )\ x\ n$

Hence, Githurai had 142 respondents, Kahawa West had 120 respondents and Roysambu had 121 respondents as demonstrated in Table 1. Purposive sampling was done to select 5 youth groups and CBO's namely: Githurai 44 Trinity Youth Group, Marurui Youth Group, Shilo Women Group, Winju CBO and Usafi waste handlers, all dealing with garbage collection in Roysambu Sub-county. According to Guest & McKenna (2017), as few as three to six focus groups are likely to identify up to 90% of the study variables. Five focus group discussions were taken with the youth groups having a mean of 8 members, thus building the evidence base for the focus group sample size. Purposive sampling was also done to select 5 key informants who were representatives from NEMA, county government environmental department and ward environmental officers from Githurai, Kahawa West and Roysambu.

Table 2 Respondents per Ward

Sampling Unit	**Respondents**
Githurai	142
Kahawa West	120
Roysambu	121
Total	383

3.4 Data Collection Techniques

Primary data was collected using structured questionnaires in household surveys while open ended questionnaires were used for key informants and FDG's. Open Data Kit (ODK) was used for household surveys to make the data collection process more efficient. Key informants interviews were carried out with representatives from NEMA, county government environmental department and ward environmental officers who expressed their opinions, knowledge and experience in waste management. FDG's were conducted with five youth groups and CBO's engaged in garbage collection in Roysambu sub-county. Secondary data was collected from journals, policy documents, county government strategic plans and waste management regulations from both national and county levels. Photography was also used to observe operations and field conditions of the study area.

3.5 Data Analysis and Presentation

Questionnaires comprised of both closed and open ended questions providing quantitative and qualitative data respectively. The study employed Likert scale questions with five choices, each of which were assigned a numerical value as demonstrated in Table 3.

Table 3 Likert Scale

Value	**Choices**
1	strongly agree
2	Agree
3	not sure
4	Disagree
5	Strongly disagree

Key factors were ranked based on the level of agreement with the given statements. Qualitative data was derived from open ended questions (FDG's and key informants interviews) where data was identified, categorized and analyzed into themes/patterns. Quantitative data from household questionnaires provided descriptive statistics which was analyzed through ranking and mean scores using Ms Excel. The results were presented using tables, figures and pictures.

The willingness of garbage collectors to engage in 4R's promotion was analyzed by adopting Contingency Valuation (CV) method which elicits individual expressions of value from respondents for specified increase or decrease in the quality or quantity of a non-market good (Whitehead, Haab & Huang, 2012). CV value estimates are derived from a hypothetical situation presented to the respondent, whereby the respondents were asked to reveal their maximum willingness to pay or accept a hypothetical change in level of provision of non-use values, which are not traded in the market (Whitehead et al. 2012). CV entails use of payment cards containing a number of monetary values which were presented to respondents, as demonstrated on Table 3.5.2

Table 4 Payment Card for Willingness to Engage in 4R's

Payment Card	**Which of the amounts listed below describes your maximum willingness to pay every year, through a tax surcharge, to engage in 4R's if markets for recovered waste are provided?**	
Amount (Ksh)	I would definitely pay(√)	I would definitely not pay
5000		
10000		
15000		
20000		
25000		

3.6 Ethical Issues

Keen attention was given to ethical issues that affected the respondents comfort and consent to participate. A written declaration was provided to assure respondents of confidentiality, that the information they provide will be used for research and learning purposes only. A letter from the university affirming this was provided. A simple and understandable language was used and the respondent were given enough time to respond. Equally, the respondents were at total liberty to refuse to answering questions that made them feel uncomfortable.

3.7 Research Instrument Reliability and Validity

According to Phelan and Wren (2006), research reliability is the degree to which an assessment tool provides consistent and constant results. The problem associated with reliability includes observers' bias and errors; and respondent's bias and error (Robson, 2002). In-order to enhance reliability, adequate and relevant questions were asked to government representatives, garbage collectors and households residing in Roysambu sub county.

In order to enhance research validity, the findings must be accurate and be free from dishonest statements (Saunders et al, 2007). The questionnaires were thus framed from the theoretical framework used in the study. Additionally, respondents from households were selected randomly which provided a variety of comparable characteristics such as age, gender and income levels. They were also given complete information about the objectives of the study, thus ensuring the study was free from false response.

3.8 Limitations of the Study

Limitations of the study included long procedures particularly when interviewing key informants. This was overcome by booking formal and informal appointments with the respondents via email and SMS weeks prior to the scheduled meeting date. The study was also

limited by non-disclosure of full information on business operations. This was overcome by assuring the respondent that all answers are were strictly confidential and for research purposes only. The study was also limited by time and financial resource, thereby focusing only on household waste management.

CHAPTER FOUR: RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents and discusses findings the analyzed data from questionnaires administered to households, garbage collectors and government representatives in Roysambu Sub-county, Nairobi. The study had a response rate of 94% since 361 questionnaires were filled and returned. The findings are focused on the objectives of the study which were to investigate factors impeding 4R's in Roysambu sub-county.

4.2 Social Demographic Characteristics

Among 361 interviewed, 70% of the respondents were female while 30% were males with majority of them aged 25-34 years old. Fifty percent of the respondents attended secondary school, 36% went to university and college while 14% went to primary school. Seventy nine percent of the participants earned less than Ksh 30,000 per month and only 7% earned above Ksh 90,000. Ninety one percent of the respondents lived in flats/apartments/semidetached houses while only 9% lived in stand-alone houses. Eighty eight percent of the respondents were tenants while only 12%% were owners living in stand-alone houses.

Table 5 Social demographic characteristics

Characteristics	**Variable**	**(%)**	**Characteristics**	**Variable**	**(%)**
Gender	Male	30	Income levels (Ksh)	Less than 30,000	79
	Female	70		31,000-60,000	8
				61,000-90,000	6
				above 90,000	7
Education	Tertiary	36	House type	Flat/apartment/Semi-detached	91
	Secondary	50			
	Primary	14		Stand-alone/maisonettes	9

Age	Below 18	2	House Ownership	Tenants	88
	18 - 24	18		Owner	12
	25 - 34	34			
	35 - 44	29			
	above 44	16			

The age findings indicated that majority of the respondents were mature middle aged individuals and would thus better understand the importance of practicing waste sorting at source. These findings also imply that these groups are able to change habits when educated with the right information. Similar studies indicated that age of the household had a negative influence on the practice of household waste management (King'oo, 2019). This implies that older households were less likely to participate in household waste management, Vis a Vis younger households. The findings also concur with those of Alberti (1999) who established that unlike older people, younger groups offer better chances of adopting new technologies and integrating new knowledge.

The gender distribution findings are attributed to the fact that during household visits, most of the respondents were female. Men requested the researcher to interview the women in the house, stating that they are more conversant with waste handling. Majority of the respondents had attended secondary and tertiary school. This was important for the study since promoting 4R's requires basic understanding of proper waste management practices. Education level findings thus revealed that respondents understood the subject and were at a better position to assimilate knowledge about promoting 4R's. These findings are in agreement with King'oo (2019) who concluded that household education levels significantly influenced household management such that the higher the education level, the higher the ability to practice proper waste management

practices. Majority of the respondents were from lower income households earning less than Ksh 30,000.

According to Banga (2011), there exists a negative relationship between income levels and solid waste sorting from the source. This implies that lower income households are more likely to sort waste from the source, as compared to higher income households who can afford to pay for waste management services and thus, do not see the need to do it themselves.

Findings on the house type indicated that most of the respondents lived in flats and apartments. These residential developments have implications on policy making in the service industry, including waste management. This is true with regards to urban planning for selection of equipment and infrastructural developments within low income residential areas. Accessibility of such residential areas may be challenging due to roads and alley width, congestion and elevation (Mugambi & Gichuki, 2017).

4.3 Waste Collection and management System

The study established that household waste from residents living in standalone/ maisonettes (high income) was collected door to door and later from centralized waste collection points within the estate, which would later be transported to Dandora dump site. It was noted that for tenants living in flats/ apartments (lower income), the landlord facilitated waste disposal by designating a garbage collection point within the building, which would then be collected by the garbage collectors.

In order to promote 4R's, there is need to embrace waste sorting from the source (Kibwage, 2002). Ninety six percent of the respondents did not sort waste from their house. This implied that there lacked garbage collecting companies which issued out more than one garbage bag per household, which would have otherwise been used to sort waste from the source. These findings

are similar to those of Longe *et al* (2009) who found that waste sorting from households was very low.

Fifty four percent of the respondents expressed that their garbage comprised of more than 50% organic material such as vegetable and fruit debris, demonstrating that majority of the household organic waste had high potential of recycling. One way that organic waste can be recycled is through vermiculture/vermicomposting whereby red worms are used to decompose organic waste into nutrient rich matter beneficial to the soil (Hassaini, 2013). According to Ernest (2018) farmers engaged in vermiculture reaped a monthly income of Ksh 100,000. This experience creates a win win situation for the environment and could be replicated in Roysambu sub county waste management, where households generating waste should be encouraged to sort waste from the source. Similar studies done in Kiambu County demonstrated that majority of household waste comprised of organic material which was channeled into farms as organic matter (King'oo, 2015).

Garbage collection services were provided by CBO's and youth groups (66%), private companies (23%) and informal collectors (11%) as demonstrated on Table 4.2.2. They collected waste weekly or monthly depending on their operations. According to Kingoo (2015) some private and informal collectors have no official disposal sites, dump waste anywhere and illegally, and only engage in the business for money. Informal collectors often operate with carts and without authorization, thus failing to meet stipulated standards provided by the CG (GoK, 2013) These findings are in agreement with those of Oruonye *et al* (2018) who alluded that majority of waste was transported to dump sites using carts and thus posing a health risk to the waste handlers.

Table 6 revealed that 86% of the residents paid for waste collection services while 14% did not pay. This implied that most of the respondents received waste collection services with those not paying resolving to either dumping in streets or disposing in their own compost pit. It was noted that waste collection fee was dependent on the house type and income levels, whereby residents living in flats/apartments/semidetached houses (low income) paid a fee of Ksh 250 while residents living in stand-alone/ maisonettes (high income) paid Ksh 500. Households who did not pay for waste collection services stated that they could not afford the service and thus resolved to either burning in their own compost pit, dumping in the streets or haphazard disposal. This explains why dump sites were spotted after every few meters in residential areas as demonstrated in figure 3. Such unhygienic environments form breeding grounds of flies, rodents and mosquitoes which are the primary carriers of diseases and infections. Similar studies done indicated that health risks associated with dump site are quite significant, including chest pains, skin and stomach problems (Njagi *et al*, 2013).

Table 6 Waste collection providers and payment of garbage collection fees

Characteristics	**Variable**	**(%)**
Payment of garbage collection fee	Proportion of households who pay	86
	Proportion of households who do not pay	14
Waste collection providers	CBO's and Youth Groups	66
	Private companies	23
	Informal collectors (Carts)	11

4.4 Reasons for non-implementing waste sorting at household level

The study identified five key factors hindering waste sorting at household level. The key factors were lack of incentives and waste sorting facilities, lack of responsibility in waste management, limited knowledge in waste sorting, and lack of understanding the value of waste as a resource. Using a Likert scale, these factors were ranked based on the number of respondents who chose these factors as impediments to waste sorting at source.

Table 7 Reasons why sorting is not done.

Factor	Frequency	Percentage (%)	Rank
Lack of waste sorting facilities	356	24	1
No incentives for waste sorting	328	21	2
Limited knowledge on how to sort waste	313	20	3
Not my responsibility to sort waste	281	18	4
Waste has no value	266	17	5

4.4.1 Waste sorting facilities and incentives

The study established that lack of waste sorting facilities such as colored bags and bins was the key factor (24%) impeding households from separating waste at home. Garbage collecting companies failed to administer more than one garbage bag per household, thereby constraining households to dispose all waste in one bag. This implies that more waste ends up in landfills, thereby posing more threats to human and environmental well-being. These findings demonstrate that a lot has to be done so as to increase households' confidence in separating waste at source. Administering more than one garbage bag to households would place them in a better position to separate waste, thus reducing the overall amount of waste ending up in landfills. This is in agreement with Reichel *et al*, (2013) who demonstrated that installation of waste sorting facilities for German residents through Enhance Resolution Mobile Sorting System increased the

level of recycling by 62% in 2010, and resulted to almost zero landfills soon after (Reichel et al, 2013).

Findings also revealed that there lacked incentives for waste sorting such as waivers, paying based on waste generated and installation of recycling centers within residential areas. This suggests that households were less likely to participate in promoting 4R's since their lacked platforms that encourage waste sorting at source. Hence, there is need to develop incentives that encourage households to separate waste at home, such as rewards for recycling and subsidizing garbage collection fees. These would reduce the weight on households' income and encourage them to promote 4R's at home. Studies done in Nigeria demonstrated positive results by introducing rewards-for-recycling platforms which resulted to diverting more than 1000 tons of recyclable waste from landfills into productive use (Global Opportunity Explorer, 2018)

4.4.2 Knowledge about and Responsibility of Waste Sorting

Twenty percent of households had no idea how to separate waste, thus resulted to mixing all waste in one bag. Lack of knowledge on how to sort waste translates to households having minimal concern about separating waste from the house (Mwangi *et al*, 2014). Similar studies done indicated that absence of attention and concern towards environment resulted to a culture of community negligence and lack of contributions towards policy making (Mangizvo, 2008). This brings to attention the fact that information and knowledge should be distinguished. Having information without a background of knowledge about waste may be counterproductive and ineffective in achieving change. Hence it is essential to endorse environmental stewardship, increase public participation, education and awareness in order to come up with an effective waste management strategy that supports 4R's. This will increase public understanding of waste management and thus encourage them to engage in waste sorting at source.

Behavior and beliefs of residents could be viewed as cultural and social barriers that impede households from separating waste at home. The researcher intended to know the extent to which these beliefs and behaviors impacted on their ability to responsibly manage waste as a community and not just individually. Majority of the respondents stated that they do not sort waste because their neighbors do not sort waste. This demonstrates that societal behaviors impact on individual's responsibility to manage waste and can potentially be inherited from one individual to another. The belief that waste handling is the responsibility of garbage collectors or local authorities unfortunately translates to the heavy burden imposed on these authorities who lack capacity to deal with the waste menace. Similar studies done by Longe et al (2009) demonstrated that residents believed waste management was the government's responsibility, thus chose not to participate. This is a challenging problem compounded by increase in population and lack of environmental knowledge. Other studies done by Kibwage (1996) revealed that households in urban centers lacked comprehensive knowledge on storage, collection, and disposal of waste Therefore, increasing environmentally relevant knowledge would play a significant role in modifying environmental behavior, thus increasing the responsibility to separate waste at source.

4.4.3. Value of Waste

The researcher had intended to know how the public perceive waste. This was so as to understand the level of appreciation for the value of waste as a resource and not just something to dispose. The findings revealed that respondent's believed solid waste holds no value to them and hence did not sort waste. The implications of not viewing waste as a resource translates to a society that is not environmentally sensitive. This explains why one of the key impediments to achieving proper solid waste management is negative attitude from the public since they lack

concern and believe the problem is unsolvable (Njagi *et al*, 2013). Additionally, people handling garbage collection are not highly regarded by the society. This negative attitude towards garbage collectors is likely to impinge on their continuity and service provision, thus leading them to focusing more on gaining profit, rather than spreading environmental awareness to the public. Lack of respect for garbage collectors and their efforts also results to poor workmanship and low working morals (Mwangi et al, 2014). Therefore, there is need to reinforce public participation, and mindfulness in order to enhance engagement in proper waste management practices, such as 4R's.

Table 7 illustrates key factors impeding waste sorting in Roysambu households: unavailability of waste sorting facilities, limited knowledge and incentives in waste sorting, and lack of understanding the value of waste as a resource. Further investigations established that households would be willing to sort waste if these challenges were addressed. If garbage collectors were given a directive to provide more than one garbage bag, the households will be in a better position to separate waste, thus resulting to promotion of 4R's.

4.5 Engagement of Garbage Collectors in 4R's Promotion

Focus group discussions with garbage collectors revealed that they had been operating in garbage collection business for more than five years and had acquired substantial skills and experience in handling of waste. The average number of employees working in the business was eight employees, indicating that the work force in the garbage collection industry is only but at an average level. Garbage collectors sourced waste from households and business premises within Roysambu sub-County. When asked whether they were involved in 4R's, four companies stated that they were indeed engaged in 4R's promotion. Only one company was not involved, expressing that their core business was not to recover waste, but rather to collect and dispose at

Dandora Dump site. It is however important to note that despite majority of the garbage collectors getting involved in waste recovering and reuse, most if it was done informally and in small scale. Five key issues were raised in focus group discussions i.e. High transport/operational cost, unstable revenues generated, lack of support and markets for recovered wastes were the key challenges hindering 4R's promotion.

Table 8 Issues experienced by garbage collectors while engaging in 4R's

Issues	**Rank**
High transport/operational cost and unstable profit generation	1
Limited markets for recovered waste	2
Lack of support which encourage 4R's	3
Poor infrastructure in waste sorting	4
Lack of protective gears	5

Table 8 revealed that the cost of doing business, waste sorting and transporting garbage was expensive. The groups expressed that providing more than one bag to the households would incur heavy cost on their businesses and reduce profits, therefore settling to issue out only one garbage bag per household, per week. These findings concur with those of Ondieki (2014) who alluded that high operational cost hindered waste recycling enterprises from engaging in 4R's promotion.

They added that trucks suffered breakdowns while maneuvering through the Dandora dump site and this incurred the cost of breakdown services as well as wasting time in recovering trucks from the dump. Acquiring license to operate was found to be dogged with punitive regulations since in most cases, the groups were required to own truck before acquiring a license, something that they could not afford. The study revealed that lack of markets for recovered waste also hindered engagement in 4R's. The garbage collectors stated that markets for selling recovered waste were undeveloped and inadequate. They expressed disappointment in low profit margins

from selling recovered waste, stating that recovered organic waste was sold to only a few individuals with pig farms within the area. The groups were faced with lack of support from county government, asserting that they never participated in any training or capacity building for 4R's. Other challenges identified include poor infrastructure and lack of protective gears while sorting waste. Many expressed that unavailability of effective infrastructure resulted to a cumbersome waste sorting process which was time consuming. They were also exposed to dangers of infections and diseases due to lack of protective gears while handling waste.

More opportunities would be exploited were these challenges dealt with. For example, high transport and operational costs could be addressed by use of efficient technologies. Capacity building and training sessions would ensure success and sustainability by encouraging the groups to take more action in recovering waste. Protective gears would ensure that employees are protected from infections and effects of hazardous waste.

4.5.1 Willingness of Garbage Collectors to Reducing Garbage Collection Fees

Households waste collection fee is equivalent to resource cost as well as external environmental charges (Gakungu *et al*, 2012). In Roysambu sub-county, garbage collection fees are not based on quantity of waste generated, but rather the house type and location. Additionally, findings revealed that households who did not pay for waste collection services felt that the fee was high and hence, could not afford. This brings about the aspect of inequity and unfairness due to the fact that households are not involved in decision making concerning the amount of fees to pay. Nonetheless, reducing the cost of garbage collection would act as an incentive that encourages households to engage in 4R's. It would also benefit them by reducing the cost of treatment for illness caused by solid waste, as well as peace of mind brought about by a clean and healthy environment. Indeed, Furedy (1992) indicated that subsidizing waste collection fees is

significant in achieving proper waste management as it would prevent external environmental cost caused by illegal dumping. Therefore, it was important to establish how much garbage collectors were willing to reduce the cost of garbage collection fee if some aspects were fulfilled. By adopting contingency valuation, three groups stated that supposing there were markets for recovered waste, they were willing to reduce the cost of garbage collection by 8.6%. This readiness to promote 4R's has a direct impact on enforcing sustainable waste management and can potentially be mainstreamed in policy making. Further investigations were undertaken to identify why the two groups were not willing to reduce garbage collection fees for households. Both groups stated that households were not interested in waste management, therefore the cost of operation might be high without realizing the profits. They added,

"Resource recovery and reuse is not our core business because our employees are mostly casuals. They do not really care much about environmental protection and conservation, but rather cared about the mere income they earn for survival".

4.6 Gaps in Policy and Institutional Frameworks Governing 4R's Promotion

The Fourth Schedule (Part 2) of the Constitution outlines responsibilities to the county government including removal of refuse, dumps and disposal of solid waste. In efforts to sensitize and facilitate pubic participation, monthly clean up days were introduced. However, with respect to garbage collection, it does not address the concerns in 4R's promotion. Despite monthly clean up days being introduced, only hundreds out of thousands of residents actually turned out to participate. According to Roysambu Garbage Collectors Association secretary (RGCA), lack of equipment and gears for cleaning were inadequate, resulting to the low levels of participation on the ground. Richard (2017) further indicated that discussions around designated waste collection points did not involve the residents and only 40 percent were aware of the

organized clean up days. Similar studies in Nigeria demonstrated that despite introducing monthly clean up days, the initiative produced more waste problems due to poor management and enforcement problems (Mugambi and Gichuki, 2017).

The National Environment Policy 2013 states that the government shall provide a wide range of training opportunities and modules in the field of environmental management. Nevertheless, the county government does not explicitly promote 4R's as garbage collectors expressed their disappointment, stating that the county government did not provide training sessions or workshops. It has failed to tackle the fundamental problems associated with waste minimization at source. Hence, youth groups lack opportunities to optimize and scale up their operational capacity. There is need to appraise the National Environment Policy to offers effective training opportunities and occasional workshops for garbage collectors as this would strengthen their understanding, skills and knowledge in environmental protection.

Section 88 of EMCA obligates NEMA to issue out licenses for waste handlers. In efforts to promote waste recovery and reuse, youth groups and CBO's were issued with licenses and recognition letters for them to operate formally. While they played an important role in waste management, four groups were engaged in 4R's promotion with only three agreeing to reduce garbage collection fees. This meant that some garbage collectors were engaged in the practice only for profit gains, with little attention given to environmental protection.

Section 1(1) of the Waste Management Regulations, 2006 states that the Authority in consultation with the relevant agencies may designate geographical locations for operations by licensed waste operators. The county government ward environmental officers stated that they had designated some areas for waste collection within residential areas. However, youth groups and waste pickers were of a contrary opinion, stating that there were no designated areas or space

for sorting the waste. In fact, some youth groups and CBO's deliberately allocated collection points for themselves, some resolving to squatter in private individuals properties and even next to the main road. They added that despite the county government providing trucks at a subsidized price, garbage usually stays for long at these collection points because the trucks take long to arrive. In some cases garbage would stay in collection points for two weeks before the county government trucks showed up. NCG is reported to have only 20 functioning waste collection trucks operating at a time, yet Nairobi itself comprises of more than 3 million inhabitants (Ministry of Environment and Natural Resources, 2016). This lack of designated areas and trucks for waste collection and sorting hindered the garbage collectors weekly operations, including 4R's. This resulted to garbage collectors failing to adhere to their weekly collection schedule, thus struggling to complete their duties. Therefore, the regulations should be repealed since they do not tackle the problem on the ground.

The National Solid Waste Management Strategy Plan, 2015 states that the county government and licensed service providers should provide color coded bags for waste segregation. The finding revealed that there still lacks infrastructure to manage different waste streams at household level. Waste separation was only practiced in hospitals where separation facilities for sorting hazardous waste were provided. The interviewed garbage collecting companies stated that the current unavailability of color coded bags exposed them to accidents and infections caused by combining all waste in one bag. Unsorted waste from households comprised of hazardous waste such as syringes, metal and glass which risked their health. This goes against section 70(1) of EMCA which prohibits dangerous handling and disposal of waste that causes ill health. In view of this, there is need review the plan in order to equip waste handlers with protective gears and color coded bags.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS.

5.1 Conclusions

On factors impeding waste sorting at source, the study concluded that households lacked proper household waste management systems that would facilitate 4R's. While Article 69(d) of the Constitution of Kenya mandates the state to promote public participation in matters of protection, management and conservation of our environment, as well as delegating implementation and enforcement duties to the county government in collection and handling of waste, these policy provisions are weak since the state does not explicitly support waste sorting from the source. Hence with no proper intervention, the bottlenecks witnessed in the study will continue to hinder 4R's, and thus infringe citizens' right to a clean and healthy environment.

On engagement in 4R's promotion, the study concludes that the county government does not explicitly promote 4R's because it does not consider the garbage collectors capacity in waste management. It is vital to ensure that there exists a functional waste management mechanism to enhance collaboration between the county government, garbage collectors and households. Incentives such as reducing garbage collection fees can be mainstreamed into policy and practice when factors such as markets for waste resources are considered in policy formulation. Additionally, successful adoption of 4R's is rooted on political goodwill, financial support, rigorous enforcement agency and participation by every individual.

On policy and institutional frameworks governing solid waste management, the study concludes that the roles of various stakeholders in waste management are clearly articulated, but their responsibilities and enforcement structures are weak. The existing gaps in policy and institutional frameworks for facilitating 4R's, together with their weak enforcement strategies and lack of political will have enhanced their vulnerability to negligence and therefore, hindered successful adoption of 4R's at county and national level.

5.2 Recommendations

Based on the conclusions, the study draws major lessons learnt which policy makers should take advantage of.

1. The researcher recommends increased public participation, education and awareness, more importantly focusing on how to sort waste, value of waste and available markets where recovered waste can be sold. Residents should be aware that they are the waste generators and it is upon them to manage waste properly. Establishing community structures will help divulge information to sensitize citizens on their rights and responsibilities in promoting 4R's. These structures will provide a platform for such communities to channel bottom-up feedback on matters concerning waste management, thus creating a basis for an environmentally sensitive society.
2. There is need to develop incentives that encourage households to sort waste at home, such as rewards for recycling and subsidizing garbage collection fees. These would reduce the weight on households' income thus encourage resident to promote 4R's at home. To promote waste sorting at source, household should be equipped with various color coded papers/ containers that can be used to store sorted waste. Subsequently, households with children will be better placed to promote the habit of waste sorting, thus act as entry points in creating an environmentally sensitive generation for the future.
3. There is need to increase markets for recovered waste by creating a link between garbage collectors engaging in 4R's, together with other companies involved in waste recycling. This would strengthen ties and create a direct link of communication by providing a platform for information sharing. Improving markets for recovered waste would enhance revenue generation, thus encourage garbage collectors to engage more in 4R's promotion.

4. There is need to provide technical assistance to garbage collectors engaging in 4R's. High transport and operational costs could be addressed by use of efficient infrastructure. This will drive down operating cost and time significantly, thus enhance revenue generation. Development of an efficient, prompt, accurate and safer billing method will also reduce the losses incurred. Garbage collectors should be equipped with protective gears which would prevent infectious diseases and effects of hazardous waste.
5. The government should provide formal technical, management training and capacity building for garbage collectors engaged in 4R's promotion. Increasing their knowledge on proper waste management practices will not only make them profit oriented, but more environmentally benign. Such informative sessions would encourage the groups to take more action in recovering waste, thus creating greener job opportunities.
6. The process of acquiring licenses should be more stringent, allowing garbage collectors to operate only if they are engaged in 4R's promotion. Strengthening regulations will ensure that garbage collectors can be instructed to consider 4R's as a key component of their waste handling activities. This will ensure efficient and swift enforcement of existing policies and by-laws that promote the 4R's.

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APPENDICES

APPENDIX 1: QUESTIONNAIRE

Introduction

This study seeks to investigate factors hindering waste sorting, recovery and reuse by households and garbage collectors within Roysambu Sub County. You have been randomly selected to participate in this study. The survey will take approximately five minutes to complete. Kindly note that all answers are strictly confidential and will be used for academic purpose only. Thank you.

(Please tick or fill in the spaces provided as appropriate and exhaustively)

SECTION A: FACTORS HINDERING WASTE SORTING (HOUSEHOLDS ONLY)

(Please tick appropriately)

1. Gender Male ☐ Female ☐

2. Age

Below 18 yrs.

☐

18-24yrs

☐

25-34yrs

☐

35-44yrs

☐

Above 45yrs

3. What is your highest level of achieved education?

Primary ☐

Secondary ☐

College/University ☐

4. House Ownership Owner ☐ Tenant ☐

5. House type Flat/Apartment ☐ Bungalow/Mansion ☐

6. Approximately how much is your gross monthly income? (*Kindly choose a bracket*)

Less than 30,000

31,000-60,000

61,000-90,000

Above 90,000

7. Do you pay for waste management services?

If Yes, How much?

Ksh 250 ☐

Ksh 500 ☐

If No, Please indicate why?

……
……
……

8. Who collects your waste? County government ☐
Private Company ☐
Informal collectors ☐

9. How frequent? Everyday ☐
Two Times/week ☐
Once a week ☐
Once/month ☐

10. Estimated type of Waste collected Food /Kitchen Waste (Biodegradables ……%

Plastic/ Glass/cans (Non-Biodegradable) ……%

11. What is your current waste management system?
(i) Waste disposal without sorting ☐
(ii) Waste disposal with sorting ☐

12. Kindly state how well you agree or disagree with the following challenges affecting waste sorting at home.

Reason why waste is not sorted in the house	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
It is not my responsibility to sort waste					
There lacks incentives for waste sorting in the house					
Solid waste has no value to me					
I do not have bins/garbage bags for sorting waste					
My neighbors do not sort waste					
There lacks knowledge on how to separate the waste					

13. Would you be willing to sort waste if the above challenges are addressed?
Yes ☐

If No, Why?
……
……

SECTION B: REDUCTION IN GARBAGE COLLECTING FEES (GARBAGE COLLECTORS: PRIVATE, CBO'S, AND YOUTH GROUPS ONLY)

1. How long have you been operating in this industry?

Less than 2 yrs. ☐
3-5 yrs. ☐
Above 5 yrs. ☐

2. Approximately how many employees are there in your business?

3. Which areas do you collect the waste?

Source	Specific area of collection
Households	
Dump sites	
Street waste	
Offices	
Waste pickers	

4. Are you involved in resource recovery, reuse and recycling?
Yes ……..
If no, Why? (*Please tick appropriately*)

We have not registered as a recycling business ☐
It will not bring any change to the environment ☐
It is not our core business ☐
We are not well equipped ☐
Strict regulations and Policies ☐
Any other reason?
……
……
……

5. What do you consider the main challenge in the waste reuse and recovery business?
(Please tick appropriately)

Challenges faced in 4R's	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
There are low profit margins					
Regulations and licensing in waste reuse and recovery punitive					
There lacks incentives for waste sorting from the source					
Transport and operation costs are high					
There lacks affective technologies and equipment for recycling.					
We do not get support from the county government and NEMA					
Poor sanitary/ hygiene conditions					

8. Would you be willing to pay for sorted waste from the household?
(Please Indicate below)

Payment Card	**Which of the amounts listed below describes your maximum willingness to pay every year, through a tax surcharge, to improve engagement in 4R's if markets for recovered waste are provided?**	
Amount (Ksh)	I would definitely pay(√)	I would definitely not pay
5000		
10000		
15000		
20000		

If no, why?
……
……

SECTION C: GAPS IN LEGISLATIVE AND INSTITUITIONAL GUIDELINES (GOVERNMENT AUTHOURITY ONLY)
Officers place of work ……

1. Given the legal provisions in waste recovery and reuse, are there implementation/enforcement strategies put in place that support waste recovery and reuse?

If yes, which ones?
……
……
……
……
If no, why?

2. What would you say are the main challenges experienced in waste recovery and reuse sector from a legal/institutional perspective?

……
……
……
……

3. What is being done to counter these problems?

……
……
……
……

4. How would you rate the following statements with regards to areas of conflict in waste recovery and reuse sector.

Statements on suggested areas of conflict in waste recovery and reuse sector	Severe	Serious	Not so serious	No problem
Inadequate allocation of funds to support waste recovery and reuse				
Poor infrastructure in handling of recovered waste				
Lack of technological knowhow in handling of recovered waste.				
Undeveloped markets for recovered waste				
Lack of public awareness on importance of sorting waste from the source				

5. What do you think should be done to maximize opportunities in waste recovery and reuse sector?

……
……
……
……

Thank you for participating in this survey.

APPENDIX 2

Figure 3 Dump sites in Githurai