University of Nairobi

School of Engineering

DEPARTMENT OF CIVIL AND CONSTRUCTION ENGINEERING

Action Plan for the Promotion of 3R in Solid Waste Management in Nairobi County

By

George Omondi Ralak

F56/74533/2014

SIGNATURE: ……..…… DATE: ……..……..

DEAN, SCHOOL OF ENGINEERING

SIGNATURE: ……. DATE: ……

CHAIRPERSON, SCHOOL POSTGRADUATE STUDIES COMMITTEE (SPSC)

SIGNATURE: ……... DATE: ……

CHAIRPERSON, DEPARTMENT OF CIVIL AND CONSTRUCTION ENGINEERING

SIGNATURE: ……. DATE: ……..

This Thesis is submitted with my approval as University Supervisor

SUPERVISOR: Prof. Patts M. A. Odira

SIGNATURE: ……. DATE: ……...

SUPERVISOR: Dr. Simeon O. Dulo

SIGNATURE: ……. DATE: ……...

Thesis submitted in partial fulfilment of the Degree of Master of Science in Civil Engineering (Environmental Health Engineering Option) in the Department of Civil and Construction Engineering of the University of Nairobi

August 2019

Declaration

I, Ralak George Omondi, hereby declare that this thesis is my original work and has not been presented for a degree in any other university."

…… …….

Ralak George Omondi, Student Date

"This thesis has been submitted for examination with our approval as university supervisors.

…… …….

Prof. Patts M. A. Odira, Date

…… …….

Dr. Simeon O. Dulo Date

Plagiarism Statement

This thesis was written by me and in my own words, except for quotations from published and unpublished sources which are clearly indicated and acknowledged as such. I am conscious that the incorporation of material from other works or a paraphrase of such material without acknowledgement will be treated as plagiarism, subject to the custom and usage of the subject, according to the University Regulations on conduct of examinations. The source of any picture, map or other illustration is also indicated, as is the source, or unpublished, of any material not resulting from my own experimentation, observation or specimen-collecting.

Name	**Signature**
Ralak George Omondi	……

DEDICATION

I wish to dedicate this thesis to my parents, Fred and Christine Ralak for their unfailing support from the beginning and in the course of my studies.

ACKNOWLEDGEMENT

I would like to acknowledge my academic supervisors, Prof. Patts Odira and Dr. Simeon Dulo, for the advice and guidance in the course of the study and making it a success.

I would also like to acknowledge the NoRAD WaSo University Chapter, through Prof. Francis Mutua for the opportunity to travel to Sri Lanka for a research exchange program at the University of Peradeniya, Kandy. Recognition also goes to the Department of Civil Engineering at the University of Peradeniya, Sri Lanka, specifically Dr. Gemunu Herath and Prof. S. B. Weerakoon. The opportunity and time spent with them enabled me to learn a lot and add value to my research.

Appreciation also goes to the members of staff of the Department of Environment at the Nairobi City County for allowing me to conduct the study within the county, and for the time taken to respond to queries that informed the study. Worth mentioning is the Embakasi East sub-county Environment officer who had been instrumental during data collection.

I also wish to appreciate my family and friends for the support and encouragement in the course of the study. Last but not least, I am grateful to God for all the strides made and the achievements thus far.

ABSTRACT

Waste management in many cities such as Nairobi has largely been centred on collection and disposal. This approach has however come under scrutiny due to increased waste quantities over time. Such has led to the strain of the existing waste sinks such as the already filled up Dandora dumpsite and increased negative impacts on the environment and public health. The aim of this study hence was to develop an action plan to promote the 3R in solid waste management in Nairobi County. Specifically, the objectives were to investigate the management of solid waste in Nairobi County, targeting Upper Savanna and Lower Savanna Wards as case studies; to identify waste management gaps, suggest interventions to address the gaps, and to develop an action plan to foster 3R (reduction, reuse and recycling) in waste management in the target area. The study was focused on municipal wastes, specifically from domestic and commercial sources. Baseline data was obtained using questionnaires responded to by households and commercial premises, and interview schedules for the Department of Environment in Nairobi City County and community groups involved in waste management. About 91% of the respondents in the study area indicated that they receive waste collection services, mostly from local community groups (67%). Despite this, open dumping and burning of waste was found to be a common practice (40%). Other noted gaps were low waste separation, limited efforts towards the 3R, and low public awareness and participation. To address these gaps, the study proposes maximum waste collection as a first step, followed by waste separation at source. These are then to be followed by 3R which attacks a

waste stream in a manner that takes steps to sequentially Reduce, Reuse, Recycle and Recover a waste stream. The cross-cutting item supporting the three is public awareness and participation, which would play a key role in introduction, implementation and sustenance of the proposed action plan.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF EQUATIONS

LIST OF ABBREVIATIONS AND ACRONYMS

3R/3Rs	Reduce Reuse Recycle
4R/4Rs	Reduce Reuse Recycle Recover
ADB IGES	Asian Development Bank Institute for Global Environmental Strategies
CBOs	Community based organisations
CCN	County Council of Nairobi
FNQLSDI	First Nations of Quebec and Labrador Sustainable Development Institute
GDP	Gross domestic product
ISWM	Integrated Solid Waste Management
JICA	Japan International Cooperation Agency
KNBS	Kenya National Bureau of Statistics
KSH	Kenya Shilling
LKR	Sri Lankan Rupee
MSW	Municipal Solid Waste
NEMA	National Environmental Management Authority
NGOs	Non-governmental organisations
NSWMSC	National Solid Waste Management Support Centre

SATREPS	Science and Technology Research Partnership for Sustainable Development Program
SID	Society for International Development
SWM	Solid Waste Management
UN HABITAT	United Nations Human Settlements Program
USD	United States Dollars
UNEP	United Nations Environment Program
US EPA	United States Environmental Protection Agency

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Solid waste management can be defined as the activities pertaining to the control of generation, storage, collection, transfer, transport, processing and disposal of wastes in a manner that is in accord with the best principles of public health, economics, engineering, conservation, aesthetics and other environmental considerations (Munala and Moirongo, 2011). Based on this definition, there are five main elements of solid waste management: generation, storage, collection, transport and disposal (Mwangi, 2011).

Baud, Post and Furedy (2004) noted that traditionally, local governments centred their urban solid waste management strategies on effective collection, transportation and disposal services with the aim of protecting and improving public health standards. This approach came under increasing pressure and scrutiny in the industrialised world in the 1960s and 1970s, as changing consumption patterns resulted in rising waste generation rates further straining the already overstretched waste sinks. The initial success of maintaining public health by removing waste from cities and dumping it outside did not last for long. This was because open dumps and open burning started having their own impact on public health and on the natural environment (Memon, 2010). This situation is further aggravated by the increase in population which

would result in the increase in quantity and complexity of waste generated (Adeolu et al., 2014).

Scenarios of increased waste quantities and overstretched waste streams have been seen to play out in various developing countries. Ifegbesan (2010) pointed this out by noting that one of the greatest challenges facing developing countries is the unhealthy disposal of solid waste. Nairobi is a good example with various sources indicating that less than half of the waste generated is collected for disposal at the designated dumpsite in Dandora, with the rest ending up in illegal dumpsites (JICA, 2010; Kasozi and Blotnitz, 2010). Furthermore, the Dandora dumpsite has been reported to have had a negative impact on the health of the residents living nearby and the environment through the contamination of water, soil and the air (Kimani, 2007). Moreover, the dumpsite has been reported to be approaching its capacity (Njoroge et al., 2014).

Such situations have led to the need for the adoption of the integrated solid waste management, ISWM, which can be defined as a comprehensive waste prevention, recycling, composting, and disposal program (United States Environmental Protection Agency, 2002). It is based on the hierarchy of waste management: reduce, reuse, recycle and recover, followed by land filling, incineration and any other disposal option (Hoornweg and Bhada-Tata, 2012). From the hierarchy emanates the 3R principle, which is defined by the first three items or actions in the list: reduce, reuse and recycle.

The 3R concept has been employed in strategies for promoting resource circulation, where waste is viewed as a resource. According to Memon (2010), 3R can be achieved through ISWM, with the aim of reducing waste due for disposal and maximizing the recovery of materials and energy from waste. Furthermore, the 3R has been described as the centre of discussion in ISWM (Mwangi, 2011). According to Yang et al (2015), resource circulation can be achieved through the modification of the 3R activities, where energy recovery was introduced to the 3R, thus resulting to the 4R (reduce, reuse, recycle and recovery).

Further afield, a number of countries and authorities have made steps towards the promotion of waste reduction and recovery. An example is Sri Lanka where the Pilisaru Project was created under the Central Environmental Authority. The outcomes of this project include the construction of compost plants and recycling centres, and the development of the National Strategy for Solid Waste Management, and the National Policy on Solid Waste Management. According to Sato et al (2014), these two documents clearly mention the 3Rs with objectives that spell it out. Sri Lanka has also realized the establishment of the National Solid Waste Management Support Centre; whose roles and strategies surround the minimization of waste and resource recovery. Furthermore, various waste reduction and recovery efforts have been made in several local authorities within Sri Lanka with varied degrees of success having been reported.

Unlike in Sri Lanka, little has been reported about the improvements in solid waste management in Kenya, specifically Nairobi, especially with regards to the 3Rs. Various literature, including media reports, and personal observations mostly indicate that solid waste management is centred on collection and disposal in both legal and illegal sites. For instance, Mwololo (2016) mentioned that the county authority acknowledged that the waste generated exceeded its capacity to manage and made a remark on the tales of heaps of garbage lying around in various neighbourhoods. Such situations leave room for the assumption that waste management in Nairobi is largely focused on collection and disposal, and there is need to increase the efforts towards waste reuse, reduction and recycling. Hence the aim of this study was to develop a framework for promoting the 3R in solid waste management in Nairobi County.

1.2 Statement of the problem

The city of Nairobi and the country at large has seen a considerable increase in population. The population growth rate in the country was reported to stand at 3% in 2009 and is currently estimated to be at about 2.5% in 2016 (United Nations Department of Economic and Social Affairs, n.d.). Going by Adeolu et al (2014), this increase in population would result in the increase in the quantities and complexities of the waste generated in the city. According to Mwololo (2016), the increase in waste generation quantities has been

acknowledged by the County Government of Nairobi, thus making large waste quantities a cause for concern in solid waste management in the county.

Furthermore, the county is also experiencing challenges in its existing waste disposal options. Dandora, which is regarded as the only official dumpsite in the city, is reported to be rapidly approaching its capacity (Njoroge et al, 2014). Kimani (2007) also mentioned that the dumpsite has had a negative impact on the environment and the health of residents that have their dwellings near the site. In addition, Nairobi has seen the emergence of several illegal dumpsites, open dumping and open burning as a means of waste disposal. Hence continued reliance on collection and disposal only as a way of managing the increasing waste quantities in the county would only further aggravate the situation.

Literature reviewed indicated that there are waste reduction and recovery activities that have been done within the county by various parties but have been marred by various challenges such as negative attitudes towards material reuse, poor waste segregation and lack of policies to encourage waste recovery and reduction efforts. According to Kasozi and Blotnitz (2010), only about 5% of the waste generated underwent reuse or recycling. This study therefore aims to develop an action plan to promote the reduction, reuse and recycling of solid waste in Nairobi County.

1.3 Objectives of the study

The overall objective of the study is to develop an action plan to promote solid waste reduction, reuse and recovery in Nairobi County.

The specific objectives of the study are:

i. To study the management of solid waste in Nairobi
ii. To identify the gaps in waste management in Nairobi County
iii. To propose interventions to address the waste management gaps in Nairobi County.
iv. To develop a solid waste management action plan for a selected area in Nairobi County as a case study.

1.4 Significance of the study

Kenya, being a developing country, is experiencing growth in its economy, with the growth rate being placed at about 5.7% in 2016 (World Bank, 2016). This growth comes with changes such as consumption patterns and to some extent, an increase in population, especially in urban areas. This can lead to an increase in the quantity of waste, a scenario similar to the industrialized countries in the 1960s and 1970s as pointed out by Baud, Post and Furedy (2004).

With the focus of the study being the 3R in solid waste management, the outcome of this study can be a step towards the achievement of the goals of increased waste recovery quantities as stated in the National Solid Waste Management Strategy in Kenya. The long-term goal of the strategy is to achieve 80% waste recovery and 20% landfilling by the year 2030. The 3R, if well implemented, can considerably increase the fractions of waste recovered and reduce the amounts due for disposal.

Furthermore, the study has looked into the waste management practices in other countries from which good practices could be borrowed, one such country being Sri Lanka, which shares a few similarities with Kenya. Both countries are located in the tropics; they are developing countries with more or less the same GDP growth rate of about 5.7% for Kenya and 5.6% for Sri Lanka (World Bank, 2016). The similarity in economic growth can be an indicator of similarity in the experiences in solid waste management connected to the growth.

With increased need for resource efficiency and the protection of health and the environment, realizable through the 3R, it is intended that this study would inspire further research into the concept, its potentials, implementation and impact, especially in Kenya and other African cities where there is little literature on the importance of and potential for waste reuse (Mwangi, 2011).

1.5 Scope of the study

The objective of the study is to develop an action plan that would aid in promoting the 3R in solid waste management in Nairobi County. As opposed to the whole of Nairobi, smaller areas were selected to be case study to represent the county. The selected areas were Upper and Lower Savanna wards in Embakasi East Sub-County. The focus of the study is municipal solid waste, which is defined as waste generated by residential, commercial, institutional and some industrial sources (Tchobanoglous & Kreith, 2002). Of

interest to the study was municipal solid waste, specifically domestic waste and waste from commercial premises.

The study looked at the experiences of other countries on waste reduction, reuse, recycling and recovery, specifically Sri Lanka, to inform the interventions to be proposed in the action plan. According to Zhu et al, (2008), the aim of the 3Rs is to reduce the amount of waste that ends up in landfills.

Furthermore, the study focused on the waste management elements or activities that precede disposal which can be manipulated to achieve the aims of the 3Rs, such as generation, collection and processing. With regards to the waste management hierarchy, the study targeted the top four options which are prevention, minimization, reuse and recycling, thus contributing to the reduction of the amount of solid waste due for disposal.

CHAPTER TWO

LITERATURE REVIEW

2.1 3Rs – Reduce Reuse Recycle

Choi (2011) defines the 3Rs of integrated solid waste management as reuse, reduce and recycle, which is a common definition from various sources. Some literature have however talked about '4R' instead of the '3R', with the additional 'R' having different meanings depending on the source. This approach is among the most widely adopted concept in integrated solid waste management (Agamuthu and Fauziah, 2011).

Zhu et al (2008) highlight the 3Rs as the state-of-the-art philosophy in waste management which aims to reduce the amount of waste that ends up in landfills. Mwangi (2011) describes the 3Rs as the centre of the discussion of integrated solid waste management, and an area of great emphasis in solid waste management. Memon (2010) adds that 3R is what is to be achieved through the process of ISWM: to minimize the quantity of waste requiring disposal and to maximize recovery of material and energy from waste. Furthermore, the '3Rs' can be helpful in addressing other global environmental challenges such as climate change (Peprah, Amoah and Achana, 2015). Yang, Zhou and Xu (2014) add that the 3R approach can be effective in supporting the efforts towards achieving the goals of sustainable development and a circular economy, as shown in the Source: ADB-IGES (2008).

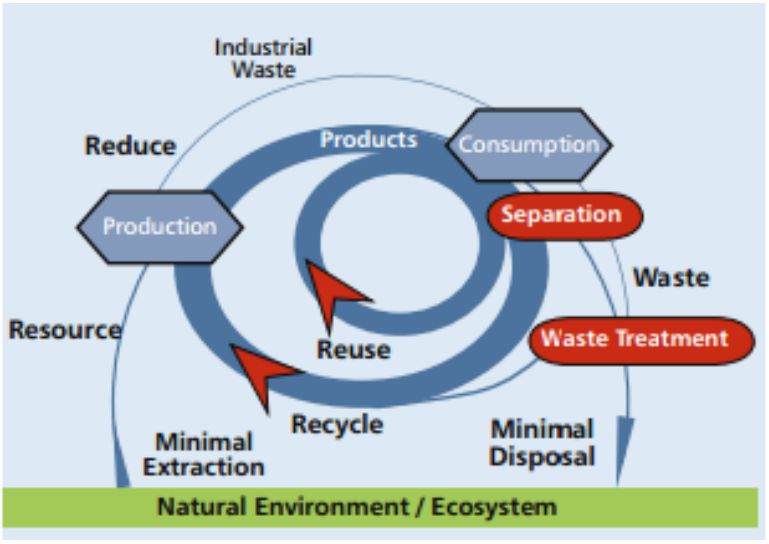


Figure 2-1: Closed loop waste economy.

Source: ADB-IGES (2008)

According to Memon (2010; as cited by Wilson, Velis and Rodic, 2013), the priorities of good waste management, at the top of the waste hierarchy, are expressed by the '3Rs'. In addition, some quarters are keen on the order in which the 3R should be implemented. FNQLSDI (2008), for instance, which embraces the 4Rs, maintains the order of waste reduction, waste reuse, recycling then finally recover. This has been reflected in the waste management hierarchy shown in Figure 2-2.

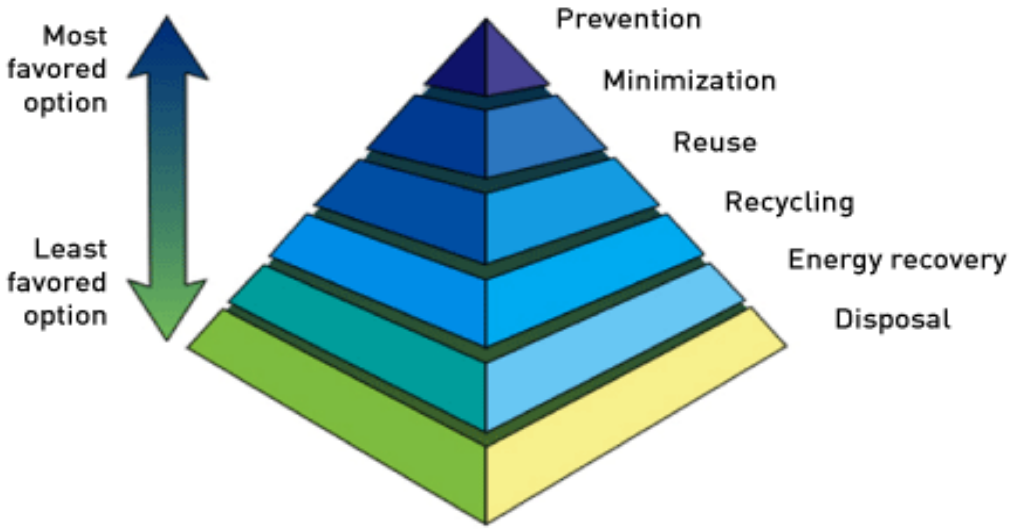


Figure 2-2: Waste Management Hierarchy

(Adopted from various sources by NEMA, 2014)

The 3R concept has proven to be workable and effective in managing solid waste in various parts of the world such as Japan, Denmark and Germany (Agamuthu and Fauziah, 2011). However, the implementation of these practices should be modified to suit the needs of the locality. Therefore, the factors that drive the practice of the 3Rs need to be well studied and understood in order to promote its implementation.

2.1.1 First R -Reduce

Source reduction, also known as waste prevention, is aimed at reducing the amount and toxicity of materials or waste that must be managed by preventing its generation in the first place. Tchobanoglous and Kreith (2002) further describe source reduction as any change in the design, manufacturing,

purchase or use of materials to reduce the amount and toxicity before they become municipal solid waste.

Reduction of waste best starts at the source, followed by production, distribution, purchasing and use. Under use and good reuse of materials and resources also do reduce the need of purchasing new ones and reduce the amount of material being disposed of as waste. Another perspective of waste reduction is composting where organic matter is biologically degraded into humus-like matter for soil conditioning (Kaluli, Mwangi and Sira, 2011). This ultimately reduces the amount of waste that goes into disposal.

The practice of waste reduction is one that faces a number of challenges, the main one being negative attitude. The perception of using less material has been seen as a sign of being 'poor'. This was noted by Mwangi (2011) in her study where those in the lower income cadre appear to be more involved in waste reuse and hence reduction. Another stumbling block to waste reduction is little or lack of awareness among citizens (Agamuthu and Fauziah, 2011, Mwangi, 2011, and Tang, 2004).

2.1.2 Second R - Reuse

Reuse can be defined as re-utilization of a waste product in its original state either for its original purpose or for a modified purpose (Agamuthu and Fauziah, 2011). It is the next preferred option after reduction. Reuse happens when something that already fulfilled its original function is used for another purpose without undergoing any reprocessing or transformation (Zhu et al,

2008). FNQLSDI (2008) speaks of reuse as the extension of life or giving a second life to something that was previously considered as waste. Reuse therefore involves thinking before deciding to get rid of a product or getting a new item to replace the old. Examples include the use of electric razors in place of disposable razors and the use of rechargeable batteries instead of regular zinc-carbon batteries (FNQLSDI, 2008).

Waste reuse has the advantage of allowing efficient use of waste and resources while having minimum effects on the environment. However, waste reuse has shortcomings in that there may be need to clean or modify the item being reused, thus the process ends up being tasking and time-consuming (Agamuthu and Fauziah, 2011).

2.1.3 Third R - Recycle

ADB IGES (2008) describes recycling as the transformation of resources into a form that can be used as an input to a new process. Recycling can also be described as a process where waste is processed to obtain a new product (Agamuthu and Fauziah, 2011). According to Zhu et al (2008), the materials are broken down into its main components which are used to make new products. For example, paper is transformed into pulp, or plastics being melted and formed into new items. Wilson, Velis and Rodic (2013) add that recycling can be split between ‘dry’ recyclables, which can be separated, processed and returned to the industrial value chain; and organic waste, which can be of

agricultural value through utilisation in processed animal feed, composting and anaerobic digestion.

Recycling is the most widely applied system among the 3Rs due to its simple procedure and effective extraction strategies. It is also applicable to a wide range of materials such as metals, paper, plastics and glass. These materials can be used to make similar products, manufacturing of other products or for conversion into energy (Agamuthu and Fauziah. 2011).

Apart from being widely used, recycling has great potential. Some parts of the United States are said to have reached 50 percent waste reduction due to recycling. It is also estimated that 80-90 % of the waste stream in the United States can be recovered through intensive recycling (Choi, 2011).

An important aspect of recycling is waste separation, especially at the source. According to a study in Indonesia by Tang (2011), the responses indicated that better source separation would help maximize recycling. The Illinois Department of Commerce and Economic Opportunity also talks about separation of waste before recycling, which can be done at a central location known as a material recovery facility (MRF), or at source.

2.1.4 4Rs

Various sources have added another ‘R’ to the traditional reduce-reuse-recycle to have the 4Rs. Recovery as the fourth ‘R’ has appeared to be more predominant in literature. In the waste management hierarchy, it is the fourth action after reduction, reuse and recycling (Hoornweg & Bhada-Tata, 2012).

FNQLSDI (2008) describes recovery as the processing of thrown-away waste materials other than destroying them. Another perspective of this is the recovery of energy stored in the material by converting it into a fuel (Zhu et al 2008). An example is methane obtained from rotting organic materials that can be used as a source of energy or fuel. Waste that cannot be reused or recycled can be incinerated to generate heat or electricity. Yang et al (2015) and Zotos et al (2009) also define the fourth R as recover, with the latter defining it as the result of the introduction of energy recovery into the existing 3R.

The Illinois Department of Commerce and Economic Opportunity (1996) refers to the fourth R as 'rebuy'. This is because the processing and manufacturing of recyclables into saleable items and their subsequent purchase is necessary to 'close the loop'. The department states that rebuying has the advantage of sustaining the demand for recycled products, among other environmental and economic benefits.

The Castro Valley Sanitary District (n.d.) mentions "Rot" as the fourth 'R' to mean composting, which is the biological decomposition of organic materials. It also adds that composting is a form of recycling. Stony Brook University (n.d.) on the other hand defines the fourth "R" as rethink. According to the university, rethinking involves considering the consequences and impacts of different actions on the environment.

Rajput, Prasad and Chopra (2009) define the 4R to entail refuse, reuse, recycle and reduce. The example given in the case of 'Refuse' is the avoidance of

purchasing or acquiring new items, such as containers, for instance, when one already has the same or similar item at home.

For the purposes of the proposed study, 3R was adopted instead of 4R. One reason is that there are varied definitions for the fourth R, while the definition of 3R is the same in all the literature reviewed. Secondly, the study aims to focus on the reduction, reuse and recycling of waste materials rather than the recovery of energy from the waste. Finally, for the review of literature, the 3R on their own do in one way or another capture the fourth 'R' in 4R as defined in various sources.

2.2 Description of Nairobi County

2.2.1 Area and population

Nairobi City County, as shown in Figure 2-3 doubles up as the capital city of Kenya sitting on a land area of about 696 km^2. It spans within the following geographical co-ordinates: $36^o39'$ and $37^o 07'$ E, and $1^o10'$ and $1^o27'$ S. The county is divided into 17 sub-counties which also double up as parliamentary constituencies and 85 wards (Nairobi City County, 2014).

The population of the county as at the 2009 population census stood at 3,138,369. With the population growth rates of about 3.8% per annum (KNBS, 2010), the population as at 2016 would stand at about 4,074,605. However, according to the United Nations Department of Economic and Social Affairs (n.d.) place the 2010-2015 and 2015-2020 average growth rate for the country

at 2.65% and 2.5% per annum respectively, which would place the population of Nairobi in 2016 at just under 4 million.

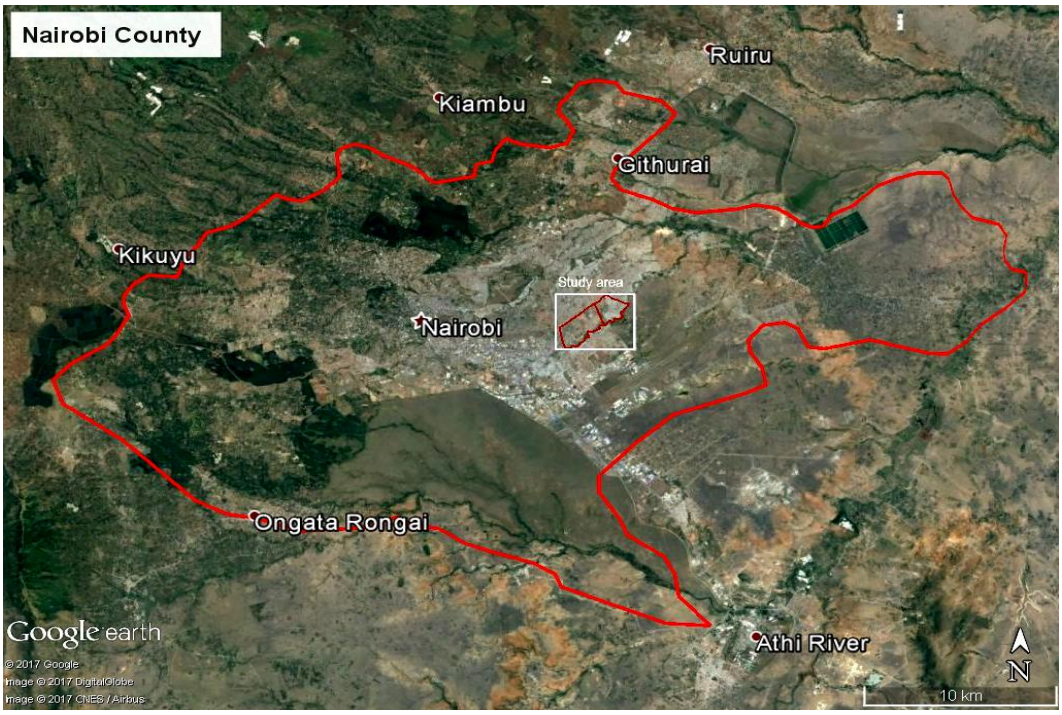


Figure 2-3: Map of Nairobi County

The Nairobi City County (2016) projected the population of Nairobi in 2012, 2015 and 2017 to stand at 3,517,325, 3,942,054, and 4,253,330 respectively. These figures were based on a geometric progression where the growth rate used was 3.87% per annum according to Kenya National Bureau of Statistics (2010). Going by this rate, the future population projections for the county are as shown in Figure 2-4.

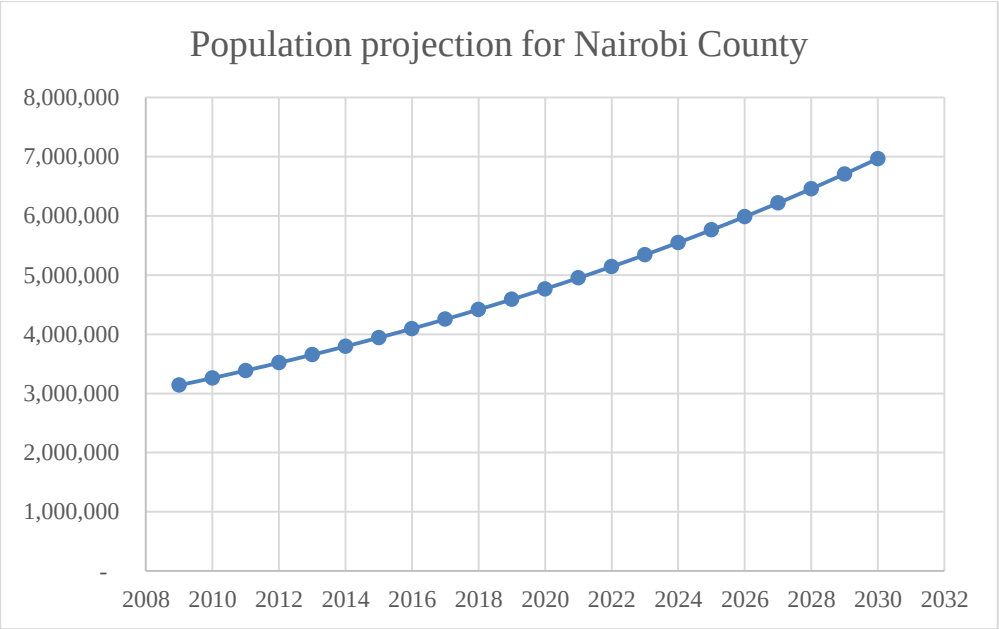


Figure 2-4: Population projection for Nairobi County

2.2.2 Nairobi City County Government

The main authority in Nairobi is the county government, part of which is comprised of the County Assembly, executive and the County Public Service Board, as shown in Figure 2-5. The Assembly is the legislative arm of the county government, composed of 127 members: 85 elected, representing 85 wards that make up the County; and 42 nominated members (Nairobi County Assembly, n.d.)

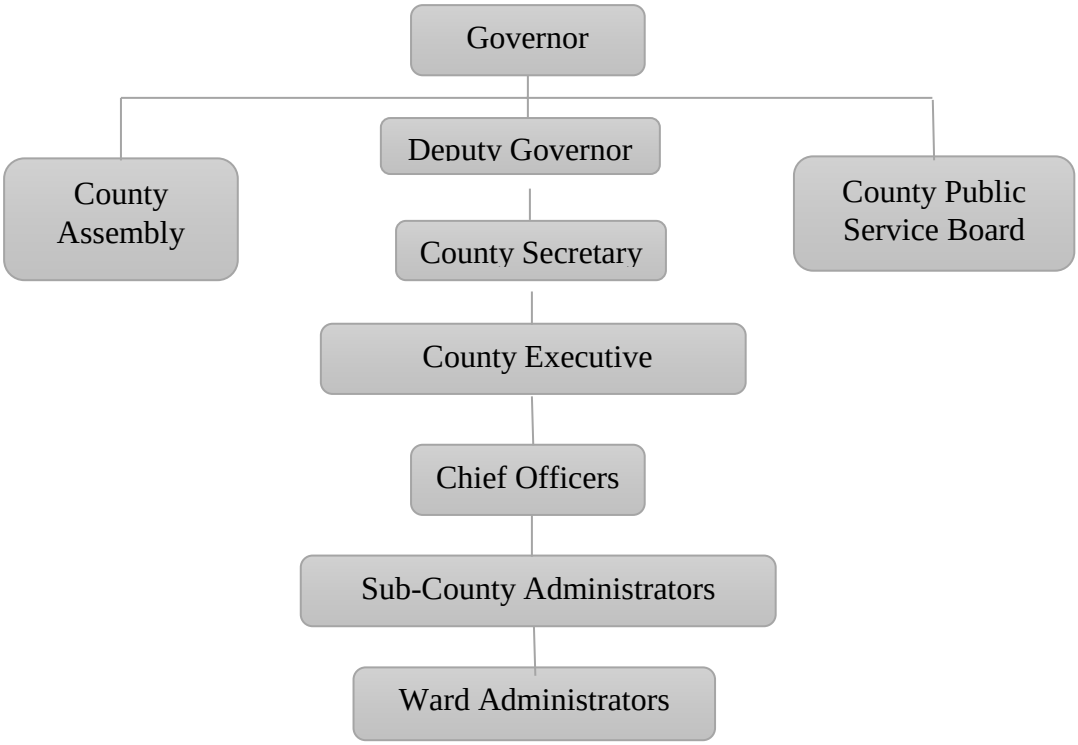


Figure 2-5: County Government Organisation structure

The other arm of the county government is the executive led by a governor and the deputy governor, under whom there is the County Executive Committee and a chief officer for each sector through which service delivery is done in the county. The responsibility of the committee is to implement the county legislation, and to manage and coordinate the functions of the county administration and its department.

There are ten sectors represented at the county committee. Out of these, solid waste management falls Water, Energy and Environment Sector; (Nairobi City County, n.d.).

2.3 Solid waste management in Nairobi

2.3.1 Legislation

In Kenya, the Environmental Management and Coordination Act (EMCA, 2015) as well as National Environmental Management Authority (NEMA) regulations on waste management mandate the respective local authorities to ensure a clean and healthy environment by properly managing wastes within their areas of jurisdiction. In the case of Nairobi, the local authority concerned is the County Government of Nairobi, formerly the City Council of Nairobi. With regards to this, the county has put in place bylaws and the Nairobi City County Solid Waste Management Act, 2015 to guide their activities. The act has been summarised in **Table 2-1**.

Table 2-1: Summary of the Nairobi City County Solid Waste Management Act 2015

Waste management aspect	**Description**
SWM responsibility	Shared between the county government, generators, owners and occupiers of properties, and contracted service providers
Separation	Waste to be divided into various categories by generators Colour codes are prescribed for specific waste categories
Duties of waste generator, owner and occupier of premises	Ensure safe collection and disposal of waste from property To separate waste at source, and ensure appropriate collection

	Ensure cleanliness around the premises
Collection, transport and disposal	Done by county governments directly or indirectly through licensed entities Charges imposed on residents for SWM Need to have proof of arrangement for waste collection services Open dumping is an offence. Disposal site is determined by the county government
Public awareness and participation	County government to promote and facilitate public education on SWM Allowance of participation of various stakeholders in SWM
Waste reduction reuse, recycling and recovery	Businesses that generate waste to demonstrate that they have established waste minimization measures County executive member establishes guidelines and undertake activities to facilitate waste materials recovery through the 3R

2.3.2 Generation, collection and disposal

UN-HABITAT (2010) and Okot-Okumu (2012) mentioned that the waste generation rate in Nairobi was about 2400 tons/day. In a preparatory survey by JICA (2010) for the City Council of Nairobi, solid waste generation for the year 2015 was projected to stand at 2,353 tons per day.

The major waste stream in Nairobi County is domestic waste, which has been found to account for more than half of the municipal waste generation as

shown in **Table 2-2** (JICA, 2010; Kasozi & Blottnitz, 2010; Okot-Okumu, 2012).

Table 2-2: Proportions of municipal waste sources

Source	**Residential stream (%)**	**Other streams (%)**
JICA (2010)	71.4	Commercial – 23.8; Market – 4.8
Kasozi & Blotnitz (2010)	68	Industrial – 14; roads – 8; hospitals – 2; markets – 1; Others- 7
Okot-Okumu (2012)	52-80	Markets, 4-20; Other commercial, 3.7-8; Institutional, 5; Industrial, 3; Healthcare, 1; Other, 11-11.4

According to JICA (2010) and Kasozi and Blotnitz (2010), the major component of municipal waste in Nairobi is organic material, which various sources report to take up between 50.9% and 69% of the waste generated. The next major components of waste are papers and plastics, which together account for about 19% of the waste. The waste composition for Nairobi as per JICA (2010) is shown in **Table 2-3**.

Table 2-3: Details of waste categories in Nairobi County

Waste category (% composition of total)	**Detail of each category**	**% composition of total generation**
Biodegradable (71.34%)	Food waste	68.9
	Other organic waste	2.44
Papers (9.43%)	Recyclable paper	4.18
	Recyclable cardboard	0.82
	Mixed papers	1.12
	Diapers	3.31
Plastics (9.42%)	Plastic sheet	3.54
	Recyclable plastic	3.32
	PET bottles	1.86
	Other Plastics	0.7
Metals		2.28
Glass		3.15
Other inorganic and unclassified materials		4.38
TOTAL		100

Solid waste collection is mainly done by private companies but only a fraction of the generated waste is collected. UN HABITAT (2010) mentions that there is 60 to 70 per cent collection coverage in the city, with about 54% of the

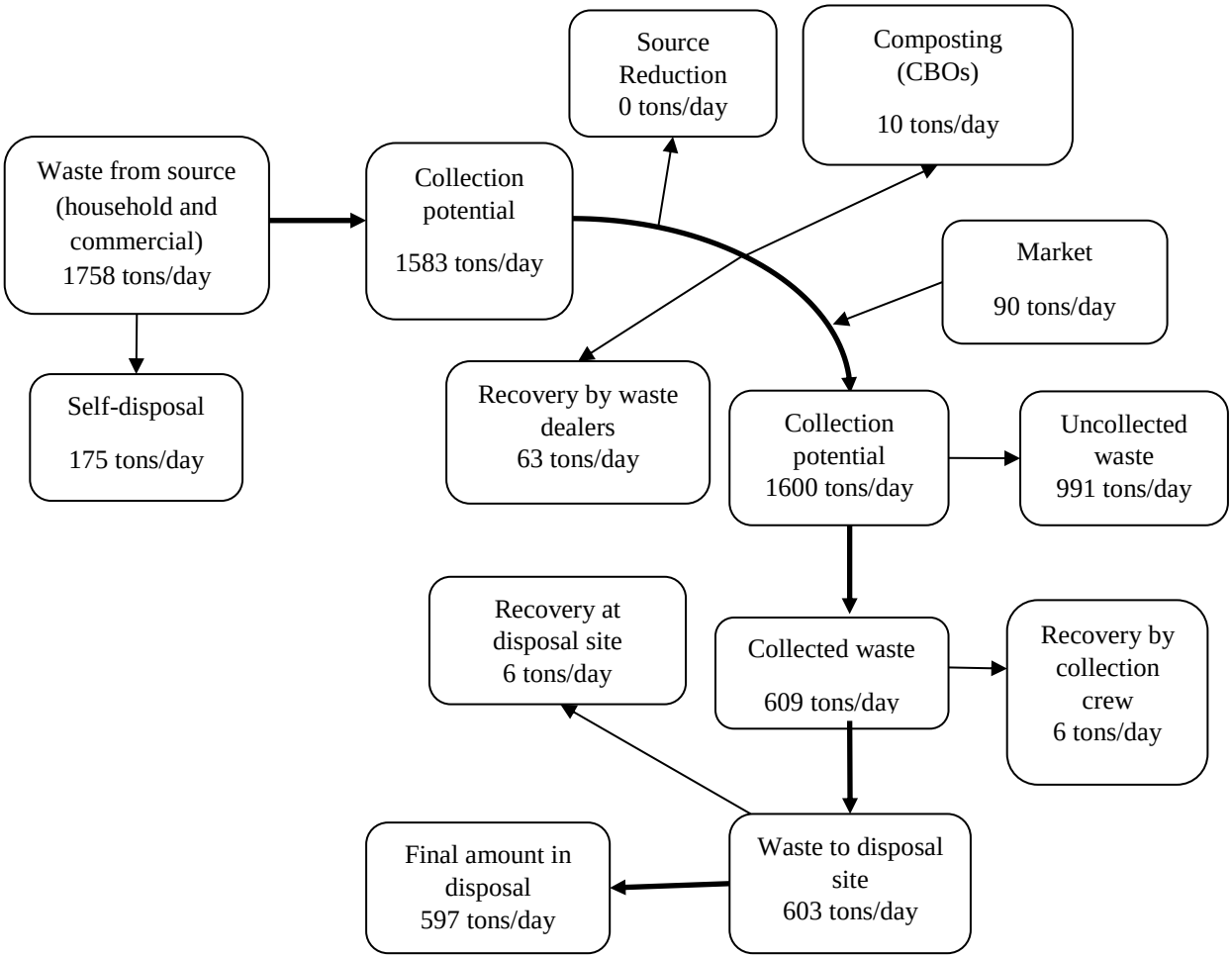
generated waste being collected. JICA (2010) on the other hand reports a collection rate of 33%, while Kasozi and Blotnitz (2010) indicate that the rate would be about 50% at best.

The waste after collection is taken to Dandora dumpsite, which is the only official dumpsite operating in the city. The dumpsite occupies an area of about 46 hectares and was owned by the then City Council of Nairobi. In addition to Dandora, there are reports of the existence of about 70 illegal dumpsites scattered throughout the city, and waste collected by some private collectors end up in these sites (JICA, 2010).

According to the Nairobi City County (2015), the rate of generation towards the end of 2014 was approximated to be 2,244 tons per day. Out of this, an average of 852 and 922 tons per day were collected and delivered to Dandora dumpsite in November and December 2014 respectively. The same report also indicated that the largest fraction of the collected waste is handled by contractors hired by the county authorities, accounting for 65% and 66.81% in November and December 2014 respectively. These contractors are then followed by the vehicles owned by the county and private vehicles, with both their fractions standing at 15%.

A summary of the flow of waste in Nairobi County according to JICA (2010) is shown in Figure 2-6.

.



2.3.3 3R related activities

A number of 3R related efforts have been reported to take place in Nairobi, majorly done by the informal sector and the private sector. The informal sector comprises of waste pickers or scavengers who collect recyclable waste from the streets or dumpsites and sell to recycling factories directly or through middlemen, who mainly are waste dealers. The private sector is comprised of the recycling factories that get the recyclable material from the waste pickers

Figure 2-7: Flow of solid waste in Nairobi County

or waste dealers. There also are community-based organisations that play the role of waste collectors, waste dealers, organic waste composters or recyclers on a smaller scale. Overall, Kasozi and Blotnitz (2010) reported that only a maximum of 5% (100-150 tons/day) of the generated waste undergoes reusing and recycling. The quantities of waste recycled in Nairobi are summarised in **Table 2-4**.

Table 2-4: Quantities of Waste recycled in Nairobi

Material	**JICA (2010)**	**Kasozi and Blotnitz (2010)**	
	Tons/day	**Recycling rate (tons/day)**	**Approx. Percentage of material generation (%)**
Organic waste (reuse)	-	3	<1
Paper	8	44	8
Plastics	23	25	5
Glass	50	Unknown	-
Metal	67	62	≈100
Total	148	144	

Reuse as one of the aspects of the 3R has been noted to be practiced at source, such as at household level. In a study of waste management in Makina area in Nairobi, Mwangi (2011) found that 40% of the respondents indicated that they reuse some of the wastes generated in their homes. Some of the reused materials include plastic bags which are used as carrying or shopping bags, containers which are reused as utensils or flowerpots, and clothes which are

given away. Also, from the same study, 80% of those that reuse waste before disposal were reported to earn less than Ksh 15,000 per month.

There have however been challenges reported to be facing waste reduction and recovery efforts within the county. Some of the issues as mentioned by JICA (2010) touch on policies, involvement of waste generators, segregation at source and provision of information. UNEP (2010) and Mwangi (2011) also mentioned negative attitudes which can be linked to lack of participation and low level of awareness among members of the public.

2.3.4 Recent interventions in solid waste management in Nairobi

A number of interventions were made in the recent past with the aim of changing or improving the prevailing solid waste management situation in the county. One notable intervention is the adoption of franchising which was aimed at improving solid waste collection. Through franchising, the county was divided into 9 zones, with each zone to be served by a single waste collector (Itere, 2014). A single zone (Zone 7) was then selected to pilot the new concept in 2014, with the contract given to a single company. This has however failed to pick up as anticipated due to the county government not doing enough awareness creation leading to low participation in the project (Mwololo, 2016).

There also have been plans to set up a new landfill site in Ruai, a site located 28 km away from the city centre and covering an area of 80 ha. This came following various challenges noted in Dandora which include the unsanitary operation conditions and its negative impacts on health and the environment.

JICA (2010) acknowledged the need to close the site as early as possible by the mention of the massive impact on the local environment due to waste fly-off and gas emissions. Kimani (2007) noted that the biggest contributing factor to the need of the transfer of the disposal site is the poor environment resulting from the poor management of the site. Furthermore, the site has been reported to be rapidly approaching its capacity (Njoroge, Kimani, and Ndunge, 2014). However, the choice of the new site has faced some setbacks due to the concerns raised by the Kenya Civil Aviation Authority about the site being on the flight path from the Jomo Kenyatta International Airport since the birds it may attract could interfere with the planes flying into and out of the airport (Mwololo, 2016).

2.4 Existing Solid Waste Management strategies and plans in Nairobi

2.4.1 The National Solid Waste Management Strategy

This document was prepared by the National Environmental Management Authority in 2014 with the aim of guiding sustainable solid waste management in Kenya to ensure a healthy, safe and secure environment for all. It discusses the prevailing situation in the country, the preferred state or targets, and how the strategy would be implemented. The strategy was proposed to cover a period of 15 years within the Vision 2030 framework and be reviewed every 5 years. With ‘Zero Waste’ as its guiding principle, the strategy recognizes the need to adopt the principle of integrated solid waste management which has

the 3R as its core. This need is further driven by the goals of improving waste recovery which were given as follows (National Environmental Management Authority, 2014):

- Short term goals - 30% waste recovery (recycling, composting) and 70% controlled dumping (tipping, compacting and covering) in key urban areas by 2020.
- Medium term goals - 50% waste recovery (recycling, composting and waste to energy) and 50% semi-landfilling by 2025.
- Long term goals – 80% waste recovery (recycling, composting and waste to energy) and 20% landfilling in a Sanitary landfill (inert material) by 2030.

2.4.2 Integrated Solid Waste Management Plan for the City of Nairobi

This plan was prepared by the members of the Environmental and Process Systems Engineering Group in collaboration with a National Task Team from Kenya for the City Council of Nairobi on assignment from the United Nations Environmental Program. It came to be as a result of collaboration between the government of Kenya and the United Nations Environment Program in response to the waste management challenges experienced in the city. The plan was developed in 2010 and was made to span up to the year 2020. Ten high level targets were indicated in the plan which touch on the improvement of collection and disposal, improved access to information and the 3Rs.

In addition, the plan has five guiding principles: waste minimizing, polluter-pay-principle, competitiveness, multi-actor approach and sustainability. The

developers of the plan noted that waste minimization can be done through the implementation of the 4R: reduce, reuse, recycle and recover.

From the above, a plan of action was proposed, with 16 actions identified categorized into five themes which are: strategic alignment and recognition of partners; Waste generation reduction and source separation; Waste movement from source to efficient collection, derivation of value and/or disposal; Resource recovery - materials and energy; and Infrastructure and systems for residual waste

2.4.3 Preparatory Survey for Integrated Solid Waste Management in Nairobi City

This survey was done by the Japan International Cooperation Agency (JICA) in 2010 covering the whole of Nairobi. The aim of the survey was to review the situation of waste management at the time. The categories of waste of concern in the survey were household waste, market waste, commercial waste, street sweepings and office waste.

This survey report has also served as a major contributor to the Project on the Integrated Urban Development Master Plan for Nairobi in 2014, specifically on solid waste management (Nairobi City County, 2014). It was noted that JICA made reference to the UNEP ISWM plan above in the development of their report.

The master plan for SWM improvement was formulated in 3 stages: Short term (2011-2015), mid-term plan (2016-2020) and long term (2021-2030). The plan is also formulated through two approaches: technical approach, and

institutional and financial approach, both of which comprise of a total of eight programmes as summarised in **Table 2-5**.

Table 2-5: Technical, and Institutional and Financial Approaches

Technical Approach	**Institutional and Financial approach**
1. Collection and transportation plan 2. 3R and Intermediate treatment plan 3. Final Disposal Plan	4. Organisational Restructuring and Human Resources Development Plan 5. Legal and Institutional Reform Plan 6. Financial Management Plan 7. Private Sector Involvement Promotion Plan 8. Community Participation Promotion Plan

Under the 3R and Intermediate treatment plan, the objectives set were:

- To lighten the cost burden of the council through the reduction of the amount of solid waste for collection and disposal;
- To save finite space and minimize landfill space;
- The stabilization and reduction of residuals in addition to resource recovery through waste conversion.

The targets under this plan are shown in **Table 2-6**.

Table 2-6: Waste reduction and recovery goals

Period	**Reduction (% of generation)**	**Recovery**	
		% of potential collection	**Tons per day**
2009	0	5.3	86
Short term (by 2015)	5	10	180
Mid-term (by 2020)	10	12.5	270
Long term (by 2030)	10	16	450

The major action areas prescribed by JICA to work towards the above objectives were: the establishment of 3R and Intermediate Treatment Task Force; public campaign and education; introduction of home composting and community composting and the construction of central composting plants.

2.5 Solid Waste Management in Sri Lanka

Sri Lanka has various notable similarities with Kenya, one of them being the economic status. Both of them are categorised as developing countries with more or less the same GDP growth rate of about 5.7% for Kenya and 5.6% for Sri Lanka (World Bank, 2016). Secondly, the two countries are located within the tropics. These serve as indicators of various other aspects where the two countries could be similar, such as solid waste management. Sri Lanka can hence be a country whose waste management experiences can be compared

with that of Kenya, specifically Nairobi. Furthermore, it serves as a country from whom lessons can be drawn on waste management.

The management of waste in Sri Lanka is the responsibility of the local authorities which include municipal councils, urban councils and *pradeshiya sabhas* or divisional councils (Herath, 2011). The authorities are also responsible for managing and operating facilities such as dumpsites, compost yards and recycling centres in some cases.

The legal basis for the management of solid waste in Sri Lanka can be found in the following legislations (Bandara, 2008):

- Municipal councils Ordinance No 16 of 1947 – Sections 129-131
- Urban Council Ordinance No 61 of 1939 – Sections 118-120
- Pradeshiya Sabha Act No 15 of 1987 – Sections 93-95
- National Environmental Act No 47, 1980
- National Environmental (protection and Quality) Regulation – No 1,1990

Various sources indicate that the total amount of waste generated in Sri Lanka is about 6400 tons per day (Wijetunga, 2013; Karunasena and Wickramasundara, n.d; Madhushan and Fujiwara, 2011). According to data provided by the National Solid Waste Management Support Centre of Sri Lanka, the amount of solid waste generated daily in the island in 2014 was 10,496 tons, which averaged to a per capita generation of 0.47kg per day. The largest fraction of the waste generated in the island is taken up by organic waste (Madhushan and Fujiwara, 2011; Hikkaduwa et al, 2015).

The ratio of waste collected to that which is generated ranges from 5% in some small urban areas, to 93% in Colombo (Liyanage et al, 2015). Hikkaduwa et al (2015) reported a slightly higher figure of 3,242 tons per day for the island. 2014 data by the NSWMSC however indicates a slightly higher collection amount of about 3,551.5 tons per day, which is 33.84% of the waste generated.

A considerable amount of municipal waste is reported to be disposed through open burning, open dumping and in some cases in illegal dumpsites (Hikkaduwa et al, 2015; Liyanage et al, 2015; Wijetunga, 2013). Furthermore, Bandara (2008) stated that the country did not yet have a state of the art fully controlled sanitary landfill, except for the Moon plains landfill in Nuwara Eliya as the best landfill in operation.

Despite the above challenges, Sri Lanka has seen the development and implementation of various efforts to help reduce the overall amount of waste due for disposal. Such efforts include the Pilisaru Project that ran from 2008 to 2010 which realized various outcomes such as the construction of compost plants, biogas plants and recycling centres, and the provision of waste separation bins (Dassanayake, 2010; Fernando, n.d.). This project also realized the development of the National Strategy for Solid Waste Management, and the National Policy on Solid Waste Management. According to Sato, Doi, Kawamoto, and Lokuliyanaga (2014), these two documents clearly mention the 3Rs with objectives that spell it out.

In addition to the above, a National Solid Waste Management Support Centre (NSWMSC) was established in 2006 under the Ministry of Local Government and Provincial Councils with the responsibility of assisting the local authorities in solid waste management. Among its strategies are waste minimization and resource recovery, where the latter delves into segregation of recyclables at source, home composting and centralized composting by the local authorities (NSWMSC, 2013).

2.6 Solid waste management in Kandy Municipality

2.6.1 Description of Kandy Municipality

Kandy municipality is located in Kandy District in the Central province of Sri Lanka and sits on a land area of about 28.53 km^2. It is also referred to as the second capital city of Sri Lanka, being the second largest city in the island after Colombo, and also referred to as the capital of the central hills. The city is located approximately 115 kilometres from Colombo, and lies between the following coordinates: 80^o 35.56' E and 80^o 39.78' E, and 7^o 15.43'N and 7^o 19.75'N.

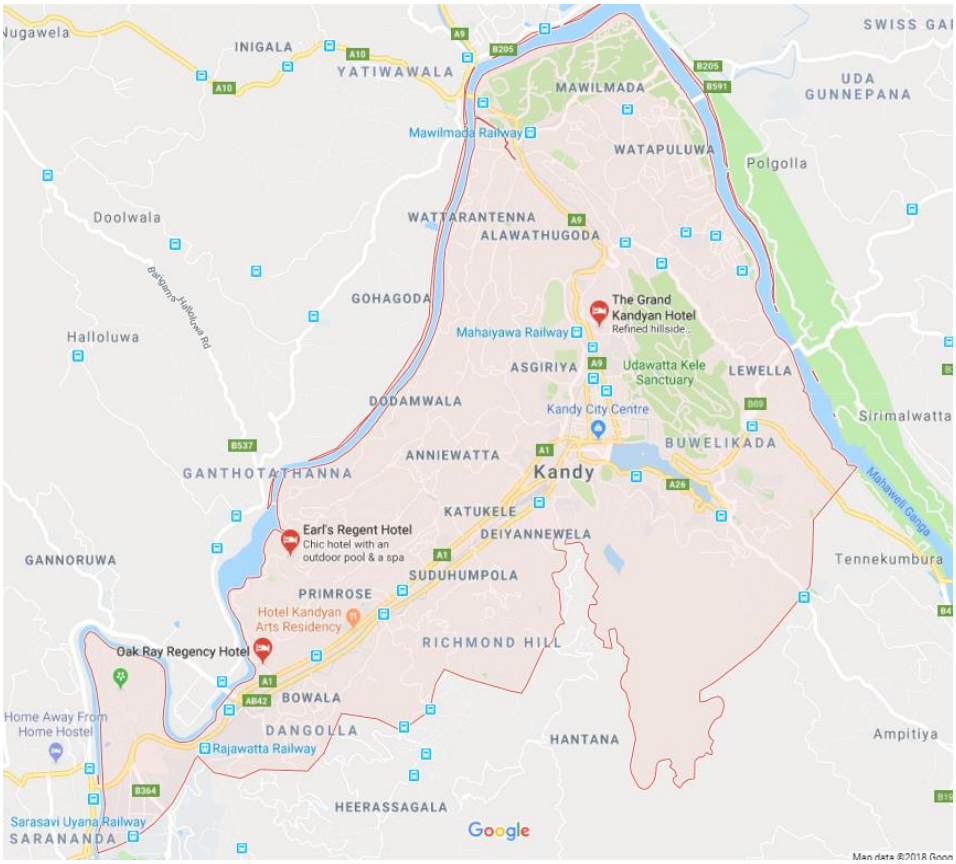


Figure 2-8: Map showing Kandy Municipality

Source: Google Maps

The topography of Kandy is largely characterised by a hilly terrain, with the higher altitude areas being on the south and the lower areas on the north. The highest points go up to more than 800 meters above sea level, with the low-lying areas going down to about 450 meters above sea level. A key geographical feature in Kandy is the Mahaveli River, the largest river in the country, which also forms part of the boundary for the municipality as shown in Figure 2-8. It flows from the south going around Kandy in the North then flows south east away from Kandy.

According to the waste management master plan report by the Kandy Municipal Council (2013), the resident population of Kandy Municipality

stood at 102,500. The report also states that there were 26,722 families as at 2012, and an average family size of 3.4 members. Furthermore, it has been stated in the report that there are up to 400,000 coming into the city daily for various activities, including work and business. A possible reason for this is that the city is centrally located in the country, thus making it a connection point for the road and railway network from almost all around the country (SATREPS, 2015). Another reason is that Kandy is a known tourist attraction, among the key attractions in the city being the Temple of the Tooth Relic (Wijerathna, Jinadasa, Herath, & Mangalika, 2012).

The governing authority in Kandy is the Kandy Municipal Council, headed by the Mayor, and comprising of elected council members. According to the Municipal Councils Ordinance (1947), some of the responsibilities of the municipal council include the regulation, control and administration of matters to do with public heath, public utility services, and the protection and promotion of the comfort, convenience and welfare of the people and the amenities within the municipality. The governance structure of the municipality is shown in Figure 2-9: Organisation Structure for the Kandy Municipal Council**Error! Reference source not found.**

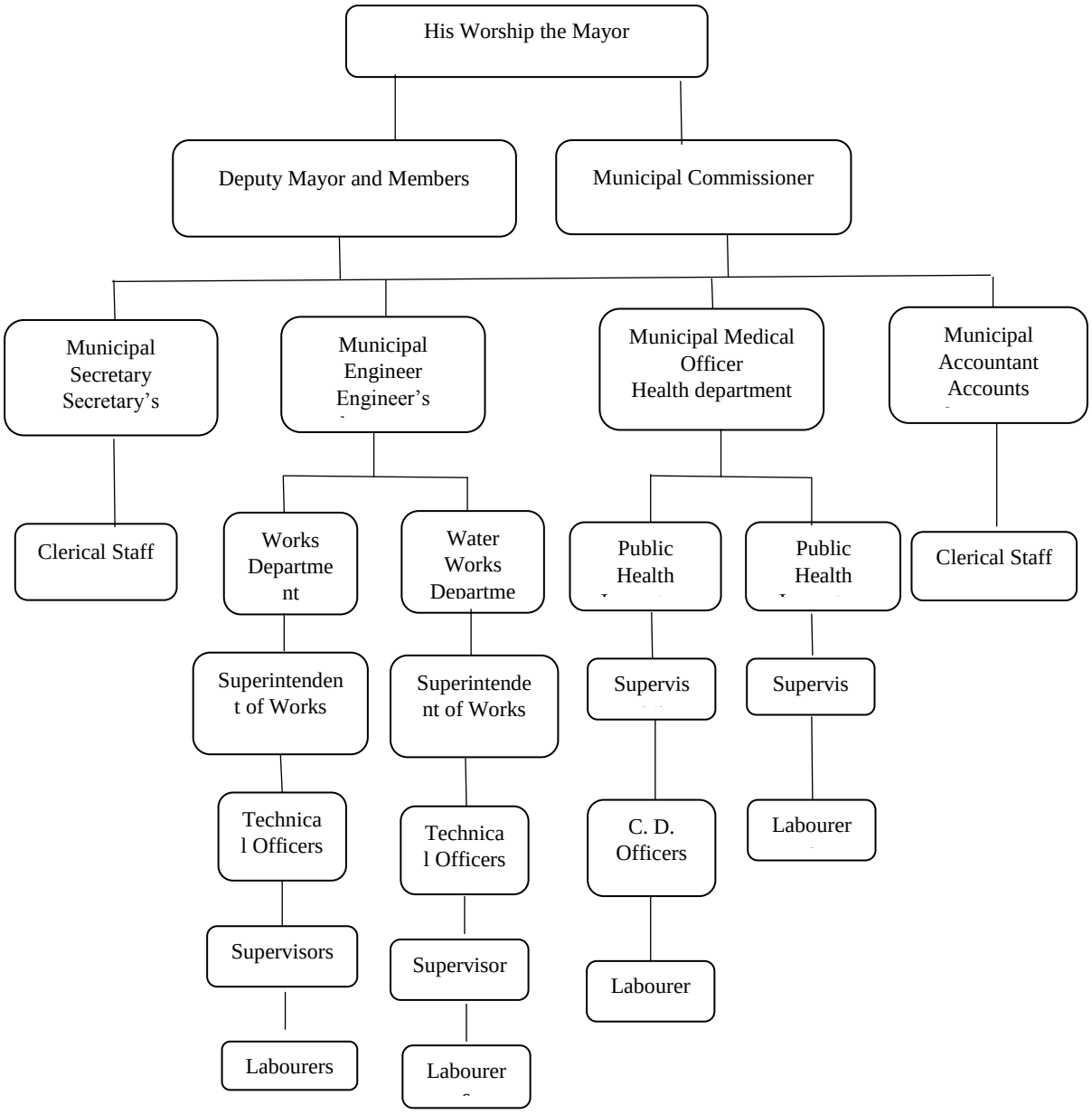


Figure 2-9: Organisation Structure for the Kandy Municipal Council

Source: SATREPS (2014a)

2.6.2 Current practice of solid waste management

2.6.2.1 Waste management authority

The authority responsible for the management of solid waste in Kandy is the municipal council. According to (Kandy Municipal Council, 2013), the

number of staff dedicated to solid waste management in Kandy is about 546, representing 27.3% of the total municipality workforce. In addition, the budgetary allocation towards waste management in the municipality in that year was LKR 160,327,000 (USD 1,046,385), representing 16.54% of the total annual budget for the municipality.

Just like the rest of Sri Lanka, solid waste management in Kandy is governed by the same legislations as mentioned in Section 2.5.

2.6.2.2 Waste generation, collection and disposal

According to NSWMSC, the city generated about 175 tons of solid waste each day. SATREPS (2014a) reports that the daily generation stands at 176.11 tons per day, with the largest fraction coming from commercial sources. The major waste component in Kandy Municipal Council is organic waste, comprising of kitchen and garden waste, accounting for between 74 and 97% of the waste depending on the specific source. The fraction of recyclables such as papers and plastics in residential waste ranged between 10-17%, while in commercial waste it ranged between 3 and 54% (SATREPS, 2014b). Other waste components and their proportions are shown in **Table 2-7: Waste composition by source in Kandy Municipality**.

Table 2-7: Waste composition by source in Kandy Municipality

	% by weight for different waste sources				
Waste type/category	**Households Average**	**Hotel**	**Restaurant**	**Organic shop**	**Non-organic shop**
Kitchen	74.6	74.6	82.2	97.3	34.2
Garden	4.8	0	0	0	0
Paper and Cardboard	7.8	10.2	8.4	0.8	35.1
Soft plastic	4.2	7.0	9.2	1.9	23.2
Hard plastic	0.9	0.6	0	0	2.5
Textiles	1.0	2.6	0	0	0.4
Rubber and leather	0.4	0	0	0	0.1
Metal	0.9	0.7	0.1	0	0.5
Glass	1.7	4.1	0.1	0	0.7
Ceramics	0.5	0.3	0	0	0
Hazardous	0.4	0	0	0	0
e-wastes	0.2	0	0	0	0
Miscellaneous	2.7	0	0	0	3.3

Source: SATREPS (2014b)

Waste collection is done largely by the municipal council at no charge to the residents and transported using trucks for disposal at the Gohagoda dumpsite, the official dumpsite for the municipality. According to (Kandy Municipal Council, 2013), 73.5% of the waste generated is collected by the municipality

for disposal at Gohagoda, and 0.26% of the waste is transported directly to the dumpsite by other parties such as the generators themselves. About 3.34% is disposed at the site where they are generated while 1.39% is reported to be disposed in illegal sites.

On the other hand, according to SATREPS (2014a), 89.14% of the waste generated in Kandy is collected by the municipal council, and there are no reports of open dumping.

2.6.2.3 Waste reduction and recovery efforts

An evidence of waste reduction and recovery effort in Kandy is the presence of a plastics crushing facility at Gohagoda dumpsite that receives up to one ton of plastics per day. The crushed plastics are then sold to recyclers for recycling. This has been promoted by the practice of source separation that takes place in the municipality. According to SATREPS (2014a), and as indicated in the interview at the Kandy Municipal Council, there are three centres for collection of recyclable items and twelve junkshops in the municipality, which have played a role in facilitating the practice of recycling.

According to Kandy Municipal Council (2013), about 20.29% of the waste generated in the municipality is taken through recycling. The recyclables originate directly from the source/generator, from the municipality after collection, or salvaged from the disposal site. The informal sector was noted as a player in waste recycling. The waste pickers are mostly located at the Gohagoda dumpsite where they salvage the recyclables for sale to recyclers.

The other key activity contributing to the reduction of waste due for disposal is composting. According to an interview with the Kandy Municipal Engineer, there were about 5000 compost barrels distributed in homes for composting, and some given to institutions and government offices. These barrels facilitate the waste generator to compost waste at the source instead of having the organic waste collected for disposal. The percentage of waste reported to be taken through on-site composting stands at about 3.39% (Kandy Municipal Council, 2013).

The flow diagram of waste in Kandy Municipality is summarised in Figure 2-10.

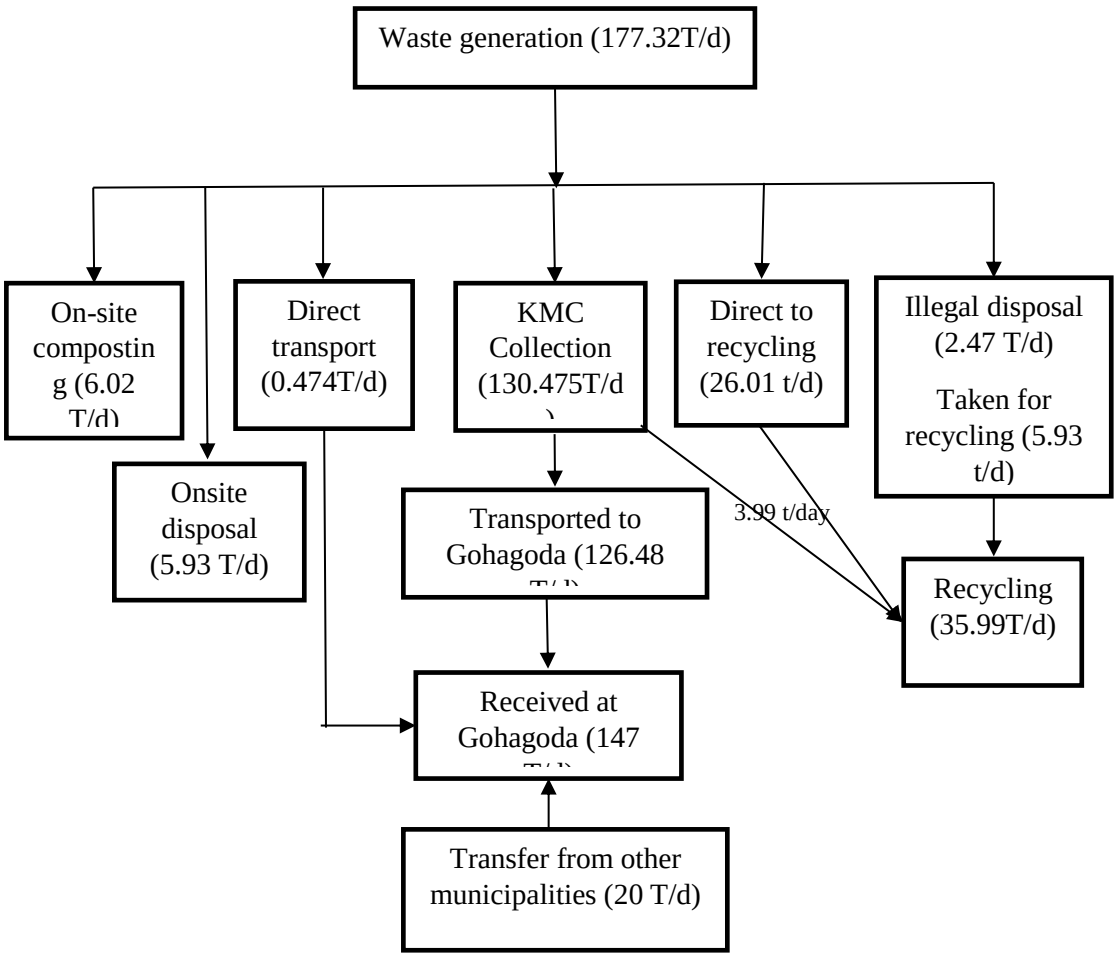


Figure 2-10: Solid waste flow diagram for Kandy Municipality

Source: Kandy Municipal Council (2013)

2.6.3 Transition of waste management practices in Kandy

2.6.3.1 Waste management in the past

In the past the waste from the generators would be put in large concrete bins spread throughout the municipality. The waste would then be collected from the bins by the municipal council on a daily basis for disposal at the Gohagoda dumpsite. The main result of this trend was the high quantities of waste that the municipalities had to collect. This high quantity partly came about from

persons residing outside Kandy bringing in waste from their homes and putting them in the bins. Furthermore, there was no control in the depositing of the waste in the bins. The large amounts of waste also resulted in foul odour and unsightly conditions, coupled with the attraction of animals to the dumping points.

2.6.3.2 Waste management interventions in Kandy

The concept of proper waste management began in the year 2010, with the focus on better use of time, resources and personnel. As a first step, a baseline study was conducted in order to establish the waste management status at the time. Some of the data obtained from the baseline study were waste generation and collection quantities, waste composition, and household data. The following steps were then followed in the implementation of the changes in waste management in Kandy.

2.6.3.2.1 Conduction of baseline study

The municipality embarked on collecting baseline data in 2012 to 2013 which included the number of households in the municipality and their income levels, waste generation and collection amounts and waste composition. The aim of this was to establish the status and trends of waste management at the time, which would help to inform measures to be taken.

2.6.3.2.2 Shift from the central collection bins to 'door to door' collection

Before rolling out the new mode of waste collection, Katugastota area was selected to be the pilot for trying out the new interventions. The concrete bins

where residents would put their waste for collection were temporarily closed, and the municipality would then collect the waste from the gates of the residents. Before the implementation of this change, awareness was created through placing of notices around the locality. This was achieved by the recruitment of a number of individuals living within the area to help in the communication of the changes to the residents, and the employment of the environmental police that would help to enforce the changes. Measures were also put in place to take legal action against individuals found to be throwing their waste in those bins.

Six months after the shift to door-to-door collection, the collection scheduled was changed such that waste from specific sources was collected on specific days rather than daily collection as was the case in the past. In residential areas or small streets, organic wastes such as food wastes were collected on three days each week: Mondays, Wednesdays and Fridays; and other wastes were collected on Saturday. In the case of the main streets where there are more commercial premises, waste collection took place daily. This was also preceded by awareness creation through notices and the individuals who would get in touch with the residents.

2.6.3.4.3 Garbage tax

Garbage tax is a fee payable by commercial entities for the collection of their waste by the municipality. The fee, introduced in 2014, is charged according to the amount of waste that is collected from the premises. The garbage tax

was introduced as a means of reducing the quantities of waste generated or collected by the municipality, especially from the commercial premises where the bulk of the solid waste originates. The municipality also indicated that there are plans to introduce such fees to the domestic waste generators.

2.6.3.2.4 Waste separation at source

The municipality came up with a waste separation program such that different waste categories are collected on different days, and different colour codes assigned for specific waste categories. The colour codes were designated as follows: Orange for plastics and polythene, blue for papers and cardboard, and red for glass, as shown in Figure 2-11. The orange bag would be collected on the first and third weekend of every month, the blue bag on the second and fourth weekend of every month, and the red bag on the last weekend after every three months. The municipality had provided each of the three colour coded bags to 25,000 families as a step towards promoting the practice of waste separation.

Figure 2-11: Colour coded bags for waste separation in Kandy Municipality

With the separation programme in place, the food wastes would be collected on their own on Mondays, Wednesdays and Fridays from domestic sources. Over time, the municipality would refrain from collecting a waste bag from a home if they found that the waste had not been separated (Bandara, Pinnawala, Herath, & Jinadasa, 2014).

2.6.3.2.5 Composting and recycling

The municipality has promoted home composting through the distribution of compost bins at a subsidised rate. As at the time of the interview, about 5,000 barrels had been distributed within the municipality against a target of about 15,000.

Buyback centres were set up where the municipality would buy the recyclable wastes and sell them to recyclers. The centres were set up in 2012 and have the ability to take up to 21 categories of waste. Alongside these centres, the

municipality set up a plastic crushing facility with the assistance of the national government. One such facility, located at the Gohagoda dumpsite, has the capacity to take up to one ton of plastics per day.

2.6.3.2.6 Awareness creation for members of the public

One way through which the municipality reaches out to the public on matters to do with waste management is through the environmental committees. Kandy municipality is divided into divisional units known as grama nilidhari divisions, which are sub-units of the divisional secretariat. Each one of these divisions has an environmental committee that assists the municipal council in reaching out to the public, awareness creation, and helps to ensure that matters to do with waste management are done accordingly.

The municipality had also employed notices placed in various residential areas, for example showing the days of collection for certain waste categories, and the change from the centralised bins to 'door-to-door' collection. There also have been efforts made to reach the public though schools, hospitals, private entities and non-governmental organisations. In addition to these, the council has also used television dramas and documentaries, public screens, radio, newspapers and exhibitions. Some of the items that have been communicated through these awareness efforts include the change to door-to-door collection, existence of buyback centres, environmental committees, use of compost barrels and waste collection schedules.

2.6.3.2.7 Other waste management initiatives

There was a mention of plans to introduce flea markets as a way of promoting waste reuse. Suitable locations for these markets would be identified within the municipality with the assistance of the environmental committees. These interventions have resulted into outcomes as shown in **Table 2-8**.

Table 2-8: Outcomes of waste management interventions in Kandy

Intervention	**Outcome**
Change of collection regime	Waste reduction of 10-15 tons/day; Collection coverage growth to 95% from 80-85% in 2010
Garbage tax	Revenue for the municipality; Increased waste segregation; waste reduction through sale of recyclables
Segregation at source	80-85% of homes segregating their waste
Recycling and buyback centres	Revenue for the municipality; reduction of quantity of waste due for disposal (about 20% undergoing recycling)
Composting	5000 compost barrels distributed; 10-15% of homes practising home composting

Other outcomes that were noted resulting from the intervention efforts in Kandy Municipality was a hotel in the municipality that uses about 300kg of organic waste each day for biogas production. As a result, the hotel has been

able to make some savings in terms of fuel costs and the costs of waste collection. The hotel has also been reported to be selling the recyclable waste that it generates. This has hence inspired the municipality to work towards having hotels or residential areas expected to generate more than 100 kg of waste per day to install biogas plants.

The efforts on awareness creation have been crucial in every step and every intervention made. Among the visible results of awareness creation is the success in the implementation of the changes in waste collection and the separation of waste at source. Efforts such as exhibition, television, radio and newspapers work to remind the residents on the proper practices in waste management.

2.6.4 Challenges in solid waste management in Kandy

One of the items mentioned as a challenge to waste management in Kandy is the gaps in legislation. During the interview with the municipal engineer, it was mentioned that the legislations in place are lacking, especially on recycling and producer responsibility. Wijerathna (2012), in a study on waste management in Kandy, also found that the officials expressed the views that the existing legislations were out of date and did not have powers to prevent indiscriminate dumping. Still on legislation, it was mentioned that there are shortfalls in the application and enforcement on the existing laws.

Another challenge reported is the absence of environmental education in school syllabi. The incorporation of education on waste management and the

environment in school syllabi would contribute towards inculcating positive attitudes and proper waste management practices from an early age. Furthermore, this would enable the education of a large number of people.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter describes the location under study, which is Nairobi County. It also gives details of the design that the study adopted, the kind of data collected, the methods used in data collection, and the activities undertaken during the study.

3.2 Description of study area

Nairobi County was selected to be the case study for the country primarily due to the advantage of availability of data and literature on solid waste management. Secondly, the city has experienced various challenges in solid waste management, especially in collection and disposal amidst an increasing rate of waste generation. This increase in waste quantity creates more need for the adoption of the 3R to reduce the overall amounts of waste due for disposal. There have also been various waste reduction and recovery efforts in the county which have been marred by various challenges that contribute to inefficiencies.

However, due to the size of Nairobi, a smaller administrative area was selected as a case study for the county. A key criterion that was considered was the size in terms of land area. A smaller area would be easier to work on with limited time and resources, and would be easier to traverse, especially during data collection. Another item that was considered in the selection of the study area

is whether the location would have a good mix of different population characteristics such as income groups and household types. Following the above criteria, the areas selected for the study were Upper and Lower Savanna Wards in Embakasi East Sub-county, shown in Figure 3-1.

Upper Savanna and Lower Savanna are two of five wards located in Embakasi East sub-county. The two wards cover a land area of 3.1 km^2 and 1.73 km^2 respectively, totalling to about 4.8 km^2 (Google Inc., 2017). The two wards are located within the following geographical coordinates: 36^o 53.16' E and 36^o 55.15' E, and 1^o 16.68' S and 1^o 18.43'S.

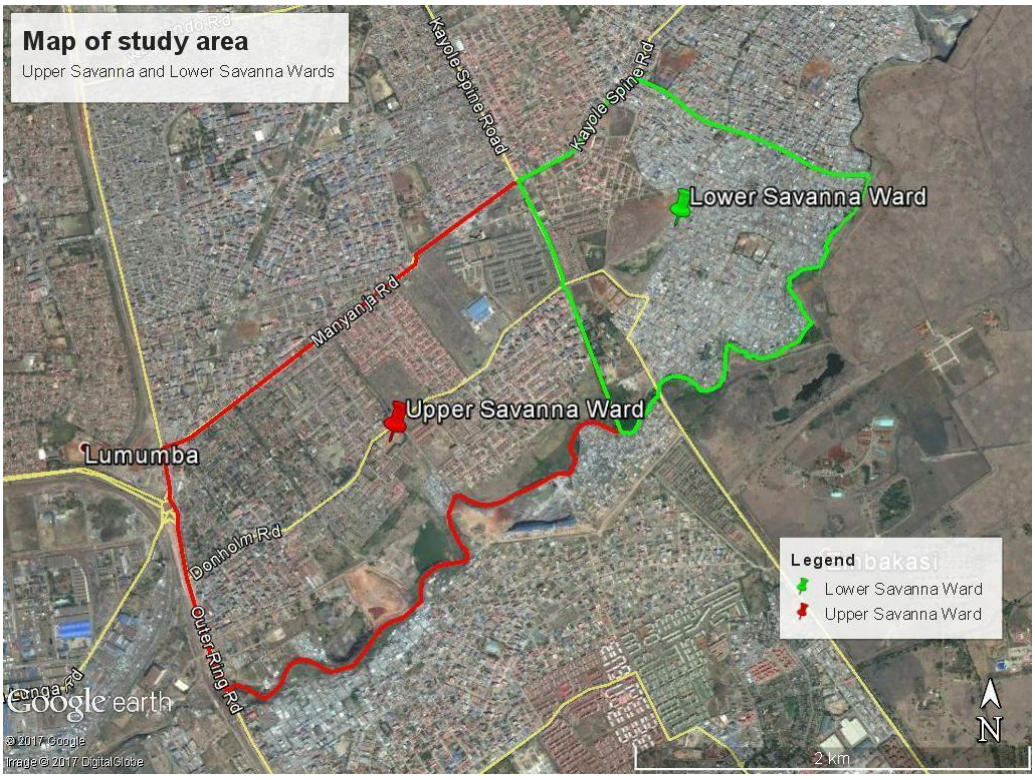


Figure 3-1: Map showing Upper Savanna and Lower Savanna Wards

Residential premises are predominant in the two wards, ranging from detached homes in gated courts, to residential apartments and informal housing, which can serve as an indication of the wide variety of income groups that reside in the location. According to KNBS and SID (2013), the total number of households in the two wards stood at about 23,160, with the total population standing at 75,423: 44,780 in Upper Savanna Ward and 30,643 in Lower Savanna Ward. The two wards also have several small businesses that serve the residents, such as grocery stores, supermarkets, barber shops and hair salons, drug stores, hardware stores and restaurants.

Key landmarks within the study area include the Greenspan Mall in the Upper Savanna Ward, located towards the North Eastern end of the ward, and about 12km from the city centre by road. In Lower Savanna Ward, one key landmark is the Soweto Catholic Church, which is centrally located in the ward, and is about 14 km from the city centre at the shortest by road.

3.3 Research Design

In the development of the action plan, the study drew from the lessons and experiences of Sri Lanka which can be replicated in Kenya. Nairobi was therefore taken as the case study for Kenya, and Kandy was considered as the case study for Sri Lanka. Going further, due to the size of Nairobi, a smaller administrative area was selected as a case study for the county. Hence a case study design was adopted. Asase *et al* (2009) did a study of a similar but more comparative nature in their comparison of municipal solid waste management

systems in Canada and Ghana, where the cities selected were London (Ontario Province), and Kumasi respectively. This study also aimed to draw lessons from the waste management systems in one city to help implement a sustainable system in another.

3.4 Study approach and activities

The following are the details of the activities that were undertaken in the study.

i. Literature review

Various literatures were reviewed to provide a background of the solid waste management practices in various parts of the world.

ii. Study of solid waste management Sri Lanka

A visit was made to Sri Lanka to investigate the waste management practices at the national level and local authority level. The sources of information at this stage were the National Solid Waste Management Support Centre in Colombo, and Kandy Municipal Council respectively where interviews were conducted, and reports and data were provided for review. For Kandy, the outcomes mainly entailed the history of waste management in the municipality, notable interventions that were made and their results.

iii. Visit to the Department of Environment, Nairobi County

One of the objectives of this visit was to gather information on waste management in Nairobi County as a whole, which would add onto or confirm what was found out from literature review. This was done by conducting an

interview for which a schedule was prepared (Appendix 3: Schedule of questions for the Environment Department, Nairobi City County). The items of interest as per the interview schedule were as follows:

- Waste management in the county: waste generation and composition, collection and disposal
- Waste reduction and recovery efforts
- Awareness and education on solid waste management
- Past interventions, plans and strategies in waste management in the county
- The capacity of waste management in Nairobi County
- Legislation and policies
- Targets in waste management and future plans

The second objective of the visit was to get the necessary approvals for conducting the study at the selected location, and the contacts of the relevant person, which in this case, was the environment officer in Embakasi East Sub-county (Appendix 1: Request to Nairobi City County for Data Collection).

iv. Acquisition of baseline data from target area

Visits were made to the Embakasi East sub-county office following the approval given by the Department of Environment (Appendix 2: Approval for data collection by Nairobi City County). The objective of the meeting was to introduce the study to the environment officer, to plan on how the data

collection process would be conducted and to seek the necessary assistance and approvals.

A pilot study was then conducted using the questionnaires meant for the field study, and their responses analysed. The aim of the pilot study was to find out the adequacy of the questions, and how the respondents would interpret them. This was followed by an amendment of the questions based on how the questions were understood by the respondents before the questionnaires would be ready for the actual study.

After the pilot study, a prior visit was made to the selected study area as reconnaissance, which was helpful in planning movements through the study area during the study period.

The visit was followed by gathering baseline data on the target area, which involved having respondents fill in questionnaires (Appendix 4: Household Questionnaire; Appendix 5: Questionnaires for commercial premises;

Appendix 6: Questionnaire for Community groups in waste management). The responses from the questionnaires were then collated and analysed using IBM SPSS version 20.

v. Discussion of waste management interventions

A meeting was held to share the outcomes of the field study where in attendance were members of staff from Embakasi East Sub-county, Environment officers from other sub-counties in Nairobi, and representatives from the CBOs and residents of the study areas (Appendix 13: Attendance list for findings presentation at the Embakasi East sub-county office. The outcome of the meeting was feedback from the audience on the findings of the field study, and thoughts on possible interventions that can be incorporated in the action plan. This was followed by another meeting with the Embakasi East sub county officer to have further discussions on the findings of the study and the meeting with the county staff and the residents.

In light of the objective of the action plan, which is to increase waste reduction and recovery rates, various waste management interventions were discussed. The interventions considered for evaluation were drawn from the responses from the field study, the literature reviewed, and the experiences of other countries, specifically Sri Lanka. Where possible, the outcomes of some of the interventions were quantified based on the available demographic and waste management data for the study area and the county at large. The quantified values would then be compared with the existing targets, such as the goals set

by NEMA in the National Solid Waste Management Strategy mentioned in Section 2.4.1.

- Short term - 30% waste recovery and 70% controlled dumping by 2020
- Medium term - 50% waste recovery and 50% semi-landfilling by 2025
- Long term – 80% waste recovery and 20% landfilling by 2030

vi. Development of action plan

An implementation schedule was developed for the action plan over a planning period. The activities to be implemented emanated from the most preferred option following the evaluation above.

3.5 Data collection methods

Interviews

Interviews were employed to gather largely qualitative data. This was employed during the visit at Nairobi City County where an interview schedule was provided to an officer at the Department of Environment. Interview has been preferred due to its flexibility and the level of control the interviewer has on the respondents and how they respond as compared to questionnaires (Corbetta, 2003; Kothari 2004).

Questionnaires

Questionnaires were used to gather data directly from members of the public in the area that was selected for the action plan. There was a mix of both open ended and close ended questions.

Physical Observation

Physical observations were used to capture or confirm the information gathered from the interviews and literature review, and to gather first-hand information during reconnaissance, with photographs taken where possible.

Desk study

Various literature was reviewed to gather secondary data on the state of solid waste management both in Sri Lanka and Nairobi. Sources included previous studies on solid waste management in both countries, reports and any other documents that were made available. This was especially useful in filling in gaps of data that would not be filled by the primary sources.

3.6 Target population and Sampling procedure

The areas targeted for the study were Upper and Lower Savanna Wards in Embakasi East sub-County. In 2013 the two wards were reported to have a population of 44,780 and 30,643 respectively, giving a total population of 75,423. In addition, there were found to be 15,255 and 7,905 households in Upper and Lower Savanna Wards (KNBS & SID, 2013).

It was anticipated that the respondents in the study would include representatives from households, business premises, and community-based organisations. A sampling procedure was hence required to select individuals

that would participate in the study as respondents. Since there is little information on the characteristics of the population Slovin's formula was used to determine the size of the sample, or the number of respondents as shown in Equation 3-1 (Ryan, 2013).

$$n = \frac{N}{1 + Ne^2}$$

Equation 3-1: Slovin's formula

Where n is the sample size, N is the population and e is the margin of error.

Taking the total population of the two wards, and a margin of error of 5% (95% confidence interval), the sample size arrived at was 398.

Cluster sampling methodology was so that each ward would be represented by the same number of respondents. Furthermore, each of the two wards was divided into zones or estates, out of which ten were selected in each. Hence each of these zones would also be equally represented by the same number of respondents in the study. However, the individual respondents were selected at random. From this, the intended sample would be as shown in **Table 3-1: Sample size by ward**, with each household or commercial entity represented by a single respondent.

Table 3-1: Sample size by ward

	U. Savanna Ward	**Respondents per zone**	**L. Savanna Ward**	**Respondents per zone**	**Total**
Households	150	15	150	15	300
Commercial premises	30	3	30	3	60
CBOs	10	N/A	10	N/A	10
Total	190		190		380

3.7 Possible sources of error

3.7.1 Sampling error

This would present itself in that the sample may not reflect the true characteristics of the population. One such error may come about due to sample bias. An example is when on category of the population features more in the sample than another or others (Blair, Czaja, & Blair, 2014).

The measure taken to mitigate this error is to have a sample as large as possible in order to minimize sampling error. In addition, the population was defined by and divided in geographical locations. This formed the basis for systematic sampling which was employed in the study.

3.7.2 Non-response error

This error occurs in the event of the inability to obtain data for all sampled units on all questions. This may be unit response where a questionnaire is not

responded to, or item nonresponse where questions in a questionnaire are not responded to (de Leeuw, Hox, & Dillman, 2008).

In order to mitigate this type of error, strategies were taken to reduce chances of refusal to respond to the questionnaires. One was to have the interviewer in contact with the target respondents to ensure maximum response to the questionnaires.

3.7.3 Measurement error

This is also known as the error of observation. It may occur due to the questionnaire, the respondent or the interviewer (de Leeuw, Hox, & Dillman, 2008). The error due to the questions can occur if they are not clear or easily understandable by the respondents. Respondents can contribute to the error if they give inaccurate or untruthful answers. The interviewer or the person administering the questionnaire can inaccurately guide the respondents or interpret the responses wrongly.

As a mitigation measure, the questionnaire was designed such that all questions were closed ended, thus eliminating the chances of ambiguous responses. The questionnaires were then tested by doing a pilot survey in order to get an indication of how well the questions were understood. Assurances of anonymity and confidentiality were given to the respondents so as to encourage them to give truthful answers and minimize errors of measurement.

CHAPTER FOUR

RESULTS

4.1 Introduction

This chapter discusses the findings from the field data collection in Upper and Lower Savanna Wards, and the findings from the interview with the Nairobi City County Department of Environment. The chapter also highlights the feedback received on the findings of the field study by county staff and community representatives, and indicate the recommendations proposed that can be incorporated in the action plan.

4.2 Interview findings of Solid Waste Management in Nairobi County

4.2.1 Authority of waste management in Nairobi County

Solid waste management in the county has been placed under the Water, Energy, and Environment Sector. This sector has one member in the county executive committee under which there is a Chief Officer. The officer is responsible for executing the mandate of the sector and is answerable to the county executive committee. Under this sector there are subsectors that include Water, Energy and Environment, with solid waste management falling under the latter. The Environment sub-sector is led by a Director and an Assistant director who supervise and coordinate environment and waste management at the county level, as shown in the organogram in Figure 4-1.

Under the director and assistant director there are Environment officers, one in each of the 17 sub-counties. Among their responsibilities include dealing with environmental issues at the sub-county level and ensuring availability of vehicles for waste collection. The officers are also responsible for supervising waste collection and cleaning up in public areas. Under these officers, there are supervisors in each ward that oversee street sweeping, and under whom there are labourers who are the sweepers. In the case of Embakasi East sub-county, there are five supervisors, one for each of the five wards. There also are supervisors under the environment officers that are in charge of the waste collection trucks. These supervisors oversee the work of loaders during waste collection.

Figure 4-1: Organogram of Solid Waste Management in Nairobi County

4.2.2 Waste generation

From the interview schedule provided to the County office, it was reported that the county generates approximately 2400 metric tons of municipal solid waste per day. This was based on a projection made by the Japan International Cooperation Agency (JICA) in their study on waste management in Nairobi in 2009. According to the Nairobi City County (2015), the generation towards the end of 2014 was approximated to stand at about 2,244 tons per day. Going by the population projection in the same year of about 3,794,501, the per capita generation rate would translate to about 0.59 kg/day. Assuming a constant per capita generation over time and an annual population growth rate of 3.87% (KNBS, 2010), the projected waste generation quantities would increase at the same rate as the population, which would be determined by Equation 4-1 based on the formula for population projection.

$$G_n = G_o(1 + r)^{n-2009}$$

Equation 4-1: Equation for projection of waste generation

Where

G_n = generation at year n

r = annual growth rate (3.87%)

G_0 = generation in 2009

This would then provide the curve as shown in Figure 4-2.

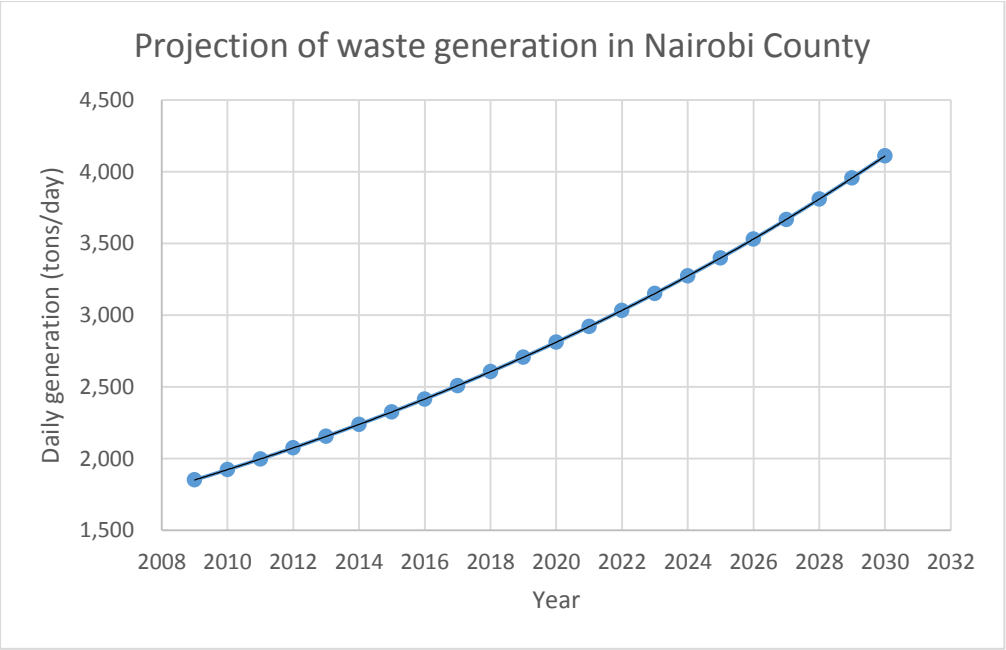


Figure 4-2: Projection of waste generation in Nairobi County

The largest fraction of the waste generated in the county is taken up by biodegradable wastes, which include food wastes and garden wastes. The non-biodegradable fraction is composed of papers, plastics, metals, glass and other inorganic and unclassified materials, which may include dirt, sand, ashes, and dry cells (JICA, 2010).

The notable challenges reported to be faced in waste management in the county from generation to disposal were lack of segregation at source, shortage of vehicles for the collection and transportation of waste, insecurity at the final disposal site, and lack of proper storage before collection.

4.2.3 Efforts on waste reduction, reuse and recycling

The main waste reduction and recovery (or 3R related) activities within the county are composting, and separation for the extraction of valuables. The main actors in the above activities include community-based organisations, the residents in waste generation areas, and the county government involved in monitoring and legislation. Another key player in waste reduction is the informal sector, which largely includes scavengers that recover waste from the dumpsite for sale to waste dealers. The most commonly recovered waste materials include metals, plastics, organic wastes and papers. According to Kasozi and Blottnitz (2010), waste recovery in Nairobi stands at 150 tons per day, or approximately 4.8% of the generated waste.

From the interview, the policies that were mentioned to promote 3R related activities were the Solid Waste Management Act of 2015, Environmental Management and Coordination Act (EMCA), Public Health Act and Composting policy at the county level.

The challenges reported to be faced in waste reduction and recovery efforts in the county were lack of waste separation at the source, and lack of market for the recovered items.

4.2.4 Public awareness and education on waste management

It was reported that there are awareness creation programs on waste management for the public done by the county staff through monthly clean-ups. The theme or focus of the programs and clean-up exercises is “My waste

is my responsibility", which is meant to encourage residents to tend to their own waste. The main target audience of the awareness programs include community-based organisations, residents and private sector providers.

The impacts that were noted to result from the awareness creation efforts made so far include the establishment of transfer points within the county, and a cleaner environment.

4.2.5 Past interventions in waste management (plans, strategies and projects)

The interventions mentioned in the interview were the Integrated Solid Waste Management Plan for Nairobi that is being fronted and funded by the Japan International Cooperation Agency. Under the plan, waste segregation has been included as a means through which the 3Rs can be fostered. Since the implementation of the plan was still underway, there were no notable outcomes to report at the time of the study.

4.2.6 Solid waste management capacity in Nairobi

This section of the interview schedule sought to find out the capacity of the county in waste management in terms of human resource, vehicles and finances. It was found that there were 410 personnel attached to solid waste management in Nairobi County, making up 3.6% of the total county workforce. It was also found that the county runs about 30 trucks for waste collection and transportation.

Regarding finances, it was indicated that the annual revenue from solid waste management related activities for the county stands at about Ksh 96 million against a budgetary allocation of about Ksh 700 million in the 2015/16 financial year (Nairobi City County, 2016). In the 2016/17 fiscal year, the budgetary allocation for solid waste management in the county, covering both development and recurrent expenditure, was Ksh 1,462,651,622, which is about 4.06% of the total budgetary allocation for the county (Nairobi City County, 2016)

On top of the above resources that are available to the county, the respondent also added that there are about 160 private companies involved in waste collection and transportation. According to Kasozi and Blottnitz (2010), there were 115 private companies and 135 CBOs and youth groups that were involved in solid waste management as at 2009.

4.2.7 Targets and future plans

A key target in waste management for the county as indicated in the interview is the collection of 100% of all the waste generated in the county, which as mentioned in the interview, stood at 2400 tons per day.

As for the future plans, the authorities intend to franchise the collection of solid waste within the county, where the county would be divided into zones, and each zone would be served by a single company.

4.3 Field Study of Upper Savanna and Lower Savanna Wards

4.3.1 Solid waste quantities in Upper Savanna and Lower Savanna Wards

According to the Nairobi City County (2015), the waste generation in Embakasi East Sub-county was 117 tons per day as at 2014. Out of this, 23.25 tons, or about 20% was reported to be collected from the sub-county each day. It can therefore be assumed that the remaining 80% is disposed illegally, for instance through open burning and open dumping Furthermore, according to KNBS and SID (2013), the population of the sub-county stood at about 159,897 residing in about 48,931 households. This would translate to a per capita waste generation of 0.73 kg per day.

Assuming a constant per capita generation across the whole of Embakasi East Sub-county and given the population of Upper Savanna and Lower Savanna wards, the waste generation in the two wards can be estimated to stand at 32.69 tons per day and 22.37 tons per day respectively. Applying the same rate of increase in waste generation in the county and adopting Equation 4-1 in the study area, the projection shown in Figure 4-3 would be obtained.

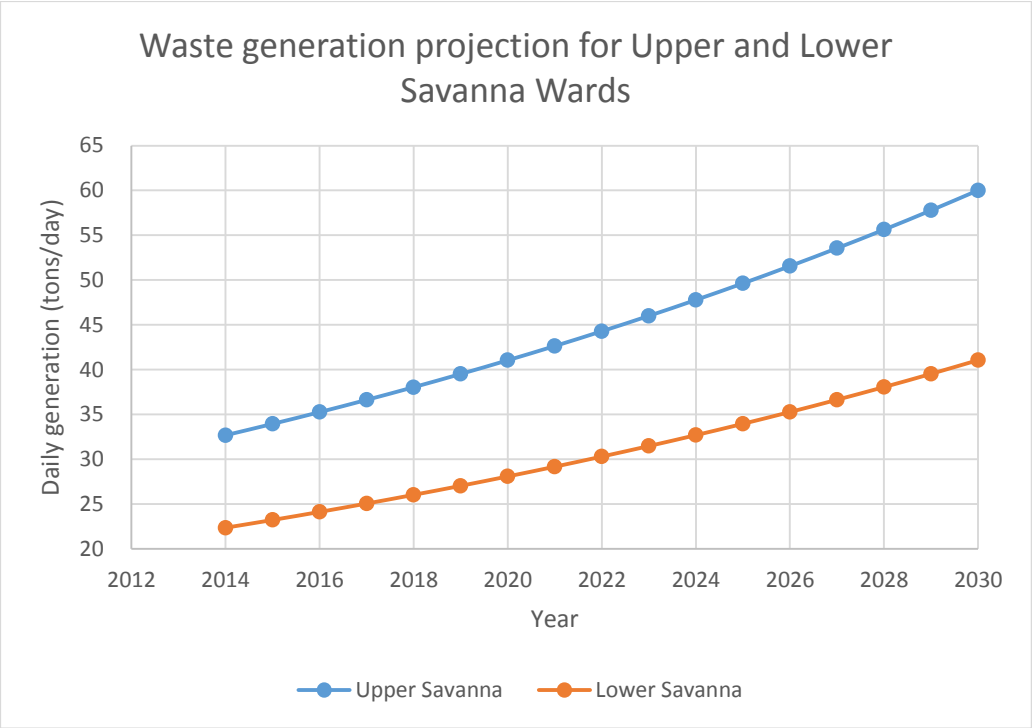


Figure 4-3: Waste generation for Upper Savanna and Lower Savanna Wards

4.3.2 Questionnaire response rate

The target respondents for the study were households, commercial premises and CBOs, in Upper and Lower Savana Wards, who responded to the questionnaires in Appendix 4: Household Questionnaire, Appendix 5: Questionnaires for commercial premises and

Appendix 6: Questionnaire for Community groups in waste management respectively. Each one of the above was represented by a single respondent, with a maximum of 380 targeted to participate. Households and commercial premises were selected because together they take up the largest fraction of the source of municipal waste in the county, and because the study area is predominantly made up of residential and commercial premises. The respondents from these two sources therefore participated in the study as waste generators, while the community groups responded as waste collectors. The response rate of the questionnaires is summarised in **Table 4-1**.

Table 4-1: Questionnaire response rate

	Lower Savanna Ward Questionnaires		**Upper Savanna Ward Questionnaires**		**Total Given**	**Total responded**
	Given	**Responded**	**Given**	**Responded**		**(% of given)**
Commercial Premises	29	28	30	25	59	53 (89.8%)
Households	62	60	89	52	151	112 (74.2%)
CBOs	5	5	6	4	11	9 (81.8%)
TOTAL (excluding	91	88	119	77	210	165 (78.6%)

CBOs)						
Total (including CBOs)	96	93	125	81	221	174 (78.7%)

4.3.3 Respondent characteristics

4.3.3.1 Households

There were 151 questionnaires (Appendix 4: Household Questionnaire) administered to the households, out of which 112 were responded to. From these, there was almost equal gender representation, with about 51.5% of the respondents being female, and the remaining 48.5% being male. Among the respondents that agreed to provide their age, twenty (20.6%) were aged below 26 years, and 35.1% were aged between 26 and 35 years, forming the majority of the respondents. Those aged above 45 were the minority at 16.5%. In addition, among those that agreed to give details of their occupation, the majority (53 out of 100) indicated that they were self-employed, followed by 24 who were unemployed and 23 who were employed.

Out of the 112 households, 73 gave ample details of the size of their households, from which the average household size was determined at about four members in both wards. In addition, majority of these households (25%) were found to have a single member, with the largest household size being 8 members

About a half of the respondents (51%) reside in single rooms, which entails rooms built at ground level only, whether made of masonry or not, which in

many cases do not have self-contained ablutions. About 25% indicated that they reside in detached houses (single home for a single family with its own gate and compound), and the rest in flats or high-rise apartments.

45.5% of the respondents indicated that they have resided in their current houses for more than 5 years, while about a quarter of the residents have maintained their current houses for between 1 and 3 years.

As shown in Figure 4-4, majority of the respondents (62.5%) indicated that their monthly household expenditure falls below Ksh 20,000 (USD 194) per month, followed by 19.6% whose expenditure falls between Ksh 20,000 and Ksh 40,000 (USD 387). 7.1% of the respondents however declined to provide details of their household expenditure.

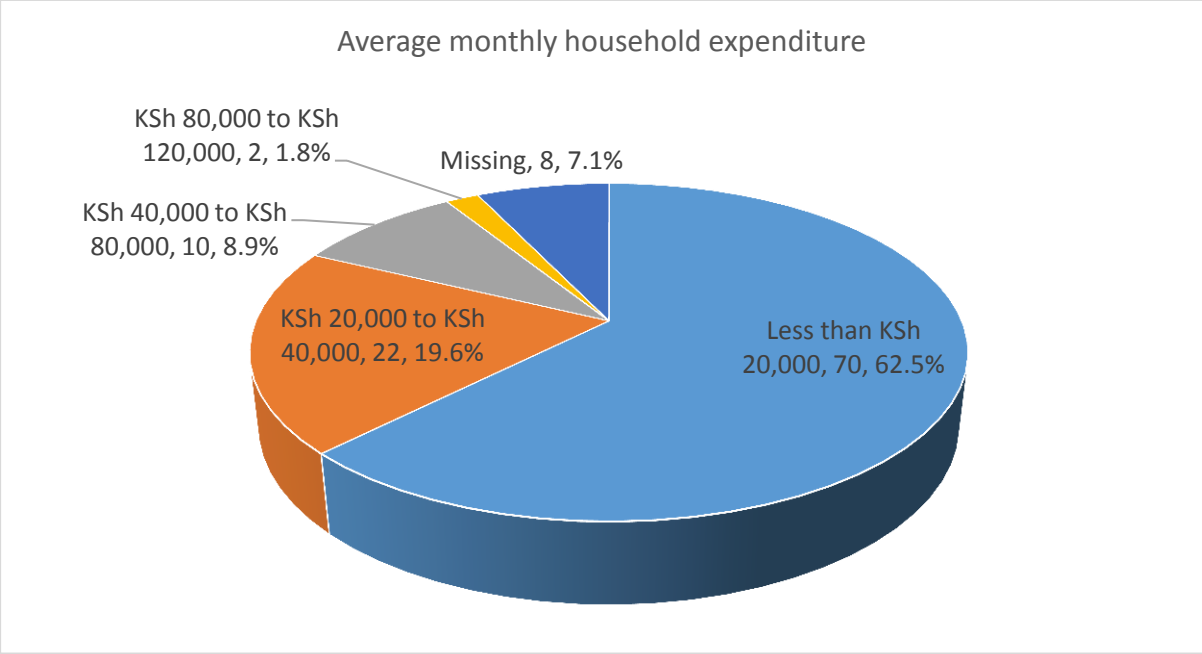


Figure 4-4: Average monthly household expenditure

4.3.3.2 Commercial premises

The majority of the businesses that were represented in the study were merchandise businesses, standing at 43.4%. Such premises included general or grocery shops, electronics shops, drug stores, hardware stores and boutiques whose businesses is based on the sale of goods. Service and hybrid industries were equally represented by 28.3% of the respondents each. Service businesses included hair salons and barber shops, cybercafés, banking and mobile money agents. Hybrid businesses, those whose activities entail both the sale of goods and services, largely include restaurants, some cybercafés and studios.

The majority of commercial premises (38.5%) represented in the study have been operating for more than 5 years, followed by 25% that have been in operation for less than a year. About 21% have been running for between 1 and 3 years, while the rest have been running for between 3 and 5 years.

4.3.3.3 Community groups

A total of nine groups participated in the study, with each group having an average membership of about 16 members. The largest group has had 30 members and the smallest having 12 members. The membership of the groups is largely dominated by males, averaging to 12 members per group against 4 female members. 3 of these groups have been in existence for less than a year, the same number having been in operation between 1 and 3 years, and the rest for more than five years. All these groups indicated that their main source of funds was the revenue from their activities.

Eight of the nine groups stated that waste collection and transport was their main activity, with one mentioning that they are involved in the cleaning up of residential areas. Among those that offered waste collection services, seven largely serve households, while one mostly served commercial premises, all of which are charged for the collection service, which is the main revenue source for the groups.

4.3.4 Waste management practices

4.3.4.1 Generation and storage

The respondents from households and commercial premises were asked to mention at most three most common categories of wastes that feature in the refuse generated from their households or business premises. Food waste was found to feature in the waste generated in 80.61% of the respondents, followed by plastics at 73.33% and papers at 69.7%, as shown in Figure 4-5. The trend is similar in Lower Savanna ward, with food waste featured in 84% of the respondents' waste, followed by plastics at a distant 65.9% and paper at 61.36% of the respondents. A contrast was witnessed in Upper Savanna Ward where plastics featured in the waste generated by most of the respondents (81.22%), followed by papers and food at 79.22% and 76.62% of the respondents respectively.

Community groups on the other hand were asked to identify three waste categories that featured most in the course of their waste management

activities. Food wastes and plastics were found to be the most common, mentioned by all nine groups, followed by papers mentioned by five groups.

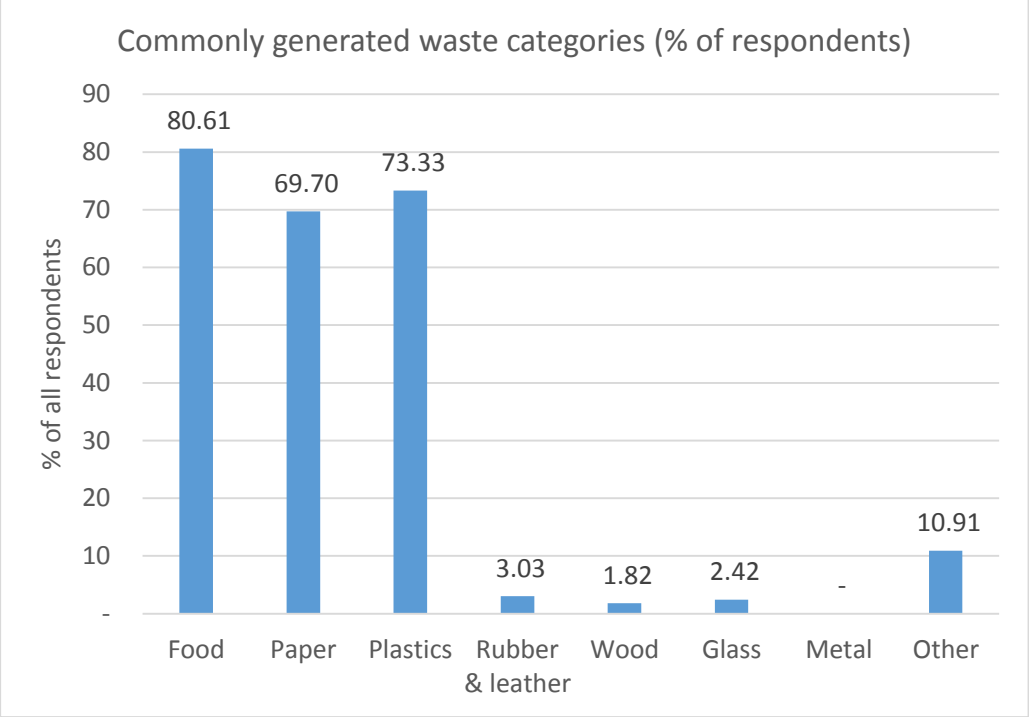


Figure 4-5: Waste categories featured in waste generated by respondents

Excluding five respondents that did not respond to this question, only 17.5% of those that did indicated that they separated their waste before collection or disposal. In Upper Savanna ward, about 21% indicated that they do separate their waste, which is 7% higher than the fraction of the respondents in Lower Savanna Ward that reported the same. Among commercial premises, 19.2% indicated that they separate their waste, which is slightly more than households, where 16.7% mentioned that they separate their waste. Some of the ways in which the respondents said that they separated their waste are as follows:

- By their individual categories, such as foods, plastics and papers
- Dry and wet, or those that can be burnt and those that cannot be burnt
- Those that can be reused and those that cannot be reused

This is however contradictory to the information provided by the county authorities, which indicated that lack of waste separation is a major challenge in the county. Those that separate waste largely do so on the basis of the individual categories, such as plastics, food waste and metals, while one indicated that they separated organic waste from inorganic waste.

On the other hand, seven out of nine groups indicated that they are involved in waste separation, mostly after collecting the waste from the clients. In the course of separation, the groups salvage materials such as plastics and food waste for sale to waste dealers or recyclers, and farmers respectively.

4.3.4.2 Collection

4.3.4.2.1 Waste collection from the perspective of waste generators

91.5% of the respondents, combining both households and commercial premises, mentioned that they receive waste collection services. This encompassed 92% of the households and 90% of commercial premises. Going by each ward, 94.3% in Lower Savanna Ward indicated that they receive waste collection service, as opposed to 88% in Upper Savanna.

Community based organisations were found to provide waste collection service to 67.8% of all the respondents. They are followed by private companies that serve 27.5% of the respondents as shown in Figure 4-6.

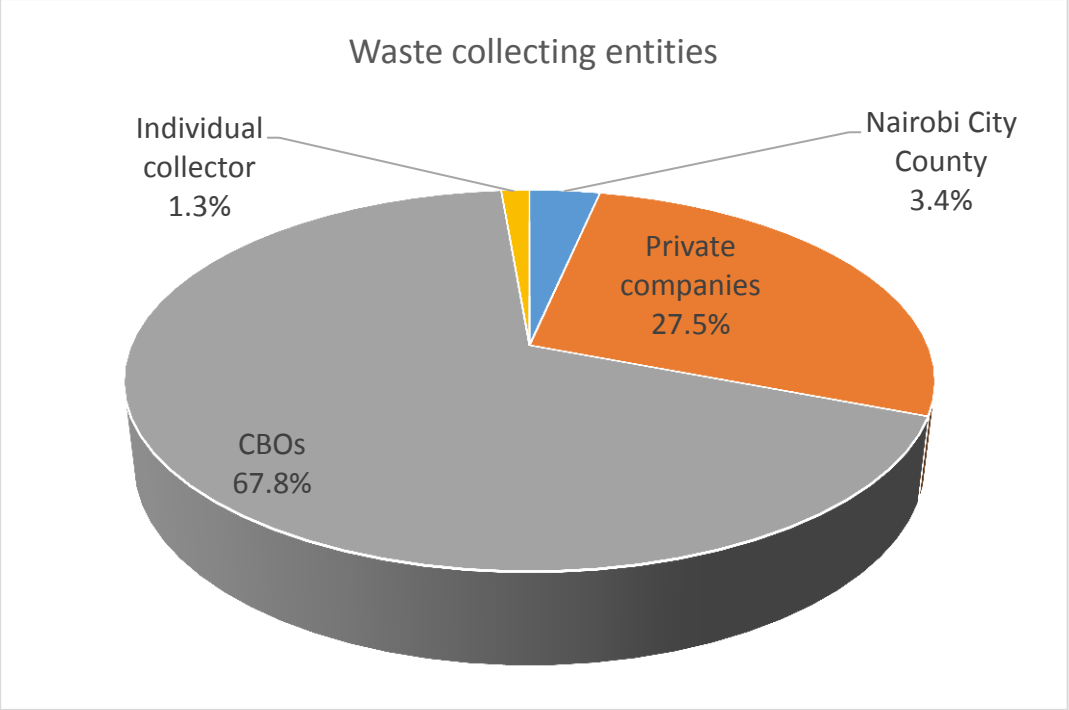


Figure 4-6: Entities responsible for waste collection

In the two wards, waste collection service is paid for by a huge majority of those that receive it (90.7%). The percentage of those paying for the service in Lower Savanna is higher than those that do pay in Upper Savanna Ward (97.6% and 82.4% respectively). The proportion of the respondents and the monthly waste collection fee is summarized in Figure 4-7.

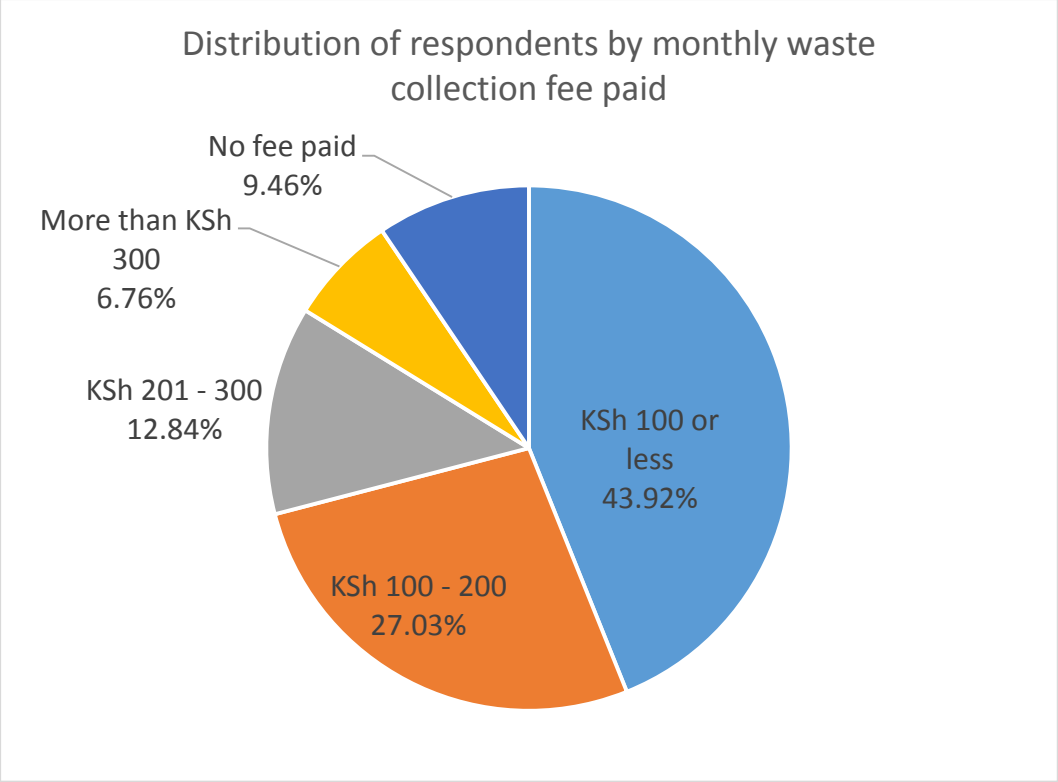


Figure 4-7: Distribution of respondents by monthly waste collection fee paid

About 71% of the respondents in the two wards indicated that they had their waste collected once a week, followed by 17.9% who had theirs collected twice a week. Majority of the respondents (71.5%) received waste collection services in the morning, followed by 6% that received the service in the afternoon. 7.3% had their waste collected in the evening and 14.6% reported that waste collection was irregular. On the mode of collection or transportation of waste, the use of hand carts was most dominant in the two wards, mentioned by 82.3% of the respondents. This was followed by lorries at a distant second, mentioned by 15% of the respondents.

About 41.1% of the respondents rated the waste collection service they received as good, 40.4% describing it as fair and 18.5% thought that it was poor, as shown in Figure 4-8. In Upper Savanna Ward, more than half (54.4%) of the respondents believed that the service they received was fair, with a quarter of the respondents rating it as poor. On the other hand, in Lower Savanna Ward, about 58% indicated that the service was good and 13% believed that the service was poor.

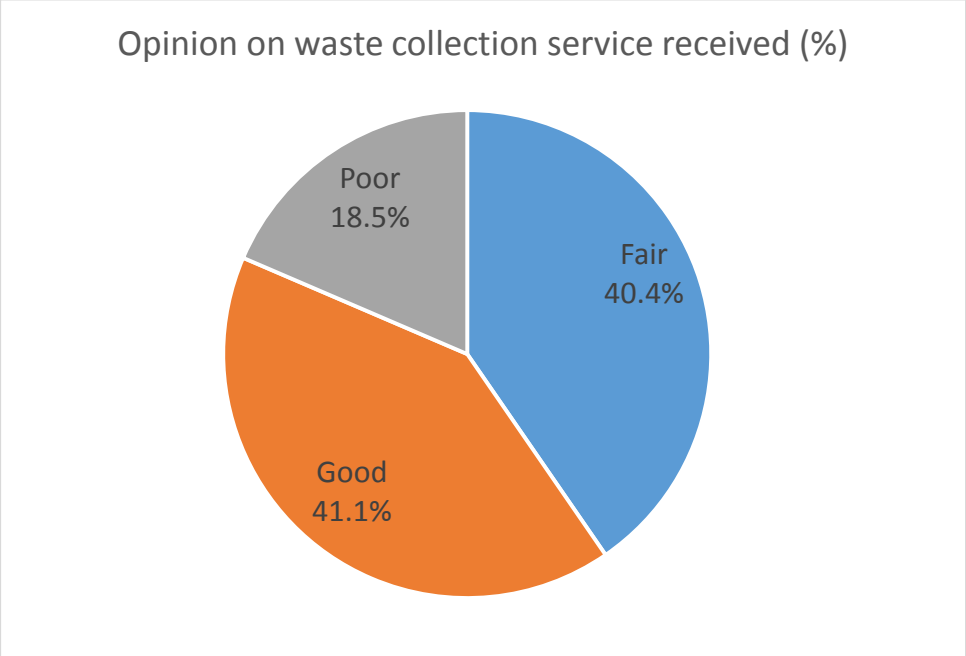


Figure 4-8: Opinion on waste collection service

4.3.4.2.2. Waste collection from the perspective of community groups

Out of the nine community groups that took part in the study, eight indicated that they take part in waste collection. One reported to largely collect waste from commercial premises, while the other seven mentioned that they largely served households. All the groups indicated that they do charge for the waste

collection services. Three of the groups indicated that they charge Ksh 50 per client per month, another three charging Ksh 80 per month, one charging Ksh 200 and one did not disclose how much they charge for their services.

Seven out of the eight groups indicated that they collect waste from each client once a week, making it the prevalent waste collection frequency in the target area. Furthermore, six out of the eight collectors use handcarts to transport their waste, with the other two using lorries. Those that use lorries deliver their waste to the official dumpsite in Dandora, while the rest take their waste to illegal open dumps, which in many cases is a river near the area.

4.3.4.3 Other waste management practices

As an alternative to the reception of waste collection services as the main mode of waste management, open burning was reported to be used by 33.3% of the respondents. Other waste management alternatives mentioned were selling or giving away of waste materials, and open dumping as shown in Figure 4-9. The majority of the respondents (33.9%), however, reported to not employ any alternative in the management of solid waste apart from having it collected by their service providers

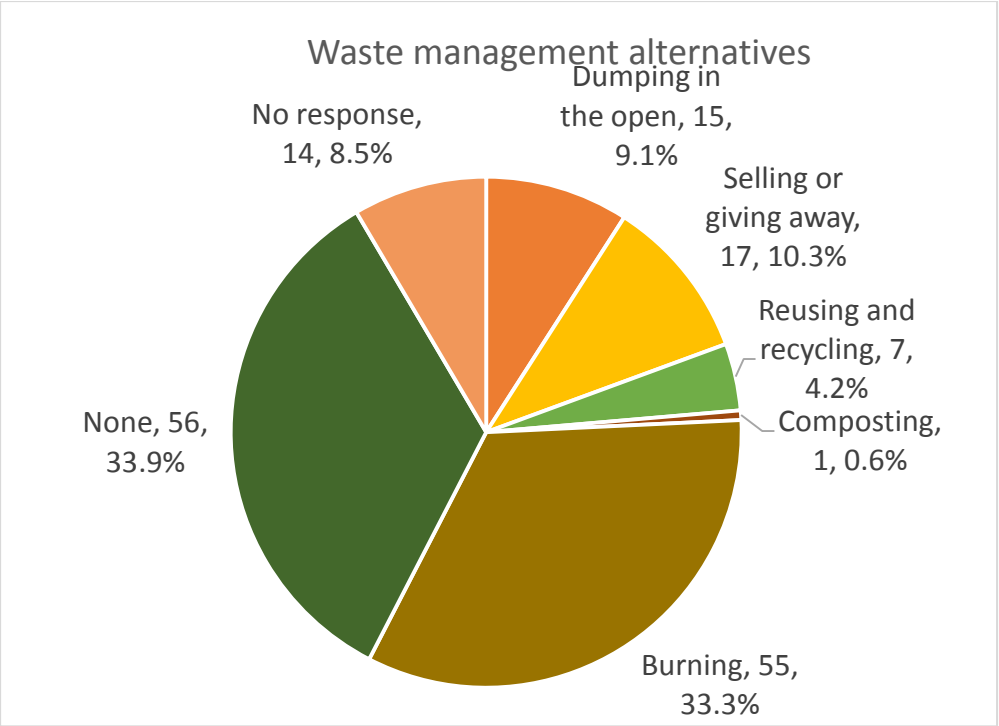


Figure 4-9: Waste management alternative besides collection for disposal

Among the waste categories that are commonly reused or given or sold for other uses are plastics, food wastes, papers, textiles and leather. The major recipients of the waste given away according to those who do so are itinerant traders and informal waste pickers, who sell materials such as plastics to recyclers or waste dealers. Food waste on the other hand is mostly given or sold to farmers as animal feed.

Among the community groups that took part in the study, seven out of the nine groups indicated that there are wastes that they recover after collection, while the remaining two send all the waste they collect or handle for disposal. The recovery activities include the collection of recyclables for sale. Plastics and food wastes were reported as the most commonly salvaged materials, which were thereafter put up for sale.

4.3.5 Awareness

When asked about their participation in awareness programs on solid waste, only 20 respondents out of 165 (12%) from both households and commercial premises put together mentioned that they have taken part in such. This included 14% of households and 7.5% of commercial premises. Twelve out of the twenty of which are from Lower Savanna Ward. Among the 19 that gave the details of their participation, 9 stated that the last time they attended such a session was between 1 and 3 years before the time of the study, 8 having attended the same less than a year before, and two more than 3 years before. Also, from the 19, nine stated that the last such session they attended was organized by community based or non-governmental organisations, followed by 6 who said that they attended those led by the private sector, and 4 organized by the county authority.

Among the nine community groups that took part in the study, four indicated that some of their members have taken part in an awareness program on solid waste management as audience. Three out of the four attended such within the twelve months preceding the study, while one attended such more than 3 years before. Two mentioned that the program they attended was organized by the county authority, and the remaining two mentioned the church, and a non-governmental organization.

The awareness on laws touching on solid waste management, such as the county bylaws, was found to be low, with about 31% mentioning that they

were aware of them. Other aspects of awareness that were looked into during the study were familiarity with the 3Rs in waste management, and awareness of existing waste reduction and recovery efforts in the locality, summarized in Figure 4-10.

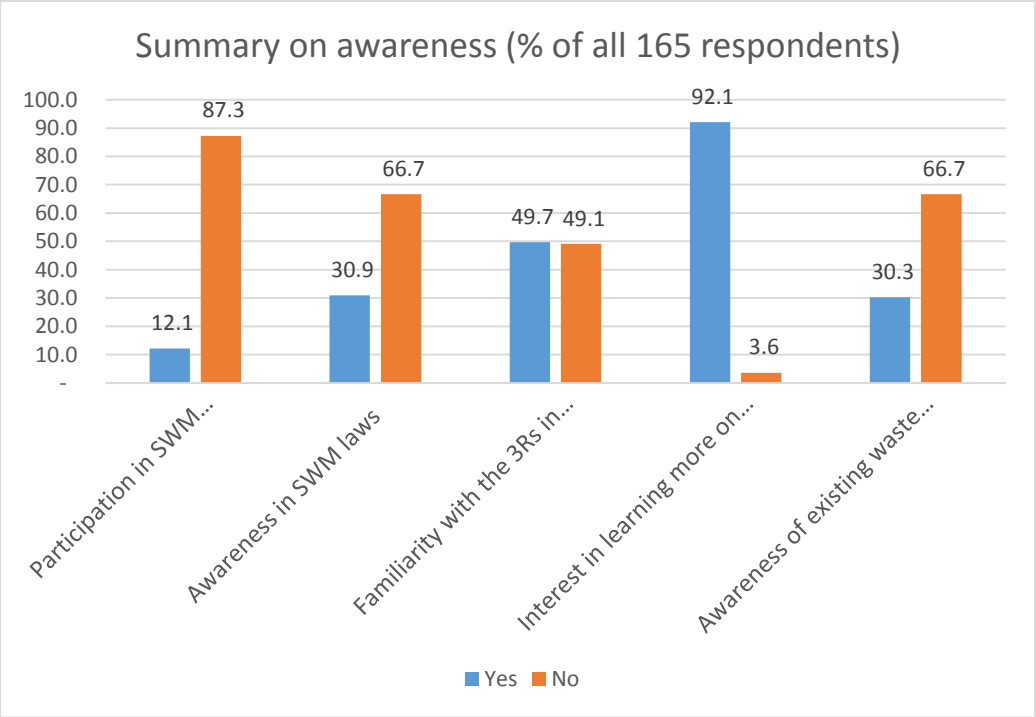


Figure 4-10: Summary on waste management awareness

Respondents from five out of the community groups mentioned that they were familiar with the 3R with regards to solid waste management, four of which were in agreement on having it incorporated in the practice of and awareness programs on waste management in their localities.

About 30% of the respondents stated that they were aware of activities or facilities through which waste was recovered or diverted from disposal, as compared to about 70% who are not aware of such. The best-known activities

are collection of recyclables for sale, recycling (9.7%), and reuse of waste to make new products as shown in Figure 4-11.

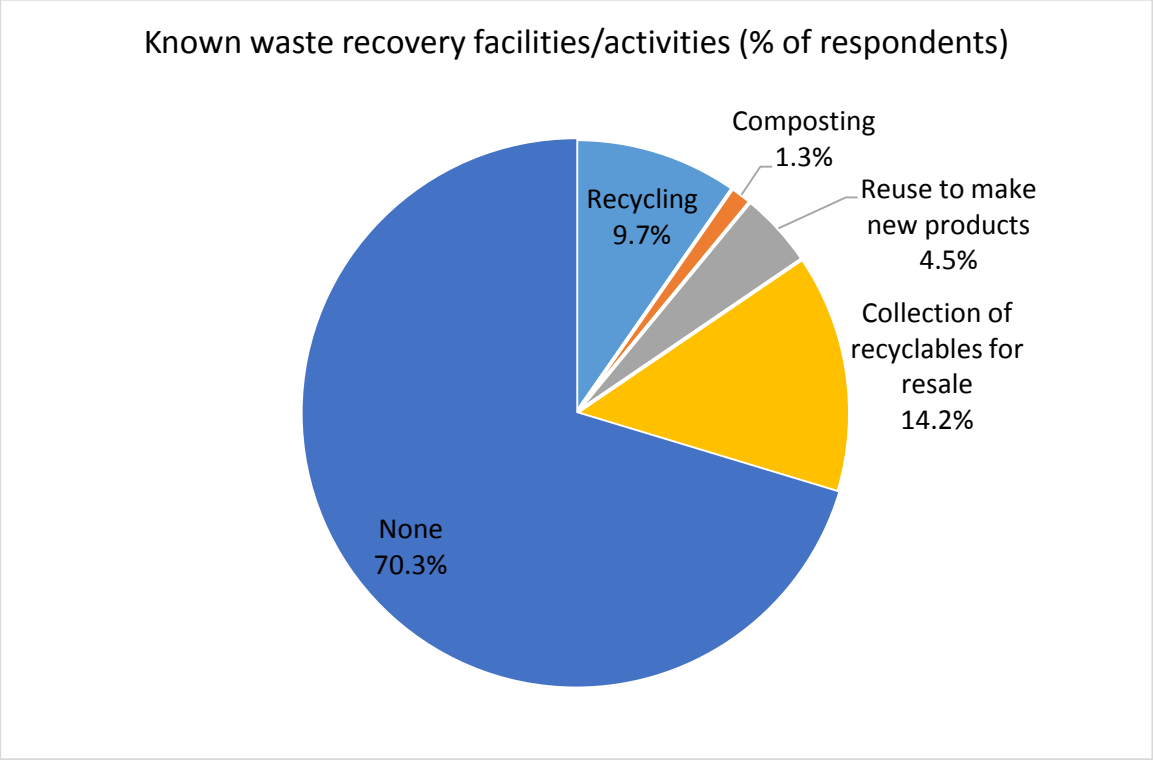


Figure 4-11: Known waste recovery efforts/facilities by respondents

When asked about the most preferred means of reaching out to members of the public on proper waste management, 59.7% of the respondents preferred the use of public meetings and clean-up exercises, followed by the use of mass media which was preferred by 28.3%, as summarised in Figure 4-12. Public meetings and clean-up exercises also received a high approval from the community groups, supported by eight out of the nine groups in the study, with one supporting mass media.

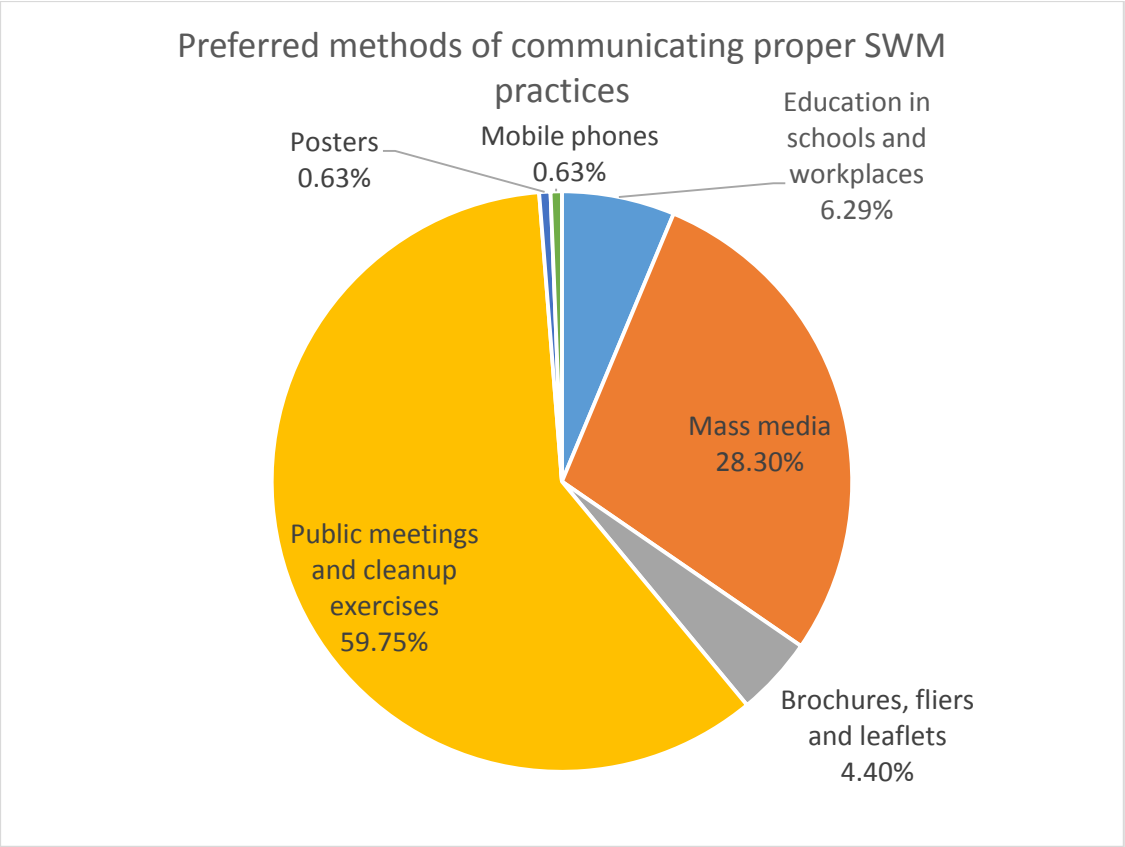


Figure 4-12: Preferred methods of awareness creation in proper SWM

4.3.6 Perception to change

97.6% of the respondents of the respondents from both commercial premises and households combined stated that it is possible to improve the waste management situation in their locality. In addition, 97% of the two groups combined mentioned that they were willing to cooperate with the county authorities or any relevant party towards the improvement of waste management in their area. However, only about a half of the respondents were willing to pay more than they do for waste management services as a way of contributing towards better waste management in their area. More than half of the respondents in Upper Savanna Ward (55.8%) were willing to pay more

towards the improvement of waste management, while about the same percentage in Lower Savana were not willing to do so. It was also noted that there was general negativity among respondents from commercial premises concerning paying more for better waste management, with about 39.6% agreeing to it, as compared to 56.6% of the households who agree to it.

All nine groups in the study believe that it was possible to improve the waste management situation in their locality, and all indicated that they were willing to cooperate with the local authorities or any other entity spearheading such efforts. However, one out of the nine groups was not willing to incur any financial costs above the usual towards such efforts.

The respondents from households and commercial premises, as waste generators, were asked to state whether or not they agreed to the inclusion of various interventions in solid waste management in their area and the county at large. 13 respondents did not respond to this section of the questionnaire, hence leaving 152, whose responses have been summarized in Figure 4-13.

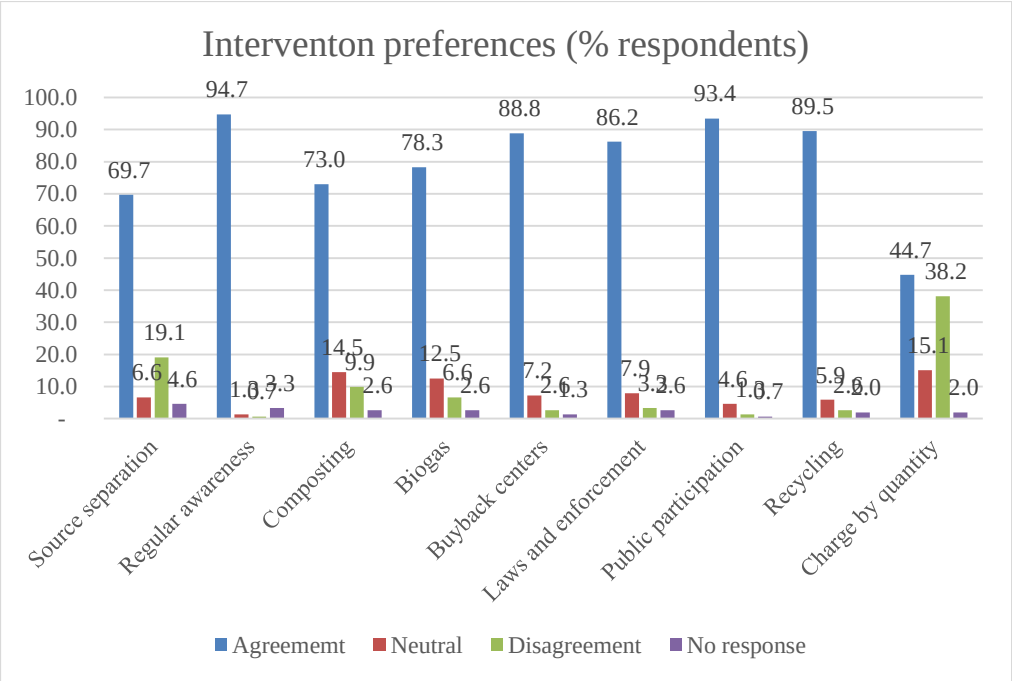


Figure 4-13: Preferences towards waste management intervention by waste generators

All the nine proposed interventions had the majority of respondents agreeing to them, with regular awareness having the largest percentage of respondents in agreement (94.7%). This was followed by public participation, recycling and setting up of buyback centres for recyclables, which was supported by 93.4%, 89.5% and 88.8% of the respondents respectively. Charging of waste collection by quantity had the least percentage of respondents agreeing to it (44.7%). It also had the highest fraction of respondents in disagreement, standing at 38.2%, followed by waste separation at source, disagreed to by 19.1%.

The community groups that participated in the study were also asked for their opinion on the introduction of the same interventions discussed above with the

findings summarized in

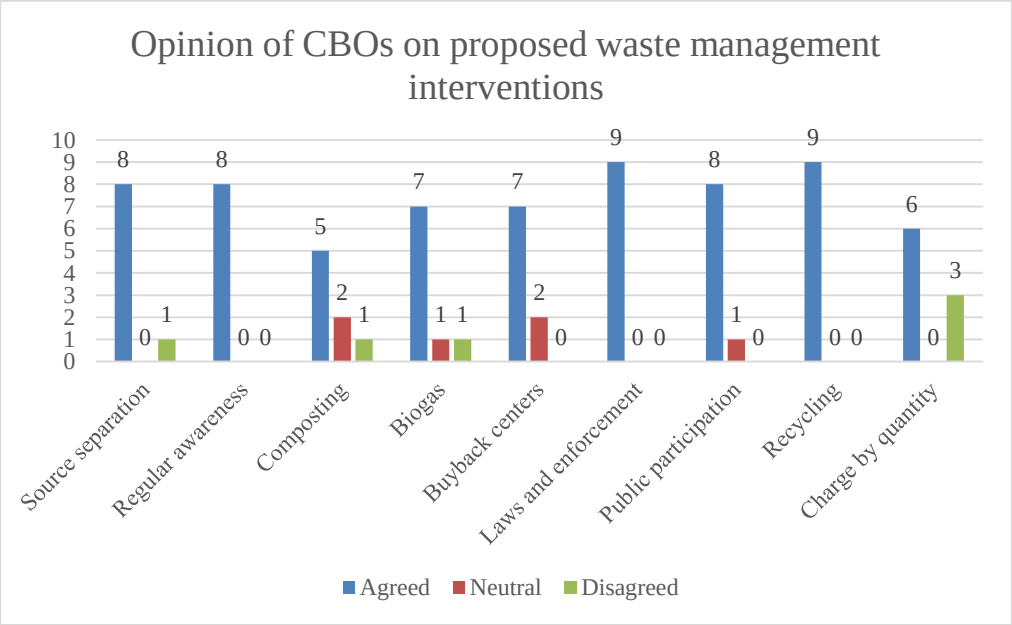


Figure 4-14.

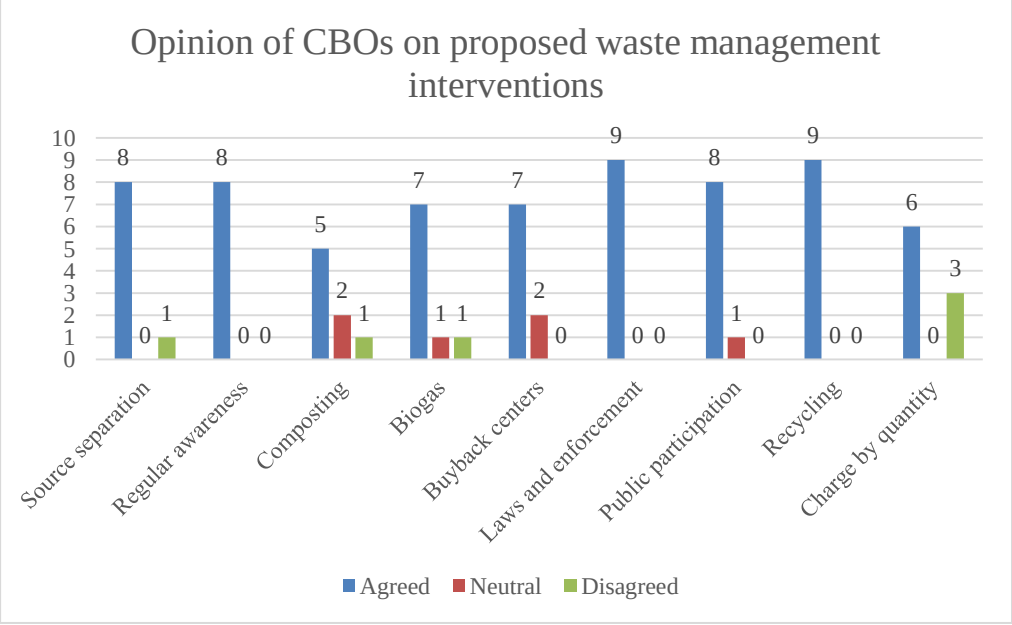


Figure 4-14: Opinion on proposed waste management interventions by CBOs

All nine groups were in agreement with recycling of waste, and the improvement and enforcement of laws regarding waste management. These are followed by waste separation at source, regular awareness creation and increased public participation, all of which were agreed to by eight of the groups. Composting had the lowest number of respondents agreeing to it, followed by charging of waste collection by quantity, at five and six respectively. In addition, the latter had three respondents against it, making it the intervention with the most respondents disagreeing to it.

4.3.7 Feedback after Data collection

Meetings were held at the Embakasi East Sub-county office after data collection as described in section 3.4 (v), and yielded the following:

- Awareness creation; with different themes for different audiences
- Meetings with the residents for sensitization on proper waste management, and public participation
- Reuse and recycling at the local/ward level
- Central location for waste storage and collection (proper planning)
- Adequate collection and transport
- Enforcement of legislations
- Waste brought in for disposal from other areas
- Motivation of CBOs and youths involved in waste management

CHAPTER FIVE

DISCUSSION

5.1 Introduction

This chapter discusses the findings of the field study as noted in chapter four. The key areas under discussion are the gaps in waste management noted in Upper Savanna and Lower Savanna Wards. It also proposes waste management interventions to be incorporated in the waste management action plan.

5.2 Gaps in solid waste management in Upper Savanna and Lower Savanna Wards

The main shortfalls noted in the study area that the proposed action plan aims to address focuses on three main areas of waste management: Collection, Open dumping, the 3Rs, and public awareness and participation.

5.2.1 Waste collection

From the field study, 88% in Upper Savanna and 94.3% in Lower Savanna, combining households and commercial premises in both cases, stated that they receive waste collection services (Appendix 10: Output of analysis of questionnaires from Upper Savanna Ward and Appendix 11: Output of analysis of questionnaires from Lower Savanna Ward. Given that the estimated waste generation rates for the two wards are 32.69 tons/day and 22.37 tons per day respectively, the quantities collected are 28.77 tons per day and 21.09 tons per day respectively. According to Nairobi City County (2015), 20% of the waste generated in Embakasi East Subcounty gets to be delivered

to Dandora for disposal. This figure may not be an accurate reflection of the waste collection rate in the study area, but it can be an indicator that there is a considerable fraction of uncollected waste from the two wards.

A possible reason for the fraction not receiving waste collection services is that some residents may not be able to afford to pay for the service, or purchase plastic bags for bin liners or waste storage (JICA, 2010). From the field study, as much as 62.7% of the respondents said that the fee they pay for waste collection services is fair, while 28.4% thought that it was expensive.

Challenges in the transportation of waste have been found to be a factor contributing to non-collection of waste. Such shortcomings include the shortage of trucks for waste collection and the inconsistency in the times when the trucks are available for waste collection at a particular location. The unavailability of the trucks means that the waste does not get to be collected as required.

Another point that stands as a gap is the frequency of collection in the study area. Low frequency of the reception of waste collection services may lead to a higher rate of accumulation of the generated waste than that which can be collected for final disposal, thus resulting to a fraction which will not be delivered to the disposal site. From the combined findings of Upper and Lower Savanna Wards, about 71% of the respondents indicated that they have their waste collected once a week and 8.6% wait more than a week before their waste is collected (Appendix 12: Output of analysis of combined data from both Upper Savanna and Lower Savanna Wards. Furthermore, low

collection frequency has been mentioned as one of the reasons of dissatisfaction in waste collection service among residents in Nairobi (JICA, 2010). Possible reasons of the low collection frequency, and non-collection in some cases, revolve around the transportation of waste, such as the shortage of trucks, and their inconsistency in timing.

It was established in the study area that about 67.8% of the respondents received waste collection services from community groups as the primary waste collector. In such cases, an arrangement is made so that the waste is taken to collection points where the county trucks or contractors collect them for disposal in Dandora. Lower Savanna ward is one such area where 85% of the residents are served by community groups. All of the groups from this ward that took part in the study indicated that they use hand carts to haul their waste from the source to a location next to a river. One challenge with such groups however is that there are several that have emerged within a short while, and some are either not well structured, or are not well informed in proper waste management. Hence such groups may not be in a position to deliver waste collection services adequately. Another challenge with this arrangement is the lack of proper collection points, which further complicates the task of collection for final disposal. Hence the groups would deliver their waste into illegal disposal sites, such as on river banks, as shown in Figure 5-1.

Figure 5-1: Open dumping in a river in Lower Savanna Ward

A notable outcome associated with non-collection of waste is the prevalence of open dumping and burning as a mode of waste management. From the field study, illegal dumping and open burning have been found to be common alternatives to waste collection service by 9.1% and 33.3% of the respondents respectively. This was confirmed by sightings of charred surfaces and garbage heaps on roadsides and in residential areas, such as that shown in Figure 5-2. If, for instance, there is a delay in waste collection, or no vehicle available for collection, the waste awaiting collection may pile up resulting to heaps of waste in the residential areas, or the potential collection points turning into dumpsites. In addition, residents who are not able or choose not to pay for waste collection services, they are likely to opt for open dumping and burning as a means of getting rid of their waste. According to JICA (2010), the

inability of many residents to afford to buy plastic bags for waste storage is presumed to be one of the causes of illegal dumping.

Figure 5-2: Open dumping in a residential area in Upper Savanna Ward

5.2.2 Waste reduction, reuse and recycling (3R)

The activities in this context include, but are not limited to composting, recycling and reusing of waste. Such have been seen to be scarce in the study area since the management of waste is largely based on collection from the generators for disposal by community groups or private companies. From the field study, 10.3% of the respondents reported to occasionally sell or give away their waste as an alternative to the usual collection service, as compared to 33.3% who do open burning, 9.1% who dump in the open, and 33.9% who only rely on waste collection services for their waste management.

A major factor contributing to the little activity in waste reduction and recovery is the minimal or lack of separation of waste at the source. Through separation, different waste components can be separated and taken through different channels of processing or recovery. According to Tang (2004), better source separation would help maximize recycling. In order to enhance recycling, for example, many municipalities in the developed countries have set up source separation requiring households to separate their waste before collection (Bolaane, 2006).

From the field study, 17.5% of the respondents in the study area indicated that they separated their waste at the source before collection for disposal, with varied criteria being used such as by their individual categories, such as foods, plastics and papers; or dry and wet. However, it was not established whether or not this was done regularly, and what is done with the waste after separation. In addition, waste separation at source has been mentioned as one of the key challenges in waste management in the county. Hence despite there being a fraction of respondents that report to separate waste at source, the practice still appears to be weak, and that the waste generated in the study area is largely commingled.

During the field study, one reason mentioned for not separating waste is the notion that all waste is still waste going into the same dumpsite regardless of whether or not they are separated before collection. The residents therefore see no need to put in extra effort to ensure that the waste is separated. Furthermore, there appears to be no guideline or infrastructure to facilitate the

separation of waste at the source. From the fraction of respondents that claimed to separate their waste, varied criteria for segregation were used, which would have been chaotic on a larger scale.

The lack of a 'visible' or known recycling or waste recovery facility or activity is another possible reason why waste reduction and recovery is low. According to Bolaane (2006) in a study on waste recycling in Gaborone, Botswana, the lack of visible recycling centres could be a contributing factor towards the relatively low level of setting aside some waste materials for recycling. From the field study, the only well-known activity where waste materials are diverted away from disposal is the salvaging of recyclables for sale, mentioned by 14.2% of the respondents. This is followed by recycling, reuse and composting, mentioned by 9.7%, 4.5% and 1.3%respectively, leaving 70% who do not know of any activity or facility for waste recovery or where 3R is practiced. However only the salvaging of waste materials for sale could be verified during the field study. This was evidenced by the spotting of individuals scavenging for materials at a dumpsite, and the presence of a waste dealer identified within Lower Savanna Ward.

5.2.3 Public awareness and participation

From the field study, 12% of the respondents indicated to have taken part in an awareness program on waste management within the last three years as at the time the study was conducted. This is comparable to the findings by JICA (2010) that almost 70% of the respondents in the preparatory survey for

Nairobi not having participated in any public education program on solid waste management. Furthermore, about 70% of the respondents stated that they were not aware of any waste reduction or recovery facility within their locality.

In addition, 30.9% of the respondents mentioned that they were aware of the laws governing solid waste management. A shortcoming with this question, however, is that there was no follow-up of the specifics of the legislations that the respondents were aware of. Hence it is difficult to accurately figure out whether or not those who say they are aware of the laws truly are. Despite this, the majority of the respondents indicated that they were not aware of the laws governing solid waste management in Nairobi, hinting that it is an area that requires attention.

Some of the prevailing practices in waste management in the study area and the county at large such as open dumping and burning and low waste separation at source can be attributed to low public awareness and negative attitudes. In a study by Muthoni (2014) on the involvement of stakeholders in waste management in Nairobi the ‘not in my backyard’ attitude has led to stakeholders pushing waste away into trenches and roadsides. He also found that there was a culture where waste management was perceived solely as the responsibility of the authorities.

Even though it was not mentioned expressly in the field study, the lack of incentives can be another reason for the little activity on waste reduction and recovery in the study area. In a study on waste recycling in Gaborone by

Bolaane (2006), 51% of households set aside glass bottles primarily because of the deposit paid back on returning them. Furthermore, among those who were aware of the deposit refund scheme, 76.3% returned their bottles to obtain the deposit; thus, indicating that if there was no incentive, there would be no motivation factor for the setting aside of waste materials for recycling.

The waste management gaps to be addressed by the action plan proposed by the study are summarized in **Table 5-1**.

Table 5-1: Summary of gaps in to be addressed by proposed action plan

Areas of attention	**Possible reasons for attention**
Non-collection of waste	● Residents not subscribed to waste collection service ● Shortage of waste collection trucks and inconsistency in collection ● Low waste collection frequency ● Poorly organised and inadequately informed waste collectors ● Lack of adequate collection points
Waste reduction, reuse and recycling (3R)	● Poor separation of waste at source ● Lack of infrastructure or 'visible' facilities and efforts towards 3R ● Negative notions and attitudes towards 3R related activities, such as source separation ● Lack of awareness and guidance on the relevant 3R practices

Low public Awareness and participation	• Limited awareness creation and education on waste management • Negative attitudes • Lack of incentives for good practices • Poor participation by stakeholders

5.3 Proposed waste management interventions in Upper and Lower Savanna Wards

The proposed actions to address the waste management gaps in Upper Savanna and Lower Savanna Wards are drawn from the experiences in Kandy Municipality, the input from residents and county officials from the field study and meetings held, and from literature review. The gaps as discussed are categorized into four: waste collection; waste separation at source; setting up and support of 3R efforts; and public awareness and participation.

5.3.1 Waste collection

Since the objective of the action plan is to foster waste reduction and recovery, collection is set to be a key factor in the success of the plan. According to Kasozi and Blotnitz (2010), it is logical to get the general waste collection and disposal working well before embarking on waste diversion. Ensuring 100% collection would mean all the generated waste is taken to the desired channels for further processes as planned, for example recycling. In addition, 100% collection would ideally mean that all the waste generated is accounted for and none ends up in illegal dumpsites.

In Kandy Municipality, the change from central collection points to door-to-door collection resulted in an increase in the collection coverage from 80-85% to about 95% in less than five years. In the case of Upper Savanna and Lower Savanna Wards, about 8.5% of the respondents indicated that they do not receive waste collection service. Furthermore, despite the predominance of door-to-door collection, there also is a possibility that a higher percentage of waste generated in the study area is uncollected, given that the average waste collection of Embakasi East was about 30%, and that of Nairobi County is at about 60% (Nairobi City County, 2015).

In its preparatory report on waste management in Nairobi, JICA set the target of 100% collection to be achieved in 2030, basing on a collection ratio of 33% in 2009. This means an increase in tonnage collected from 609 tons per day to 2872 tons per day, or an annual increase in the daily waste collection rate of approximately 7.7%.

Based on this this projection, the action plan will therefore adopt 7% as the target annual rate of growth in waste collection quantities as a step towards achieving 100% waste collection, or the point where waste generation equals waste collection. Applying this rate in the projection formula as used in Equation 4-1 would yield as follows:

$$q_n = q_o(1.07)^{n-2009}$$

Equation 5-1: Projection of daily waste collection rates

Where

q_n = daily collection at year n

q_0 = daily generation in 2009

This would yield the curves for collection quantities as shown in Figure 5-3 and Figure 5-4.

At this rate, Upper Savanna and Lower Savanna would achieve 100% collection in the year 2023 and 2020 as shown in Figure 5-3 and Figure 5-4 respectively. Beyond the said years, theoretically, the collection rate would surpass the generation rate. However, practically, waste collection would match the generation rate.

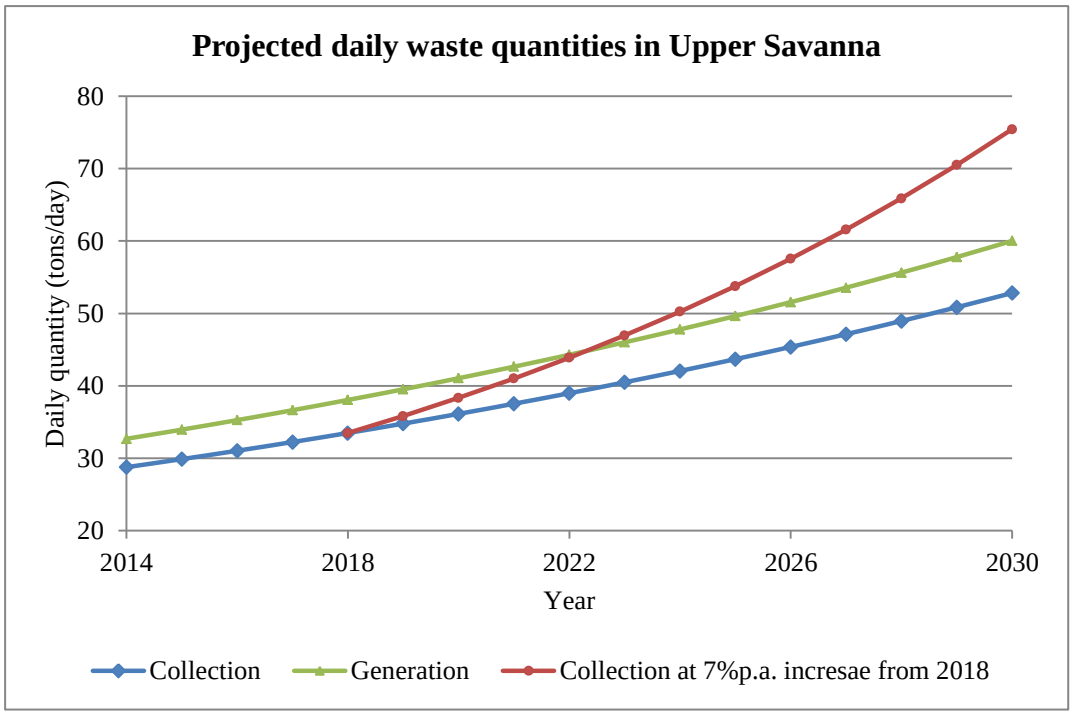


Figure 5-3: Projected daily waste quantities in Upper Savanna Ward

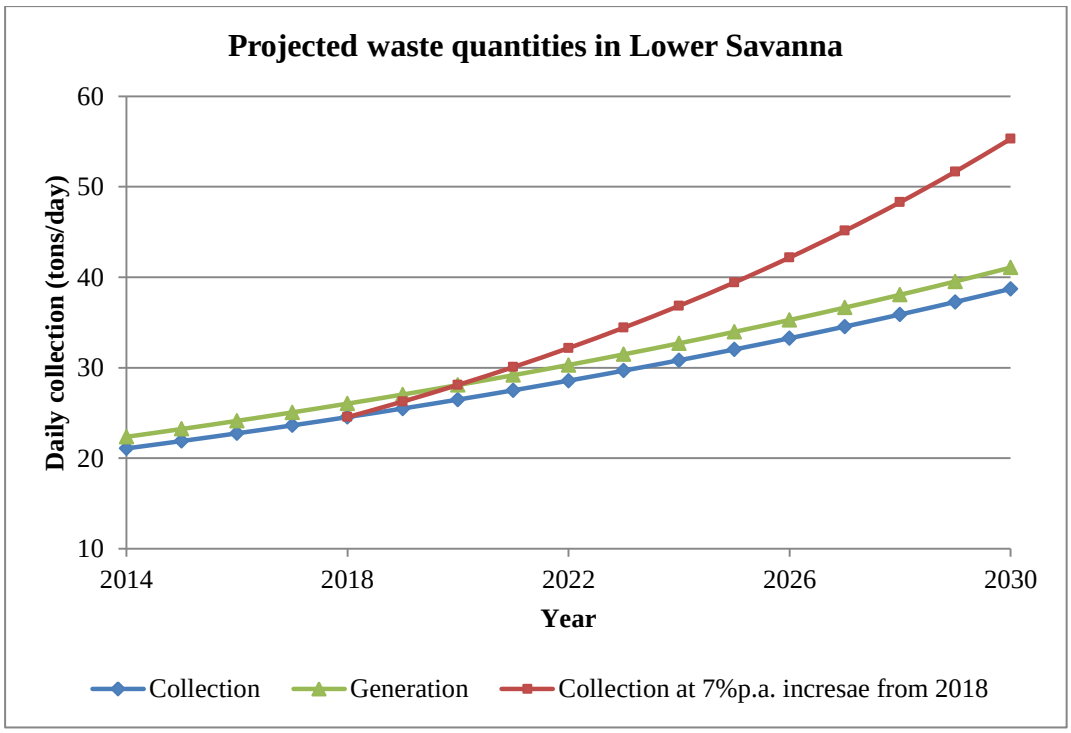


Figure 5-4: Projected waste quantities for Lower Savanna Ward

Hence the objective under waste collection is the realisation of 100% collection by 2020 in Lower Savanna and 2023 in Upper Savanna. This can be achieved through ensuring a 7% increase per annum of the tonnage of waste collection which can be done through addressing the following items.

5.3.1.1 Waste collection coverage

It was noted during the field study that some respondents were not subscribed to waste collection services by any entity. Efforts should hence be focused towards maximum waste collection. One way would be to encourage residents to engage with collection service providers and emphasize on the importance of their service. Landlords or premise owners can also work on ensuring that

their tenants are registered for waste collection, as prescribed in the Nairobi City County Solid Waste Management Act 2015. The existing waste collectors may also be encouraged to take up more clients depending on their capacity. It was noticed during the field study that specific waste collectors work in specific estates or zones. Hence efforts can be made by the waste collectors to ensure that their respective zones or estates are fully served.

The costs of the collection service should be considered such that it is not discouraging to potential clients. From the field study, just about 50% of the respondents indicated that they were willing to pay more than they do currently towards improvements in waste management in their area. Some of those that were not willing to do so mentioned that they would when the results of the changes or improvement are visible. Furthermore, the collectors are to be encouraged to offer good services as a way of showing value to the service that the residents are paying for, such as collection of waste on time.

5.3.1.2. Waste collection trucks and consistency of collection

In the short term, planning should be done in such a way that the available collection trucks are well distributed across the areas they are meant to serve. In the long term, the number of trucks in operation can be increased through purchasing new ones or partnering with other stakeholders so as to reduce the duration between collections. Even with more vehicles in operation, proper planning and scheduling should still be done to have them distributed adequately in terms of space and time, and cognizant of the amounts of waste to be collected. The waste collectors on their part can work to ensure that their

vehicles are in good order so as to avoid long periods of non-collection of waste due to the vehicles not being in operation.

With the planning and scheduling of collection, proper communication should be made to the residents and relevant parties in the management of waste in the area. If both the waste generators and collectors adhere to the schedule, it would help avoid the accumulation of waste in case of delays in collection.

5.3.1.3 Collection frequency

Just over 70% of the respondents in the field study indicated that they receive waste collection service once a week and about 8.6% have to wait more than a week to receive the service. In Kandy Municipality, biodegradable waste is collected from domestic sources on three days each week, with the recyclables such as plastics, papers and glass being collected over the weekend. Hence in essence, each residence receives waste collection service about four times each week. This coupled with the introduction of door to door collection has helped to improve the coverage in waste collection services in the municipality.

In the case of Upper Savanna and Lower Savanna ward where waste collection is predominantly done once a week, the frequency can be increased to twice a week over time. This goes with the proposal of the respondents from the study that the waste collection frequency be increased. One of the reasons behind this proposal is to prevent the accumulation of waste before the subsequent collection. Waste collection twice a week can also help in waste separation efforts by having different waste categories collected on different days.

The change of waste collection frequency may come with a change in the cost of operation for the waste collectors, and to some extent, the amount that residents may have to pay as waste collection fees. As found in the field study, about half of the respondents were willing to pay more than they normally do for improved waste management, while a fraction of the remaining half needed to be convinced by visible changes in waste management in their area. Hence the increase of collection frequency can come following interventions that bring about visible positive changes such as the increase in waste coverage and timely waste collection, and the reduction or elimination of waste heaps in open dumps.

5.3.1.4 Organization of waste collectors

A way of ensuring better management of waste collectors is enforcement to ensure that they adhere to the set requirements, including how they are organized, in the case of community groups, and their waste management activities. Awareness creation and education can also be done to the members of the public interested in starting up groups on how to go about the formation, and to the existing groups on the best practices in waste management.

5.3.1.5 Lack of adequate collection points

The county authorities together with the residents can agree on a location where waste can be collected for disposal by the county government trucks or contractors hired by the county, such as Lower Savanna Ward. Considerations can be made regarding ease of access of the trucks, public health, safety, and the avoidance of nuisance, among other factors that may be raised.

5.3.2 Waste separation at source

Waste separation at source has been reported as a major challenge in waste management in Nairobi County. From the field study, 17.5% of the respondents indicated that they separate their waste at the source. However, it could not be verified whether this was a regular practice, and the specific actions taken on the separated waste. Hence despite the small fraction that indicated to practice waste separation, the impacts of this practice may not be significant.

In Kandy Municipality, waste separation is in practice and is propagated by the waste collection regime in place. Biodegradable waste from domestic sources, for instance, is collected on Mondays, Wednesdays and Fridays, while recyclables such as papers, plastics and glass are collected on Saturdays.

Waste separation hence ought to be introduced and promoted such that it is uniform across the two wards. The introduction of the practice was also agreed upon by 69.7% of the respondents and 8 out of 9 CBOs. According to Kasozi and Blottnitz (2010), separation at source is critical in realizing a reduction in the quantities of waste due for disposal.

Separation at source would make it easier to pick out materials that can be reused or recycled without incurring extra costs and time in sorting them. This would hence contribute towards pulling out some of the materials from the waste stream. The practice would also help to address the challenge of poor quality of salvaged materials since the materials that can be recovered would

have minimal or no contamination (Government of Western Australia, 2014). According to Bolaane (2006), public participation in proper separation of waste at source is important in implementing recycling initiatives.

The most basic way of waste segregation is to divide them into two groups: biodegradable wastes, and non-biodegradable (Ministry of Housing and Local Government, Malaysia, 2006). Biodegradable wastes mainly include kitchen and garden wastes, and are sometimes referred to as wet wastes, while the non-biodegradables include plastics, metals, glasses and papers. The non-biodegradables can also be further divided into recyclables such as papers and plastics, and non-recyclables such as diapers, dirt and other inorganics.

Suggestions of levels of waste separation are summarised in **Table 5-2**, listing the main categories expected to be found in municipal solid waste in Nairobi. In reference to **Table 2-2**, the main waste categories and their composition are biodegradable wastes (71.34%), papers (9.43%), plastics (9.42%), metals (2.28%), glass (3.15%) and other inorganic and unclassified materials (4.38%).

Table 5-2: Levels of waste separation

Waste category	**Level 1: 2-way separation**	**Level 2: 3-way separation**	**Level 3: 4-way separation**
Biodegradables	Group 1	Group 1	Group 1
Papers	Group 2	Group 2	Group 2

Plastics			Group 3
Metals		Group 3	Group 4
Glass			
Other inorganics and unclassified materials			

From the findings of the field study, the three waste categories that featured among those mentioned by the respondents were food, paper and plastics, hence making them possible categories for separation at source.

Source separation can begin with the most basic where biodegradables are separated from the non-biodegradables, denoted as groups 1 and 2 under level 1 in Table 5-2 respectively. Assuming that waste generation patterns will not change over time, or due to the practice of waste separation, group 1 (biodegradables) will compose of 71.34% of the generated wastes, while group 2 will take up the remaining 28.66%.

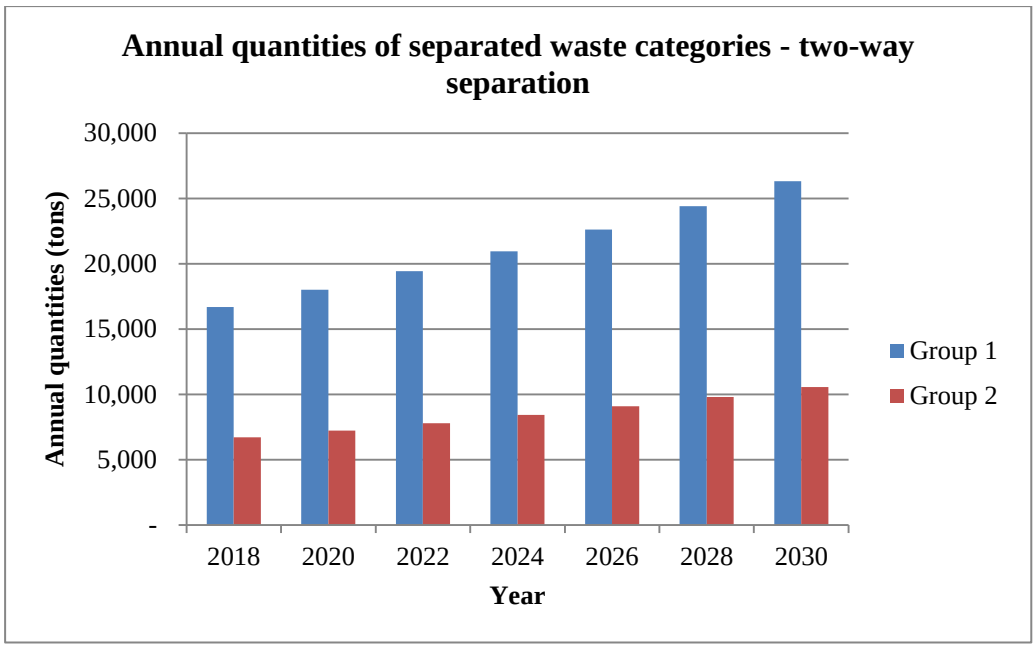


Figure 5-5: Annual quantities for 2-way separation in Upper Savanna and Lower Savanna

From Figure 5-5, the total quantities of biodegradable waste (Group 1) that would be realised if separated from the waste stream from both wards would be 16,689 tons in 2018. Assuming that the waste generation patterns remain constant with time, this figure would rise to 26,321 tons in 2030. The quantities of group 2 (dry wastes) are estimated to be about 6,704.5 tons in 2018 and are projected to rise to 10,574.2 tons in 2030.

Over time, the waste separation can be escalated to Level 2 where waste is categorized into biodegradables, papers and plastics, and inorganics, denoted as groups 1, 2 and 3 respectively. The Nairobi City County Solid Waste Management Act 2015 prescribes for this mode of waste separation providing the colour codes as green for organic waste, blue for plastics and papers, and brown for any other waste.

In Figure 5-6: Annual quantities for 3-way separation in Upper Savanna and Lower Savanna, the estimated quantities for group 1 (biodegradable wastes) remain the same as they are in 2-way separation. Group 2 (papers and plastics) and group 3 wastes (glass, metals and others) as per Table 13 are estimated to stand at 4,409.62 tons and 2,294.87 tons in 2018 respectively. These are expected to rise to 6,954.77 tons and 3,619.43 tons in 2030.

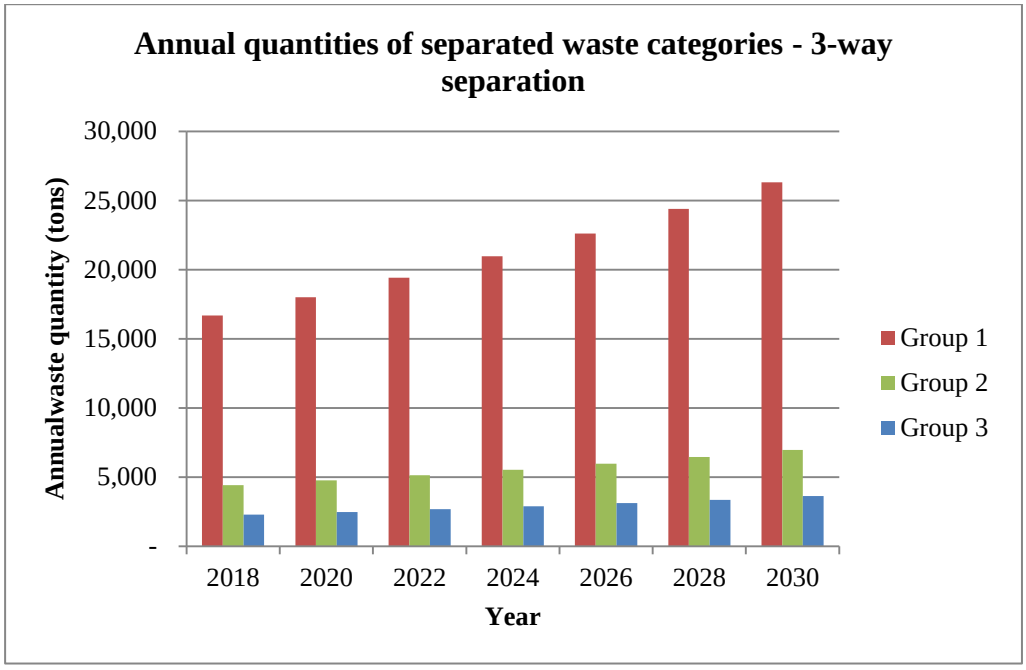


Figure 5-6: Annual quantities for 3-way separation in Upper Savanna and Lower Savanna

The quantities discussed above show the potentials that the different groups of waste in 2-way or 3-way separation have as materials for recycling or recovery. The most significant is biodegradable waste (Group 1) in both 2-way and 3-way accounting for about 70% of the total waste generation. This

translates to a potential of 16,688.71 tons of waste in 2018 for recovery through, for instance, composting.

Furthermore, based on the quantities projected in Figure 5-5 and Figure 5-6, it can be recommended that on the onset of waste separation, biodegradable waste be collected more than once a week due to their nature and their large quantities. The dry wastes on the other hand can be collected once a week or once in two weeks due to their dry nature and small quantities.

If there is room to go further, separation can be escalated to four-way and in the following categories: biodegradables, papers, plastics and inorganics. The waste collection schedule and frequency can be organized such that the separated wastes are collected without being mixed again.

Before commencing and in the course of implementing the separation of waste at source, awareness creation should be done to the public to ensure that they are in the know about the intended intervention, to provide guidance in the practice, and to cast off the negative notions about separation of waste at source. Furthermore, adequate infrastructure should be put in place to promote the practice, such as the provision of colour coded bins, collection or transport schedules for the separated waste, and markets or facilities for the reception of the separated materials. A system can also be considered where those who properly separate waste at source, or waste collectors that push for waste separation are given incentives.

5.3.3. Setting up and support of 3R efforts

From the field study, 70% of the respondents mentioned that they were not aware of any facility in their area where any waste reduction and recovery take place. Among the 30% that knew, the most common was the salvaging of recyclables for sale, together with a few mentions of recycling and composting. However, some of these could not be identified during the field study. This indicates that there may be a few of such facilities in existence, and the few that exist are not well known by members of the public. This would form the basis for introducing more of such facilities and promoting or publicizing them together with those that are already known. Such facilities would be the reception points for the waste material separated at source.

5.3.3.1 Composting

Given that biodegradable waste occupies the single biggest fraction of all the waste generated in Nairobi County, and by extension, Upper Savanna and Lower Savanna wards, compost facilities can be reception points for this category of waste. From the field study, 73% of the respondents agreed to compost as an intervention they would recommend in their area. Intercepting this portion of waste and taking it through composting would have the advantage of reduction of the amount of waste that due for collection and disposal, and consequently a reduction in the associated costs. Vazquez and Soto (2017) in their study of home composting programs in Camarinas Council in Spain, found that a 77% efficiency was realised in terms of the

reduction of organic waste collected by municipal services. Similarly, Lekammudiyanse and Gunatilake (2010) found that there was a 69% reduction in the amount of waste collected as a result of the introduction of household composting in Gampaha Municipal Council.

For the action plan, a waste reduction efficiency of 70% of organic waste can be adopted. This will result in the annual potential of waste reduction quantities shown of up to 6,935 tons in 2018. If factors were to remain constant, the amount of waste taken out of the waste stream would be about 10,939 in the year 2030. This translates to a reduction of the amount due for disposal by almost 50%.

Basing on the quantities projected in Figure 5-3 and Figure 5-4, composting goals can hence be set as shown in Table 5-3.

Table 5-3: Waste composting targets for Upper Savanna and Lower Savanna Wards

Year	**% Generated waste targeted for composting**	**Estimated waste quantities targeted for composting (tons per year)**
Short term (2020)	5	1,261.94
Medium term (2025)	25	7,628.88
Long term (2030)	50	18,447.66

In the promotion of composting, considerations can be made between having a centrally located compost site, and the provision of compost barrels to homes, following the path taken by Kandy Municipality.

5.3.3.2 Waste buyback and recycling

Waste buyback centres can be introduced and can serve as points where recyclable waste is bought from the residents or groups, and then sold to recyclers. These centres can complement the existing waste dealers as reception points for recyclable waste materials, thus having them out of the waste stream. Setting up of buyback centres received the acceptance of 88.8% of the respondents in the field study, with 7 out of 9 groups also agreeing to the intervention.

Assuming that there will be minimal or no contamination of the waste materials as a result of successful waste separation efforts, all plastics, papers, metal and glass wastes can be taken as candidates for recycling. From the waste composition for the county shown in

Table 2-3, these categories take up 24.28% of the waste generated. Therefore, short, medium and long-term goals for the salvaging of recyclables can be set as shown in **Table 5-4**.

Table 5-4: Waste recovery and recycling targets in Upper and Lower Savanna Wards

Year	**Generated waste targeted for recycling (%)**	**Estimated waste quantities targeted for recycling (tons per year)**
Short term (2020)	5	1,709.86
Medium term (2025)	15	4,577.33
Long term (2030)	25	9,223.83

5.3.4 Promotion of public awareness and participation

Public awareness has been noted to be a key gap in waste management in Upper Savanna and Lower Savanna Wards. From the field study, only 12% of the respondents indicated that they had participated in a public awareness program within five years preceding the study (between 2011 and 2016). Furthermore, the majority of the respondents indicated that they were not aware of legislations governing solid waste management.

From the field study, about 95% of the respondents were in support of regular awareness creation, while 93.4% agreed to public participation as interventions in solid waste management. In addition, none of the two interventions received any rejection from the CBOs that took part in the study.

5.3.4.1. Focus of awareness creation

The items of focus in waste management awareness efforts can be recurrent matters where residents get to be reminded on what should be practiced or informing the public of changes. Some of the recurrent issues include legislations such as the Nairobi City County Solid Waste Management Act of 2015, where the residents would be reminded of what is expected of them and other stakeholders in waste management. The programs can also highlight the preferred or acceptable waste management practices and shed light on the perils of the negative practices such as open dumping and burning.

Proper awareness creation is also applicable in situations where there is need to communicate changes in practice. In Kandy Municipality, for example, the council together with the environmental committee had to communicate to the residents about the avoidance of the use of the centrally located bins, the shift to door-to-door collection and the new waste collection schedule. Therefore, regular and consistent awareness creation would be key in implementation of the action plan.

From the field study, about 92.1% of the respondents indicated that they were interested in learning more about the 3R in waste management against about 49% that indicated they were familiar with the principle. Furthermore, about 66.7% of the respondents indicated that they were unfamiliar with existing 3R related facilities, and about the same percentage were not familiar with legislations governing waste management in the county. Hence among the items to be considered in awareness creation are the 3Rs and the legislations

on waste management. Other items to be proposed in the action plan will also include but not restricted to those listed in **Table 5-5**.

Table 5-5: Items of communication in awareness creation to the public

Aspect	**Item of communication**
Non-collection	● Encouragement of residents to register for waste collection service
Collection schedule and frequency	● Days and times for waste collection ● Change of collection frequency and collection specific days
Open dumping and burning	● Transfer/collection points for waste ● Prohibition of open burning and illegal dumping
Source separation	● Education on source separation, colour codes and necessary infrastructure ● Official commencement of source separation ● Official cessation of collection of commingled waste ● Reminders on waste separation
3R facilities and activities	● Existence, operation and access of 3R facilities ● 3R opportunities open to the public and their practice
Miscellaneous	● SWM Legislations: proper practices and offences ● Roles of various stakeholders in solid waste management ● Status and progress of SWM in the locality

5.3.4.2 Methods of awareness creation

From the field study, majority of the respondents (60%) believe that public meetings and clean-up exercises would be effective in reaching out to the public, as compared to 28% that were in support of mass media. Hence the use of meetings and clean-up exercises within the two wards can be a starting point for public awareness, coupled with notices and posters. Mass media, on the other hand, due to its nature of having a wider reach, can be more applicable to a wider audience such as the whole of Nairobi County, and hence cannot be the best starting point for awareness that only targets two wards in the county.

Despite only being mentioned by less than 1% of the respondents, there is a potential in reaching a large fraction of the residents in the study area. As it stands in Kenya, about 86.2% of the population have mobile phone subscription, and 89.4% have access to the internet (Communications Authority of Kenya, 2017). Furthermore, smartphone penetration in the country has been reported to reach more than 60% of the population (Omulo, 2017). These fractions could be higher in Nairobi County by virtue of it being an urban area, thus making mobile phones and internet-based application such a social media channels with a great potential of reaching many people. They can be used for communication between the authority and the residents or among the residents themselves and the residential committees or associations.

Another initiative that can be employed is the formation of environmental committees. In Kandy Municipality, the members of the committees are drawn from the public or the residents of the specific area and have been used as channels of communication between the council authority and the residents. Having such committees in Upper Savanna and Lower Savanna Wards will enable the residents through the appointed representatives to get actively involved in matters to do with solid waste management. These committees can also play the role of being links between stakeholders in waste management such as the public, the county government, CBOs, the waste collectors and any other active party in the locality. During the field study, it was found that the estates or zones within the wards had committees or leadership structures put in place. These existing structures can be starting points for the formation of environmental committees or having them play the roles of the environmental committees.

Generally, the target for the awareness or education intervention in waste management should be all community members regardless of gender. From the field study, 51.5% of the respondents from households were female with 48.5% being male, though the difference is not greatly significant. However, the study did not inquire as to who is responsible for solid waste management, or disposal at the households. According to JICA (2010), most of the respondents in their survey in Nairobi were housewives. From this survey, it was found that the wives or female housekeepers were the main people responsible for waste discharge. Maji na Ufanisi (2014) in their baseline study of informal settlements in Kasarani found that in 57% of the cases, wives were

the ones responsible for waste disposal or discharge from the home for collection. This hence brings to light that as much as all members can be targets for awareness creation and waste intervention, women appear to play a more active role in waste management, and a factor to be considered in the interventions.

Also, to be considered is the incorporation of education on solid waste management in schools. Schools in their nature are centres for learning and instilling discipline. Furthermore, they have the advantage of having an audience of many people in one place. In the short term, the local schools can work together with the county government, community groups or among themselves to have sessions where students get to be taught about and practise proper waste management, including the 3Rs. In the long term and on a wider scale, waste management can be incorporated in the school syllabus across the county and the country at large.

5.3.4.3 Stakeholder participation

According to Nairobi City County Solid Waste Management Act 2015, solid waste management is a shared responsibility among all actors that include the county government, waste generators, owners and occupiers of premises and contracted service providers. The act also allows for the involvement of other parties in any aspect of waste management, including individuals, corporate entities and community associations or organisations.

According to the Act, the county government is expected to play a more guiding and supervisory role, such as provision of guidelines for material

recovery, and the licensing of collectors, transporters or any private entity involved in any aspect of waste management. The county government also takes up the responsibility of establishing a disposal site, provision of disposal containers in public places, promotion of public awareness and the collection of waste directly or indirectly.

The occupiers and owners of premises are expected to clean outside their compound within a radius of 10m, provide waste containers within their premises and ensure that waste is collected and properly disposed. Waste generators are required to separate waste in prescribed categories before collection and ensure that their waste is collected. The landlords are also required to ensure that all their tenants are registered for waste collection.

As far as the proposed action plan is concerned, the roles that can be played by different stakeholders are as summarised in

Table 5-6.

Not mentioned in

Table 5-6 are the environmental committees, which when formed, can play the role of being the link between the public, the county government, waste collectors and any other active party in the locality. They can be channels through which communications regarding waste management can be passed to and from the residents. Furthermore, they can also play a part in making decisions on matters to do with waste management such as collection

schedules and frequency, and identification of sites for composting or materials recovery if such were to be set up.

Table 5-6: Role of stakeholders in proposed action plan

Nairobi County Government	**Owners/occupiers of premises and general public**	**Private sector/ NGOs. CBOs**
• Collection of waste • Provide containers for waste disposal • License collectors/transporters • Promote public awareness • Monitoring of waste management • Provide guidance for waste separation and waste recovery • Enforcement of SWM laws	• Clean around premises • Provide waste containers within premises (owner) • Ensure all occupants are registered for waste collection (owner) • Ensure waste is collected • Separation of waste before collection (generator) • Participation in awareness programs (general public)	• Acquire necessary licenses • Waste collection and transportation • Support public awareness creation • Setting up, operating or supporting waste reduction and recovery facilities

5.3.4.4 Incentives and recognition

Provision of incentives or some form of recognition can also be a key contributor to public participation. In a study on waste recycling in Gaborone, Botswana, more than half of the households involved in the study set aside glass bottles primarily to be able to get the deposit on returning them (Bolaane, 2006). This may be a single aspect in waste management, but it is an indicator that incentives can help to promote good practice.

In Sri Lanka, there are annual competitions in solid waste management at the local authority level, with judges appointed to assess the participating local authorities. The local authorities that receive high scores in the competition get to have the recognition as being among the best in waste management in the country, which as a result promotes them and other local authorities towards improving their waste management practice. Such methods of recognition also send a message that the authorities and members of the public are vigilant about waste management in their residential areas. The scale, however, may be different in Nairobi County, or more specifically in Upper Savanna and Lower Savanna wards, but a mode of recognition or reward can be devised to encourage good practice by individuals, estates, groups or any other active party.

Common incentives that can be considered include subsidies and tax reliefs for items or activities that contribute to the 3R, and deposit refunds in the case of giving away of recyclables, such as glass to buyback centres. In Kandy

Municipality, for instance, residents would acquire compost barrels at a subsidized price so that as many homes as possible practice home composting. Recognition may involve acknowledging or awarding the active parties such as waste collectors and the residents through their respective estates for good practices. Some of the activities that can be considered for recognition and the respective actors are listed in **Table 5-7**.

Table 5-7: Items for consideration in recognition or provision of incentives

Active party	**Activity to recognize or incentivise**
Waste generator	● Separation at source ● Home composting ● Delivery of reusable or recyclable waste to buyback centres or waste dealers
Waste collectors	● Strict collection of separated waste ● Separation of waste collected before disposal ● Timely and consistent collection of waste
Estates/ residential areas	● Achievement of 100% or near 100% collection rate or coverage ● Clearance of open dumps ● Cleanliness of the neighbourhoods
Private sector and other stakeholders	● Setting up and operation of 3R facilities ● Awareness creation and education

On the other hand, higher charges can be placed on negative waste management practices, such as open dumping, or on prevailing practices that are inhibitors to the 3R and need to be phased out, such as the collection of comingled waste. In addition, the negative practices can also be named together with where they are taking place so as to serve as examples of what the residents ought to desist from.

5.4 Action steps for the action plan

5.4.1 Achievement of 100% waste collection

The first step of the action plan is to ensure 100%, or near 100% collection of waste from the target area, which can be accomplished through the activities described in the interventions such as increased waste collection frequency, encouragement of residents to take up collection services, proper planning and maintenance of collection vehicles and proper sensitization of waste collectors. This is aimed at ensuring that as much waste as possible is collected and to reduce or eliminate indiscriminate accumulation of waste due to non-collection.

In addition to the above, waste collection and transfer points can be identified and set up where waste collected from the sources can be placed before being transferred to the final disposal point in Dandora.

5.4.2 To promote waste separation at source

The approach towards, or achievement of 100% waste collection will require the change of perspective of waste as a resource and goes with the assumption

that all the generated waste is collected. The waste stream can then be separated in order to create opportunities for or enable the identification of waste categories of potential value. Guidance and infrastructure can then be provided on how the separation at source will take place. In addition, guidance should also be provided on the destination of the separated waste categories.

As described in the interventions, two-way separation can be a first step in waste separation due to its simplicity, with relevant colour codes provided, together with the collection schedules for the different waste categories if they will be collected differently. Two-way separation can then be escalated to the three-way separation with time depending on the progress of the waste separation practice.

5.4.3 Introduction and promotion of 3R efforts

3R related efforts will include composting, recycling, recycling buyback centres, and any other that may be deemed relevant depending on the waste categories in question. These efforts and facilities will be the destination of the waste categories after separation. Wet wastes, being the largest fraction of the generated waste, can be a category of focus in the development of composting facilities, or in the introduction of composting efforts. The dry wastes on the other hand can be candidates for recycling facilities directly or through buyback centres or waste dealers.

When the composting, recovery and recycling efforts are combined, the waste reduction quantities and percentages expected will be as shown in **Table 5-8**.

Table 5-8: Target waste reduction resulting from combined 3R efforts

Year	**% waste reduction**	**Total composting and recycling targets (tons/year)**
Short term (2020)	11.77	2,971.80
Medium term (2025)	40.00	12,206.20
Long term (2030)	75.00	27,671.48

5.4.4 Public awareness and participation

Public awareness and participation will contribute to the above three steps. The aim is to get members of the public informed about the prevailing situation on waste management, changes in waste management practices, and educating members of the public as stakeholders on proper waste management practices and the various roles that they can play. In addition to this, stakeholders such as community groups, the private sector, corporate entities, academic institutions and government agencies, among others, are roped in. The stakeholders can play a part in waste management and the mentioned interventions in ways that may include, but are not limited to financial support, material support, technical support and awareness creation.

Some of the stakeholders can also play a role in supporting waste separation efforts such as material support where infrastructure is lacking and assist in awareness creation. They can also play a role in creating destinations for the waste categories separated such as recycling and composting facilities. In addition, some can play the part of consumers or receptors of materials emanating from the recycled, composted or recovered waste materials.

The county government on the other hand can play a supervisory or regulatory role as far as the proposed interventions are concerned. They also have the role of formulating policies and legislation and enforcing them in the course of implementation.

In summary, the steps proposed for the action plan to promote the 3Rs in waste management are shown in Figure 5-7.

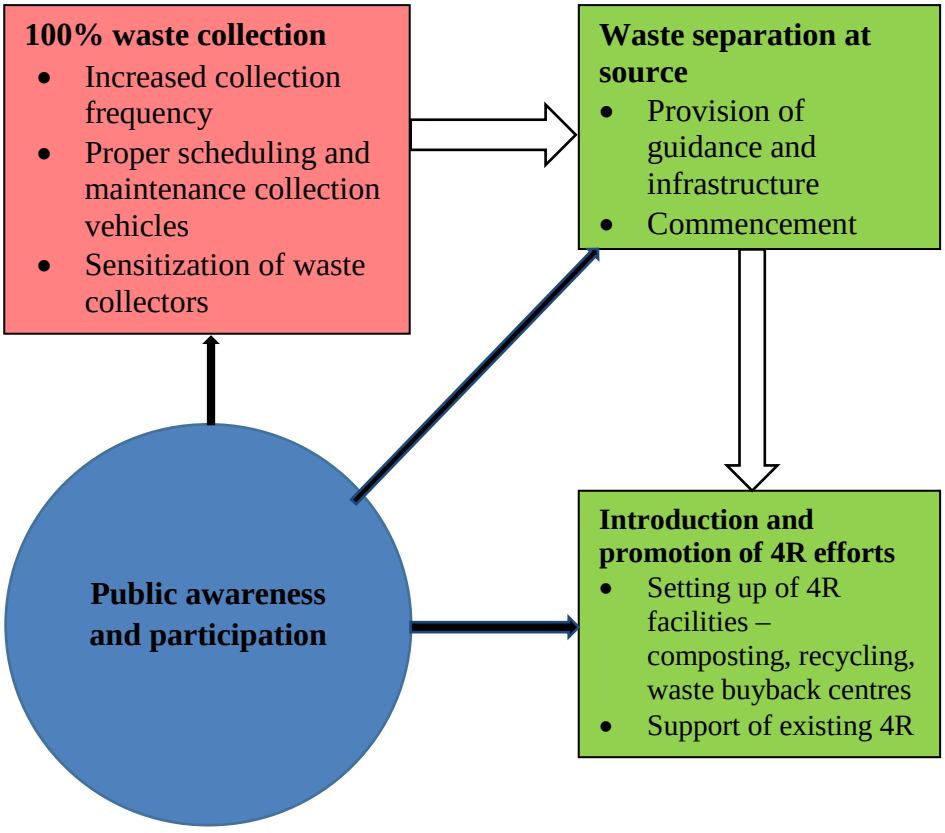


Figure 5-7: Framework of Action Plan to promote 3Rs in Upper and Lower Savanna Wards

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

6.1.1 Solid waste management in Nairobi County

From the study and the literature reviewed on waste management in Nairobi County, the following conclusions can be made:

- There is a gap in waste recovery, or 3R in the in Nairobi. It was noted that about 5 to 10 % of the waste generated in the county is diverted away from disposal (JICA, 2010; Kasozi and Blotnitz, 2010).
- Waste management in Nairobi County is largely focused on waste collection and disposal.
- Open dumping is a common practice in Nairobi County. This is evidenced by the large fraction of unaccounted for. Furthermore, this was evidenced by several sightings of heaps of waste and their charred remains on roadsides and in open parcels of land and had also been cited as a major problem in waste management in the county.

6.1.2 Solid waste management in Upper Savanna and Lower Savanna Wards

From the study of Upper Savanna and Lower Savanna Wards, the following conclusions were made:

- The waste collection rate in the two wards is higher than that of Nairobi County, given that 91.5% of the respondents (households and residential premises combined) indicated that they receive waste collection services. However, in the long term, if the collection capacity remains the same, the collection rate may reduce leading to more waste ending up in illegal dumpsite. Therefore, there is need to improve waste collection in the study area.
- There was limited capacity of the waste collectors in the two wards. It was revealed from the field study that community groups served about two thirds of the respondents, with handcarts being the most common method for waste transport, as indicated by 82.3% of the respondents. The use of handcarts would mean that the waste collectors do not have the means to deliver waste to the dumpsite in Dandora.
- Efforts towards the 3R in the study area are low, including waste separation at source. From the findings, 17.5% of the respondents indicated that they separate their waste at source. However, there was no evidence as to whether this was regularly practised. Another reason for this conclusion is the small percentage (30%) of respondents that are aware of any efforts towards the 3R (waste reduction, reuse, recycling or recovery) within their locality. This would indicate that they were simply not aware of such or there they are very few if any.
- There is low public awareness on solid waste management among the residents of Upper Savanna and Lower Savanna Wards. From the study, about 12% of the respondents indicate that they had participated

in awareness programs on waste management. This could be linked with the lack of knowledge of the laws governing waste management, and the responsibilities that members of the public have towards waste management.

6.2 Recommendations

Based on the findings of the field study and of Upper Savanna and Lower Savanna Wards, and Nairobi County at large, the following recommendations have been suggested:

1. Given that biodegradable waste takes up about 70% of the waste generated in the county and found to be the most featured waste in the study area, composting as an intervention should be greatly considered as a means of exploiting the potential that biodegradable waste can offer as a resource, and consequently reduce the fraction of waste that ends up in disposal.
2. Awareness creation and description of roles for public participation to be emphasised as it can play a crucial role in the implementation of the action plan, and contribute to the transformation of waste management. An example through which this can be fostered is the formation of environmental committees. These can be comprised of residents who oversee matters to do with waste management in their respective areas.
3. Efforts to be made on ensuring maximum collection of waste. Such efforts can include proper scheduling of waste collection vehicles,

increasing waste collection frequencies, promoting the subscription to waste collection services and streamlining of waste collectors and waste collection service. This will ensure that as much waste as possible is taken through the desired channels of waste management and reduce or eliminate cases of illegally dumped waste. Furthermore, efficient collection plays a part in handling waste as a resource where further action such as separation, processing and the 3Rs can be done.

4. Regular monitoring of waste management and acquisition of related data in order to assess progress and inform necessary actions.

The study also makes the following recommendations for further research.

1. An investigation of waste collection in Upper Savanna and Lower Savanna wards in a bid to understand the prevailing practices, the parties involved the gaps and challenges in the practice, among other things.
2. A study on the viability and potential of 3R efforts in the county of Nairobi, and if possible, in specific areas within the county.
3. A survey to establish the quantities and composition of waste generated in specific wards, or Nairobi at large, and the changes with time. This is in light of the fact that the most recent study done to establish the quantities of waste in Nairobi was in 2010 by JICA. This Is in addition to the possibility that the patterns and quantities could have changed since then.

REFERENCES

Adeolu, A., Enesi, D., & Adeolu, M. (2014). Assessment of Secondary School Students' Knowledge, Attitude and Practice towards Waste Management in Ibadan, Oyo State, Nigeria. *Journal of Research in Environment Science and Toxicology, 3*(5), 66-73.

Agamuthu, P., & Fauzia, S. (2011). *3Rs Practices in Asia and the Pacific Islands.* Retrieved September 13, 2015, from International Solid Waste Association: http://www.iswa.org/media/publications/knowledge-base/?tx_iswaknowledgebase_searchbox%5Bsearchphrase%5D=3Rs%20Practices%20in%20Asia%20and%20the%20Pacific%20Islands.%20&cHash=5c8a4cf4ae641819b5d7a92111cae426

Asase, M., Yanful, E., Mesah, M., Stanford, J., & Amponsah, S. (2009). Comparison of municipal solid waste management systems in Canada and Ghana: a case study of the cities of London, Ontario, and Kumasi, Ghana. *Waste Management*, 2779-2786. doi:10.1016/j.wasman.2009.06.019

Asian Development Bank, Institute of Global Environmental Strategies. (2008). *Towaed Resource-efficient Economies in Asia and the Pacific: Reduce, Reuse Recycle.* Manila: Author.

Bandara, M., Pinnawala, M., Herath, G., & Jinadasa, S. (2014). Awareness of citizens and attitude towards Local Authority in Solid Waste Management: the CaseStudy in Kandy District, Sri Lanka. *4th International Conference on Solid Waste Management.* Hyderabad.

Bandara, N. (2008). Municipal Solid Waste Management - The Sri Lankan Case. *Proceedings of the International Forestry and Environment Symposium, Sri Lanka.* Department og Forestry and Environmental Science, University of Sri Jayawardenepura. Retrieved from http://journals.sjp.ac.lk/index.php/fesympo/article/view/21

Baud, I., Post, J., & Furedy, C. (Eds.). (2004). *Solid Waste Management and Recycling.* Dordrecht: Kluwer Academic Publishers.

Blair, J., Czaja, R., & Blair, E. (2014). *Design Surveys: A Guide to Decisions and Procedures* (3rd ed.). Los Angeles: SAGE.

Bolaane, B. (2006). Constraints to promoting people centered approaches in recycling. *Habitat International*, 731-740.

Castro Valley Sanitary District. (n.d.). *The 4Rs: Reduce, Reuse, Recycle & Rot.* Retrieved November 7, 2015, from CVSan: http://www.cvsan.org/4Rs

Choi, W. (n.d.). Practices and Challenges of 3Rs in Korea. *Solid Waste Association World Congress.* Daegu.

Communications Authority of Kenya. (2017). *Third Quarter Statistics Report for the Financial Year 2016/17 (January-March 2017).* Author. Retrieved September 8, 2017, from http://www.ca.go.ke/images/downloads/STATISTICS/SECTOR%20STATISTICS%20REPORT%20Q3%20FY%202016-2017.pdf

Corbetta, P. (2003). *Social Research: Theory, Methods and Techniques.* (B. Patrick, Trans.) London: Sage Publications.

Dassanayake, M. (2010). *Successful Integrated Urban Planning Approach to Solid Waste Management in Sri Lanka: Planning and Implementation of "Pilisaru" National Solid Waste Management Project, Sri Lanka.* PilisaruNational Solid Waste Management Project. Retrieved February 15, 2016

de Leeuw, E., Hox, J., & Dillman, D. (2008). *International Handbook of Survey Methodology.* New York: Taylor and Francis Group.

Environmental Managemenet and Co-ordination Act. (2015).

Fernando, J. (n.d.). *National 'Pilisaru' Waste Management Programme.* Central Environmental Authority, Sri Lanka. Retrieved February 15, 2016, from http://www.iiirr.ucalgary.ca/files/iiirr/256.pdf

First Nations of Quebec and Labrador Sustainable Development Institute, FNQLSDI. (2008). *Reduce, Reuse Recycle and Recover Waste: A 4R's Guide - FOr the First Nations Communities of Quebec and Labrador.* (D. Dickey, Ed.) Quebec: Author.

Google Inc. (2017). Google Earth Pro, Version 7.3.0.3832.

Government of Western Australia. (2014, January). *Source Separation of Waste.* Retrieved November 28, 2017, from Waste Authority: https://www.wasteauthority.wa.gov.au/media/files/documents/Source_Separation_of_Waste_2014.pdf

Herath, C. (2011). National Solid Waste Management Strategy and its Employment Dimensions. *Proceedings of the National Green Jobs Conference, Sri Lanka.* Retrieved February 19, 2016, from International Labour Organisation: http://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/---ilo-colombo/documents/presentation/wcms_150744.pdf

Hikkaduwa, H., Gunawardana, K., Halwatura, R., & Youn, H. (2015). Sustainable Approaches to the Municipal Solid Waste Management in Sri Lanka. *6th International Conference on Structural Engineering and Construction Management.* Kandy.

Hoornweg, D., & Bhada-Tata, P. (2012). *What a Waste: A Global Review of Solid Waste Management.* Washington DC: World Bank.

Ifegbesan, A. (2010). Exploring secondary school students' understanding and practices of waste management in Ogun State, Nigeria. *International Journal of Environmental and Science Education, 5*(2), 201-215.

Illinois Department of Commerce and Economic Opportunity Bureau of Recycling. (1996). *Municipal Solid Waste and the 4Rs: An Illinois MIddle School Teacher's Guide.* Champaign: Stipes Publishing Company. Retrieved July 12, 2015, from https://www.illinois.gov/dceo/whyillinois/TargetIndustries/Energy/Recycling/Documents/Middle%20School%20Teachers%20Guide-%20Municipal%20Solid%20Waste%20and%20the%204Rs.pdf

Itere, G. (2014, August 12). *County Government embraces new concepts to manage garbage*. Retrieved November 20, 2015, from Nairobi CIty County Web Portal: http://www.nairobi.go.ke/home/news/county-government-embraces-new-measures-to-manage-garbage/

Japan International Cooperation Agency. (2010). *Preparatory Survey for Integrated Solid Waste Management in Nairobi CIty in the Republic of Kenya.* Final Report.

Kaluli, W., Mwangi, H., & Sira, F. (2011). Sustainable Solid Waste Management Strategies in Juja, Kenya. *Journal of Agriculture, Science and Technology, 13*(1), 79-90.

Kandy Municipal Council. (2013). *Master Plan For the Kandy Municipal Council Solid Waste Management Division 2014-2024.* Kandy Municipal Council, Solid Waste Management Division, Kandy.

Karunasena, G., & Wickramasundara, C. (n.d.). comparison of municipal solid waste mnagement in selected local authorities in Sri Lanka.

Kasozi, A., & Blottnitz, H. (2010). *Solid Waste Management in Nairobi: A Situation Analysis.* Technical document accompanying the Integrated Solid Waste Management Plan. Retrieved from http://www.unep.or.jp/ietc/GPWM/data/T3/IS_6_1_Nairobi_SWM_SituationAnalysis.pdf

Kenya Nationa Bureau of Statistics and Society for International Development. (2013). *Exploring Kenya's Inequality: Pulling apart or Pooling together?* Nairobi: Author.

Kenya National Bureau of Statistics. (2010). *The 2009 Kenya Population and Housing Census: Population and Household Distribution by Socio-Economic Charactersitics.* Retrieved February 21, 2015, from http://www.knbs.or.ke/index.php?option=com_phocadownload&view=category&download=585:volume-2-population-and-household-distribution-by-socio-economic-characteristics&id=109:population-and-housing-census-2009&Itemid=599

Kimani, N. (2007). *Environmental Pollution and Impact to Public Health; Implication of the Dandora Municipal Dumping Site in Nairobi, Kenya.* Nairobi: United Nations Environment Programme.

Kothari, C. (2004). *Research Methodology: Methods and Techniques* (2nd ed.). New Delhi: New Age International Publishers.

Lekammudiyanse, L., & Gunatilake, S. (2010). Efficiency of Household Compost bin as a waste management technique in Sri Lanka (A Case study in Gampaha Municipal Area). *International Journal of Basic and Applied Sciences, 10*(1), 54-59. Retrieved July 4, 2018, from http://ijens.org/105901-7878%20IJBAS-IJENS.pdf

Liyanage, B., Gurusinhe, R., Herat, S., & Tateda, M. (2015). Case Study: Finding Better Solutions for Municipal Solid Waste Managment in Semi Local Authority in Sri Lanka. *Open Journal of Civil Engineering*.

Madhushan, K., & Fujiwara, T. (2011). Survey of residents willingness to separate waste collection and improvement of waste management in Sri Lanka. *Society for Social Management Systems Internet Journal*. Retrieved February 29, 2016, from http://hdl.handle.net/10173/834

Maji na Ufanisi. (2014). *Baseline Survey for Informal Settlelements Located within a radius of 12 kms from Garden City, Nairobi County.* Retrieved May 31, 2016, from http://majinaufanisi.org/attachments/article/11/Baseline-Survey-for-Informal-settlements-Kasarani-Nairobi.pdf

Memon, M. (2010). Integrated solid waste management based on the 3R approach. *Journal of Material Cycles and Waste Managmenet, 12*, 30-40. doi:10.1007/s10163-009-0274-0

Ministry of Housing and Local Government, Malaysia. (2006). *Guidelines for Source Separation of Municipal Solid Wastes.* Kuala Lumpur: Ministry of Housing and Local Government, Malaysia. Retrieved August 21, 2017, from http://jpspn.kpkt.gov.my/resources/index/user_1/Sumber_Rujukan/garis_panduan_jpspn/Guidelines_for_Source_Separation_of_Municipal_Solid_Wastes.pdf

Munala, G., & Moirongo, B. (2011). The need for an integrated solid waste managemet in Kisumu, Kenya. *Journal of Agriculture, Science and Technology, 13*(1).

Municipal Councils Ordinance. (1947). Sri Lanka.

Muthoni, P. (2014). *Stakeholder's involvement in municipal solid waste management: A case study of Nairobi City County-Kenya.* Masters Thesis, University of Jyväskylä, School of Economics and Business Management. Retrieved August 15, 2017, from https://jyx.jyu.fi/dspace/bitstream/handle/123456789/44288/URN:NBN:fi:jyu-201409192825.pdf?sequence=1

Mwangi, C. (2011). *Assessment of Household Solid Waste Management in Makina Informal Settlements, Nairobi, Kenya.* Masters Thesis, Kenyatta University, Department of Environmental Studies and Community Development. Retrieved July 13, 2015, from http://ir-library.ku.ac.ke/bitstream/handle/123456789/3851/Mwangi,%20Catherine%20Muthoni.pdf?sequence=3

Mwololo, M. (2016, May 4). Managing solid waste remains a nightmare for Nairobi County. *Daily Nation.* Retrieved May 6, 2016, from http://mobile.nation.co.ke/lifestyle/Nairobi-City-sinking-in-trash/-/1950774/3188156/-/mj2yfhz/-/index.html

Nairobi City County. (2014). *The Project on Integrated Urban Development Master Plan for the CIty of Nairobi in the Republic of Kenya.* Final Report.

Nairobi City County. (2015). *Sector Review Report for November and December 2014.* Environment and Forestry Sub-sector. Retrieved June 20, 2016, from http://www.nairobi.go.ke/assets/Documents/January-2015-Environment-Sector-monthly-review.pdf

Nairobi City County. (2016). *Financial Estimates: Program Based Budget 2016/17.* Retrieved March 13, 2017, from http://www.nairobi.go.ke/assets/Documents/FINAL-2016-17-PERFORMANCE-BASED-BUDGET-b1.compressed.pdf

Nairobi City County. (n.d.). *Nairobi City County Services*. Retrieved May 10, 2017, from Nairobi City County: http://www.nairobi.go.ke/home/services/

Nairobi City County Solid Waste Management Act. (2015). Retrieved August 12, 2017, from http://kenyalaw.org/kl/fileadmin/pdfdownloads/Acts/NairobiCityCountySolidWasteManagementAct_2015.pdf

Nairobi County Assembly. (n.d.). Retrieved May 5, 2016, from Nairobi County Assembly: http://nairobiassembly.go.ke/who-we-are/

Nairobi Sub County Administration. (n.d.). Retrieved July 30, 2016, from Nairobi City County Web Portal: http://www.nairobi.go.ke/home/subcounty-administration/

National Environmental Management Authority. (2014). The National Solid Waste Management Strategy. Retrieved March 28, 2016, from http://www.nema.go.ke/images/Docs/Media%20centre/Publication/National%20Solid%20Waste%20Management%20Strategy%20.pdf

National Solid Waste Management Support Center. (2013). *Annual Report 2013.* Ministry of Local Government and Provincial Councils.

Retrieved March 26, 2016, from http://www.lgpc.gov.lk/eng/wp-content/uploads/2014/07/An_R_2013.pdf

Njoroge, B., Kimani, M., & Ndunge, D. (2014). Review of Municipal Solid Waste Managmenet: A Case study of Nairobi, Kenya. *International Journal of Engineering and Sciences, 4*(2), 16-20.

Okot-Okumu, J. (2012). Solid Waste Management in East African Cities - East Africa. Retrieved from http://www.intechopen.com/books/waste-management-an-integrated-vision/solid-waste-management-in-african-cities-east-africa

Omulo, C. (2017, April 22). Over 60pc of Kenyans have smartphones, shows study. *Business Daily*. Retrieved September 8, 2017, from http://www.businessdailyafrica.com/corporate/Over-60pc-Kenyans-smartphones-shows-study/539550-3899256-iyu4xcz/index.html

Peprah, K., Amoah, S., & Achana, G. (2015). Assessing'3Rs' Model in Relation to Municipal Solid Waste Management in Wa, Ghana. *World Environment, 5*(3), 112-120. doi:10.5923/j.env.20150503.03

Rajput, R., Prasad, G., & Chopra, A. (2009). Scenario of solid waste management in present Indian context. *Caspian Journal of Environmental Sciences, 7*(1), 45-53.

Ryan, T. (2013). *Sample Size Determination and Power.* New Jersey: John Wiley and Sons.

Sato, N., Doi, A., Kawamoto, K., & Lokuliyanaga, M. (2014). Environmental Policy of 3Rs and Implementation of 3Rs Pilot Project by Local Authorities in Sri Lanka under JICA Technical Corporation PRoject. *Proceedings of the 3R International Scientific Conference.* Retrieved March 24, 2016, from http://www.uncrd.or.jp/content/documents/14073RINCS-2014-4.pdf

SATREPS. (2014a). *Baseline Survey Report on Current Solid Waste Management of Local Authorities in Central Province, Sri Lanka, 2011.*

SATREPS. (2014b). *Waste Amount and Composition Surveys (WACS) implemented in Central and Southern Provinces of Sri Lanka.*

SATREPS. (2015). *Action Plan for Solid Waste Management in Kandy MC, Sri Lanka Year 2015-2024.*

Stony Brook University. (n.d.). *4R's*. Retrieved September 15, 2015, from http://www.stonybrook.edu/com/recycling/4rs.shtml

Tang, J. (2004). *A Case Study of a Hotel Solid Waste Management Program in Bali, Indonesia.* Masters Thesis, University of Waterloo, Canada. Retrieved July 24, 2015, from http://etd.uwaterloo.ca/etd/jtang2004.pdf

Tchobanoglous, G., & Kreith, F. (2002). *Handbook of Solid Waste Management* (2nd ed.). New York: McGraw Hill.

United Nations Department of Economic and Social Affairs. (n.d.). *World Population Prospects, the 2015 Revision*. Retrieved June 9, 2016, from https://esa.un.org/unpd/wpp/DataQuery/

United Nations Environment Program. (2010). *Integrated Solid Waste Management Program for the City of Nairobi, Kenya 2010-2020.* Retrieved May 11, 2016, from http://www.unep.or.jp/ietc/GPWM/data/T3/IS_6_4_Nairobi_ISWMplan_draft1_19Feb.pdf

United Nations Human Settlements Programme. (2010). Waste Management in the World's Cities: Water and Sanitation in the World's Cities 2010. UN HABITAT.

United States Environmental Protection Agency. (2002). Retrieved from What is Integrated Solid Waste Management?: https://www3.epa.gov/climatechange/wycd/waste/downloads/overview.pdf

Vazquez, M., & Soto, M. (2017). The efficiency of home composting programmes and compost quality. *Waste Management, 64*, 39-50. doi:https://doi.org/10.1016/j.wasman.2017.03.022

Wijerathna, D., Jinadasa, K., Herath, G., & Mangalika, L. (2012). Solid Waste Management Problem in Kandy Municipal Council - A Case Study. *Proceedings of the SAITM Research Symposium on Engineering Advancements*, (pp. 84-91). Retrieved March 5, 2016, from

http://www.saitm.edu.lk/fac_of_eng/RSEA/SAITM_RSEA_2012/imagenesweb/23.pdf

Wijetunga, S. (2013). Community Views and Attitudes for Waste Management Improvement in a Higher Education Institute: Case Study. *Journal of Environmental Professionals Sri Lanka*, 57-69. doi:10.4038/jepsl.v1i1.5142

Wilson, D., Velis, C., & Rodic, L. (2013). Integrated sustainable waste management in developing countries. *Proceedings of the INstitution of Civil Engineers: Waste and Resource Mangement, 166*, pp. 52-68. doi:10.1680/warm.12.00005

World Bank. (2016). *Data: Countries and Economies*. Retrieved March 17, 2016, from http://data.worldbank.org/country

Yang, Q., Zhou, J., & Xu, K. (2014, April). A 3R Implementation Framework to Enable Circular Consumption in Community. *International Journal of Environmental Science and Development, 5*(2), 217-222. Retrieved April 27, 2016

Yang, W.-S., Park, J.-K., Park, S.-W., & Seo, Y.-C. (2015). Past, present and future of waste management in Korea. *Journal of Material Cycles and Waste Management, 17*(2), 207-217. doi:10.1007/s10163-014-0301-7

Zhu, D., Asnani, P. U., Zubrügg, C., Anapolsky, S., & Mani, S. (2008). *Improving Solid Waste Management in India: A sourcebook for Policy Makers and Practioners.* Washington DC: The World Bank.

Zotos, G., Karagiannidis, A., Zampetoglou, S., Malamakis, A., Antonopoulos, S., Kontogianni, S., & Tchobanoglous, G. (2009). Developing a holistic strategy for integrated waste management within municipal planning: Challenges, policies, solutions and perspectives for Hellenic municipalities ain the zero-waste, low-cost direction. *Waste Management*, 1686-1692. doi:10.1016/j.wasman.2008.11.016

APPENDICES

Appendix 1: Request to Nairobi City County for Data Collection

George Ralak
Department of Civil and Construction Engineering,
University of Nairobi
P. O. Box 30197-00100,
Nairobi.

5 October 2016

Chief Officer,
Environment Energy and Water
Nairobi City County
P. O. Box 30075-00100,
Nairobi.

Chief Officer -
Environment & Forestry
Nairobi City County Government
Received:.....Date: 6/10/16

Dear Sir,

RE: DATA COLLECTION FOR MSC RESEARCH

I, the above mentioned, am a student at the Department of Civil and Construction Engineering at the University of Nairobi undertaking a Master of Science degree in Civil Engineering.

The topic of my research is "Action Plan for the Promotion of 3R in Solid Waste Management in Nairobi County" with the objective of developing an action plan that will help to promote waste reduction and recovery activities in the county. In order to achieve this, I will look into the current status of solid waste management in the county. In addition, a small area within the county will be identified to serve as a target area for the action plan.

In connection to the above, I wish to submit my request for the following:

1. Data and information as per the schedule of questions attached to the letter.
2. Support in the identification of and acquisition of baseline data for the target area.

I shall be available for further discussions or clarifications if the need arises. My contacts have been indicated on the schedule attached to the letter.

Yours sincerely,

George Ralak

Appendix 2: Approval for data collection by Nairobi City County

NAIROBI CITY COUNTY

Telephone: 020 344194
www.nairobi.go.ke

City Hall,
P. O. Box 30075-00100,
Nairobi,
KENYA.

ENVIRONMENT, ENERGY & WATER

EMCE/DOE/1/1/642

18th October 2016

TO WHOM IT MAY CONCERN

RE: DATA COLLECTION FOR MASTER OF SCIENCE RESEARCH

This is to inform you that **George Ralak** holder of **ID No. 27297751** a student of University of Nairobi is undertaking a research on **Action Plan for the Promotion of 3R in Solid Waste Management** in Nairobi County. Solid Waste Management is a devolved function undertaken by the County Government.

Besides this research being intended for academic purposes, the study is important to the county government as its findings will provide baseline information upon which sustainability of solid waste management strategies can be derived. He will undertake the research in liaison with the Sub-County Environment Officer Embakasi East Cell No. 0725-360349.

The researcher is however, expected to ensure that the research is carried out in an ethical manner. He is also required to provide the county government with a copy of his finding upon completion of his research.

Any assistance accorded to him will be highly appreciated.

ISAAC MURAYA
CHIEF OFFICER – ENVIRONMENT, ENERYGY & WATER

Appendix 3: Schedule of questions for the Environment Department, Nairobi City County

Investigation of Solid Waste Management in Nairobi County

Dear Sir,

Many thanks for consenting to respond to the questions below. The questions have been divided into eight parts covering various aspects of solid waste management. The information gathered will be used for the purposes of the study only. In case of queries and further clarification or discussions, my contacts are as follows:

Telephone number: 0724 004 014
Email address: ralakgeorge06@yahoo.com

Schedule of Questions

1. Demographics

a) Latest population figures countywide (and by sub-county if available)

_____

_____

b) Number of households and commercial entities within the county

_____

_____

2. Waste management from generation to disposal

a) What is the current generation and collection rate of municipal solid waste in the county?

_____

_____

_____

b) What is the composition of municipal waste generated in Nairobi?

_____

_____

_____

c) What are the fractions of municipal waste generated by source? (residential, commercial, etc.)

_____

_____

d) Which entities are involved in the collection, and how much waste does each handle on average?

_____

_____

_____

e) What are the waste disposal options available to the county and their capacities?

_____

_____

f) What are the notable challenges faced from generation to disposal of waste in the city?

_____

_____

3. Waste reduction and recovery (3Rs – reduce, reuse recycle) efforts

a) What are the main 3R related activities within the county?

_____

_____

_____

Who are the major actors in the above activities and what are their roles?

_____

_____

_

b) What infrastructure and policies are in existence that enable or promote 3R related activities?

_____

_____

_____

What waste materials and amount are reduced and/or recovered from the above activities

_____

_____

_____

c) What are the challenges experienced in the existing waste reduction and recovery efforts?

_____

_____

_____

4. Public awareness and education on waste management

a) Are there any awareness creation programs for the public on waste management in the county? If yes, by who are they led and what methods are used?

_____

_____

_____

b) What are the themes/topics of the awareness creation programs?

_____

_____

c) Who are the target audiences in the awareness creation activities?

_____

_____

_____

d) What are the notable impacts of the awareness programs?

_____

_____

_____

5. Past interventions in waste management (plans, strategies, projects, etc.)

a) What are some of the recent interventions made in solid waste management in Nairobi?

_____

_____

_____

Have there been any interventions that focus on or highlight the 3Rs?

_____

_____

What are the outcomes of the said interventions?

_____

_____

What are the attributes to the positive and the negative outcomes of the interventions?

_____

_____

6. Solid waste management capacity in Nairobi

a) How many personnel does the county have attached to solid waste management? What fraction is this to the entire county staff?

_____

_____

b) How many vehicles does the county have for the purposes of solid waste management?

_____

c) What is the annual budgetary allocation for solid waste management in the county? What fraction is this the total budget for the county?

_____

_____

d) What is the annual revenue arising from solid waste management activities? What fraction is this as compared to the total annual revenue for the county?

_____

_____

e) How many private waste collection companies are there in the county?

_____

_____

7. Legislations and policies

a) What are the existing legislations and policies on solid waste management in the county?

_____

_____

_____

Is there need to make improvements on the existing legislations on waste management, and why if so?

_____

_____

_____

8. Targets and future plans

a) What targets that the county have for solid waste management?

_____

_____

What plans/interventions that the county have for waste management in the future?

_____

_____

Appendix 4: Household Questionnaire

November 2016

Dear respondent,

Thank you for taking time to respond to this questionnaire. The purpose of the questionnaire is to gather baseline data for the development an Action Plan for promoting the 3Rs in Solid Waste Management as indicated in the letter attached. The findings of this study will also help inform initiatives on solid waste management envisaged by the county government.

It is assured that all the information that provided will be treated with utmost confidence and will only be used for the purpose of this study.

Yours faithfully,

George Ralak

INSTRUCTIONS

1. Where choices are provided, circle **ONLY ONE** that reflects your response unless stated otherwise.
2. Where your response in the multiple-choice questions falls under '*other'*, please write your best response in the blank space provided.
3. **DO NOT** write your name on the questionnaire.

Section 1: Household details

1. Please provide the details of the members of your household in the table below with you (respondent) being member 1.

NB:

- Under **Education**, indicate whether Primary; Secondary; Certificate/Diploma; Undergraduate degree; or Postgraduate degree
- Under **Occupation**, indicate whether Employed; Self-employed; Student; or Unemployed

Member	Relation to respondent	Age	Sex	Education	Occupation
1	Respondent				
2					
3					
4					
5					

6					
7					
8					

2. How much is your average household expenditure per month?
    a. *Less than KSh 40,000*
    b. *KSh 40,000 – KSh 80,000*
    c. *KSh 80,001 – KSh 120,000*
    d. *More than KSh 120,000*
3. Which one best describes the nature of your residence/house?
    a. *Flat/apartment*
    b. *Detached house (house for a single family with its own gate and/or compound)*
    c. *Informal housing (house not made of stone or concrete walls)*
4. How long have you lived in your current house?
    a. *Less than 1 year*
    b. *1-3 years*
    c. *3 – 5 years*
    d. *More than 5 years*

Section 2: Waste management at household level

5. In the blank spaces below, please indicate the three most common waste categories generated in your household from the choices given below.
   (Most common) _____
   (Second most common) _____
   (Third most common) _____

a. *Food waste*
b. *Paper*
c. *Plastics*
d. *Rubber and leather*
e. *Wood*
f. *Glass*
g. *Metal*
h. Other (sand, textile, etc.)

6. Do you separate your waste before collection or disposal?
    a. *Yes*
    b. *No* (If NO, proceed to question 8)
7. If yes to Question 3, into which categories?
   _____
   _____
8. How do you store the waste generated in your household before collection or disposal?
    a. *Polythene bags*
    b. *Dust bin*
    c. *Rubbish pits*
    d. *Other* _____

9. Does your household receive waste collection services?
    a. *Yes* (If **Yes**, go to **Question 10**)
    b. *No* (If **No**, **DO NOT** answer questions **10 to 17**)

10. Who is responsible for the collection of solid waste from your household?
    a. *Nairobi city county*
    b. *Private collection companies*
    c. *Community based organisations,*
    d. *Other* _____
11. Do you pay any fee for the waste collection services?
    a. *Yes*
    b. *No* (If **No**, **DO NOT** answer questions **12 and 13**)

12. If yes to Question 8, how much do you pay per month? _____

13. How would you rate the amount you pay for waste collection fees?
    a. Expensive,
    b. Reasonable
    c. Cheap

14. What is the frequency of waste collection from your household?
    a. *Once a week*
    b. *Once in two weeks*
    c. *Once a month*
    d. Other _____
15. At what time is solid waste/garbage collected from your residence for disposal?
    a. *Morning*
    b. *Afternoon*
    c. *Evening*
    d. *Irregular*
16. What means does your waste collection service provider use to transport collected waste?
    a. *Lorry,*
    b. *Pick-up,*
    c. *Tractor and trailer,*
    d. *Hand cart,*
    e. *Other* _____
17. How would you rate the waste collection service in your area?
    a. *Very poor*
    b. *Poor,*
    c. *Fair,*
    d. *good,*
    e. *Very good*
18. What other waste management alternative do you commonly use in your household?

a. *Dumping in the open*
b. *Selling and/or giving away*
c. *Reusing and recycling*
d. *Composting*
e. *Burning*
f. *None*
g. *Other*_____

19. Are there any waste materials that are reused in your household?
    a. Yes
    b. No
20. If yes to Question 19, which waste material is most commonly reused in your household?
    a. Food waste
    b. Plastics
    c. Papers
    d. Textile(clothes) and leather
    e. Glass
    f. Other _____
21. Are there any waste materials that you give away or sell for other uses apart from disposal?
    a. Yes
    b. No
22. If yes to question 21, which waste material is most commonly sold or given away?
    a. Food waste
    b. Plastics
    c. Papers
    d. Textile(clothes) and leather
    e. Glass
    f. Other _____
23. If yes to question 21, who are the buyers/recipients of these materials?
    a. Nairobi City County
    b. Informal waste pickers
    c. Itinerant traders (*mali mali)*
    d. Community based organisations
    e. Other _____

Section 3: Awareness

24. Have you or any member of your household been part of an audience in any awareness or education activity on solid waste management?
    a. Yes
    b. No
25. If yes to question 24, when was the last time such a program was attended?
    a. *Less than 1 year ago*
    b. *1-3 years ago*
    c. *More than 3 years ago*
26. If Yes to question 24 by whom was the awareness activity done?
    a. *Nairobi City County*
    b. *National government*
    c. *Community based organisations and NGOs*
    d. *Private sector*
    e. *Other* _____
27. Are you aware of any laws that touch on solid waste management?
    a. *Yes*
    b. *No*

28. Are you familiar with the term '3R' (reduce reuse recycle) in solid waste management?
    a. *Yes*
    b. *No*
29. If yes to question 28, would you like to see the '3R' being practiced in the management of solid waste in your area and the county at large?
    a. *Yes*
    b. *No*
30. Are you interested in gaining more knowledge about the '3R' in solid waste management?
    a. *Yes*
    b. *No*
31. Are you aware of any waste recovery activities and facilities in your residential area (recycling, composting, reuse of waste to make other products, etc.)
    a. *Yes*
    b. *No*
32. If yes to question 31, which of the waste recovery activities below do you know of takes place in your residential area?
    a. Recycling
    b. Composting
    c. Reuse for making new products
    d. Other _____
    e. I do not know of any waste recovery activities in my area
33. Which would be your preferred method of receiving communication on proper waste management practices?
    a. Education in schools and workplaces
    b. Mass media (television, radio, internet, newspaper)
    c. Brochures, fliers and leaflets
    d. Public meetings and clean-up exercises
    e. Other _____

Section 4: Perceptions to change

34. Do you think there is need to improve the management of waste in your residential area?
    a. *Yes,*
    b. *No*
35. Would you be willing to cooperate with the county authorities (or any other relevant parties) in the improvement of waste management in your area?
    a. *Yes,*
    b. *No*
36. Would you be willing to pay more than what you currently pay as waste collection fees in order to have better waste management service in your area?

a. *Yes,*
b. No

37. How would you agree with the introduction of the following in the management of solid waste in your area? (tick appropriately for each item)

	Item	**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
1	Waste separation at source					
2	Regular awareness creation and education on proper solid waste management					
3	Composting of organic waste					
4	Biogas production from organic waste					
5	Collection centres for recyclable waste					
6	Improved laws and their enforcement					
7	Increased public participation					
8	Recycling of waste					
9	Charge of waste collection fee by quantity collected					

38. Briefly, what changes would you recommend in the management of waste in your area of operations apart from the above?

_____

_____

Thank you for your cooperation.

Appendix 5: Questionnaires for commercial premises

QUESTIONNAIRE FOR COMMERCIAL PREMISES

November 2016

Dear respondent,

Thank you for taking time to respond to this questionnaire. The purpose of the questionnaire is to gather baseline data for the development an Action Plan for promoting the 3Rs in Solid Waste Management as indicated in the letter attached. The findings of this study will also help inform initiatives on solid waste management envisaged by the county government.

It is assured that all the information that provided will be treated with utmost confidence and will only be used for the purpose of this study.

Yours sincerely,

George Ralak

INSTRUCTIONS

1. Where choices are provided, circle only one that reflects your response unless stated otherwise.
2. Where your response in the multiple-choice questions falls under '*other'*, please write your best response in the blank space provided.
3. **DO NOT** write your name on the questionnaire.

Section 1: Details of the business

1. How many members of staff do you have in your business premises?
    a. Male _____
    b. Female _____
2. What is the nature of your business?
    _____
3. Which one best describes the nature of your business activities?
    a. *Provision of services (e.g. salons and barbers)*
    b. *Merchandise (sale of goods, e.g. retail shops)*
    c. *Hybrid (offering both goods and services)*
4. How old is your business?
    a. *Less than 1 year*
    b. *1-3 years*
    c. *3 – 5 years*
    d. *More than 5 years*

Section 2: Waste management at source

5. In the blank spaces below, please indicate the TWO most common waste categories generated in your household from the choices given below.
   (Most common) _____
   (Second most common) _____
   (Third most common) _____

a. *Food waste*
b. *Paper*
c. *Plastics*
d. *Rubber and leather*
e. *Wood*
f. *Glass*
g. *Metal*
h. *Other (sand, textile, etc.)*

6. Do you separate your waste before collection or disposal?
   a. *Yes*
   b. *No* (If NO, proceed to question 7)
7. If yes, into which categories?
   _____
   _____
8. How do you store the solid waste generated in your business before collection or disposal?
   a. *Polythene bags*
   b. *Dust bin*
   c. *Rubbish pits*
   d. *Other* _____
9. Does your business receive waste collection services?
   a. *Yes* (If **Yes**, go to **Question 9**)
   b. *No* (If **No**, **DO NOT** answer questions **9 to 16**)
10. Who is responsible for the collection of solid waste from your business?
    a. *Nairobi City County*
    b. *Private collection companies*
    c. *Community based organisations,*
    d. *Other* _____
11. Do you pay any fee for the waste collection service?
    a. *Yes*
    b. *No* (If **No**, **DO NOT** answer questions **11 and 12**)
12. If yes, how much do you pay per month? _____
13. How would you rate the amount you pay for waste collection fees?
    a. Expensive,
    b. Reasonable
    c. Cheap

14. What is the frequency of waste collection from your business?

a. *Once a month*
b. *Once in two weeks*
c. *Once a week*
d. *Two times a week*
e. *Daily*
f. Irregular
g. Other _____

15. At what time is solid waste/garbage collected from your residence for disposal?
    a. *Morning*
    b. *Afternoon*
    c. *Evening*
    d. *Irregular*
16. What means does your waste collection service provider use to transport collected waste?
    a. *Lorry,*
    b. *Pick-up,*
    c. *Tractor and trailer,*
    d. *Hand cart,*
    e. *Other* _____
17. How would you rate the waste collection service that you receive?
    a. *Very poor*
    b. *Poor,*
    c. *Fair,*
    d. *Good,*
    e. *Very good*
18. What other waste management alternative do you use in your business?
    a. *Dumping in the open*
    b. *Selling and/or giving away*
    c. *Reusing and recycling*
    d. *Composting*
    e. *Burning*
    f. *None*
    g. *Other*_____
19. Are there any waste materials that are reused in your business?
    a. Yes
    b. No
20. If yes to question 18 which waste material is most commonly reused in your business?
    g. Food waste
    h. Plastics
    i. Papers
    j. Textile(clothes) and leather
    k. Glass
    l. Other _____
21. Are there any waste materials that you give away or sell for other uses apart from disposal?
    a. Yes
    b. No

22. If yes in question 20, which waste material is most commonly sold or given away?
    a. Food waste
    b. Plastics
    c. Papers
    d. Textile(clothes) and leather
    e. Glass
    f. Other_____
23. If yes to question 20, who are the buyers/recipients of the said materials above?
    a. Nairobi City County
    b. Informal waste pickers
    c. Itinerant traders (*mali mali)*
    d. Other _____

Section 3: Awareness

24. Have you or any member of staff in your business been part of an audience in any awareness or education activity on solid waste management?
    a. Yes
    b. No
25. If yes to question 23, when was the last time such a program was attended?
    d. *Less than 1 year ago*
    e. *1-3 years ago*
    f. *More than 3 years ago*
26. If Yes to question 23 by whom was the awareness activity done?
    a. *Nairobi City County*
    b. *National government*
    c. *Community based organisations and NGOs*
    d. *Private sector*
    e. *Other* _____
27. Are you aware of any laws that touch on solid waste management?
    a. *Yes*
    b. *No*
28. Are you familiar with the term '3R' (reduce reuse recycle) in solid waste management?
    a. *Yes*
    b. *No*
29. If yes to question 28, would you like to see the '3R' being practiced in the management of solid waste in your area and the county at large?
    a. *Yes*
    b. *No*
30. Are you interested in gaining more knowledge about the '3R' in solid waste management?
    a. *Yes*
    b. *No*
31. Are you aware of any waste recovery activities and facilities in your residential area (recycling, composting, reuse of waste to make other products, etc.)?

a. *Yes*
b. *No*

32. If yes to question 31, which of the waste recovery activities below do you know of takes place in your residential area?
    a. Recycling
    b. Composting
    c. Reuse for making new products
    d. Other _____
    e. I do not know of any waste recovery activities in my area
33. Which would be your preferred method of receiving communication on proper waste management practices?
    a. Education in schools and workplaces
    b. Mass media (television, radio, internet, newspaper)
    c. Brochures, fliers and leaflets
    d. Public meetings and clean-up exercises
    e. Other _____

Section 4: Perceptions to change

34. Do you think there is need for change the management of waste around the location of your business?
    a. *Yes,*
    b. *No*
35. Would you be willing to cooperate with the county authorities (or any other relevant parties) in the improvement of waste management in your area?
    a. *Yes,*
    b. *No*
36. Would you be willing to pay more than what you currently pay as waste collection fees in order to have better waste management service in your area?
    a. *Yes,*
    b. No
37. How would agree with the introduction of the following in the management of solid waste in your area? (tick appropriately for each item)

	Item	**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
1	Waste separation at source					
2	Regular awareness creation and education on proper solid waste management					
3	Composting of organic waste					
4	Biogas production from organic waste					
5	Buyback centres for recyclable waste					

6	Improved legislations and their enforcement					
7	Increased participation by the public					
8	Recycling of waste					
9	Charge of waste collection fee by quantity collected					

38. Briefly, what changes would you recommend in the management of waste in your area of operations apart from the above?

    _____

    _____

Thank you for your cooperation.

Appendix 6: Questionnaire for Community groups in waste management

November 2016

Dear respondent,

Thank you for taking time to respond to this questionnaire. The purpose of the questionnaire is to gather baseline data for the development an Action Plan for promoting the 3Rs in Solid Waste Management as indicated in the letter attached. The findings of this study will also help inform initiatives on solid waste management envisaged by the county government.

It is assured that all the information that provided will be treated with utmost confidence and will only be used for the purpose of this study.

Yours faithfully,

George Ralak

INSTRUCTIONS

1. Where choices are provided, circle **only one** that reflects your response unless stated otherwise.
2. Where your response in the multiple-choice questions falls under '*other'*, please write your best response in the blank space provided.

Section 1: Details of the Organisation

1. What is the name of your organization?

_____

2. How many members do you have in your organization??
   Male _____
   Female _____
3. Which is the main solid waste management activities that the group is involved in?
   a. *Collection and transport*
   b. *Disposal*
   c. *Composting*
   d. *Recycling*
   e. *Sale of recyclable waste*
   f. *Other* _____

4. How long has the organization been in existence?
    a. *Less than 1 year*
    b. *1-3 years*
    c. *3 – 5 years*
    d. *More than 5 years*

5. What is the main source of funds for the group?
    a. Revenue from group activities
    b. National government support
    c. County government support
    d. Non-governmental organisations support
    e. Private sector support
    f. Other _____

Section 2: Waste management activities

6. In the blank spaces below, please indicate the three most common waste categories that your group handles from the choices given below.
   (Most common) _____
   (Second most common) _____
   (Third most common) _____

    a. *Food waste*
    b. *Paper*
    c. *Plastics*
    d. *Rubber and leather*
    e. *Wood*
    f. *Glass*
    g. *Metals*
    h. *Other* _____

7. Does your group take part in any waste sorting/separation activities?
    a. *Yes*
    b. *No*
8. If yes to question 7, into which categories?
   _____
   _____
9. Does your group offer waste collection services?
    a. *Yes* (If **Yes**, go to **Question 10**)
    b. *No* (If **No**, **DO NOT** answer questions **10 to 16**)

10. Which group makes up the largest fraction of the clients that you serve?
    a. Households
    b. Commercial premises and businesses (e.g. shops and markets)
    c. Institutions (e.g. schools and health facilities)
    d. Others _____
11. Approximately how much waste does your group collect per day?
    a. Less than 0.5 tons
    b. 0.5 to 1 ton
    c. 1 – 1.5 tons

d. More than 1.5 tons

12. Do you charge any fee for the waste collection service?
    a. *Yes*
    b. *No*
13. If yes to question 12, how much do you charge per client per month? KSh _____

14. How many days in a week do you offer waste collection services?
    a. *1-3*
    b. *4-6*
    c. *7*
15. What means do you use to transport the collected waste?
    a. *Lorry,*
    b. *Pick-up,*
    c. *Tractor and trailer,*
    d. *Hand cart,*
    e. *Other* _____
16. Where do you deliver the waste collected?
    a. *Official dumpsites (e.g. Dandora)*
    b. *Transfer or collection points for further transport and final disposal*
    c. *Illegal/open dumps*
    d. *Other* _____

17. Are there any waste materials collected by the group are diverted to uses other than disposal?
    a. Yes
    b. No
18. If yes to Question 17, which waste material is most commonly diverted from disposal?
    a. Food waste
    b. Plastics
    c. Papers
    d. Textile(clothes) and leather
    e. Glass
    f. Other _____

19. If yes to Question 17, what does your group do with the waste material diverted above?
    a. Selling for other uses
    b. Recycling
    c. Composting
    d. Reuse them to make new products
    e. Other _____

Section 3: Awareness

20. Have you or any member of your group been part of an audience in any awareness or education activity on solid waste management?

a. Yes
b. No

21. If yes to question 20, when was the last time such a program was attended?
    g. *Less than 1 year ago*
    h. *1-3 years ago*
    i. *More than 3 years ago*

22. If yes to question 20, by whom was the awareness activity done?
    a. *Nairobi City County*
    b. *National government*
    c. *Community based organisations and NGOs*
    d. Private sector
    e. *Other* _____
23. Has your group/organization ever conducted an awareness or education program on waste management to members of the public?
    a. Yes
    b. No
24. If yes to question 23, when was the awareness program conducted?
    c. *Less than 1 year ago*
    d. *1-3 years ago*
    e. *More than 3 years ago*
25. Are you aware of any laws that touch on solid waste management?
    a. *Yes*
    b. *No*
26. Are you familiar with the term '3R' (reduce reuse recycle) in solid waste management?
    a. *Yes*
    b. *No*
27. If yes to question 26 above, would you like to see the '3R' being practiced in the management of solid waste in your area and the county at large?
    c. *Yes*
    d. *No*
28. Which of the following do you think is the best way of reaching out to the public regarding proper waste management practices??
    a. Education in schools and workplaces
    b. Mass media (television, radio, internet, newspapers)
    c. Brochures, fliers and leaflets
    d. Public meetings and clean-up exercises
    e. Other _____

Section 4: Perceptions to change

29. Do you think there is need to improve the management of waste in your area of operation?

c. *Yes,*
d. *No*

30. Would you be willing to cooperate with the county authorities (or any other relevant parties) in the improvement of waste management in your area?
    a. Yes
    b. No
31. Would your group/organisation be willing to spend more than it currently does in order to contribute towards better waste management in your area of operation?
    c. *Yes,*
    d. No
32. How would agree with the introduction of the following in the management of solid waste in your area? (tick appropriately for each item)

	Item	**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
1	Waste separation at source					
2	Regular awareness creation and education on proper solid waste management					
3	Composting of organic waste					
4	Biogas production from organic waste					
5	Buyback centres for recyclable waste					
6	Improved legislations and their enforcement					
7	Increased participation by the public					
8	Recycling of waste					
9	Charge of waste collection fee by quantity collected					

33. Briefly, what changes would you recommend in the management of waste in your area of operations in addition to the above?

_____

_____

_____

Thank you for your cooperation.

Appendix 7: Output of analysis of household questionnaires

Respondent Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	51	45.5	50.5	50.5
	Male	50	44.6	49.5	100.0
	Total	101	90.2	100.0	
Missing		11	9.8		
Total		112	100.0		

Respondent occupation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Employed	23	20.5	23.0	23.0
	Self-employed	53	47.3	53.0	76.0
	Unemployed	24	21.4	24.0	100.0
	Total	100	89.3	100.0	
Missing		12	10.7		
Total		112	100.0		

Respondent age groups

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	below 26	20	17.9	20.6	100.0
	26 to 35	34	30.4	35.1	35.1
	36 to 45	27	24.1	27.8	62.9
	Above 45	16	14.3	16.5	79.4
	Total	97	86.6	100.0	
Missing		15	13.4		
Total		112	100.0		

Average monthly household expense

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than KSh 20,000	70	62.5	67.3	67.3
	KSh 20,000 to KSh 40,000	22	19.6	21.2	88.5
	KSh 40,000 to KSh 80,000	10	8.9	9.6	98.1
	KSh 80,000 to KSh 120,000	2	1.8	1.9	100.0
	Missing	8	7.1		
Total		112	100.0		

Type of housing

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Flat/Apartment	26	23.2	23.4	23.4
	Detached house	28	25.0	25.2	48.6
	Single rooms	57	50.9	51.4	100.0
	Total	111	99.1	100.0	
Missing		1	.9		
Total		112	100.0		

Duration of stay in current house

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 1 year	21	18.8	18.8	18.8
	1 to 3 years	27	24.1	24.1	42.9
	3 to 5 years	13	11.6	11.6	54.5
	More than 5 years	51	45.5	45.5	100.0
	Total	112	100.0	100.0	

Prevalence of waste categories generated

	Food	Paper	Plastics	Rubber and Leather	Wood	Glass	Metal	Other
No. of cases	100	82	87	3	2	4	0	4
Percentage	89.29	73.21	77.68	2.68	1.79	3.57	-	3.57

Separation at source

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	18	16.1	16.7	16.7
	No	90	80.4	83.3	100.0
	Total	108	96.4	100.0	
Missing		4	3.6		
Total		112	100.0		

Whether waste collection is received at the household

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	103	92.0	92.0	92.0
	No	9	8.0	8.0	100.0
	Total	112	100.0	100.0	

Waste collector

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Nairobi City County	3	2.7	2.9	2.9
	Private companies	24	21.4	23.5	26.5
	CBOs	75	67.0	73.5	100.0
	Total	102	91.1	100.0	
Missing		10	8.9		
Total		112	100.0		

Whether household pays for waste collection

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	93	83.0	90.3	90.3
	No	10	8.9	9.7	100.0
	Total	103	92.0	100.0	
Missing		9	8.0		
Total		112	100.0		

Monthly waste collection fee paid by the recipient (Kenya Shillings)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 100	51	45.5	56.7	95.6
	101-200	23	20.5	25.6	25.6
	201-300	12	10.7	13.3	38.9
	More than 300	4	3.6	4.4	100.0
	Total	90	80.4	100.0	
Missing		22	19.6		
Total		112	100.0		

Waste collection frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than once a week	10	8.9	9.7	9.7
	More than once a week	18	16.1	17.5	27.2
	Once a week	75	67.0	72.8	100.0
	Total	103	92.0	100.0	
Missing		9	8.0		
Total		112	100.0		

Time of day when waste is collected

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Afternoon or Evening	12	10.7	11.7	11.7
	Irregular	14	12.5	13.6	25.2
	Morning	77	68.8	74.8	100.0
	Total	103	92.0	100.0	
Missing		9	8.0		
Total		112	100.0		

Mode of transport used by collector

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Lorry	12	10.7	12.1	12.1
	Pick-up	1	.9	1.0	13.1
	Tractor and trailer	1	.9	1.0	14.1
	Hand cart	85	75.9	85.9	100.0
	Total	99	88.4	100.0	
Missing		13	11.6		
Total		112	100.0		

Rating of waste collection service by respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Fair	42	37.5	40.8	40.8
	Good	41	36.6	39.8	80.6
	Poor	20	17.9	19.4	100.0
	Total	103	92.0	100.0	
Missing		9	8.0		
Total		112	100.0		

Waste management alternative apart from the waste collection service received

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Dumping in the open	13	11.6	12.9	12.9
	Selling or giving away	10	8.9	9.9	22.8
	Reusing and recycling	6	5.4	5.9	28.7
	Composting	1	.9	1.0	29.7
	Burning	39	34.8	38.6	68.3
	None	32	28.6	31.7	100.0
	Total	101	90.2	100.0	
Missing		11	9.8		
Total		112	100.0		

Whether there are waste materials sold or given away

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	51	45.5	46.8	46.8
	No	58	51.8	53.2	100.0
	Total	109	97.3	100.0	
Missing		3	2.7		
Total		112	100.0		

Common waste material given away or sold

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Food waste	3	2.7	7.1	7.1
	Plastics	14	12.5	33.3	40.5
	Papers	3	2.7	7.1	47.6
	Textiles and leather	21	18.8	50.0	97.6
	Metals and electronics	1	.9	2.4	100.0
	Total	42	37.5	100.0	
Missing		70	62.5		
Total		112	100.0		

.Recipients of wastes given away or sold

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Informal waste pickers	11	9.8	21.6	21.6
	CBOs	4	3.6	7.8	29.4
	Itinerant traders (mali mali)	34	30.4	66.7	96.1
	Farmers	1	.9	2.0	98.0
	Waste traders	1	.9	2.0	100.0
	Total	51	45.5	100.0	
Missing		61	54.5		
Total		112	100.0		

If household member has taken part in awareness programs in waste management

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	16	14.3	14.4	14.4
	No	95	84.8	85.6	100.0
	Total	111	99.1	100.0	
Missing		1	.9		
Total		112	100.0		

Last time awareness program was attended

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 1 year ago	7	6.3	43.8	43.8
	1-3 years ago	7	6.3	43.8	87.5
	More than 3 years ago	2	1.8	12.5	100.0
	Total	16	14.3	100.0	
Missing		96	85.7		
Total		112	100.0		

Organiser of awareness activity recently attended

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Nairobi City County	3	2.7	20.0	20.0
	CBOs and NGOs	8	7.1	53.3	73.3
	Private sector	4	3.6	26.7	100.0
	Total	15	13.4	100.0	
Missing		97	86.6		
Total		112	100.0		

Whether responded is aware of any legislation regarding waste management

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	35	31.3	32.1	32.1
	No	74	66.1	67.9	100.0
	Total	109	97.3	100.0	
Missing		3	2.7		
Total		112	100.0		

Whether respondent is familiar with the 3R in solid waste management

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	54	48.2	49.1	49.1
	No	56	50.0	50.9	100.0
	Total	110	98.2	100.0	
Missing		2	1.8		
Total		112	100.0		

Whether respondent would like to see 3R incorporated in SWM

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	53	47.3	98.1	98.1
	No	1	.9	1.9	100.0
	Total	54	48.2	100.0	
Missing		58	51.8		
Total		112	100.0		

Whether respondent is aware of waste recovery activities and facilities in their locality

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	34	30.4	31.8	31.8
	No	73	65.2	68.2	100.0
	Total	107	95.5	100.0	
Missing		5	4.5		
Total		112	100.0		

The waste recovery activity/facility known by the respondent

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Recycling	10	8.9	33.3	33.3
	Composting	1	.9	3.3	36.7
	Reuse to make new products	6	5.4	20.0	56.7
	Collection of recyclables for resale	13	11.6	43.3	100.0
	Total	30	26.8	100.0	
Missing		82	73.2		
Total		112	100.0		

Preferred method of reaching out to the public on proper SWM

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Education in schools and workplaces	6	5.4	5.7	5.7
	Mass media	27	24.1	25.5	31.1
	Brochures, fliers and leaflets	4	3.6	3.8	34.9
	Public meetings and cleanup exercises	68	60.7	64.2	99.1
	Notices/	1	.9	.9	100.0
	Total	106	94.6	100.0	
Missing		6	5.4		
Total		112	100.0		

Whether respondent believes that it is possible to improve waste management in their locality

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	109	97.3	98.2	98.2
	No	2	1.8	1.8	100.0
	Total	111	99.1	100.0	
Missing		1	.9		
Total		112	100.0		

Willingness to cooperate with NCC to improve waste management

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	110	98.2	99.1	99.1
	No	1	.9	.9	100.0
	Total	111	99.1	100.0	
Missing		1	.9		
Total		112	100.0		

Willingness to pay more for better waste management services

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	60	53.6	56.6	56.6
	No	46	41.1	43.4	100.0
	Total	106	94.6	100.0	
Missing		6	5.4		
Total		112	100.0		

Preference of waste management intervention

	Agreement		Neutral		Disagreement		Missing	
	Count	%	Count	%	Count	%	Count	%
Source separation	76	74.51	5	4.9	16	15.69	5	4.9
Regular awareness	97	95.1	1	0.98	0	-	4	3.92
Composting	72	70.59	13	12.75	14	13.73	3	2.94
Biogas	78	76.47	12	11.76	8	7.84	4	3.92
Buyback centers	93	91.18	6	5.88	2	1.96	1	0.98
Laws and enforcement	87	85.29	9	8.82	4	3.92	2	1.96
Public participation	95	93.14	6	5.88	1	0.98	0	-
Recycling	91	89.22	7	6.86	2	1.96	2	1.96
Charge by quantity	41	40.2	20	19.61	39	38.24	2	1.96

Appendix 8: Output of analysis of questionnaires from commercial premises

Nature of business activity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Service provision	16	29.1	29.1	29.1
	Merchandise	24	43.6	43.6	72.7
	Hybrid	15	27.3	27.3	100.0
	Total	55	100.0	100.0	

How old is the business

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 1 year	14	25.5	25.9	25.9
	1-3 years	11	20.0	20.4	46.3
	3-5 years	9	16.4	16.7	63.0
	More than 5 years	20	36.4	37.0	100.0
	Total	54	98.2	100.0	
Missing		1	1.8		
Total		55	100.0		

Prevalence of waste categories generated

	Food	**Paper**	**Plastics**	**Rubber & leather**	**Wood**	**Glass**	**Metal**	**Other**
Number of cases	18	19	18	1	1	0	0	7
Percentage	33.96	35.85	33.96	1.89	1.89	-	-	13.21

Separation at source

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	11	20.0	20.8	20.8
	No	42	76.4	79.2	100.0
	Total	53	96.4	100.0	
Missing		2	3.6		
Total		55	100.0		

If waste collection service is received

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	49	89.1	90.7	90.7
	No	5	9.1	9.3	100.0
	Total	54	98.2	100.0	
Missing		1	1.8		
Total		55	100.0		

Waste collector

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Nairobi City County	2	3.6	4.2	4.2
	Private companies	17	30.9	35.4	39.6
	CBOs	27	49.1	56.3	95.8
	Individual collector	2	3.6	4.2	100.0
	Total	48	87.3	100.0	
Missing		7	12.7		
Total		55	100.0		

Payment of collection fee

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	45	81.8	91.8	91.8
	No	4	7.3	8.2	100.0
	Total	49	89.1	100.0	
Missing		6	10.9		
Total		55	100.0		

Monthly waste collection fee paid by recipient (Kenya Shillings)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 100	14	26.4	31.8	31.8
	101-200	17	32.1	38.6	81.8
	201-300	7	13.2	15.9	97.7
	301-400	1	1.9	2.3	100.0
	More than 400	5	9.4	11.4	43.2
	Total	44	83.0	100.0	
Missing		9	17.0		
Total		53	100.0		

Waste collection frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than once a week	3	5.7	6.3	6.3
	More than once a week	13	24.5	27.1	33.3
	Once a week	32	60.4	66.7	100.0
	Total	48	90.6	100.0	
Missing		5	9.4		
Total		53	100.0		

Time of day when waste is collected

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Afternoon or evening	10	18.9	20.8	20.8
	Irregular	8	15.1	16.7	37.5
	Morning	30	56.6	62.5	100.0
	Total	48	90.6	100.0	
Missing		5	9.4		
Total		53	100.0		

Mode of transport used by collector

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Lorry	10	18.2	20.4	20.4
	Pick-up	1	1.8	2.0	22.4
	Hand cart	37	67.3	75.5	98.0
	Manual	1	1.8	2.0	100.0
	Total	49	89.1	100.0	
Missing		6	10.9		
Total		55	100.0		

Rating of waste collection service by respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very poor	5	9.1	10.2	10.2
	Poor	3	5.5	6.1	16.3
	Fair	20	36.4	40.8	57.1
	Good	16	29.1	32.7	89.8
	Very good	5	9.1	10.2	100.0
	Total	49	89.1	100.0	
Missing		6	10.9		
Total		55	100.0		

Waste management alternative apart from the waste collection service received

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Dumping in the open	2	3.6	3.9	3.9
	Selling or giving away	8	14.5	15.7	19.6
	Reusing and recycling	1	1.8	2.0	21.6
	Burning	16	29.1	31.4	52.9
	None	24	43.6	47.1	100.0
	Total	51	92.7	100.0	
Missing		4	7.3		
Total		55	100.0		

Whether there are waste materials sold or given away

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	22	40.0	41.5	41.5
	No	31	56.4	58.5	100.0
	Total	53	96.4	100.0	
Missing		2	3.6		
Total		55	100.0		

Common waste material given away or sold

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Food waste	9	16.4	42.9	42.9
	Plastics	7	12.7	33.3	76.2
	Papers	2	3.6	9.5	85.7
	Textiles and leather	1	1.8	4.8	90.5
	Other	1	1.8	4.8	95.2
	Motor vehicle plugs	1	1.8	4.8	100.0
	Total	21	38.2	100.0	
Missing		34	61.8		
Total		55	100.0		

.Recipients of wastes given away or sold

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Informal waste pickers	5	9.1	25.0	25.0
	CBOs	2	3.6	10.0	35.0
	Carpenters	1	1.8	5.0	40.0
	Itinerant traders (mali mali)	2	3.6	10.0	50.0
	Farmers	5	9.1	25.0	75.0
	General public	4	7.3	20.0	95.0
	Mechanics/garages	1	1.8	5.0	100.0
	Total	20	36.4	100.0	
Missing		35	63.6		
Total		55	100.0		

If respondent has taken part in awareness programs in waste management

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	4	7.3	7.4	7.4
	No	50	90.9	92.6	100.0
	Total	54	98.2	100.0	
Missing		1	1.8		
Total		55	100.0		

Last time awareness program was attended

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 1 year ago	1	1.8	25.0	25.0
	1-3 years ago	3	5.5	75.0	100.0
	Total	4	7.3	100.0	
Missing		51	92.7		
Total		55	100.0		

Organiser of awareness activity recently attended

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Nairobi City County	1	1.8	25.0	25.0
	CBOs and NGOs	1	1.8	25.0	50.0
	Private sector	2	3.6	50.0	100.0
	Total	4	7.3	100.0	
Missing		51	92.7		
Total		55	100.0		

Whether responded is aware of any legislation regarding waste management

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	17	30.9	32.1	32.1
	No	36	65.5	67.9	100.0
	Total	53	96.4	100.0	
Missing		2	3.6		
Total		55	100.0		

Whether respondent is familiar with the 3R in solid waste management

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	28	52.8	52.8	52.8
	No	25	47.2	47.2	100.0
	Total	53	100.0	100.0	

Whether respondent would like to see 3R incorporated in SWM

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	26	49.1	92.9	92.9
	No	2	3.8	7.1	100.0
	Total	28	52.8	100.0	
Missing		25	47.2		
Total		53	100.0		

Whether aware of waste recovery activities and facilities in the area.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	16	29.1	30.2	30.2
	No	37	67.3	69.8	100.0
	Total	53	96.4	100.0	
Missing		2	3.6		
Total		55	100.0		

The waste recovery activity/facility known by the respomdent

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Recycling	5	9.1	31.3	31.3
	Composting	1	1.8	6.3	37.5
	Reuse to make new products	1	1.8	6.3	43.8
	Collection of recyclables for resale	9	16.4	56.3	100.0
	Total	16	29.1	100.0	
Missing		39	70.9		
Total		55	100.0		

Preferred method of reaching out to the public on proper SWM

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Education in schools and workplaces	4	7.3	7.5	7.5
	Mass media	18	32.7	34.0	41.5
	Brochures, fliers and leaflets	3	5.5	5.7	47.2
	Public meetings and cleanup exercises	27	49.1	50.9	98.1
	Phones	1	1.8	1.9	100.0
	Total	53	96.4	100.0	
Missing		2	3.6		
Total		55	100.0		

Whether respondent believes that it is possible to improve waste management in their locality

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	51	96.2	96.2	96.2
	No	2	3.8	3.8	100.0
	Total	53	100.0	100.0	

Willingness to cooperate with NCC to improve waste management

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	50	94.3	96.2	96.2
	No	2	3.8	3.8	100.0
	Total	52	98.1	100.0	
Missing		1	1.9		
Total		53	100.0		

Willingness to pay more for better waste management services

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	21	39.6	39.6	39.6
	No	32	60.4	60.4	100.0
	Total	53	100.0	100.0	

Preference of waste management intervention

	Agreement		Neutral		Disagreement		Missing	
	Count	%	Count	%	Count	%	Count	%
Source separation	30	60	5	10	13	26	2	4
Regular awareness	47	94	1	2	1	2	1	2
Composting	39	78	9	18	1	2	1	2
Biogas	41	82	7	14	2	4	0	0
Buyback centers	42	84	5	10	2	4	1	2
Laws and enforcement	44	88	3	6	1	2	2	4
Public participation	47	94	1	2	1	2	1	2
Recycling	45	90	2	4	2	4	1	2
Charge by quantity	27	54	3	6	19	38	1	2

Appendix 9: Output of analysis of questionnaires from local community groups

Main activity for the group

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Collection and transport	8	88.9	88.9	88.9
	Disposal	1	11.1	11.1	100.0
	Total	9	100.0	100.0	

Age of group

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 1 year	3	33.3	33.3	33.3
	1-3 years	3	33.3	33.3	66.7
	More than 5 years	3	33.3	33.3	100.0
	Total	9	100.0	100.0	

Group membership

	N	Minimum	Maximum	Mean	Std. Deviation
Male members	9	7	20	11.67	4.924
Female members	9	0	10	4.44	2.877
Members	9	10	30	16.11	5.904
Valid N	9				

Waste categories handled by groups

	Food Waste	**Paper**	**Plastics**	**Rubber and leather**	**Wood**	**Glass**	**Metals**	**Other**
No.	**9**	**5**	**9**	**0**	**0**	**1**	**2**	**1**

Whether group practices waste separation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	7	77.8	87.5	87.5
	No	1	11.1	12.5	100.0
	Missing	1	11.1		
Total		9	100.0		

Whether group offers waste collection services

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	8	88.9	88.9	88.9
	No	1	11.1	11.1	100.0
	Total	9	100.0	100.0	

Commonly served clients for waste collection services

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Households	7	77.8	87.5	87.5
	Commercial premises	1	11.1	12.5	100.0
	Total	8	88.9	100.0	
Missing		1	11.1		
Total		9	100.0		

Whether group charges a fee for waste collection services

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	8	88.9	100.0	100.0
Missing		1	11.1		
Total		9	100.0		

Collection frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Once a week	7	77.8	87.5	87.5
	Daily	1	11.1	12.5	100.0
	Total	8	88.9	100.0	
Missing		1	11.1		
Total		9	100.0		

Means of transport for collected waste

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Lorry	2	22.2	25.0	25.0
	Hand cart	6	66.7	75.0	100.0
	Total	8	88.9	100.0	
Missing		1	11.1		
Total		9	100.0		

Destination of collected waste

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Official Dumpsite	2	22.2	25.0	25.0
	Transfer/collection points	1	11.1	12.5	37.5
	Illegal/open dumps	5	55.6	62.5	100.0
	Total	8	88.9	100.0	
Missing		1	11.1		
Total		9	100.0		

Whether there are waste categories recovered by the group

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	7	77.8	77.8	77.8
	No	2	22.2	22.2	100.0
	Total	9	100.0	100.0	

Categories of waste recovered by the group

	Food waste	Plastics	Papers	Textile	Glass	Other
No.	**4**	**6**	**1**	**0**	**0**	**1**

Whether group members have been part of SWM awareness program

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	4	44.4	44.4	44.4
	No	5	55.6	55.6	100.0
	Total	9	100.0	100.0	

Last time awareness program was attended

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 1 year ago	3	33.3	75.0	75.0
	More than3 years ago	1	11.1	25.0	100.0
	Total	4	44.4	100.0	
Missing		5	55.6		
Total		9	100.0		

Organiser of the most recently attended awareness program

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Nairobi City County	2	22.2	50.0	50.0
	CBOs and NGOs	1	11.1	25.0	75.0
	Church	1	11.1	25.0	100.0
	Total	4	44.4	100.0	
Missing		5	55.6		
Total		9	100.0		

Whether group organises awareness programs on waste management

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	7	77.8	77.8	77.8
	No	2	22.2	22.2	100.0
	Total	9	100.0	100.0	

Whether respondent is aware of laws touching on SWM

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	4	44.4	44.4	44.4
	No	5	55.6	55.6	100.0
	Total	9	100.0	100.0	

Whether respondent is familiar with the 3R in waste management

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	5	55.6	55.6	55.6
	No	4	44.4	44.4	100.0
	Total	9	100.0	100.0	

Whether respondent would like to see 3R being incorporated in SWM

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	4	44.4	80.0	80.0
	No	1	11.1	20.0	100.0
	Total	5	55.6	100.0	
Missing		4	44.4		
Total		9	100.0		

Preferred method of reaching out to the public on proper SWM

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Mass media	1	11.1	11.1	11.1
	Public meetings and cleanup exercises	8	88.9	88.9	100.0
	Total	9	100.0	100.0	

Whether respondent thinks that it is to improve SWM in your residential area

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	9	100.0	100.0	100.0

Willingness to cooperate with NCC to improve SWM

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	9	100.0	100.0	100.0

Willingness to pay more for better SWM

		Frequency	Percent	Valid Percent	Cumulative Percent
	Yes	8	88.9	88.9	88.9
Valid	No	1	11.1	11.1	100.0
	Total	9	100.0	100.0	

Preference of waste management intervention

Name	Agreed	Neutral	Disagreed
Source separation	8	0	1
Regular awareness	8	0	0
Composting	5	2	1
Biogas	7	1	1
Buyback centers	7	2	0
Laws and enforcement	9	0	0
Public participation	8	1	0
Recycling	9	0	0
Charge by quantity	6	0	3

Appendix 10: Output of analysis of questionnaires from Upper Savanna Ward

Prevalence of waste categories generated

	Food	Paper	Plastics	Rubber & leather	Wood	Glass	Metal	Other
No.	59	61	63	4	2	4	0	9
% of respondents	76.62	79.22	81.82	5.19	2.60	5.19	-	11.69

Separation at source

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	16	20.8	21.6	21.6
	No	58	75.3	78.4	100.0
	Total	74	96.1	100.0	
Missing		3	3.9		
Total		77	100.0		

If waste collection service is received

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	68	88.3	88.3	88.3
	No	9	11.7	11.7	100.0
	Total	77	100.0	100.0	

Waste collector

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Nairobi City County	4	5.2	6.1	6.1
	Private companies	32	41.6	48.5	54.5
	CBOs	30	39.0	45.5	100.0
	Total	66	85.7	100.0	
Missing		11	14.3		
Total		77	100.0		

Payment of collection fee

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	56	72.7	82.4	82.4
	No	12	15.6	17.6	100.0
	Total	68	88.3	100.0	
Missing		9	11.7		
Total		77	100.0		

Monthly waste collection fee paid by respondent (Kenya Shillings)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 100	9	11.7	17.0	17.0
	101-200	18	23.4	34.0	62.3
	201-300	19	24.7	35.8	98.1
	301-400	1	1.3	1.9	100.0
	More than 400	6	7.8	11.3	28.3
	Total	53	68.8	100.0	
Missing		24	31.2		
Total		77	100.0		

Monthly waste collection fee paid by respondent (Kenya Shillings)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		24	31.2	31.2	31.2
	<=100	9	11.7	11.7	42.9
	>400	6	7.8	7.8	50.6
	101-200	18	23.4	23.4	74.0
	201-300	19	24.7	24.7	98.7
	301-400	1	1.3	1.3	100.0
	Total	77	100.0	100.0	

Transport used by collector

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Lorry	21	27.3	32.8	32.8
	Pick-up	2	2.6	3.1	35.9
	Hand cart	41	53.2	64.1	100.0
	Total	64	83.1	100.0	
Missing		13	16.9		
Total		77	100.0		

Frequency of waste collection

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than once a week	5	6.5	7.4	7.4
	More than once a week	29	37.7	42.6	50.0
	Weekly	34	44.2	50.0	100.0
	Total	68	88.3	100.0	
Missing		9	11.7		
Total		77	100.0		

Time of day waste is collected

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Afternoon or evening	12	15.6	17.6	17.6
	Irregular	10	13.0	14.7	32.4
	Morning	45	58.4	66.2	98.5
	Night	1	1.3	1.5	100.0
	Total	68	88.3	100.0	
Missing		9	11.7		
Total		77	100.0		

Rating of waste collection service by respondent

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Fair	37	48.1	54.4	54.4
	Good	14	18.2	20.6	75.0
	Poor	17	22.1	25.0	100.0
	Total	68	88.3	100.0	
Missing		9	11.7		
Total		77	100.0		

Waste management alternative apart from the waste collection service received

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Dumping in the open	6	7.8	8.2	8.2
	Selling or giving away	14	18.2	19.2	27.4
	Reusing and recycling	4	5.2	5.5	32.9
	Composting	1	1.3	1.4	34.2
	Burning	32	41.6	43.8	78.1
	None	16	20.8	21.9	100.0
	Total	73	94.8	100.0	
Missing		4	5.2		
Total		77	100.0		

If there are waste materials sold or given away

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	41	53.2	55.4	55.4
	No	33	42.9	44.6	100.0
	Total	74	96.1	100.0	
Missing		3	3.9		
Total		77	100.0		

Common waste categories given away or sold

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Food waste	6	7.8	15.4	15.4
	Plastics	12	15.6	30.8	46.2
	Papers	4	5.2	10.3	56.4
	Textiles and leather	15	19.5	38.5	94.9
	Metals and electronics	1	1.3	2.6	97.4
	Motor vehicle plugs	1	1.3	2.6	100.0
	Total	39	50.6	100.0	
Missing		38	49.4		
Total		77	100.0		

Recepients of wastes given away or sold

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Informal waste pickers	10	13.0	25.0	25.0
	CBOs	3	3.9	7.5	32.5
	Carpenters	1	1.3	2.5	35.0
	Itinerant traders (mali mali)	22	28.6	55.0	90.0
	General public	3	3.9	7.5	97.5
	Mechanics/garages	1	1.3	2.5	100.0
	Total	40	51.9	100.0	
Missing		37	48.1		
Total		77	100.0		

Whether respondent has taken part in any awareness program on waste management

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	8	10.4	10.5	10.5
	No	68	88.3	89.5	100.0
	Total	76	98.7	100.0	
Missing		1	1.3		
Total		77	100.0		

Last time awareness program was attended

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 1 year ago	1	1.3	14.3	14.3
	1-3 years ago	5	6.5	71.4	85.7
	More than 3 years ago	1	1.3	14.3	100.0
	Total	7	9.1	100.0	
Missing		70	90.9		
Total		77	100.0		

Organizer of awareness activity recently attended

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	CBOs and NGOs	2	2.6	28.6	28.6
	Private sector	5	6.5	71.4	100.0
	Total	7	9.1	100.0	
Missing		70	90.9		
Total		77	100.0		

Whether respondent is aware of any legislation regarding waste management

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	27	35.1	37.0	37.0
	No	46	59.7	63.0	100.0
	Total	73	94.8	100.0	
Missing		4	5.2		
Total		77	100.0		

Whether respondent is familiar with the 3R in solid waste management

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	44	57.1	58.7	58.7
	No	31	40.3	41.3	100.0
	Total	75	97.4	100.0	
Missing		2	2.6		
Total		77	100.0		

Whether respondent would like to see 3R incorporated in SWM

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	43	55.8	95.6	95.6
	No	2	2.6	4.4	100.0
	Total	45	58.4	100.0	
Missing		32	41.6		
Total		77	100.0		

Whether aware of waste recovery activities and facilities in the area.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	11	14.3	15.3	15.3
	No	61	79.2	84.7	100.0
	Total	72	93.5	100.0	
Missing		5	6.5		
Total		77	100.0		

The waste recovery activity/facility known by the respondent

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Recycling	8	10.4	11.1	11.1
	Composting	1	1.3	1.4	12.5
	Reuse to make new products	2	2.6	2.8	15.3
	None	61	79.2	84.7	100.0
	Total	72	94	100	
Missing		5	6.5		
Total		77	100.0		

Preferred method of reaching out to the public on proper SWM

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Education in schools and workplaces	5	6.5	6.8	6.8
	Mass media	26	33.8	35.6	42.5
	Brochures, fliers and leaflets	6	7.8	8.2	50.7
	Public meetings and cleanup exercises	36	46.8	49.3	100.0
	Total	73	94.8	100.0	
Missing		4	5.2		
Total		77	100.0		

Whether respondent believes that it is possible to improve waste management in their locality

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	75	97.4	98.7	98.7
	No	1	1.3	1.3	100.0
	Total	76	98.7	100.0	
Missing		1	1.3		
Total		77	100.0		

Willingness to cooperate with NCC to improve waste management

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	73	94.8	97.3	97.3
	No	2	2.6	2.7	100.0
	Total	75	97.4	100.0	
Missing		2	2.6		
Total		77	100.0		

Willingness to pay more for better waste management services

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	43	55.8	60.6	60.6
	No	28	36.4	39.4	100.0
	Total	71	92.2	100.0	
Missing		6	7.8		
Total		77	100.0		

Opinion on intervention

	Agreement		Neutral		Disagreement		Missing	
	Count	%	Count	%	Count	%	Count	%
Source separation	60	78.95	5	6.58	7	9.21	4	5.26
Regular awareness	70	92.11	2	2.63	0	0	4	5.26
Composting	54	71.05	13	17.11	7	9.21	2	2.63
Biogas	54	71.05	13	17.11	6	7.89	3	3.95
Buyback centers	62	81.58	9	11.84	4	5.26	1	1.32
Laws and enforcement	65	85.53	6	7.89	2	2.63	3	3.95
Public participation	69	90.79	5	6.58	1	1.32	1	1.32
Recycling	64	84.21	5	6.58	4	5.26	3	3.95
Charge by quantity	36	47.37	16	21.05	22	28.95	2	2.63

Appendix 11: Output of analysis of questionnaires from Lower Savanna Ward

Prevalence of waste categories generated

	Food	Paper	Plastics	Rubber & leather	Wood	Glass	Metal	Other
No.	74	54	58	1	1	0	0	9
% of respondents	84.09	61.36	65.91	1.14	1.14	-	-	10.23

Separation of waste at source

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	12	13.6	14.0	14.0
	No	74	84.1	86.0	100.0
	Total	86	97.7	100.0	
No response		2	2.3		
Total		88	100.0		

If waste collection service is received

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	83	94.3	94.3	94.3
	No	5	5.7	5.7	100.0
	Total	88	100.0	100.0	

Waste collector

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Nairobi City County	1	1.1	1.2	1.2
	Private companies	9	10.2	10.8	12.0
	CBOs	71	80.7	85.5	97.6
	Individual collector	2	2.3	2.4	100.0
	Total	83	94.3	100.0	
No response		5	5.7		
Total		88	100.0		

Payment of collection fee

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	81	92.0	97.6	97.6
	No	2	2.3	2.4	100.0
	Total	83	94.3	100.0	
No response		5	5.7		
Total		88	100.0		

Monthly waste collection fee paid by respondent (Kenya Shillings)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 100	56	63.6	69.1	69.1
	101-200	22	25.0	27.2	97.5
	301-400	2	2.3	2.5	100.0
	More than 400	1	1.1	1.2	70.4
	Total	81	92.0	100.0	
Missing (Fee not paid or waste collection service not received)		7	8.0		
Total		88	100.0		

Mode of transport used by the waste collector

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Lorry	1	1.1	1.2	1.2
	Tractor and trailer	1	1.1	1.2	2.4
	Hand cart	80	90.9	96.4	98.8
	Manual	1	1.1	1.2	100.0
	Total	83	94.3	100.0	
No response		5	5.7		
Total		88	100.0		

Frequency of waste collection

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than once a week	13	7.9	8.6	8.6
	More than once a week	31	18.8	20.5	29.1
	Weekly	107	64.8	70.9	100.0
	Total	151	91.5	100.0	
Missing		14	8.5		
Total		165	100.0		

Time of day waste is collected

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Afternoon or evening	20	12.1	13.2	13.2
	Irregular	22	13.3	14.6	27.8
	Morning	108	65.5	71.5	99.3
	Night	1	.6	.7	100.0
	Total	151	91.5	100.0	
Missing		14	8.5		
Total		165	100.0		

Rating of waste collection service by respondent

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Fair	61	37.0	40.4	40.4
	Good	62	37.6	41.1	81.5
	Poor	28	17.0	18.5	100.0
	Total	151	91.5	100.0	
Missing		14	8.5		
Total		165	100.0		

Waste management alternative apart from the waste collection service received

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Dumping in the open	9	10.2	11.5	11.5
	Selling or giving away	3	3.4	3.8	15.4
	Reusing and recycling	3	3.4	3.8	19.2
	Burning	23	26.1	29.5	48.7
	None	40	45.5	51.3	100.0
	No response	10	11.4		
Total		88	100.0		

Whether there are waste materials sold or given away

		Reuse			Selling or giving
		Frequency	Percent	Valid Percent	Frequency
Valid	Yes	21	23.9	23.9	32
	No	67	76.1	76.1	56
	Total	88	100.0	100.0	88

Whether there are waste materials sold or given away

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	32	36.4	36.4	36.4
	No	56	63.6	63.6	100.0
	Total	88	100.0	100.0	

Common waste material given away or sold

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Food waste	6	6.8	25.0	25.0
	Plastics	9	10.2	37.5	62.5
	Papers	1	1.1	4.2	66.7
	Textiles and leather	7	8.0	29.2	95.8
	Other	1	1.1	4.2	100.0
	Total	24	27.3	100.0	
No response		64	72.7		
Total		88	100.0		

Recipients of wastes given away or sold

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Scavengers	6	6.8	19.4	19.4
	CBOs	3	3.4	9.7	29.0
	Itinerant traders (mali mali)	14	15.9	45.2	74.2
	Farmers	6	6.8	19.4	93.5
	General public	1	1.1	3.2	96.8
	Waste traders	1	1.1	3.2	100.0
	Total	31	35.2	100.0	
No response		57	64.8		
Total		88	100.0		

Whether respondent has taken part in any awareness program on waste management

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	12	13.6	13.6	13.6
	No	76	86.4	86.4	100.0
	Total	88	100.0	100.0	

Last time awareness program was attended

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 1 year ago	7	8.0	58.3	58.3
	1-3 years ago	4	4.5	33.3	91.7
	More than 3 years ago	1	1.1	8.3	100.0
	Total	12	13.6	100.0	
No response		76	86.4		
Total		88	100.0		

Organizer of awareness activity recently attended

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Nairobi City County	4	4.5	33.3	33.3
	CBOs and NGOs	7	8.0	58.3	91.7
	Private sector	1	1.1	8.3	100.0
	Total	12	13.6	100.0	
No response		76	86.4		
Total		88	100.0		

Whether responded is aware of any legislation regarding waste management

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	24	27.3	27.3	27.3
	No	64	72.7	72.7	100.0
	Total	88	100.0	100.0	

Whether respondent is familiar with the 3R in solid waste management

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	38	43.2	43.2	43.2
	No	50	56.8	56.8	100.0
	Total	88	100.0	100.0	

Whether respondent would like to see 3R incorporated in SWM

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	36	40.9	97.3	97.3
	No	1	1.1	2.7	100.0
	Total	37	42.0	100.0	
No response		51	58.0		
Total		88	100.0		

Whether respondent is aware of waste recovery activities and

facilities in their locality

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	39	44.3	44.3	44.3
	No	49	55.7	55.7	100.0
	Total	88	100.0	100.0	

The waste recovery activity/facility known by the respondent

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Recycling	7	8.0	20.0	20.0
	Composting	1	1.1	2.9	22.9
	Reuse to make new products	5	5.7	14.3	37.1
	Collection of recyclables for resale	22	25.0	62.9	100.0
	None	49	55.7		
	Total	84	95.5		
	No response	4	4.5		
Total		88	100.0		

Preferred method of reaching out to the public on proper SWM

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Education in schools and workplaces	5	5.7	5.8	5.8
	Mass media	19	21.6	22.1	27.9
	Brochures, fliers and leaflets	1	1.1	1.2	29.1
	Public meetings and cleanup exercises	59	67.0	68.6	97.7
	Posters	1	1.1	1.2	98.8
	Phones	1	1.1	1.2	100.0
	No response	2	2.3		
Total		88	100.0		

Whether respondent believes that it is possible to improve waste management in their locality

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	85	96.6	96.6	96.6
	No	3	3.4	3.4	100.0
	Total	88	100.0	100.0	

Willingness to cooperate with NCC to improve waste management

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	87	98.9	98.9	98.9
	No	1	1.1	1.1	100.0
	Total	88	100.0	100.0	

Willingness to pay more for better waste management services

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	38	43.2	43.2	43.2
	No	50	56.8	56.8	100.0
	Total	88	100.0	100.0	

Opinion on waste management interventions

	Agreement		Neutral		Disagreement		Missing	
	Count	%	Count	%	Count	%	Count	%
Source separation	46	60.5	5	6.6	22	28.9	3	3.9
Regular awareness	74	97.4	0	-	1	1.3	1	1.3
Composting	57	75	9	11.8	8	10.5	2	2.6
Biogas	65	85.5	6	7.9	4	5.3	1	1.3
Buyback centers	73	96.1	2	2.6	0	-	1	1.3
Laws and enforcement	66	86.8	6	7.9	3	3.9	1	1.3
Public participation	73	96.1	2	2.6	1	1.3	0	-
Recycling	72	94.7	4	5.3	0	0	0	0
Charge by quantity	32	42.1	7	9.2	36	47.4	1	1.3

Appendix 12: Output of analysis of combined data from both Upper Savanna and Lower Savanna Wards

Commonly generated waste categories

	Food	Paper	Plastics	Rubber & leather	Wood	Glass	Metal	Other
Number	133	115	121	5	3	4	0	18
% of respondents	80.61	69.70	73.33	3.03	1.82	2.42	-	10.91

Separation of waste at source

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	132	80.0	82.5	82.5
	Yes	28	17.0	17.5	100.0
	Total	160	97.0	100.0	
Missing		5	3.0		
Total		165	100.0		

Whether respondent receives waste collection service

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	14	8.5	8.5	8.5
	Yes	151	91.5	91.5	100.0
	Total	165	100.0	100.0	

Waste collector

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	CBOs	101	61.2	67.8	67.8
	Individual	2	1.2	1.3	69.1
	Nairobi City County	5	3.0	3.4	72.5
	Private companies	41	24.8	27.5	100.0
	Total	149	90.3	100.0	
Missing		16	9.7		
Total		165	100.0		

Whether respondent pays for waste collection service

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	14	8.5	9.3	9.3
	Yes	137	83.0	90.7	100.0
	Total	151	91.5	100.0	
Missing		14	8.5		
Total		165	100.0		

Monthly waste collection fee paid by respondent (Kenya Shillings)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 100	65	39.4	48.5	48.5
	101-200	40	24.2	29.9	83.6
	201-300	19	11.5	14.2	97.8
	301-400	3	1.8	2.2	100.0
	More than 400	7	4.2	5.2	53.7
	Total	134	81.2	100.0	
Missing		31	18.8		
Total		165	100.0		

Frequency of waste collection

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than once a week	13	7.9	8.6	8.6
	More than once a week	31	18.8	20.5	29.1
	Weekly	107	64.8	70.9	100.0
	Total	151	91.5	100.0	
Missing		14	8.5		
Total		165	100.0		

Time of day when waste is collected

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Afternoon or evening	20	12.1	13.2	13.2
	Irregular	22	13.3	14.6	27.8
	Morning	108	65.5	71.5	99.3
	Night	1	.6	.7	100.0
	Total	151	91.5	100.0	
Missing		14	8.5		
Total		165	100.0		

Mode of transport used by waste collector

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Hand cart	121	73.3	82.3	82.3
	Lorry	22	13.3	15.0	97.3
	Manual	1	.6	.7	98.0
	Pick-up	2	1.2	1.4	99.3
	Tractor and trailer	1	.6	.7	100.0
	Total	147	89.1	100.0	
Missing		18	10.9		
Total		165	100.0		

Opinion of waste collection service received by respondent

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Fair	61	37.0	40.4	40.4
	Good	62	37.6	41.1	81.5
	Poor	28	17.0	18.5	100.0
	Total	151	91.5	100.0	
Missing		14	8.5		
Total		165	100.0		

21.If there are waste materials sold or given away

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	73	44.2	45.1	45.1
	No	89	53.9	54.9	100.0
	Total	162	98.2	100.0	
Missing		3	1.8		
Total		165	100.0		

22.Common waste material given away or sold

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Food waste	12	7.3	19.0	19.0
	Plastics	21	12.7	33.3	52.4
	Papers	5	3.0	7.9	60.3
	Textiles and leather	22	13.3	34.9	95.2
	Other	1	.6	1.6	96.8
	Metals and electronics	1	.6	1.6	98.4
	Motor vehicle plugs	1	.6	1.6	100.0
	Total	63	38.2	100.0	
Missing		102	61.8		
Total		165	100.0		

23.Recepients of wastes given away or sold

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Informal waste pickers	16	9.7	22.5	22.5
	CBOs	6	3.6	8.5	31.0
	Carpenters	1	.6	1.4	32.4
	Itinerant traders (mali mali)	36	21.8	50.7	83.1
	Farmers	6	3.6	8.5	91.5
	General public	4	2.4	5.6	97.2
	Mechanics/garages	1	.6	1.4	98.6
	Waste traders	1	.6	1.4	100.0
	Total	71	43.0	100.0	
Missing		94	57.0		
Total		165	100.0		

Waste management alternative in the event of absence of waste collection

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Burning	55	33.3	36.4	36.4
	Composting	1	.6	.7	37.1
	Dumping in the open	15	9.1	9.9	47.0
	None	56	33.9	37.1	84.1
	Reusing and recycling	7	4.2	4.6	88.7
	Selling or giving away	17	10.3	11.3	100.0
	Total	151	91.5	100.0	
Missing		14	8.5		
Total		165	100.0		

Whether respondent has taken part in a waste management awareness program

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	144	87.3	87.8	87.8
	Yes	20	12.1	12.2	100.0
	Total	164	99.4	100.0	
Missing		1	.6		
Total		165	100.0		

Last time awareness program was attended

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1-3 years ago	9	5.5	47.4	47.4
	Less than 1 year ago	8	4.8	42.1	89.5
	More than 3 years ago	2	1.2	10.5	100.0
	Total	19	11.5	100.0	
Missing		146	88.5		
Total		165	100.0		

Organizer of the awareness activity recently attended

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	CBOs and NGOs	9	5.5	47.4	47.4
	Nairobi City County	4	2.4	21.1	68.4
	Private sector	6	3.6	31.6	100.0
	Total	19	11.5	100.0	
Missing		146	88.5		
Total		165	100.0		

Whether respondent is aware of any legislation regarding waste management

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	110	66.7	68.3	68.3
	Yes	51	30.9	31.7	100.0
	Total	161	97.6	100.0	
Missing		4	2.4		
Total		165	100.0		

Whether respondent is familiar with the 3R in solid waste management

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	81	49.1	49.7	49.7
	Yes	82	49.7	50.3	100.0
	Total	163	98.8	100.0	
Missing		2	1.2		
Total		165	100.0		

Whether respondent would like to see 3R incorporated in SWM

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	3	1.8	3.7	3.7
	Yes	79	47.9	96.3	100.0
	Total	82	49.7	100.0	
Missing		83	50.3		
Total		165	100.0		

Whether aware of waste recovery activities and facilities in the area.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	110	66.7	68.8	68.8
	Yes	50	30.3	31.3	100.0
	Total	160	97.0	100.0	
Missing		5	3.0		
Total		165	100.0		

The waste recovery activity/facility known by the respondent

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Collection of recyclables for resale	22	13.3	14.2	14.2
	Composting	2	1.2	1.3	15.5
	None	109	66.1	70.3	85.8
	Recycling	15	9.1	9.7	95.5
	Reuse to make new products	7	4.2	4.5	100.0
	Total	155	93.9	100.0	
Missing		10	6.1		
Total		165	100.0		

Preferred method of reaching out to the public on proper SWM

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Brochures, fliers and leaflets	7	4.2	4.4	4.4
	Education in schools and workplaces	10	6.1	6.3	10.7
	Mass media	45	27.3	28.3	39.0
	Notices/	1	.6	.6	39.6
	Phones	1	.6	.6	40.3
	Public meetings and cleanup exercises	95	57.6	59.7	100.0
	Total	159	96.4	100.0	
Missing		6	3.6		
Total		165	100.0		

Whether respondent believes that it is possible to improve waste management in their locality

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	4	2.4	2.4	2.4
	Yes	160	97.0	97.6	100.0
	Total	164	99.4	100.0	
Missing		1	.6		
Total		165	100.0		

Willingness to cooperate with NCC to improve waste management

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	3	1.8	1.8	1.8
	Yes	160	97.0	98.2	100.0
	Total	163	98.8	100.0	
Missing		2	1.2		
Total		165	100.0		

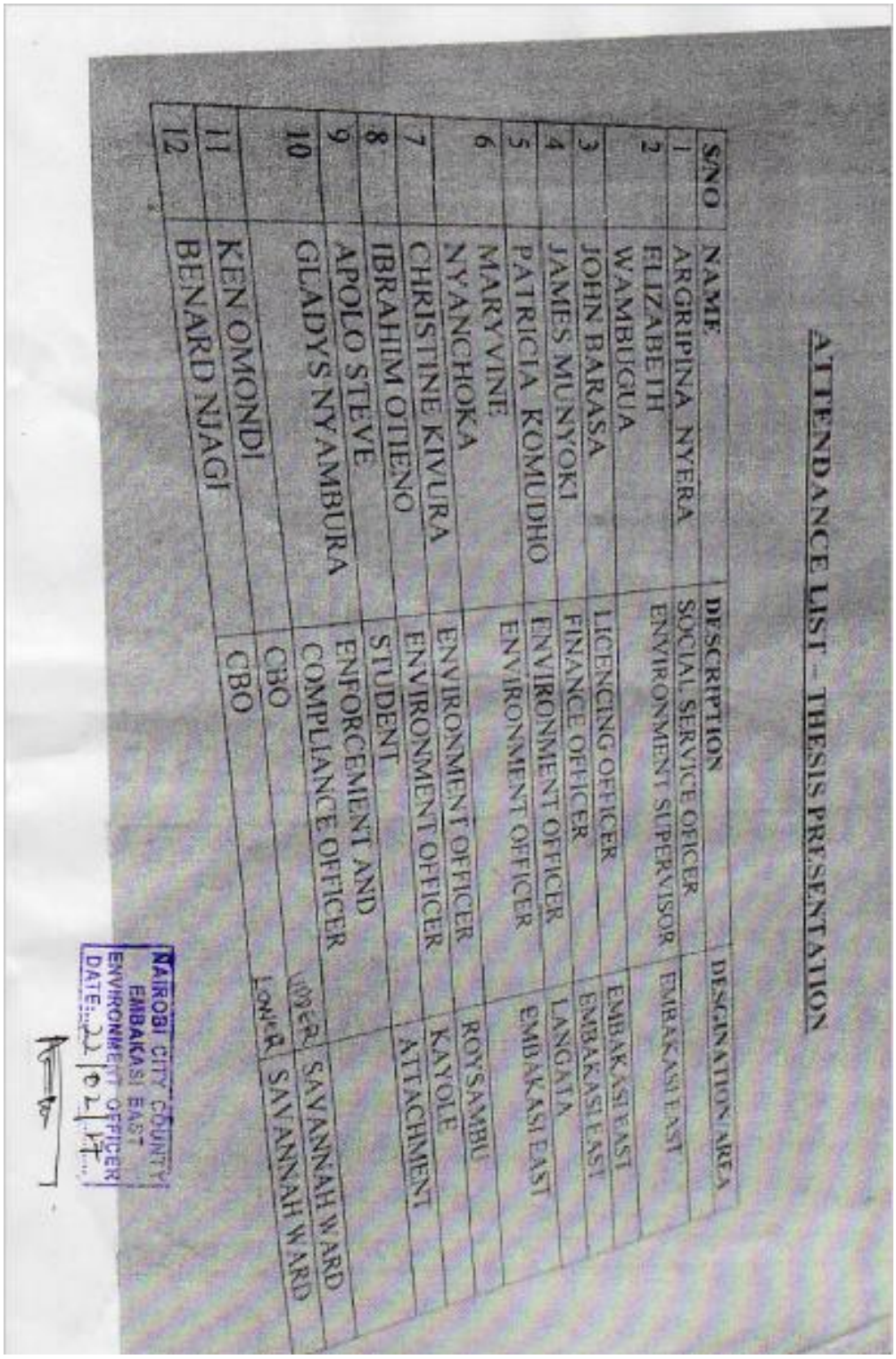
Willingness to pay more for better waste management services

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	78	47.3	49.1	49.1
	Yes	81	49.1	50.9	100.0
	Total	159	96.4	100.0	
Missing		6	3.6		
Total		165	100.0		

Preference of waste management interventions

	Agreement		Neutral		Disagreement		Missing	
	Count	%	Count	%	Count	%	Count	%
Source separation	106	69.7	10	6.6	29	19.1	7	4.6
Regular awareness	144	94.7	2	1.3	1	0.7	5	3.3
Composting	111	73	22	14.5	15	9.9	4	2.6
Biogas	119	78.3	19	12.5	10	6.6	4	2.6
Buyback centers	135	88.8	11	7.2	4	2.6	2	1.3
Laws and enforcement	131	86.2	12	7.9	5	3.3	4	2.6
Public participation	142	93.4	7	4.6	2	1.3	1	0.7
Recycling	136	89.5	9	5.9	4	2.6	3	2
Charge by quantity	68	44.7	23	15.1	58	38.2	3	2

Appendix 13: Attendance list for findings presentation at the Embakasi East sub-county office



ATTENDANCE LIST – THESIS PRESENTATION

S/NO	NAME	DESCRIPTION	DESIGNATION/AREA
1	ARGRIPINA NYERA	SOCIAL SERVICE OFICER	EMBAKASI EAST
2	FLIZABETH WAMBUGUA	ENVIRONMENT SUPERVISOR	
3	JOHN BARASA	LICENCING OFFICER	EMBAKASI EAST
4	JAMES MUNYOKI	FINANCE OFFICER	EMBAKASI EAST
5	PATRICIA KOMUDHO	ENVIRONMENT OFFICER	LANGATA
6	MARYVINE NYANCHOKA	ENVIRONMENT OFFICER	EMBAKASI EAST
7	CHRISTINE KIVURA	ENVIRONMENT OFFICER	ROYSAMBU
8	IBRAHIM OTIENO	STUDENT	KAYOLE
9	APOLO STEVE	ENFORCEMENT AND COMPLIANCE OFFICER	ATTACHMENT
10	GLADYS NYAMBURA	CBO	SAVANNAH WARD (MER)
		CBO	SAVANNAH WARD (LOW'R)
11	KEN OMONDI		
12	BENARD NJAGI		

NAIROBI CITY COUNTY
EMBAKASI EAST
ENVIRONMENT OFFICER
DATE: 22/11/19

Appendix 14: Plates

Plate 1: Charred remains of waste in Upper Savanna Ward

Plate 2: Waste awaiting collection in Upper Savanna Ward

Plate 3: A waste dealer's yard in Lower Savanna

Plate 4: Informal waste picking in Lower Savanna

Plate 5: Waste collection in Upper Savanna Ward

Plate 6: Dandora dumpsite

Plate 7: A poster in a supermarket in Kandy promoting reuse of shopping bags

Plate 8: Inside a plastic crushing facility at the Gohagoda dumpsite, Kandy

Plate 9: Meeting with county and sub-county officers and representatives from Upper Savanna and Lower Savanna Wards to share findings of field study.