



UNIVERSITY OF NAIROBI

**ASSESSMENT OF RESIDENTS' KNOWLEDGE, ATTITUDE AND PRACTICES ON
SOLID WASTE MANAGEMENT IN EASTLEIGH SOUTH WARD, NAIROBI,
KENYA**

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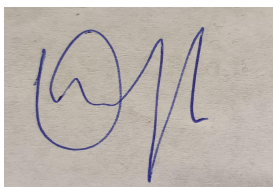
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DECLARATION

This thesis is my original work and has not been presented for award of a degree in any other university.

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DEDICATION

I wish to dedicate this thesis to my father- Muiruri Gathura and my late mother- Rahab Waithira for their dedication and desire to see me reach the greatest heights in my education.

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I thank God for getting me this far, it was his will that I managed this far. I am grateful to my devoted supervisors Prof. Raphael Wahome and Dr. Kiemo Karatu for their invaluable contribution to my success. Truly without them it would have been impossible to achieve my goal. Special thanks to my lead supervisor Prof. Raphael Wahome for his encouragement when the going got so tough to a point of throwing in the towel. May God bless him to supervise many more students. To the WMI fraternity, thank you for many words of encouragement.

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ACRONYMS AND ABBREVIATIONS

ACCP	African Clean Cities Platform
AESSL	Agricultural Engineering Society of Sri Lanka
CBO	Community Based Organizations
C&D	Construction and Demolition
EMCA	Environmental Management co-ordination Act
EU	European Union
GHG	Green House Gases
IPLA	International Partnership for Local Authorities
ISWA	International Solid Waste Association
ISWM	Integrated Solid Waste Management
KAP	Knowledge Attitude Practices
KNBS	Kenya National Bureau of Statistics
LA	Local Authorities
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
NEAP	National Environmental Action Plan
NEMA	National Environmental Management Authority
NEP	National Environmental Plan

NGO	Non- Governmental Organisations
PAYT	Pay As You Throw
PCBS	Palestinian Central Bureau of Statistics
SPSS	Statistical Package of Social Sciences
SWM	Solid Waste Management
UK	United Kingdom
UN	United Nations
UNIDO	United Nations Industrial Development Organization
UNDESA	United Nations Department of Economic and Social Affairs ...
UNDP	United Nations Development Program
UNEP	United Nations Environmental Program
UNPFA	United Nations Population Fund
USA	United States of America
WAP	Willingness to pay
WHO	World Health Organisation

ABSTRACT

Solid waste disposal has grown into a big challenge in most developing countries arising from population growth and urbanization in the cities. Municipal authorities who are responsible in enforcing existing by-laws appear not to have the capacity to tackle the worsening situation of waste. The purpose of the study was to evaluate the locals' knowledge, attitudes, and practices around management of solid waste in Eastleigh South Ward, Nairobi, Kenya. Choosing Eastleigh South Ward as the study site was largely influenced by the fact that Eastleigh South Ward in Kamukunji Sub-County is one of Nairobi's more densely populated urban areas with a population density of 25,455 persons per km². The study's goal was to look into Eastleigh South Ward people's solid waste management knowledge, attitudes and practices. The study anticipated that individuals' level of awareness has little bearing on the management of solid waste in Eastleigh South Ward. Further, the study hypothesized that resident's attitudes do not affect management of solid waste in Eastleigh South Ward. The study was anchored on theory of planned behaviour proposed by Ajzen. Purposive sampling technique was employed in picking the buildings from where participants were drawn, respondents choice mainly depended on their availability and willingness to take part in the survey. Three methods were applied in data collection; questionnaires, key informant interviews and field observation. About 43% of the respondents indicated that most of the waste that was generated was from organic food remains. Another 43% indicated fruit and vegetable peelings as the source, while faeces and old clothing were cited by 12.2% and 1.9% of the respondents respectively. Inorganic waste was mainly generated from plastics according to 40.6% of the respondents while 18.9% and 5.5% respectively indicated inorganic waste was from obsolete cutlery, glass and metal. The prevailing

methods of solid waste management included dumping onto the roadside and into the storm drainage systems as indicated by 48% of the respondents while placing waste in dump pits and open burning was cited by 43% of the respondents as the preferred method. Solid waste management was associated with many challenges including infrequent/irregular waste collection, (61% of respondents), unregularized dumping, low awareness of its adverse effects and consequent resident's apathy coupled with Nairobi County Government's casual manner of handling waste management issues. Unwillingness and avoidance of residents to contract private garbage collectors was also indicated as a contributing factor to poor waste management with only 5.1% of the participants indicating they were happy with the waste collection and disposal services.. Participants in the study were found to be informed on several areas of waste management. However, the respondents' attitude was found to be negative. From the participant's responses 82.6% did not think that it was everybody's responsibility to manage waste. Another 48% of participants interviewed indicated that they had never participated in any clean-up exercise. In conclusion, knowledge did not influence attitude positively and waste management methods practiced were unsustainable and unhealthy to the environment. It was recommended that awareness be created alongside attitude development practices including sufficient equipment and enforcement of existing laws and regulations, and orderly collection schedules.

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

The amount of waste generated by cities globally is forecasted to increase to 3.4 billion tonnes by 2050 (World Bank, 2019). At the same time, studies show that waste management systems in cities are unsustainable, uncoordinated, poorly organized, ineffective, and pose great danger to the ecological systems and public health. The majority of waste is produced in homes (Karak *et al.*, 2012). Despite the fact that many people are not ignorant of the environment and health effects caused by poor disposal of waste, their attitude toward maintaining high level of a healthy environment is negative (Licy *et al.*, 2013).

Leton & Omotosho (2004) described solid wastes as non-gaseous and non-liquid things, such as garbage, refuse and trash, that are typically of no value to their possessor or have lost value due to changing consumption patterns, lifestyle, and county's rate of development.

In recent years, Africa's population has grown at a greater rate than any other continent expanding by 44% between 2000 and 2015. Over the same period the population of African cities where solid waste management is more crucial expanded at a faster rate of 69 percent. Africa's population is projected to rise by 105% by 2050, with the urban population tripling over the same period (UN, 2014). The increase in the volume of solid waste produced in East, Central and West Africa will be substantial.

The development of waste management has not kept pace with the rapid generation of waste that has accompanied this fast population growth and urbanisation in Sub Saharan Africa, where 50% of the waste generated remains uncollected, with adverse effects on sanitation and aesthetic conditions of cities (UNDESA - United Nations Department of Economic and Social Affairs, 2015). The current state of municipal SWM in African countries on the other hand was

described as dire at the First ACCP Meeting because of their inability to manage waste. Municipal waste management is the responsibility of each municipality, city or local government but regrettably, implementation capability is often inadequate, facilities and implements are seldomly sufficient, and maintenance, management and garbage disposal are sometimes not well coordinated.

Many urban management authorities in underdeveloped nations have struggled to put in place proper waste management systems, while garbage collection systems are either non-existent or ineffective (Laor *et al.*, 2018). Although the majority of solid waste produced can be recycled, the proportion that is recycled is insignificant. Participation of the public in recycling initiatives would greatly lessen the amount of garbage discarded in areas that are not designated for waste disposal (Nasrabadi *et al.*, 2008).

In order to implement sound solid waste management programs, city governments need to not only put more resources in SWM infrastructure, but also educate citizens by raising their awareness of the importance of a clean environment. As result of public awareness creation, recycling of used materials has been found to be beneficial in reducing the detrimental effects of the ever-increasing volume of waste (Ehrampoush *et al.*, 2005; Laor *et al.*, 2018; Jatau, 2013). In most developed countries this has worked successfully with between sixty and eighty percent and between twenty and thirty-two percent of MSW being reused or reprocessed, respectively, and the remainder of eight percent being buried in a hygienic way (Jamshidi *et al.*, 2011).

Historically, development has always had a close relationship with SWM because of its association with public health and aesthetics. If MSW appropriate programmes are implemented, the public will find it easy to segregate garbage at the source, recycle waste and finally disposing waste via the process of receiving instructions including encouragement (Chung & Lo,

2008; De Feo & De Gisi, 2010; Krook *et al.*, 2007).

Poor trash disposal is caused by lack of information, unplanned and disorganized garbage disposal. The main issue for human health is lack of understanding on safe garbage disposal (Shahzad *et al.*, 2018). If people have a good knowledge towards household waste disposal they can keep their environment clean and protect themselves from infectious diseases (Jatau, 2013). Lack of adequate knowledge and improper handling of household waste may result in serious impact on the environment and health consequences in a significant way (Shahzad *et al.*, 2018).

According to NEMA (2015), there exists inadequate level of knowledge and awareness on the need and importance of an environment that is clean and healthy. Ultimately this has brought about practices that are poor in regard to waste management which has led to pollution of the environment. Improper handling of waste at the level of household includes lack of segregation, reduction, reuse and also recycling. Additionally, poor attitude towards management of waste and failure to take personal responsibility has to a large extent contributed to unhealthy practices that include illegal dumping, open burning and littering.

Residents' attitudes and engagement in garbage creation and disposal methods must be evaluated in order to gain a good comprehension of programs related to management of waste in urban environments. According to studies, the waste problem is caused by human activities and that the remedy lies in changing behaviour (Milea, 2009). According to Zhu *et al.*, (2008), public attitude and awareness on solid waste affects the whole SWMS. Insufficient norms, poor participation of the public and inadequate information and education on waste management strategies that are effective are among the reasons for the gap between attitudes and unhealthy behaviour of (Milea, 2009; O Conell, 2011).

Studies of this nature have been carried out with results that vary greatly. Laor *et al.*, (2018) conducted a survey among highland dwellers in northern Thailand finding that they had a high degree of knowledge about solid waste management (MSW) and a negative attitude towards it. Omar *et al.*, (2018) conducted a research on knowledge, attitudes and practices in the District of Karan- Mogadishu in Somalia and found that while the residents had a favourable attitude and a decent understanding of SWM their practice was poor.

Pender (2011) on Health Promotion Model emphasizes raising awareness, changing attitudes and changing practices. This model is widely used in research, education and practice. This model is focused on helping people attain higher levels of well-being by promoting health strategies such as educating people, behaviour change and practices in order to promote good health. By use of this model peoples' knowledge is enhanced through awareness creation which helps people change their attitude and ultimately their practices. This will help modify peoples' way of thinking and attitude regarding waste and improve their behaviour about different methods of disposal of waste (Shahzadi *et al.*, 2018).

Management of solid waste systems (MSW) have resulted to major challenges for emerging cities more so in under developed countries (Munyaga, 2016). Further, Safiuddin *et al.*, (2010) observes waste management problem continues to deepen owing to heightened human activities. Wilson *et al.*, (2012) pointed out that the main challenge with disposal of waste stemmed from poorly grounded strategies that occasion littering, illegal waste disposal including burning. According to Kassim & Ali (2006) waste occasioned by human activities should be discarded in order to lessen the risk to the health of human, animals and the environment.

Figures from Kenya National Bureau of Statistics (KNBS, 2019), indicate around 13 million people or 34.8 percent of Kenya's population live in urban areas. Nairobi, Mombasa, Kisumu, Nakuru and Eldoret the five biggest urban centers account for a third of the entire urban population. The population of Nairobi City County is believed to be over 4.4 million people who produce upto 3000 tons of solid garbage every day a problem that needs to be addressed. This scenario, according to King'oo (2019) will most certainly continue to create greater socio-economic, environmental and institutional issues until adequate waste management mechanisms are put in place.

Nairobi like other African cities does not have appropriate solid waste management systems which has had detrimental short and long-term effects on the health of human including that of the environment in general (Njoroge *et al.*, 2014; Musyoka, 2019). Muniafu & Otiato (2010) noted that several Kenyan laws have mandated local authorities with the responsibility of handling solid waste. However, the process of putting in places these policies and legal provisions have not been done according to plan.

According to Nairobi Solid Waste Management Plan (2013-2017), of all waste generated in Nairobi, 68% is domestic in nature making it prudent to focus on categories of solid wastes generated including the practices employed to dispose waste by the residents.

1.2 Problem Statement

According to Oyake (2015), solid waste that remains scattered and uncollected is a serious environmental challenge in Nairobi City County. Waste is disposed indiscriminately on the roadside, in the drainage systems or in open spaces, with no care of the negative effect it poses to the environment, the public and the living standards of the generations to come. The population of Nairobi has also grown rapidly from about 3.4 million people in 2009 to about 4.4 in 2019 (KNBS, 2019) translating to growth in generation of waste. Currently 50% of the generated waste remains uncollected and 50% of people, especially in the low and middle-income areas of Nairobi lack access to waste management services (NEMA, 2014).

The Nairobi County government has failed to implement its Integrated Solid Waste Management Plan (2010-2020) because of lack of the capacity, weak institutional structures, and budgetary challenges (Haregu *et al.*, 2017). Consequently, out of 3,000 tonnes of waste generated daily only half is collected, and there are over 70 illegal dumpsites in Nairobi.

Meanwhile, population growth continues compounding the problem: The County of Nairobi waste generation will be 35% greater by 2030 than it is presently (Musyoka 2019; National Sustainable Waste Management Policy, 2019).

Although rules and regulations on management of waste exist, their enforcement is wanting. The Constitution of Kenya 2010 largely bestows responsibility of maintaining a clean environment on every citizen. Nairobi County Solid Waste Act of 2015 gives the county government the jurisdiction to collect solid waste from the streets or any other public location either directly or indirectly and only delegates a ten-metre radius responsibility to occupants, owners or agents of a property. The act prohibits the placement of waste on the exterior of a house, building or other property unless it is to facilitate its collection (National Sustainable Waste Management Policy, 2019). There is need therefore to create lessons on how the

residents can be mobilized to participate in ensuring a clean environment through development of appropriate awareness and attitudinal packages that will result in correct garbage disposal attitudes and habits. The residents' knowledge, understanding, attitudes and behavior about correct garbage disposal methods are analysed and discussed in this thesis.

1.3 General Objective

The objective of this study was to examine and document residents' knowledge, attitudes and practices used in solid waste management in Eastleigh South Ward Nairobi, Kenya, and make recommendations on sustainable solid waste management practices.

1.3.1 Specific Objectives

The study's specific objectives were to:

1. Assess the level of residents' knowledge of solid waste management in Eastleigh South Ward, Nairobi County
2. To examine how residents' attitudes in Eastleigh South Ward, Nairobi County, affect solid waste management.
3. To investigate how residents in Eastleigh South Ward, Nairobi County, dispose of solid waste.

1.4 Research Questions

- i. Has the resident's knowledge influenced solid waste management in Eastleigh South Ward, Nairobi County?
- ii. How has the attitude of citizens in Eastleigh South Ward, Nairobi County, influenced waste management?
- iii. How do the various methods employed by residents in Eastleigh South Ward, Nairobi County, to dispose of solid waste affect the area?

1.5 Hypotheses

- i. Residents' knowledge does not influence solid waste management in Eastleigh South Ward, Nairobi, Kenya.
- ii. Residents' attitudes have no bearing on solid waste management in Eastleigh South Ward, Nairobi, Kenya.
- iii. Residents' waste disposal behaviour has no effect on Eastleigh's South Ward solid waste management.

1.6 Significance and Justification of the Study

Management of garbage presently is a high priority issue as unsustainable waste disposal creates environmental and public health problems as well as financial losses. The majority of developed countries have seen some degree of success in management of solid waste. However, the situation in Kenya is different because the country is still dealing with waste. Kenya is a signatory to the Agenda for Sustainable Development-2030 dubbed "Transforming our World." The eleventh goal of Sustainable Development targets to make cities safer, more resilient and more sustainable for everyone. Target 11.6 requires members to reduce waste production per person in order to reduce detrimental impact on settlements. This will be accomplished by focusing on the quality of air including other management of waste programs. By 2030, member countries are expected to cut waste generation significantly through prevention, according to Target 12.5 (UN, 2015).

All the states that are party to the Fourth UN General Assembly resolution UNEP/EA/4/L.8 on waste management that is good for the environment, agreed to actively promote integrated methods to solid waste management through sustainable consumption. Kenya as a UN member

decided to adopt the resolution. The Environmental Management and Co-ordination Act EMCA (1999) is the framework law on which other institutions such as the National Environmental Management Authority (NEMA) are anchored. It stipulates how solid waste should be managed in a healthy and sustainable way. NEMA is mandated to implement all policies and supervision over matters- environment that includes management of solid waste. The Constitution of Kenya bestows on every citizen the responsibility of maintaining a clean environment it also highlights the rights of all citizens to a clean environment. This study recommends that best practices be adopted as a priority in waste management methods for metropolitan areas in order to make EMCA (1999) a reality. The choice of the study area was guided by the fact that it is one of the densely populated areas with an estimated 30,000 homes, a population of 90,000 on a land area of about 4 square kilometres and a population density of 25,455 persons per sq km. (KNBS 2019) the second highest in Nairobi.

1.7 Scope and Limitation of the Study

The study focused on Eastleigh South Ward, Kamukunji Sub-County in Nairobi County. Nairobi County has eighty-five electoral wards and Eastleigh South Ward is one of the most densely populated wards in Nairobi County only second to Mathare. The study's focus was on examining the resident's knowledge, attitude and methods they used in disposing solid waste. Waste management is one of the most challenging tasks that many municipal governments face (Anomanyo,2004). The ongoing rise of the human population which has resulted in urbanization and many economic activities has had a negative impact on waste management systems in cities and towns around the world (Tacoli, 2012).

Nairobi City County is highly stratified with high end and low-end areas with very diverse socio-economic status. This study's findings can be replicated in other densely populated urban areas in Nairobi County including but not limited to Mathare North, Kariobangi North, Huruma Estate, Umoja Estate, Githurai, Zimmerman and Pipeline estate among others.

The scope of this study was limited to the Eastleigh South Ward, the area of its focus, and to similar estates in terms of infrastructure and population densities.

CHAPTER TWO: LITERATURE REVIEW

2.0 Definition of Waste

Any unwanted or unwelcome material whether solid, liquid, gaseous or radioactive, discharged, deposited or released in the environment in such volume, manner or composition likely to damage or alter the environment is considered waste (EMCA, 1999). Human and animal activities generate waste which is thrown as useless and undesirable. The materials come from a number of places including residential, commercial and industrial operations and are typically processed in various ways (Abdel-Shafy & Mansour, 2018). Solid waste encompasses both organic and inorganic waste products as well as solid items produced as a result of human and animal activity that are deemed unusable and hence discarded (Mahar *et al.*, 2007). According to UNFPA (2001) report, waste is generated mainly from domestic sources accounting for 68%, industrial sources (14%), roads (8%), education institutions/schools (3%), hospitals (2%), 1% from markets and 4% from other sources. A large portion of waste is mainly from packaging materials that include plastic. Every year more than 260,000,000 tonnes of plastic are generated worldwide, accounting for 8% of total waste output (Oyake, 2015). According to UNFPA (2001), around 1 trillion plastic bags are created and used each year. As a result, the packaging industry plays a significant role in the production of solid waste. Approximately half of the plastic bags produced end up in urban drainage systems, accounting for 55% of the solid waste in these systems.

2.1 Global Trends in Waste Generation

Solid waste creation continues to rise at both the home and industrial levels around the world as a result of increased consumption brought by population growth especially in the wealthy countries where it is six times that of developing countries. The annual generation of municipal solid waste is expected to reach over 1.3 billion metric tons or 1.2 kilograms per person every day. If current trends continue worldwide, waste production will have increased fivefold by 2025 (Achankeng, 2003; UNEP, 2011; 2013).),

Annually, 62 million tonnes of solid waste are created in Sub-Saharan Africa, averaging 0.09 to 3.0 kilogram per person each day (Hoorneweg, 2013). Each year, the Pacific Region and East Asia produce over 270 million tonnes of waste with China accounting for 70% of the total in the region and generating 0.44 to 4.3 kg of waste per person per day on average (Aazam *et al.*, 2016). The industrialized and developing worlds have different approaches to waste management. North America, Europe and other developed countries have developed ways for minimizing household waste and subsequently disposing it of in landfills (AESSL, 2007). However, in poor countries, household waste accounts for more than 60% of all solid waste with collection rates usually less than 70% and the rest dumped in unregulated landfills (Hoorneweg & Bhada, 2013).

2.2 The Influence of Urbanization on Waste

Solid waste is often thought of as an issue that only affects cities. Rural people are often poorer, buy less store-bought items (which means less packaging), and reuse and recycle more. As a result, waste generation is far lower in rural locations. Currently more than half of the world's population is housed in the cities and the rate of urbanization is constantly increasing (Ritchie & Roser, 2018). Cities will be home to as many people by 2050 as the entire world's

population was in 2000 bringing new waste management challenges (Modak *et al.*, 2018). Citizens and businesses will have to take on greater responsibility for waste generated and disposal, particularly in terms of product design and waste separation. Aliu *et al.*, (2014) intimated that promoting micro-enterprises and organising the informal sector are some of the effective ways of enhancing services of waste collection that are affordable.

2.3 Types of Waste and Environmental Implications

Municipal solid wastes (MSW), otherwise termed garbage or trash, are produced on a daily basis as a result of people's activities. Despite the fact that all sectors are sources of MSW, it is usual practice in the construction and demolition (C&D) industries to treat waste separately from other MSW since responsible parties takes responsibility for its effective management (Daniel & Perinaz, 2012).

Mwesigye *et al.*, (2009) reported that residential waste account for roughly 61 percent, followed by industrial (including the automobile, fabric, and manufacturing industries) of all waste produced in Kenyan cities.

Institutional wastes are wastes generated by organizations like schools. Wastes generated by street cleaning, parks, beaches and wastewater treatment facilities are also examples of municipal services wastes (Nebiyeleul, 2006). Potential waste must be managed carefully depending on the material hazard to achieve optimum environmental practices.

2.4 Composition of Garbage

Paper, tin, bottles, textiles, glass, metals, e-waste and hazardous wastes like paint and aerosol spray are just a few examples of these types of waste. Residential waste is one of the most common waste forms. Waste composition varies with income level, season, climate,

population, social behaviour, industrial production, extent of urbanization, waste markets size, materials and the efficacy of recycling and re-use and greatly directly influenced by affluence (Achankeng, 2003). The more affluent persons yield a higher percentage of inorganic waste (e.g. metal, glass, plastics and textile). Low-income earners on the other hand generate more organic waste (vegetable leaves and peels)(Malinauskaite *et al.*, 2017).

2.4.1 Biodegradable Waste

Biodegradable waste is organic waste from animals or plants that can be broken down into its constituent parts by microorganisms and other living things in a relatively short period of time (Argun *et al.*, 2017). Organic waste is composed of both fruit and vegetable waste. The waste can be used for making compost manure for agricultural purposes. It can also be used as a resource to produce electricity, heat and fuel through anaerobic digestion or incineration process to produce biogas (Wainaina *et al.*, 2020).

2.4.2 Recyclable Waste

The recyclable wastes are materials that can be repurposed into new products. They can be used to make items that are similar to one another. Paper, glass bottles, tin cans, plastics, cardboard, aluminium cans and foils, metals, some types of clothes, tires, textiles, wood, wire, cables, plastic goods, rubber, and electronics-computers, cellular phones, keyboards, batteries, and other tiny electronic equipment are all recyclable (Abdel-Shafy & Mansour, 2018).

2.4.3 Inert Waste

Inert waste is a sort of waste that is neither biological nor chemical, does not induce or promote any change and is unlikely to harm other matter it comes into touch with (Menegaki & Damigos, 2018). Construction waste, such as bricks, hard-core concrete, boulders, sand,

trash and rubble are examples of inert waste (Bao *et al.*, 2020). Inert waste has no negative effects on the environment or the health of plants and animals but large amounts can be a concern because it takes up a lot of space (Malay *et al.*, 2020).

2.4.4 Composite Wastes

Composite materials are made up of two or more materials that work together to produce greater results than if the individual components were utilized alone (Naqvi *et al.*, 2018). It can also refer to materials that are made up of two or more materials in order to take use of a variety of material qualities. Composite materials are widely utilized in the automotive, aerospace and renewable energy industries because they are stronger, lighter and require less maintenance than conventional materials as well as having a longer lifespan (Yang *et al.*, 2017).

2.4.5 Domestic Hazardous Waste and Toxic Wastes

Industrial, medical, and some types of home wastes are examples of hazardous wastes that may contain hazardous substances. When exposed to other compounds, these wastes may be caustic, combustible, explosive or react with them. Hazardous wastes can be exceedingly dangerous to humans, animals and plants (Prakash & Gowtham 2019). Toxic wastes are poisonous in trace concentrations or small amount. They may have immediate implications such as death or serious disease or long-term consequences such as irrevocable injury (Hasan *et al.*, 2018). Some of them are carcinogenic or mutagenic, which means that long-term exposure to them causes cancer. Reactive wastes that are chemically unstable react violently when exposed to air or water. They have the ability to cause explosions and release toxic gases. Ignitable wastes are flammable because they burn quickly and at low temperatures.

Corrosive wastes include those that are extremely acidic or alkaline. They use a chemical process to kill solid material or live tissue when they come into touch with it.

Hazardous waste management entails reducing or eliminating waste exposures by lowering the amount of hazardous compounds produced in order to lessen their toxicity (Hasan *et al.*, 2018). Some of the waste-treatment options include chemical, physical, biological, incineration and stabilization or solidification. Based on the characteristics of the wastes being treated, the most effective procedure is chosen (Hasan *et al.*, 2018).

2.4.6 Industrial Wastes

Industrial wastes are non-metallic wastes that are produced during the production or industrial process and can include both hazardous and non-hazardous waste. Chemical goods, paper, and printing materials are among the industrial wastes. Hazardous waste includes things like batteries, paint, motor oil and disinfectants. Non-hazardous waste comprises, among other things, paper, cardboard, glass, plastic and wood (Chertow *et al.*, 2019; Ngoc & Schnitzer, 2009).

2.4.7 Agricultural Wastes

Animal husbandry, plant seeding and milk production among other activities generate agricultural waste (Sangeetha *et al.*, 2017). Crop leftovers, animal excrement and silage effluent are examples of agricultural waste products. Agricultural wastes are frequently used as a source of energy in the industrial sector. According to Sasakova *et al.*, (2018), unless agricultural waste is handled and managed properly it can impact the ecosystem. For example, excessive manure application on land could harm ground and surface water.

Agricultural crop wastes, livestock waste and agro-industrial by-products have all increased as

a result of increased agricultural productivity (Sasakova *et al.*, 2018). They include crop residue, rice husk, mustard seed, castor seed, sesame sticks, tobacco, and sunflower stalks (Singh, 2018; Koopmans & Koppejan, 1997).

2.4.8 Sewage Sludge

Any solid, semi-solid or liquid residue left over following the municipal waste and sewage treatment process is referred to as sewage sludge. Inorganic and organic components, high concentrations of various plant nutrients, much lesser levels of several trace elements and chemical compounds and pathogens are all present in this mixture. Depending on the wastewater composition and treatment procedures utilized, sewage sludge can contain a wide range of components (Fytli & Zabaniotou, 2008).

Due to massive sewage sludge discharges all over the world, organic waste must be properly controlled. The two fundamental disposal options for municipal sewage sludge management are reuse of sewage sludge for agriculture or landscaping as well as final disposal. Reusing sewage sludge can be done in a number of ways, each with its own set of drawbacks. Another possibility is sludge processing which involves preparing sewage sludge for reuse.

If sewage sludge treatment plant cannot be utilized it should be neutralized. The most fundamental concept associated with the transformation of sewage sludge is the recovery, recycling, or recovery of organic components. One of the most important problems for resolving outstanding practices in the field of municipal sewage sludge is information on the amount of sewage sludge produced in sewage treatment plants around the world (Kacprzak *et al.*, 2017).

2.4.9 Municipal Solid Waste

Municipal solid waste, according to the UNEP (2005), encompasses all household garbage and trash both hazardous and non-hazardous as well as institutional, industrial and commercial waste produced in cities. Small amounts of dangerous stuff, such as batteries, light bulbs, car components and unused drugs and chemicals are found in the waste collected. Municipal waste generation rates vary by region, city and season due to a strong association between activities, economic development, affluence and poverty. High-income countries produce MSW at rates ranging from 1.1 to 5.0 kg per person per day, while poor countries produce 0.5-1 kg per person per day (UNESCAP, 2017). In middle and low income countries organic waste accounts for more than 70% of municipal waste (Karak *et al.*, 2012).

2.5 Challenges of Solid Waste Management

MSW needs to be collected and safely disposed off. Pollution of the air, water and land results from improper solid waste disposal and insufficient collection systems, harming human health and the ecology (Zohoori & Ghani, 2017). In most nations solid waste management (SWM) is characterized by a lack of collection system coverage, inadequate collection methods and poor municipal solid waste disposal (Tsai *et al.*, 2020; Blight and Mbande, 1996), due to insufficient funding. Consequently, a large portion of generated garbage ends up in undesignated dumping locations such as roadside ditches, drainage systems and other public utility areas (Mugo, 2019).

Non-governmental actors have been able to participate in a variety of waste management operations, such as garbage collection, transportation, and disposal, as well as re-use, waste recovery and recycling (Oluoko-Odingo & Mutisya, 2019). The majority of these collaborations, on the other hand are not recognized by the government. Residents in most

urban areas are charged for garbage collection, which some, primarily low-income residents, do not pay. As a result, inhabitants frequently dump garbage in undesignated sites such as open pits on neighbouring vacant plots, roadsides, rivers and public spaces while some prefer to burn waste within their complexes.

Cities that can't handle garbage properly aren't likely to be proactive in areas like health, education or transportation. Poor waste management has a substantial impact on public health, the local and global environment and the economy; in most circumstances, the cost of properly processing waste in the first place is greater than the cost of improper waste management (Attiogbe *et al.*, 2019). The contribution of MSW to GHG emissions such as methane from the organic element of the waste stream as well as the growing global linkages of products, urban lifestyles and the recycling industry reflects its global nature.

Solid waste management initiatives have been based on public health and safety concerns in most jurisdictions as solid waste management is critical to public health. Uncollected and dumped solid waste can produce insects, vermin and scavenging animals resulting in the spread of air and waterborne diseases. Diarrhoea is twice as common and acute respiratory infections are six times more likely in places where waste is not collected as frequently, according to UN- Habitat surveys (UN-Habitat, 2009).

Waste that is not properly collected or disposed of may have a harmful influence on the environment (Boadi & Kuitunen, 2005). MSW is regularly deposited in low-lying locations and on property next to slums in low- and middle-income nations (Nassar & Elsayed, 2018; Sessa *et al.*, 2009).

2.6 Solid Waste Management

2.6.1 SMW as a Human Right

Solid waste management (SWM) has a history that is long and extremely complex (Nathanson, 2015). In the 4th century A.D., the Ancient Greeks were among the first to employ waste management techniques. The Greeks had to deal with a variety of obstacles, including balancing garbage collection methods with an expanding population, a lack of space and sanitary concerns. Waste was collected and carted to pits outside of town which at the time was a primitive waste management system. Until cities grew in population waste was not considered a hazard to human and environmental health. Cities began to grow quickly to accommodate the growing population and the situation in these densely populated areas began to deteriorate. Garbage collected by municipal authorities or on their behalf and disposed of through established waste management systems is referred to as municipal waste. Waste management is a key function that supports our society in the twenty-first century, particularly in metropolitan regions. It has now been elevated to the status of a basic human need and a fundamental human right. This fundamental human right encompasses drinkable water, sanitation, solid waste management, shelter, transportation, energy, communication and food all of which benefit society and the economy (United Nations Environment Programme, 2016).

2.6.2 Goal of SMW

The major goal of urban solid waste management, according to the World Bank (2015), is to sort, collect, process and dispose of solid waste generated by all urban population groups in an environmentally and socially acceptable manner using the most cost-effective processes.

Waste has traditionally been assigned to municipal solid waste, whilst “wastewater” has

been assigned to the water or industry sectors (UNEP, 2011). Waste management include the collection, transportation, treatment, and disposal of waste materials as well as their monitoring and management. The word usually refers to materials that have been processed to reduce the impact of human activities on human health, the environment or aesthetics. Proper waste management is essential for maintaining optimal environmental health and human health benefits accrued to residents (Adogu *et al.*, 2015).

According to Bernstaen (2004), socioeconomic variations have a substantial impact on a community's ability to organize local waste management. Those with greater wages may be able to put more money into garbage collection (Telfer, 2002). If waste management operations are correctly handled they can have a positive impact on the environment. In the past, there has been little or no attempt to raise community knowledge of the consequences of inadequate waste management or the easy steps that every citizen can take. This may have aided in the reduction of waste output and the promotion of efficient garbage management. The situation is however changing as more individuals become aware of the harmful environmental consequences of improper garbage management (Gentil *et al.*, 2009).

Landfilling and incineration are two waste management alternatives that do not totally fix the problem. Nobody wants a garbage disposal facility in their neighbourhood. People's attitudes toward waste must change in lockstep with the increasing variety of waste created. People must realize that waste can be used as a resource instead of being dumped (Jessica, 2015).

Solid waste management in most developing countries is a challenge when compared to industrialized countries. In this context, developing countries are concentrating on efficient garbage collection, treatment and disposal while developed countries are concentrating on transforming waste into resources. Ghana, as a developing country, is having trouble

managing solid waste from collection to treatment and disposal, because garbage is not considered a resource. As a result, waste management firms have rebranded themselves as garbage collectors, significantly limiting their potential (Mungure, 2008).

2.6.3 Unsustainable SMW Practices

People in countries that are developing frequently use methods of disposing waste that are hazardous to health of human being and the environment, which include: open burning and dumping in unregulated landfills, since they believe they are lacking in other alternatives (Mwanthi & Nyabola, 1997; Goett, 1998; Alavi *et al.*, 2009; Narayana, 2009; Al-Khatib *et al.*, 2015; Hilburn, 2015). As a result of industrial innovation, expanding metropolitan zones and fast growth, management of solid waste has grown into a great concern in many countries that are developing. According to research done in numerous rural cities in India, waste was often thrown or burned in unregulated areas (Narayana, 2009). Hundreds of thousands of people who do not receive garbage collection have no choice except to burn their trash, which is illegal. Majority of homes in these towns have localized garbage pits, where garbage is put daily and after two weeks it is burned. Garbage is moved to larger pits on the outside of town once the pits are full (Narayana, 2009).

The majority of landfills are located in low-lying, environmentally vulnerable areas such as forest borders, marshes or areas near bodies of water. They frequently lack liners, soil covers, fences and compactors as is the situation in most developing countries (Troschinetz and Mihelcic, 2009). Due to a lack of appropriate controls, solid waste is frequently dumped in abandoned quarries and other comparable areas. The Dandora dump site in Nairobi, which was previously a quarry is where municipal waste is disposed of. As a result, residents who

live near the dumpsite are exposed to health and environmental hazards. Despite the dangers to their health, the urban poor are frequently forced to live near garbage sites. Many other developing countries have similar issues, with population and industrial growth on the increase and the systems that are very weak and inadequate to contain the growing stress. In response to the rapid increase in garbage new waste management methods must be developed and these systems must be long-term and adaptive to the needs and challenges of developing countries. Understanding current research on the subject will help us fill in the gaps in our knowledge regarding SWM in developing countries (Troschinetz and Mihelcic, 2009).

2.7 Cost of SWM

Rapid urbanization in Africa has been connected to the difficulty of urban solid waste management. Waste generation has surpassed safe disposal rates as industry and urbanisation have grown particularly in most African cities (Hofny-Collins, 2006). The amount and type of waste created is expected to increase in lockstep with civilization's population and material affluence (Scharfe, 2010). As the population grows income grows and consumption patterns change and the amount of disposable products changes. The difficulties and high costs of disposing of the massive volumes of garbage generated by families and businesses are considerable in high-income countries. In low-income countries, collection is a serious issue, with one-third to half of all solid waste created in third-world cities left un-attended (Raj, 2010).

2.8 Public Opinion on Waste

Over the last two decades, the world's population has shown widespread concern about the need

to reduce pollution and protect the environment. In the same way, the general public has become more aware of the problems created by environmental degradation, underlining the significance of coordinated global action to address these challenges. The transmission of knowledge about the ever-increasing environmental concerns has expanded, according to the United Nations Environment Programme (UNEP, 2005; Kassim and Ali, 2006; Kassenga & Mbuligwe, 2009; Omofonmwan & Eseigbe, 2009).

If left unchecked, environmental contamination will have particular and negative consequences that will harm not just the natural environment but also public health. Rapid urbanization, industrialisation and rural-urban migration have resulted in urban people adopting unsustainable production and consumption patterns. The trend is particularly noticeable in urban settlements with large human populations that generate massive volumes of solid waste, making solid waste management a major concern for city planners especially in emerging nations with rapidly growing urban populations (Abdelnaser & Maria, 2008).

2.9 The SWM in Kenyan cities

The SWM burden has also increased as the population of Nairobi and other East African cities has grown. This predicament is exacerbated by a lack of financing for waste management departments. In East Africa close to 100 million people do not enjoy good sanitation according to Troschinetz & Mihelcic (2009). In Nairobi solid waste is discarded in an uncontrolled manner in any accessible open place.

Kenya's population has been quickly increasing over the last ten years and as a result, solid waste creation has increased as a result of increased population and industrial expansion (Muniafu & Otiato, 2010). Solid waste creation is expected to increase by 2030 as the country strives to become a middle-income country. Rapid urbanization, which is linked to the rise of slums, is a major issue in third-world nations like Kenya²⁴ which sees an increase in solid waste generation

and improper disposal as a result of population and economic growth (Haregu *et al.*, 2017). In Kenya, the county governments are in charge of solid waste management, collecting and disposing of garbage within their domains (Muniafu & Otiato, 2010).

Nairobi City County Government is the authority tasked with providing waste management services to Nairobi citizens. Because of insufficient waste management facilities provided by incompetent local authorities and county governments most citizens confront major sanitation issues. Only around 26% of Nairobi's solid waste gets collected on a daily basis, according to Ikiara *et al.*, (2004). Local governments' solid waste services have been decreasing (Muniafu and Otiato, 2010), and thus private groups that charge fees for garbage collection services have stepped in.

2.10 Solid Waste Management Systems

The meticulous handling of waste products from their point of origin to their final destination is referred to as "sustainable waste management." To safeguard the environment, human health and natural resources, it is important to properly govern solid waste generation, storage, collection, transportation, processing, and disposal (Tchobanoglous & Kreith, 2002). When employed as a conservation technique, the emphasis is on waste reduction, reuse and recycling as well as providing an environmentally acceptable waste management option (Ogunrinola & Omosalewa, 2012). Waste prevention should be addressed to ensure that there is less garbage to dispose of (Gertsakis & Lewis, 2003). Reduce (prevention), reuse and recycle are the three R's that can be used to reduce waste output. These are methods that entail the use of waste management approaches that are integrated (IWMP). If well practiced they can cut the amount of waste produced by half.

2.11 Reduction (Prevention) of Waste

Waste prevention, also referred to as "source reduction," comprises using and discarding fewer units. Waste reduction can be accomplished through the purchase of long-lasting items, backyard composting, long-term use of environmentally friendly products such as toxic-free products and packaging, double-sided copying of papers, redesigning products to use less raw material production and reducing transportation packaging. These techniques have yielded significant environmental benefits (Gertsakis & Lewis, 2003).

Source reduction benefits include reduced greenhouse gas emissions, natural resource and energy conservation and the elimination of the need for additional landfills and combustors (Sreenivasan *et al.*, 2012). It decreases waste output and is the most widely used waste management method considerably assisting in environmental protection.

2.12 Reuse of Waste

Repairing artefacts, donating them to charity and community groups or reselling them, are all examples of reusing objects. Reusing products is a better alternative than recycling because they do not need to be repaired. Reusing durable glassware, steel, cloth napkins or towels, bottles, boxes and purchasing refillable pens and pencils are all examples of reuse (Abdul-Rahman & Wright, 2014).

The term "reuse" refers to the reuse of waste resources, either in part or in their entirety. Trade in second hand items such as electronics, clothing, furniture, autos, and other commodities exemplifies waste reuse (Goldman & Ogishi, 2001). Instead of separating at the disposal site, rigorous operations of evaluating, reconditioning, cleaning, and repairing full or spare parts commodities are utilized to accomplish reuse (Abdul-Rahman & Wright, 2014; Chalmin & Gaillochot, 2009).

2.13 Recycling of Waste

Recycling is the process of repurposing waste resources to create new materials and items that

would otherwise be discarded. As a result, millions of tons of rubbish have been diverted from landfills. Paper and paperboard are recycled at a rate of 48 percent, while batteries are recycled at a rate of 93 percent. Recycling eliminates the need for new landfills and combustors, saves energy, gives valuable raw materials to industry, creates jobs, supports the development of greener technology, and prevents the release of several greenhouse gases that have a detrimental impact on global climate change (Chen & Lin, 2008).

Recycling has the potential to save a lot of money while also benefiting the environment, society, and economy. Plastics, metals, glass, and paper are collected, separated, and shipped to processing plants where they are recycled into new products. Recycling is based on waste materials that cannot be directly reused but can be turned into valuable items or raw materials through transformation procedures (Ezeah *et al.*, 2013).

Recycling and recovery have two key advantages: they reduce abandoned waste and return commodities to the economy. In many developing countries, informal waste collectors at collection points and disposal sites retrieve a significant amount of garbage. In China, for example, about 20% of waste is recovered for recycling, owing primarily to informal rubbish collection (Hoorweg *et al.*, 2013). Regulatory, sociological, and philanthropic issues, according to Gonzelez-Torre and Adenso-Diaz (2005), are some of the reasons why some towns generate high recycling tendencies.

2.14 Functional Elements of Solid Waste Disposal

2.14.1 Waste Collection

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This is an important part of trash management since it entails strategically putting garbage

collection bins and collecting waste on time. Garbage collection is the most important link between rubbish sources and waste collection service providers, who are either local governments or private businesses. Local governments should strategically place collection centers throughout cities and towns. To improve trash separation, the collection bins should be clearly labeled according to the waste stream. Waste collection should be timely and well-coordinated, and collection centers should be well-managed (Shekdar, 2009).

2.14.2 Transfer and Transport

Rubbish transport trucks are used to transfer waste from collection stations in the city/town or residential areas to a specified dump site or landfill. Local governments are responsible for ensuring that appropriate transportation is available for specific types of garbage. The waste vehicles should be well-maintained and protected. The vehicles should only be used to transport rubbish and should be approved by the relevant environmental agency (Okot-Okumu & Nyenje, 2011).

2.14.3 Disposal

This is the last step of the waste management system. It entails disposing of waste in designated areas such as landfills, dump sites, incinerators, or energy recovery centers. To reduce the amount of harm to the environment, trash should be processed before disposal. (Daskalopoulos *et al.*, 1997).

2.14.4 Landfill

A landfill is the final disposal site for all types of waste after recyclable elements have been separated for various uses and other biodegradables have been taken from the garbage for use as compost, heat, or electricity; or after incineration (Williams, 2005). Therefore, they should be

planned and operated in a manner that preserves the environment and public health. Some of the well managed landfills in the world include: Laogang in Shanghai, China which measures about 1,000 acres and receives about 70% of waste generated in the city. Close to 80% of organic waste is composed in the landfill producing bio-gas that serves close to 100,000 homes with electricity. Sudokwon landfill in Korea is the largest in the world. The landfill receives 7 million tons of waste every year. The facility produces both water and electricity from waste.

2.14.5 Composting

The controlled aerobic biological decomposition of biodegradable solid waste to produce compost is known as composting. Compost is used as an organic fertilizer in agricultural production. Composting is a natural process that decomposes organic waste into nutrient-rich compost that is good for gardening. Organic materials that have been resting in a compost pile or bin for months are broken down by microbes. Composting is the recommended technique of organic waste disposal since it conserves more nutrients than incineration. The biggest disadvantage is the time it takes for organic materials to decompose into compost. This method also necessitates enough area to construct a huge compost pile, which may be difficult to come by if one lives in a multi-family apartment or have a tiny plot of land.

2.15 Energy Generation from Waste

2.15.1 Thermal Treatment of Waste

The process of burning garbage at certain temperatures with or without the presence of air is known as thermal treatment, which includes waste incineration, pyrolysis, and gasification. On

non-reusable and non-recyclable waste, thermal treatment, an environmentally friendly method for lowering trash volume and inserting any harmful components, can be employed. Energy can be recovered in the form of a finished product at the same time (Lombardi *et al.*, 2015).

2.15.2 Waste Incineration

Incineration is the process of burning liquid, solid, and gaseous waste under regulated conditions. This method can be used to handle both hazardous and municipal solid waste streams (Lombardi *et al.*, 2015).

2.15.3 Gasification

The process of converting waste into usable goods including energy, chemicals, fertilizers and natural gas by reacting it at high temperatures (>700 degrees C) without using oxygen or steam is known as gasification. For landfills, this could be a realistic solution (Situmorang *et al.*, 2020).

2.15.4 Pyrolysis

Pyrolysis is a heat-based chemical decomposition of organic molecules in the absence of oxygen. Pyrolysis is a chemical reaction that takes place at temperatures between 400 and 500 degrees Celsius and occurs under pressure (Isahak *et al.*, 2012).

2.16 Biological Treatment of Waste

In the presence of microorganisms, biological therapy is a natural process that breaks down plant and animal components (biomass). An aerobic or anaerobic biological treatment strategy can be applied. Anaerobic treatment decomposes waste in the absence of oxygen and in the presence of

microbes, whereas aerobic treatment decomposes organic waste in the presence of oxygen. Biogas (which generates power) and organic fertilizer are two of the most famous products produced by these two processes (Gray, 2004).

2.17 Waste Health Risks

The possible health effects of waste as well as the repercussions of waste management have been the subject of extensive investigation (Rushton, 2003). Waste is a complicated mixture of a variety of compounds, some of which are harmful to human health.

For example, the domestic waste stream contributes significantly to water pollution. Household garbage in both metropolitan and pre-urban settings can be harmful if not adequately collected or managed causing health and environmental issues (Gutberlet & Uddin, 2017).

Hazardous waste in the home has serious health consequences as well as poisoning groundwater and putting wildlife habitats at jeopardy. For example, batteries and fluorescent lights that have been incorrectly disposed of are hazardous to the environment. Likewise, garbage can leach poisons into the ecosystem causing soil damage while heavy metal pollution was found in house dust, food, ground water and farm soil (Srikanth *et al.*, 2008; Gutberlet & Uddin, 2017). Thus, people are exposed to harmful effects from waste dumps and recycling plant (Xu *et al.*, 2018).

Waste management workers all over the world suffer respiratory and gastrointestinal disorders with wide ranging symptoms including muscular pain, headache, fever, fatigue, pulmonary problems, mechanical trauma, musculoskeletal damage, poor emotional well-being, skin, and eye irritation (Gutberlet & Uddin, 2017).

2.18 International Commitments and treaties to Waste management.

International and domestic trade are also affected by waste management. As a result, Kenya is a signatory to a number of international waste-related treaties. By participating in and executing multilateral environmental agreements as well as participating in worldwide debates on waste management, Kenya obtains vital insights into what can be done to improve waste management systems.

2.18.1 Multilateral Environment Agreement

The agreement, which was signed on September 11, 1988, is a global agreement aimed at protecting the ozone layer by eliminating ozone-depleting compounds from consumption and production through new and adaptive methods.

2.18.2 Basel Convention on the Transboundary Movement of Hazardous Waste and Disposal

On the 6th of June, 2000, the agreement was ratified. Parties agreed to prohibit hazardous waste from crossing international borders, limit toxicity and dispose of and recover waste as close to the source of generation as possible.

2.18.3 Amendments to the Basel Convention 22nd Sept. 1995

The revisions now include plastics, which require parties to avoid transboundary plastic waste movement reduce contamination from plastic waste and manage plastic waste as close to its source as possible.

2.18.4 Bamako Convention (1998)

The agreement forbids hazardous waste imports into Africa and establishes criteria for its movement and management across borders.

2.19 Transforming our World

Kenya is a signatory to the 2030 Agenda for Sustainable Development, dubbed "Transforming

our World." Goal 11 of the Sustainable Development Goals focuses on enhancing equity, security, resilience and long-term viability in cities and human settlements. Member states must by 2030 lessen the environmental impact of cities per capita with a focus on the quality of air and waste management in particular. Member states agreed to significantly reduce waste generation by 2030.

2.20 The Fourth UN General Assembly (UNEA4 OF 2019)

Member states committed themselves to promote successful solid waste management initiatives through sustainable production and consumption, according to UNEP/EA/4/L.8 on environmentally sound waste management. The key issues addressed included waste reduction, hazardous substance removal, recycling, reduction, and re-use.

2.21 Policy and Legal Framework on Waste Management in Kenya

Kenya has some of the world's most effective environmental management and MSWM legislation, plans, regulations and policies. Kenya's Constitution (2010), Kenya's Vision 2030, the National Environment Policy 2013, the National Solid Waste Management Strategy, the Environmental Management and Co-ordination (2013) Act and Impact Assessment and Audit Regulations 2003, and the Environmental Management and Co-ordination (Impact Assessment and Audit) Regulations 2003, the Public Health Act Chapter 242 of the Laws of Kenya (revised 2012), the Occupational Safety and Health Act 2007, the County Governments Act 2012, The urban areas and cities Act 2011, and Local Government Act (Cap 265).

(1) Constitution of Kenya

The constitution (2010) charges the government³⁵ with responsibility for ensuring sustainable use, management and conservation of the environment and natural resources as well as equitable

benefits and adjures citizens to participate in environmental management, preservation, and conservation. According to Kenya's Constitution (2010), chapter 4 (2) clause 42, everyone has the right to a clean and healthy environment.

(2) Kenya Vision 2030

Kenya's Vision 2030 is a development plan aimed at making the country an internationally competitive, prosperous and high-quality-of-life country by 2030. Besides, it aspires to transform Kenya into a newly industrializing middle-income country that provides a good quality of life to all of its citizens in a safe and secure a clean, safe, and sustainable environment. This will be accomplished through encouraging environmental conservation as a means of bolstering the economy.

(3) National Environment Policy (NEP), 2013

This policy framework was developed to ensure that natural resources and the environment are managed in a way that encourages long-term growth.

(4) National Environmental Action Plan (NEAP 2009 -2013)

The National Environmental Action Plan (NEAP) was a comprehensive policy framework aimed at integrating environmental concerns into the country's economic and social development. A multi-sectoral approach was to be used to consider environmental management and natural resource conservation in societal decision-making.

(5) Environmental Management and Coordination Act (EMCA 1999)

Section 87 of the Act sought to ensure that waste was managed without degrading the environment or threatening the health of any person. It also provided for licencing for handling and management of waste (NEMA, 2006).

(6) Nairobi County Solid Waste Act 2015

The Act gives the county government the jurisdiction to collect solid garbage and prohibits the placement of trash on the exterior of a property.

2.22 The Sustainable Waste Management Bill 2019

This bill is under consideration to encourage long-term waste management by implementing the waste management hierarchy, encouraging a circular economy, and assuring efficient garbage transportation.

2.23 Formal and Informal Private Sectors in Contracting Municipal Solid Waste Management Services

2.23.1 Formal Private Sector

The "formal private sector" refers to institutions, firms, corporations, and individuals that have been incorporated as businesses with official licenses and are subject to labour legislation. The formal private sector's principal objective is to make a profit. Waste management activities such as resource recovery, waste collection, incineration and landfill management are all carried out by the private sector (Chaturvedi *et al.*, 2015). They can also participate in waste management systems in a variety of ways, including through paid contracts with governments to provide cleaning services, garbage transportation, collection, processing and disposal and through individual or company waste collection contracts. A typical formal private sector waste

management system includes profit incentive, potential income generating, and the municipal government regulating and/or contracting with businesses. Kenyan county governments have employed private trash management companies to collect, transport, and dispose of garbage. These businesses cater to commercial, residential, and industrial clients. Garbage is collected twice a week in most wealthy neighbourhoods, but only once a week in middle-income

neighbourhoods (Kenya national waste management policy 2019).

Despite the fact that the government is primarily responsible for enforcing this system, garbage heaps are nonetheless a typical sight in residential areas. They've also been accused of illegally dumping waste in rivers, along highways, and at dumpsites. Furthermore, there is no guiding structure for the regular charge costs of private sector garbage management businesses, resulting in the majority of them charging exorbitantly, that most low-income residents cannot afford (Kenya National Waste Management Policy, 2019).

2.23.2 Informal Private Sector

Unregistered, uncontrolled, or unplanned operations carried out on a small scale by individuals, families, or community enterprises with low capital input and labour-intensive techniques are referred to as the informal private sector (Wilson & Cheeseman, 2006). In contrast to the formal sector, informal waste collection and recycling activities are frequently motivated by poverty and begin spontaneously (and sometimes haphazardly) in the struggle for survival (although some businesses, particularly those engaged in recycling, manage to make significant profits) (Mugo, 2012). As a result, the items to collect first are determined by the worth of the waste materials, as well as the simplicity with which they may be extracted, handled, and transported. Even though organic garbage and manures are present in considerably smaller quantities, metals, paper, and

plastics gathered from more affluent residential or industrial locations tend to receive more attention than organic or biodegradable elements. Individuals and families that work for a living, as well as small enterprises that function in much the same way as their bigger registered counterparts but without the benefit of official registration, make up the informal sector. Outsiders struggle to grasp how these initiatives are organized and structured. This is true not

just for garbage collectors and itinerant waste purchasers, but also for other recycling firms, such as small businesses that recycle metals or plastics. The most prevalent garbage workers are religious or ethnic minorities, poor families or rural newcomers looking for a way to make a livelihood in the city (Ali, 1999).

While the informal sector's activities are highly variable, depending on sociological, religious, and economic factors, some gender roles can be generalized. Women and children conduct the least demanding sorts of labour, such as collecting garbage from streets and dumps and early sorting of items. The vast majority of women and children work from home where they manage and organise everything. Men are more likely to work in the processing or creation of commodities as well as the sale of recovered products and resources (Van de Klundert & Lardinois, 1995).

2.24 Community Knowledge on Solid Waste Management

2.24.1 Waste as a Resource

Despite the fact that waste management rules and regulations exist, poor implementation and processes have resulted in towns and cities being overtaken by their own garbage, posing a health and environmental risk (NEMA, 2014). In addition to waste avoidance and recycling, treating garbage as a valuable resource is a crucial pillar of waste management strategy.

It is possible to use modern technology to recover renewable energy from non-hazardous trash collected during municipal waste operations (Haas *et al.*, 2015). The Circular Economy philosophy of resource management aims to change current practices to replicate sustainable natural cycles, in which all materials are intended to be used as resources by others and to shift to a new practice (Franco-García *et al.*, 2019;³⁷ Ali, 1999). The industry uses and service-life

extension of goods as a waste avoidance, regional employment development and resource efficiency strategy (Ali, 1999).

2.24.2 Closed Loop Economy

Closed loop recycling as opposed to down cycling, involves the ongoing recycling and reusing of materials. It uses a technology that keeps resources in a loop to encourage a circular economy (Ding *et al.*, 2016). Rather than being used once and then wasted, materials should be recycled and reused throughout the process.

The circular economy incorporates the aforementioned instruments, disperses them across the system and raises their status. Its goal is to reorganize product life cycles in order to reduce waste and resource consumption. In a circular economy, there is no waste, therefore today's things are tomorrow's raw materials. As a result, there is a closed loop or cycle created (Lieder & Rashid, 2016).

In middle and low income countries, recycling is primarily done through an active, albeit sometimes unofficial, company. Making new items out of recycled materials can save a lot of energy. For example, aluminium made from recycled material uses 95% less energy than aluminium made from raw material (UN-Habitat, 2009).

2.24.3 Environmental Knowledge and Awareness

"Knowledge" refers to information on management issues. Information is an essential predictor of behaviour because a lack of knowledge causes a decrease in self-efficacy, which leads to the belief that the individual is unable to engage because they lack the necessary understanding (Barr and Gilg, 2005). Knowledge has long³⁸ been acknowledged as a critical aspect in

encouraging environmental action (Oskamp *et al.*, 1991). Higher volumes of environmentally relevant information have been suggested to have a substantial impact on changing environmental behaviour.

The preservation of appropriate waste disposal options has been aided by information and understanding, as well as a constructive attitude. Bernad-Beltrán *et al.*, (2014) showed that individual attitudes are likely to be positively associated to solid waste management. A lack of information and understanding of effective waste management solutions is one of the key difficulties in developing countries. According to McAllister (2015), a lack of environmental understanding leads to a culture of community non-participation in decision-making, exacerbating a lack of accountability for pollution and waste. Citizens who obtain waste education become more knowledgeable and consequently more responsible. The community's participation in decision-making and structural modifications on waste management activities boost their sense of belonging and ownership, leading to improvement rather than condemnation. However, people may be aware of recycling and other sustainable waste-management strategies, according to McAllister (2015), but fail to participate in pro-environmental initiatives such as recycling programs.

A culture of community non-participation in decision-making is fostered by a lack of interest in the environment. This kind of thinking adds to a lack of accountability when it comes to pollution and waste. As a result, people are either unaware of or apathetic about their environmental impact (Poswa, 2001). This could boil down to the difference between knowledge and information. It's possible that informing individuals who don't know what they don't know

will not lead to a change of heart.

2.25 Transforming Community Interest in Waste Management

If the above communities are provided with new waste management information, they may be more inclined to accept and implement reforms. Researchers have long recognized the necessity of raising public understanding of waste management and community participation (Lumbreras *et al.*, 2014). When people witness others recycling in their neighborhood, they are more motivated to join in garbage control initiatives. Because formal recycling systems are scarce in underdeveloped countries, affluent residents rely on informal recyclers (O'Connell, 2011). Thus, environmental knowledge and responsibility enhances individual conscience and inculcates sustainable consumption patterns, and waste management education (Aini *et al.*, 2002). However, if information on recycling was insufficient, good attitudes may not have resulted in recycling (Aini *et al.*, 2002). As a result, waste managers must ensure that the information provided by the public is compatible with their past understanding.

Banga (2013) argued that the extent of knowledge on solid waste management confounded with household income, educational level, and gender in its influence on participation. In Ogun State, secondary school teachers were competent and knowledgeable on rubbish management.

However, they possessed only crude and antiquated practices. This affected participation different than it would have if they knew of incineration and recycling (Ayodeji, 2012; Adeyemo and Gboyesola, 2013; Mrayyan and Hamdi, 2006).

2.26 Participation on Recycling

Recycling requires community participation and social awareness to be effective. It is effective if only, the recycling policy and regulation encouraged people-centered approaches (Bolaane, 2006). In a study that analyzed university students' views, level of knowledge and attitude; attitudes were unrelated with practice (Al-Khatib *et al.*, 2015; Arora and Agarwal's (2011)). External incentives (monetary reward and social reinforcement) as well as intrinsic motivation (personal fulfillment) have been established to influence behavior of recycling. Even then, having a strong desire for recycling and a favourable attitude about it does not automatically imply that a person would act appropriately (Aini *et al.*, 2002). Various government agencies and non-governmental groups should employ holistic and systematic strategies and activities to educate the public about the fundamental reasons for recycling as well as the severe environmental consequences of rising waste. Because intrinsic motives have been shown to have stronger motivational factors among respondents, they ought to be fostered and cultivated in order to increase participation in recycling and promote greater environmentally conscious behaviour overall (Aini *et al.*, 2002).

2.27 Awareness and Concern

In order to manage the solid waste crisis, individuals' consciences must be developed through influencing environmental knowledge and concern. Instilling sustainable consumption habits and waste management skills is also critical. Environmental awareness and understanding of environmental conservation, according to research, have a positive impact on recycling attitudes.

Professionals in waste management must take initiatives to increase public awareness of solid waste management (McAllister, 2015). SWM techniques' environmental impact is becoming better understood (ISWA and UNEP, 2002). Recent surveys show that waste disposal has become a major source of concern for many households. The interest in SWM is gaining

popularity as a result of its influence on social concern for the environment (De Oliveria & Borenstein *et al.*, 2007). Perceptions that mismanagement of waste is associated with health issues (such as cancer) is of greatest importance in bringing about the concern especially among the less educated people (Sessa *et al.*, 2009). Twumasi (2017) investigated solid waste management techniques and awareness in Ghana's Winneba municipality. The majority of respondents who were aware of solid waste management strategies did not want to use them

2.28 Role of Attitude in Solid Waste Management

As the urban population grows, solid waste management has become a significant concern. SWM has harmful health and environmental repercussions, and it's getting worse, particularly in developing countries. Procedures for solid waste management are designed to address the environmental, health, aesthetic, economic and land-use difficulties that bad waste disposal causes for countries, towns, businesses, and individuals all over the world (Henry *et al.*, 2006; Nemerowet *et al.*, 2009).

The vast majority of waste is dumped in undesignated places along roadsides, rivers, and drainage systems, where it is not collected. As a result, residents face health dangers as well as environmental catastrophes. In residential areas, uncollected waste attracts rodents and insects, which are linked to diseases like cholera.

2.28.1 Responsibility and Action

Environmentally sound waste management must go beyond the safe disposal or recovery of wastes generated, and aim to change the core causes of the problem, which are unsustainable production and consumption habits (Ngoc & Schnitzer, 2009). For this to happen, an integrated

approach that unifies development, manufacturing and consumption is required, following a framework of a hierarchy of objectives focused on the four major waste-related program areas:

1) waste minimization, 2) environmentally sound waste reuse and recycling, 3) environmentally sound waste disposal and, 4) treatment and expanding waste service coverage.

The paradigm must shift from just regulation to insistent persuasion of inhabitants being educated on good waste management practices. Asmawati *et al.*, (2012) claimed that all material in the world have a use in some form including waste. It is people's ignorance that leads them to categorise some things as useless. Thus, people's attitudes must change to realize that the solution lies in treating waste as a valuable resource rather than a product that must be cast away.

2.28.2 Ring-fencing Knowledge and Attitude

Knowledge and attitude have worked as SWM drivers in high-income nations. According to Mihai & Grozavu (2019), open burning, dumping and polluting incinerators are all regarded poor practices that have led to negative impressions of modern SWM tactics among the general population. Negative views have inevitably led to a negative reaction to new waste management systems no matter how clean or sustainable they may appear (Wilson *et al.*, 2015). Movement toward better management of solid waste is hindered by a negative attitude and a lack of understanding about sustainable solid waste management. Many studies have been conducted in underdeveloped countries in order to identify and implement techniques that can help reduce littering through behavioural change but nothing much has been achieved (Al-Khatib *et al.*,

2009). To overcome public attitudes and unsustainable behaviour, good SWM requires effective communication, active participation of all essential stakeholders and a broad public understanding of SWM requirements. Behavioural adjustments are required for repair, recycling re-use, home composting and sustainable consumption among other SWM best practices and

procedures (Wilson *et al.*, 2015). Raising public awareness and focusing public attention on the need to attain sustainable behaviour through such measures have also been SWM drivers.

According to the findings of an Indian survey, even while respondents regard garbage as an issue in Delhi they have minimal knowledge of how to fix it (Milea, 2009). The basic process through which humans acquire knowledge of the world is by the way they interpret issues. This also includes our sense organs' reactions to external stimuli (sight, hearing, touch, taste, and smell) (Gibson & Tierney, 2006). Perceptions are shaped by our knowledge, resources, beliefs, values and conventions but they can also be formed without prior experience with the object or person (Mariwah *et al.*, 2010).

A person's attitude refers to how they feel about something or how they think in cooperative or uncooperative behaviour (Krosnick, 2014). Individuals' attitudes toward solid waste management are positively influenced by knowledge and education but they have little influence on environmental conditions (Browne *et al.*, 2014). It has been shown that attitude is a significant predictor of an individual's intention or behaviour toward solid waste management and the association is considerable (Ifegbesan, 2010; Kumar, 2012). Awareness creation, building campaigns and teaching on the harmful effects of improper garbage collection on public health and environmental circumstances can confer knowledge. This in turn can be used to positively influence attitudes (Bernstein, 2004; Vicente and Reis, 2008 Goh *et al.*, 2013).

2.28.3 Shaping behavior as Part of SWM Design

Environmental attitude is a deep-rooted phenomenon in an individual's self-perception of the degree of connectedness between the individual and the environment (Schultz and Zelezny, 2000; Ajzen and Fishbein, 1980). It serves as a precursor to attune behavioural degree of positivity or negativity (Ajzen, 1991) as viewed by the community (Warner, 2006). It is critical that the

design and implementation of a municipal solid waste management system include a thorough examination of main stakeholders' current behaviour, including their attitudes, world views and values (Suleman *et al.*, 2015). The cultural and social surroundings influence the attitudes of the urban population the most. Rewarding and reinforcing ideas, behaviours, and attitudes are more likely to be repeated and assimilated into value set and behaviour patterns (Gagne, 2003). The effective use of incentives and prizes increases the likelihood that the individual who is recognized will repeat the desired attitude, as well as serving as a motivation for others to do the same (Johnston, 2010).

Most community members are rarely involved in decision-making and as a result, they have a poor or non-concerned attitude toward waste management, rendering them irresponsible (McAllister, 2015). Nevertheless, a functional waste management system can have a positive impact on people's behaviour and attitudes, especially where basic needs of food and shelter have been met or are satisfied. Having a good attitude toward a particular action strengthens the intention to engage in that behaviour. But people's attitudes toward recycling and waste management are rarely influenced by their occupation, gender, or educational background. There is a discrepancy between an individual's values and conduct in the attitude/behaviour gap. This is particularly evident when it comes to the discrepancy between people's worry about the environmental harm caused by household garbage and their lack of interest in waste reduction or other ecologically beneficial activities (O'Connell, 2011).

2.28.4 Perceptions of Solid Waste

Abdul-Rahman, Wang, and Yap (2010), described perception as the ability to see, hear and interpret something. Perception is positively related to people's waste recycling and reuse behavior and have a significant role in determining a person's willingness to participate in solid waste management strategies (Haider *et al.*, 2015; Choon *et al.*, 2017).

2.28.5 Littering Behavior

Littering is a harmful behaviour that is frequently linked to poor solid waste management in underdeveloped countries. A lack of societal pressure to discourage littering, a lack of genuine fines or regular enforcement, and a lack of understanding of the environmental consequences of littering all contribute to the rise in public littering (Al-Khatib *et al.*, 2009). There are several factors to examine, including the amount of trash present at a given area, signs indicating the presence of litter bins and the number, placement, and the look of waste collection bins at a given location. Many studies have shown that having simple garbage bins is a top priority when disposing of rubbish and that having insufficient or unavailable garbage bins is enough to cause littering (Henry *et al.*, 2006).

Because there are no official processes for sorting and disposal in particular communities, people become accustomed to dropping their waste on streets and other undesignated areas and when changes are made they do not change their behavior of disposing waste because of the custom and habit (Yousif & Scott, 2007). Likewise, a variety of socio-economic reasons influence society views on littering, as well as how frequently people litter and how effective it is to stop someone from littering (Al-Khatib *et al.*, 2009). Because such characteristics vary by place and culture, it's critical to perform your research before coming up with a litter-prevention strategy.

2.28.6 Age and Behavioral Change in SWM

Because there is limited history of establishing informal and formal community environmental education awareness initiatives in underdeveloped nations the difficulty of waste management has just lately arisen. In order to educate inhabitants and foster the development of environmentally good community waste behaviour, such initiatives must be adopted swiftly.

Beneficial programs should be designed in such a way that they will engage their target

audiences in expanding their environmental knowledge, attitude, skills, and behaviour. In this regard, the process of determining prior knowledge of specific age groups should be taken as the first step in the program design, which includes categories such as level of knowledge, everyday application and sources (Palmer, 1995; Caneer, 1997; Tucker *et al.*, 1998), as well as the targeted audiences' behaviour intention and attitude (Ballantyne and Packer, 1996; Ballantyne, 1998).

University students, according to Arora and Agarwal (2011), have a negative attitude toward waste management. Furthermore, although there was a significant correlation between waste management knowledge and practices, there was no association between waste management knowledge and attitudes or practices. Environmental researchers must assess student attitudes and comprehension on the subject of waste management in our cities and the environment as a whole, and make recommendations to key stakeholders, due to a huge knowledge gap (Eneji *et al.*, 2016).

2.28.7 Practices used by Residents in Managing Solid Waste

People generate municipal solid waste as a result of civilisation and industrialization (Soltani *et al.*, 2015), Incineration, composting, recycling, and landfilling are the most frequent waste disposal strategies (Magrinho, Didelet *et al.*, 2006), Narayana, 2009).

2.28.8 Final Disposal of Waste

The term "solid waste disposal management" refers to the collection and processing of solid wastes. It offers recycling options for items that should not be discarded. Solid waste management is the process of turning trash into a profitable resource. The management of solid waste is a significant technical challenge. They can also set off a chain reaction of economic, administrative, and social issues that need to be addressed (UNEP, 2005).

Solid waste disposal, as the final phase in solid waste pollution control, attempts to separate solid waste and its environmental impact from the biosphere, keep harmful components in wastes

below bearable levels, and ensure the safety of human health and the environment (Soltani *et al.*, 2015). Waste disposal to regulated landfills, on the other hand, should only be used as a last resort when further waste treatment is neither economically or physically feasible (Hamer, 2003). Unfortunately, due to low prices, unregulated land-based waste dumping is the preferred alternative in many Asian cities. Dumped garbage produced liquid and gaseous emissions, rendering the region useless, and dump sites quickly become breeding and hosting grounds for enormous numbers of disease-bearing organisms. Nonetheless, professionally-managed sanitary landfills should be used to replace open dumps in order to reduce waste-to-environment contact by concentrating rubbish in a well-defined and regulated area (UNEP, 2005).

Waste management sustainability, according to the World Bank, is crucial for providing an effective service that meets end-user needs. Strategic planning is one of the pillars of long-term solid waste management. A cost analysis of solid waste disposal options is another pillar. The world is coming to the realization that governments cannot fund, manufacture, or manage infrastructure on their own. The development of waste infrastructure necessitates collaboration between the public and commercial sectors.

2.29 Best Global Practices in Waste Management

Sustainable waste management is a crucial paradigm for a circular economy that delivers chances and benefits to current generations' society, economy and environment without risking future generations' requirements (Lieder & Rashid, 2016). Sorting, collecting, recycling and processing waste are all part of sustainable waste management and when done correctly, they can provide energy and resource source (Demirbas, 2011). As a result, waste management techniques are improved, employment are created and human and environmental impacts are reduced, resulting in improved water and air quality.⁴⁸ The deposit-refund scheme is one of the most

effective waste management initiatives. Returning drinking bottles and cans in exchange for monetary reimbursement, reducing landfill pressure, increasing recycling rates and extending the product's life cycle (Oke *et al.*, 2020).

Recycling is the principal waste management approach, if residents are responsible for separating waste and transferring it to a recycling centre (Sherburne, 2019). Recycled waste may be used as a resource for generating energy or bio- fertilizers.

Unique solutions for sustainable garbage management have been created in some developed economies where robotic machines clean trash and debris from the river (Louis, 2004). In Australia, for example, *SmartBelly bins*, are used to sort waste at the point of collection, compost and treat waste, as well as connect individual bins to garbage collectors, speeding up the waste process. A design firm in Rosenbaum, Brazil, promotes people to repurpose plastic garbage to embellish and decorate their homes while ECOBOT vending machines in Columbia provide monetary rewards, vouchers and movie tickets to those who deposit plastic bottles (Louis, 2004).

2.30 Challenges in Sustainable Waste Management

One of the most difficult components of waste disposal is the collection methods. Certain waste collectors supply garbage containers, but others provide garbage bags. In many underdeveloped countries, neither is available. Different coloured containers for different types of waste are used in industrialized countries. Glasses should be placed in blue bins, papers in green bins, and other trash in red bins. In Sweden, waste bin contents are regulated, and mistakes like placing food scraps in the bins or putting the wrong stuff in the wrong container can result in severe fines.

Trash containers are preferable to waste bags because of their longevity. If collectors do not remove rubbish from the bags, animals and rodents may rip the bags. Bags, on the other hand, may appear to be less expensive at first than dumpsters (Louis, 2004).

Transportation is another issue. Waste transportation from the collection location to the disposal site is a severe problem. Because of the enormous distance between the collecting hubs and the disposal location, this is the case. In poorer countries, poor roads are a major hindrance to waste management. Having disposal sites at each local government in the state is less expensive.

Another issue with garbage disposal is figuring out how to deal with the waste that has been collected. Waste management necessitates both technological and technical knowledge. Landfills and garbage dumps in most circumstances become environmental dangers and eyesores. Waste disposal facilities should be tucked away in green zones with a buffer zone around them to keep them hidden from view or buried in the woods to protect community's health (Thompson, 2010). It's important to highlight that collected solid waste is mostly disposed in open dumpsites in Kenya and other developing countries. It's also worth noting that waste collection has been delegated to local governments.

In Nairobi, inorganic waste is purchased in bulk from vast groups of unregistered individual trash pickers and neighbourhood-based itinerant waste traders and sold in bulk to large-scale trash recyclers by licensed waste dealers (Baud *et al.*, 2004). According to Karanja (2005), garbage collection in Nairobi is divided into two types: street picking, which takes place largely in small open city waste sites, streets, and dustbins; and waste dump pickers, who work in big official or illegal dumpsites. At the Dandora dumpsite alone, there are over 2000 pickers and dealers who make a living from the recovery and sale of recyclables (Karanja, 2005). Garbage

management is affected by quality of equipment, road design, and urban planning in addition to funding and labour availability and quality. It is further complicated by stakeholder coordination and collaboration.

Garbage disposal challenges in Kenyan cities are analogous to those in other African towns. Nakuru's expanding population has resulted in an increase in waste dumping, resulting in the town's previous status as "East Africa's cleanest town" being shattered (Karanja, 2005). Because of the growing urban population and the increase of informal settlements, demand for essential services such as water, rubbish collection, and sanitation much outnumbers supply. In order to manage urban concerns such as garbage disposal, a lot of groups must come together to pool resources (Karanja, 2005).

2.30.1 Knowledge Gaps

This study looked at how knowledge, attitude, and practices affect solid waste management. It aims to fill the gap left by studies like Mahmood *et al.*, (2019), Twumasi (2017), Sudipta *et al.*, (2016), Eneji *et al.*, (2016) and Dauda *et al.*, (2015). While all these studies are on solid waste management they focused on different aspects of SWM and did not adequately address

knowledge, awareness, attitude, and practices and their interconnections in solid waste management. Some address practices leaving out the attitude and knowledge (Awomeso *et al.*, 2021; Mule, 2013). Others failed to crosscut regions and identify core responsible factors (Abdulghan *et al.*, 2019) and their interactions with demographics (Barloa, 2016). Scholars have paid little attention on how knowledge, attitude and practices affect solid waste management leaving a void that this study intends to fill (Khatib & Arafat, 2009; Sudipta *et al.*, 2016; Ariva *et al.*, 2015; Chengula *et al.*, 2015; Twumasi, 2017).

2.31 Theoretical Framework

2.31.1 Theory of Planned Behavior

Ajzen (2002) established the Planned Behavior Theory, a model of planned environmental conduct that considers the intention to act and objective situational factors as direct determinants of pro-environmental behavior. The intention is seen as a summary of the interaction of cognitive variables (knowledge of action techniques and challenges, action abilities) and personality traits (locus of control, attitudes and personal responsibility). The Planned Behavior Theory grew out of the Theory of Reasoned Action, which proposes that three norm constructions drive human behavior: beliefs about consequences, expectations of others and items that may support or hinder behavior (Hammond & WRI, 1995).

The theory's central premise is that at a conceptual level, links between influences on behavior and their outcomes are captured by one of the model's components or relationships. The model's application to this study is that it provides further insight into the relationship between knowledge, attitude, behavioral intention and actual behavior as they influence waste management techniques.

Although knowledge is not a distinct component in the model, "attitudes are a function of norms, since norms pertain to information about a certain conduct in this context. As a result, Azjen's (1991) paradigm allows for the depiction of cognitive elements via affective factors' influence on norms. A person that is knowledgeable has control over a situation, for example, over their behavioral intentions and beliefs about the outcome. This is a reflection of understanding.

This theory has been applied in broad areas of behavior so as to gain insight as to why

individuals behave in certain ways. It is one of the widely supported theories in social psychology as far as human behavior is concerned. It is premised on the fact that behavioural decisions are occasioned by a reason process where behavior is influenced by attitude, perceived behaviour control and norms.

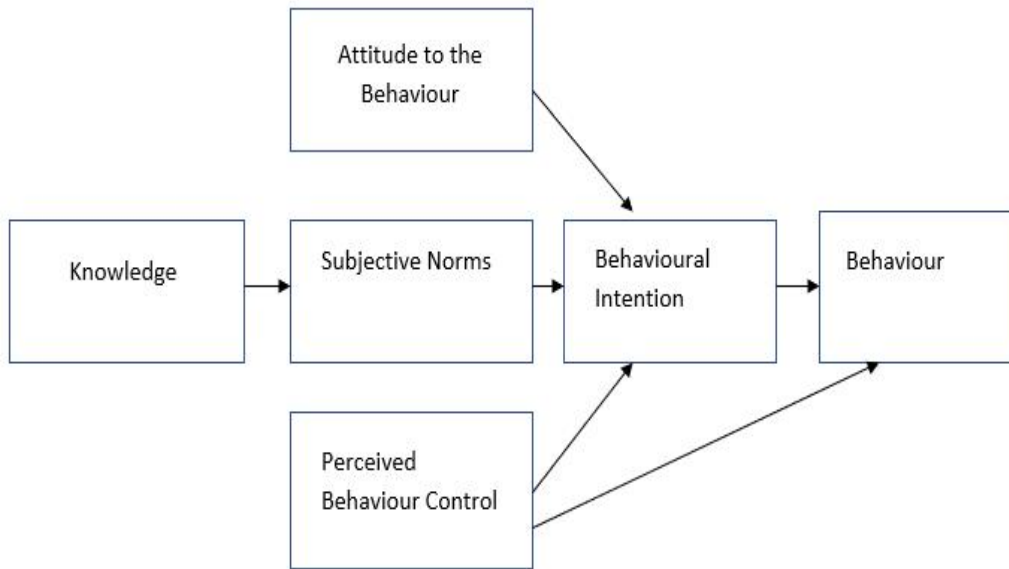


Figure 2.1: Model of Theory of Planned Behaviour by Ajzen (1991)

2.32 Conceptual Framework

This conceptual framework is founded on the idea that people's attitudes toward a phenomenon

are determined by their knowledge about the phenomenon or lack thereof. People's attitudes regarding the environment will be positive if they are properly informed about the surroundings, processes, rules and regulations (Figure 2). When individuals are made aware of the risks of uncontrolled littering, they may recognize the importance of keeping the environment clean. This is because people's perceptions of a phenomenon are influenced to a great extent by their understanding about it. As a result, attitude is considered as crucial because it impacts how people react to the phenomena.

People's attitudes are shaped by their knowledge and their attitudes impact how they react to the phenomenon. People's attitudes on the need to keep the environment clean are expected to alter as they become more aware of the dangers of improper solid waste management. As a result, people will be more aware of how they dispose of waste. Lack of information is likely to lead to a negative impact on their attitude with regard to the environment resulting in uncontrollable littering. Human actions are responsible for all waste that is generated. These activities take place in an environment that includes systems at both the national government, county governments and other agencies. In Kenya these agencies include the National Environment Management Authority (NEMA), Ministry of Environment among others. These systems and entities are responsible for delivering public amenities and waste management information, which should serve as the foundation for waste management expertise.

The independent variables in this conceptual framework are: knowledge, attitude and practices.

The dependent variable is waste management, which is dependent on resident's knowledge,

attitude and practices. There are other intervening variables that directly or indirectly influence the independent variables. In this conceptual model, the intervening variables are the rules and regulations that govern management of solid waste.

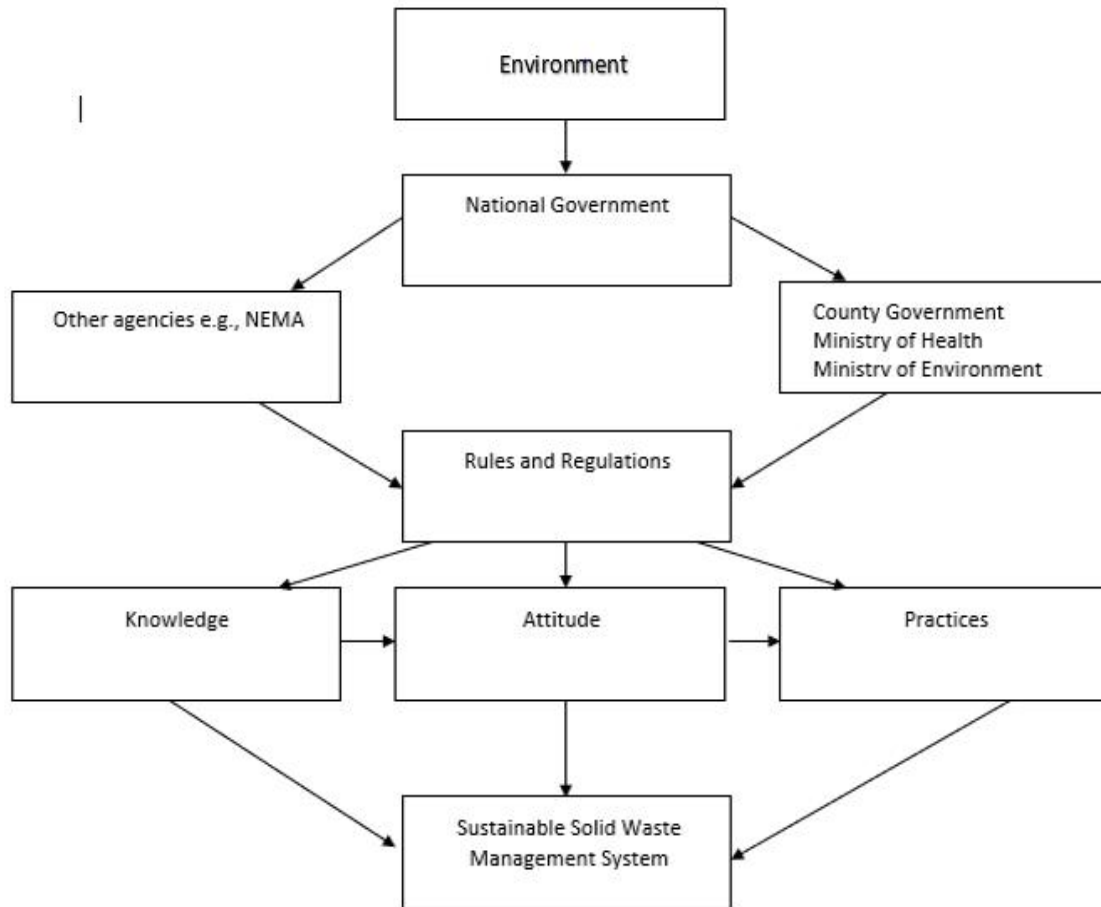


Figure 2.2: The Model of the Conceptual Framework

Source: Researcher

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Study Area Characteristics

The study was conducted in Eastleigh South Ward in Kamukunji Sub- County within Nairobi County, Kenya, located East of the Central Business District at geographical coordinates; 1.2734° S, 36.8481° E (Figure 3). The area of study has several ethnic groups including; Kikuyu, Luo, Kamba with the people of Somali ethnicgroup forming the majority. It is a busy commercial center with majority of business owned by the Somali community. The choice of the study site was based on the fact that it is one of the highly densely populated areas with a population density of 24,455 persons per sq. km and only second to Mathare Sub-County (KNBS, 2019).

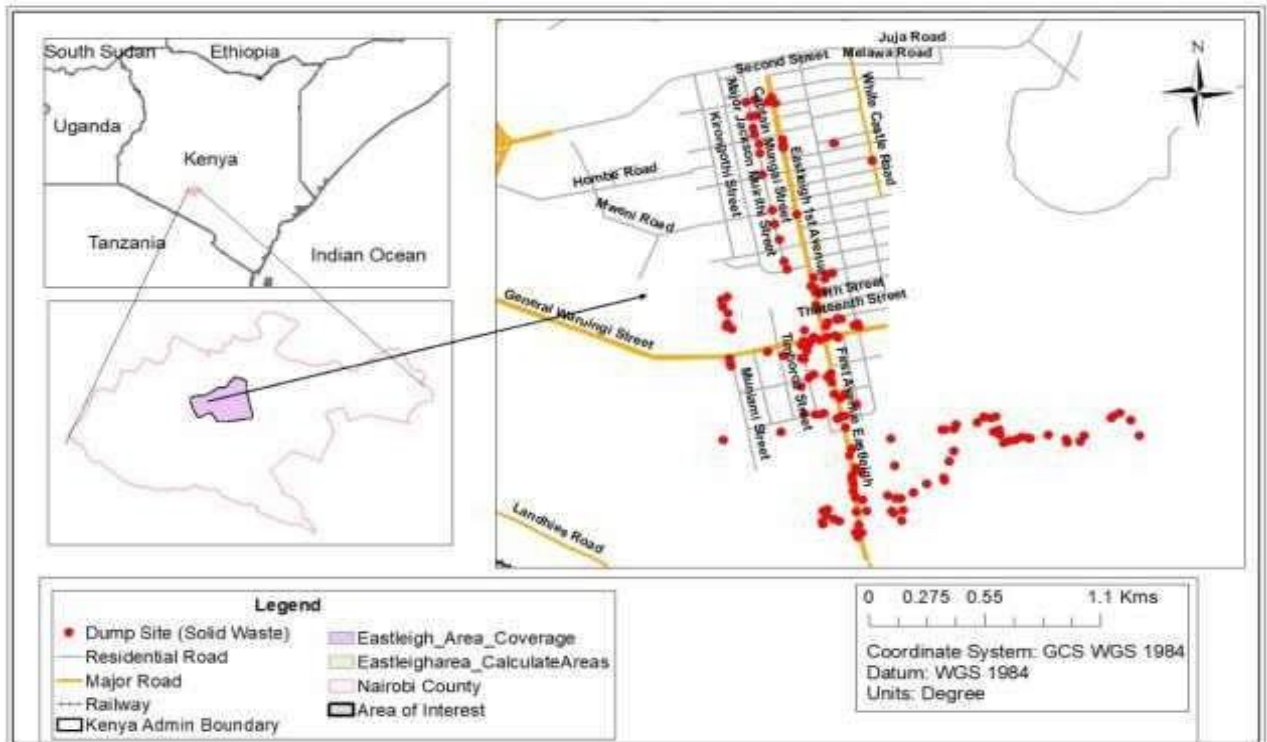


Figure 3.1: Area of Study

3.2 Economic Activities

Eastleigh South Ward is one of the five electoral areas in Kamukunji Sub-County, Nairobi County. Kamukunji Sub County has a land area of approximately 11 square kilometres and a population of 264000 persons (KNBS, 2019). Eastleigh South Ward the area of study has an approximate land area of 4 square kilometres. According to Kenya population and housing census, Eastleigh South Ward has a population of 90,0000 persons and households estimated at 30,000. The study area is mainly a business center and business is the main livelihood activity.

3.3 Research Design

The study used a descriptive research design. A descriptive research design refers to a research method that employs systematic and empirical investigation on facts about characteristics of the population or phenomenon being studied. It describes the present conditions based on reactions of the respondents of the research, nature and status of a situation at a particular time in the study. This design attempts to describe such things as possible behaviour, attitudes, values and characteristics (Mugenda & Mugenda, 2003), which is what this study focused on.

Quantitative and qualitative approaches were used in the process of data collection, which was administered in the form of interviews, questionnaires, field observation and document analysis. Quantitative method involved numeric data that can be measured and counted while qualitative methods involved descriptive and conceptual data to provide in-depth information. Mixed methods approach of qualitative and quantitative data allowed the researcher to cross check data to allow for valid and credible results (Bryman, 2004).

3.4 Sample Size and Sampling Procedure

3.4.1 Sample Size

Using Booth *et al.*, (2003) formula below a sample size of 188 households was obtained and brought to the nearest hundred to give a sample size of 200 respondents to whom questionnaires were administered.

$$n = \frac{(z^2 \times p \times q \times N)}{e^2 (N - 1) + (z^2 \times p \times q)},$$

where:

n	=	Sample size (being determined)
N	=	Population size (29,022)
p	=	Sample proportion (assumed to be 0.02, if not given)
q	=	$1 - p$
e	=	0.02 (since the acceptable error should be 2%)
z	=	Standard deviation at a given CI ($z = 1.96$ at 95% CI)
n	=	200

3.4.2 Sampling Procedure

To identify respondents at the household level, the study used purposive sampling from the three main streets. The three main streets; 1st avenue (now known as Yusuf Haji avenue), 2nd avenue and 3rd street were chosen since they carry most of the flats in Eastleigh South ward in the area of study. Because majority of flats had an average of 3-4 levels, three households from each floor were purposively picked from selected flats on the three main streets. However, the choice of the buildings entirely depended on accessibility, willingness and the cooperation of the caretaker responsible. Selection of households was also done depending on willingness, accessibility and availability of the respondents to participate in the survey.

3.5 Data Collection

The study used three methods of data collection (Questionnaires, key informant interviews and observation).

3.5.1 Questionnaire

Questionnaires that had open and closed questions were used in obtaining data on respondents socio-economic, types and sources of household waste generated, knowledge and resident's practices towards solid waste management. Data collected was examined for consistency, reliability and completeness regularly.

3.5.2 Key Informant interviews

Key informant interviews were conducted through a face-to-face approach at the doorsteps of the sampled households only. The sampled households depended solely on accessibility and the willingness of the respondent to answer the questions. Key informant interviews included ward administrator and other officers in-charge (five participants), caretakers of the buildings (six participants), waste pickers (six participants) and private waste service providers (six participants).

3.6 Data Analysis

Quantitative data obtained through questionnaires was coded, keyed in, using Statistical Package for Social Sciences (SPSS) version 21.0. while qualitative data involved content analysis where data was transcribed and thematically categorized and reported in prose. Frequencies and percentages were used to measure knowledge, attitudes, composition of solid waste, waste storage and demographic factors. Cross tabulation was used to check on association while chi-square analysis were used to assess the significance level.

Table 3.1: Summary of Data Analysis

Thematic Areas	Research Questions	Variables	Analysis Method
Knowledge	1. What are the factors influencing solid waste management?	Age, marital status, education, income	Descriptive statistics
	2. State the nature of the waste you generate?	Food waste, fruits, and vegetable, peelings, old clothing, human waste, plastics, bottles, glass and metal, old furniture and obsolete cutlery	Descriptive statistics (means, percentages, frequency distribution)
	3. Who collects the waste for disposal?	Nairobi County Council, private collectors, self, nobody collects waste	Descriptive statistics (percentages, frequency distribution)
Attitudes	4. Are you eager to know where waste is disposed of after collection?	Yes No	Descriptive Statistics
	5. Do you think everyone has a responsibility towards better solid waste disposal in your locality?	Yes No	Descriptive Statistics
Practices	6. What type of waste storage and collection containers do you use for your household waste?	Plastics containers/buckets, metallic bins, Plastic bags, No storage containers	Descriptive statistics (means, percentages, frequency distribution)
	7. Where do you discard generated waste?	Discarding along the road in a heap/drainage, burning, Disposing at designated collection points, recycling	Descriptive statistics (means, percentages, frequency distribution)
Variables	Descriptive statistics	Descriptive statistics (means, percentages, frequency distribution)	Descriptive statistics (means, percentages, frequency distribution)

CHAPTER FOUR: RESULTS AND DISCUSSIONS

4.1 Demographic Characteristics of the Respondents

Demographic characteristics of individuals; age, marital status, education level, monthly income and size of family have been found to be a vital component when evaluating peoples' knowledge, attitude and practice (KAP) (Castagna *et al.*, 2013; Chu *et al.*, 2016). Among the 200 questionnaires distributed, 118 residents (59%) of the target respondents consented to answer the questions. According to Sekaran and Buogie (2016), a response rate of 30% and above is adequate for a survey. More data was sourced from key informants in the study area. The demographic characteristics of the respondents are presented in Table 1. Majority were aged between 18-44 years (85.5%), 55.1% of whom were married. Majority of respondents (55.9%) had secondary education level. Most respondents' monthly earnings ranged between Ksh. 10,000-20,000 which accounted for 43.2%. Most of the respondents had a family of 4-6 persons (61%) in the household (Table1). Key informants included Ward administrators and other county officers (5), private waste service providers (6), waste pickers (6) and caretakers (6).

Table 4.1: Respondents Demographic Characteristics

Variable	Group	Frequency	Percent
Age	18-24 Years	32	27.1
	25-34 Years	49	41.5
	35-44 Years	20	16.9
	45-54 Years	15	12.7
	Over 55 Years	2	1.7
	Total	118	100
Marital Status	Single	45	38.1
	Married	65	55.1
	Separated	4	3.4
	Widowed	4	3.4
	Total	118	100
Education Level	None	1	0.8
	Primary	9	7.6
	Secondary	66	55.9
	College	42	35.6
	Total	118	100
Monthly Income	<Ksh. 10,000	19	16.1
	Ksh. 10,000-20,000	51	43.2
	Ksh. 20,000-50,000	42	35.6
	Ksh. 50,000-100,000	6	5.1
	Total	118	100
Number of people in household	<3	34	28.8
	4-6	72	61.0
	7-9	10	8.5
	>10	2	1.7
	Total	118	100

4.2 Residents Knowledge on Solid Waste Management

Resident's knowledge on solid waste management was examined using various thematic areas as follows;

4.2.1 Composition of Waste Generated

The researcher assessed the residents' knowledge on the composition of waste generated in their households. Respondents were asked to state the nature of waste they generate. According to the responses given the respondents were aware on the type of waste generated in their households which comprised both organic (Bio-degradable) and inorganic waste (non-biodegradable). Of the respondents, 43% indicated that most of the waste generated comprised food remains and same for fruits and vegetable peelings with 12% indicating old clothing and 2% human waste (Figure 4). All comprising the organic waste.

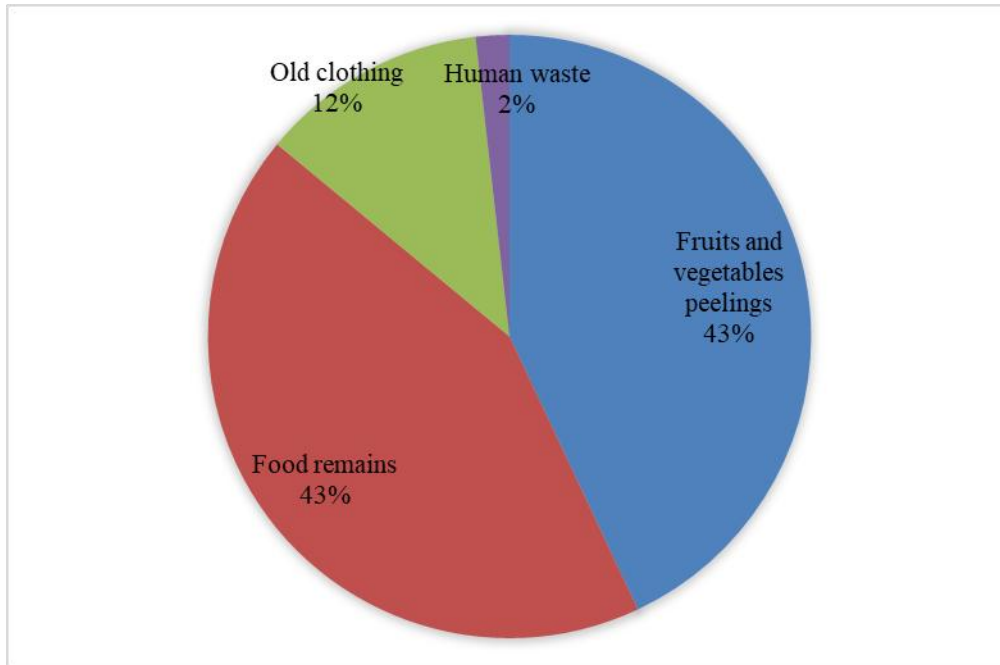


Figure 4.1: Composition of Organic Waste (Bio-Degradable)

Inorganic waste comprised mainly various plastics (40.6%), empty bottles (32.3%), broken and obsolete cutlery (plates, spoons and cups) (18.9%) with 4.2% of the waste generated from glass and metal while 2.5% was from broken and old furniture (Figure 5). Research carried out by Mwaura (1991) on the composition of waste generated in Nairobi indicated that organic matter constituted 58%, plastics 13.8%, papers 11.3%, inorganic 8.3% and leather and textiles at 7.8%. In another research by Kasozi & Von (2010) established waste characterization in Nairobi stood at; organic 58.6%, plastics 15.9%, paper 11.9%, glass 1.9%, metal 2.0%, and others at 9.7%. Both researcher's findings are fairly consistent with this study. In all the studies the food waste in solid waste has always been high.

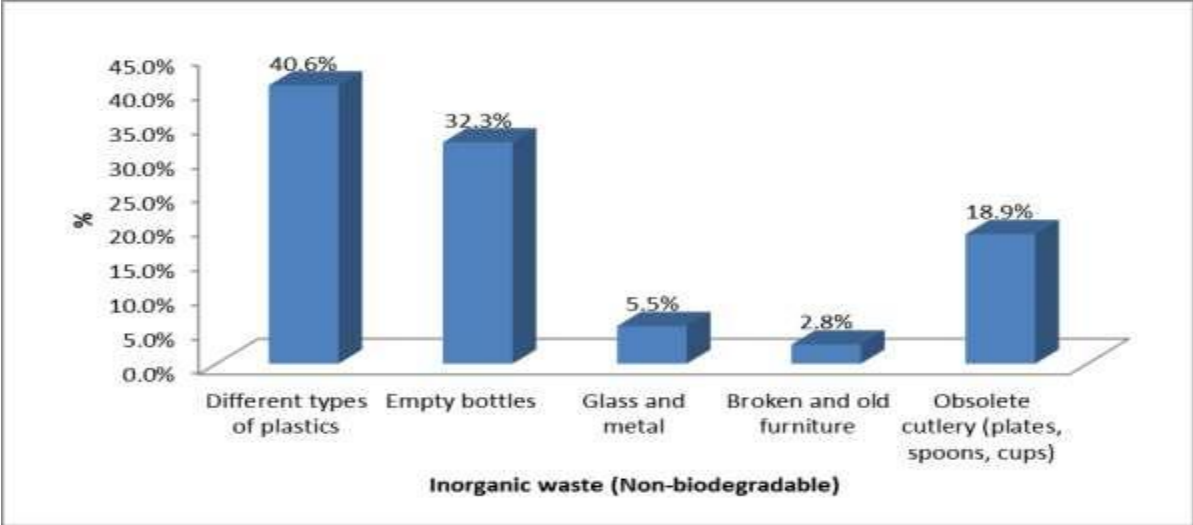


Figure 4.2: Composition of Inorganic Waste (Non-Biodegradable)

The findings of the study indicated that due to improper methods of waste collection and storage, separation was not done and waste ended up in undesignated areas. This is despite the fact that laws, policies, strategies and regulations governing solid waste management exists. For example, Environment Management and Co-ordination (Waste Management) Regulations 2006 provides general provisions; No person shall dispose of any waste on a public highway, street, road, recreational area or in any public place except in a designated waste receptacle. The regulation also states that any person whose activities generate waste has an obligation to ensure that such waste is transferred to a person who is licensed to transport and dispose off such waste in a designated waste disposal facility. However, these regulations are hardly adhered to. Providing suitable management systems of waste in residential areas would reduce solid materials production and create effective systems in the city (Grey *et al.*, 2005). Identification of types of solid waste generated within the business zone is vital to help in determining viable management plans and programs to involve the public in. To reduce the use of plastics, strong campaigns against single use are needed to avoid high production of plastic materials such as bottles and food containers.

4.2.2 Levels of Waste Generated

The study sought to rate level of waste generated from respondents. Table3 indicates how respondents rated the levels of waste in their residential area. About 40.7% expressed that the levels were average with 33.10% indicating levels were high while another 12.7% said the levels were very high. For a long time solid waste collection and disposal in Nairobi has been characterised by unfavourable, inadequate and inefficient organisational set-up. Less than 40% of the city receive waste collection services. The remaining 60% is either dumped in open spaces and burnt or scavenged (Mwaura, 1991).

Table 4.2: Levels of Waste Generated

Level of Waste Generated	N	Percentage
Low	16	13.6
Average	48	40.7
High	39	33.1
Very high	15	12.7
Total	118	100

With rapid increase in urban population, waste generation has increased tremendously with much of it ending up in undesignated dump site. In a study by Dhamija (2006), in India in 2001, the population in the urban areas had increased to 93.0% from 52.7% in 1901. This led to significant increase in solid waste in urban areas resulting to a hazardous dimension. The waste estimate generation increased from 4,500 Metric Tonnes/day (MT/day), 6,500 MT/day to 12,000 MT/day in the year 1981, 1991, and 2001 respectively. This is expected to rise to 17,000-25,000 MT/day by 2021 with assumption of 6-8% growth rate. In Nairobi, there is a similar situation of population increase where from 1969 to 2019 population has grown from 509,000 to 4,397,000 (Figure 6) with a growth rate of 4.1% (KNBS, 2019). The increase in the number of residents in Nairobi City County coupled with economic growth has led to increased in Municipal Solid Waste generation (Marcussen, 2020). In Eastleigh South Ward the population stands at 29,022 in an area of 4sq.km.

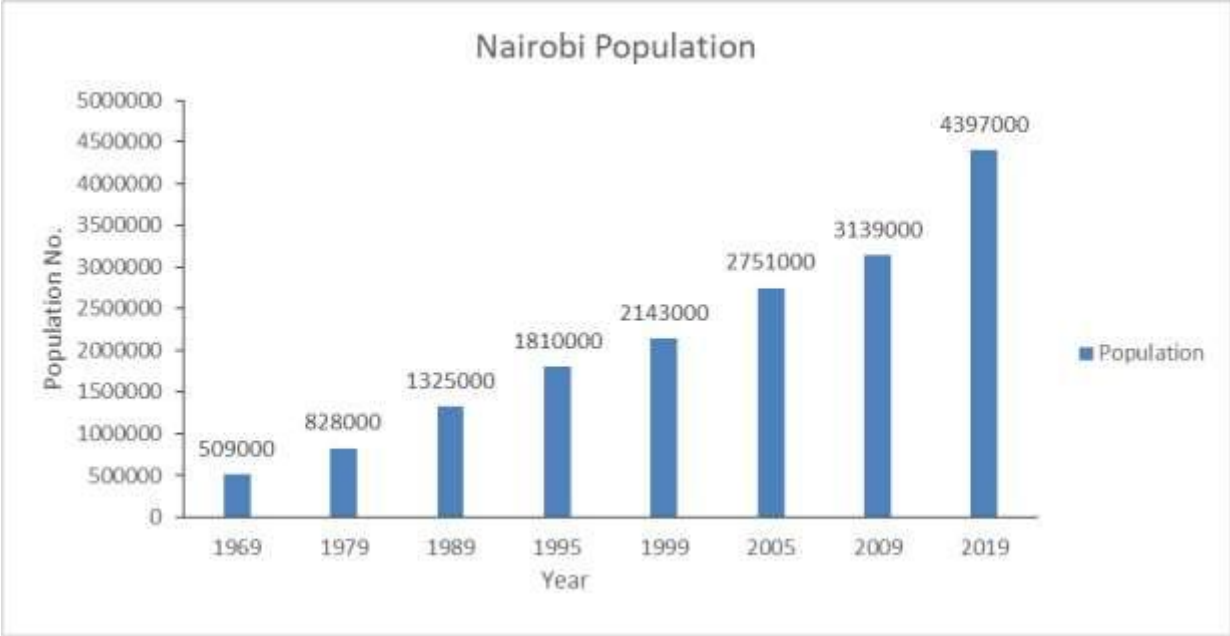


Figure 4.3: Nairobi Population Trend from 1969 to 2019 (KNBS, 2019)

During the field visit, observations showed waste was usually disposed unsorted in heaps in undesignated areas. According to Firdaus & Ahmad (2010), waste generated is drastically increased when relevant agencies charged with collecting and disposing waste are unable to deal with the large quantities produced on daily basis. This results to accumulation and rotting of uncollected garbage at collection sites, this study revealed that this is the situation in Eastleigh South Ward. According to a study by Wilson *et al.*, (2006) communities should be prevailed upon to take responsibility of their own waste collection and disposal. Through community self help, self interest is enhanced and waste management costs greatly reduced.

4.2.3 Waste Sorting

The sorting of waste before disposal is beneficial since this helps in separating recyclable material from un-recyclables. Residents were asked to indicate whether they sorted waste before disposal. The finding of the study did not establish significance difference ($p=0.815$) between knowledge and solid waste management (Table 3).

Table 4.3: Waste Sorting

		Do you perform any sorting of waste in your household before disposal		Total
		Yes/%	No/%	
Education Level	None	1	0	1
		100	0	100
		0.9	0	0.8
	Primary	9	0	9
		100	0	100
		7.7	0	7.60
	Secondary	65	1	66
		98.5	1.5	100
		55.6	100	55.9
	College	42	0	42
		100	0	100
		35.9	0	35.6
Total		117	1	118
		99.2	0.8	100
		100	100	100

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.795a	3	0.851
Likelihood Ratio	1.169	3	0.76
Linear-by-Linear Association	0.174	1	0.677
N of Valid Cases	118		

Although majority (65.3%) of the respondents claimed to sort waste, however, from observations done it was found out that waste was unsorted before disposal. The respondents were also asked whether they were aware of the importance of waste segregation of which none of the respondent provided an answer. This indicates lack of knowledge on importance of waste sorting among the residential dwellers. According to key informants, people did not sort solid waste generated while those who sorted it did the sorting at the collection centers and sold the sorted waste to buyers for eventual recycling and re-use. The knowledge of the waste sorting does not influence solid waste management. Hence, the researcher accepts the hypothesis that resident's knowledge has no bearing on solid waste management. The study established that residents had little or no knowledge on sorting and that explains why most of the waste was left unsorted. According to (NEMA, 2015) very few households do any segregation of waste at household level. There is also very little sorting done at source within the CBD areas in institutions, industries and in most towns. The recovery of recyclable items like Glass, plastics, metals and papers is mainly done by informal groups which keep growing by day. Collection transportation of waste in CBD is mainly by the county government while the private operation continues to dominate in residential areas at a fee. Waste collection is low in low income areas while informal settlements collection is done by CBOs and organised groups.

Citizens are key players in the management of waste. They are consumers of goods and services, generators of waste, main players of waste minimisation and sorting at source. Their participation or lack of it determines the success or failure of the adoption and implementation of waste management initiatives (Kenya Waste Management Policy, 2019).

Interestingly, waste paper collectors are the ones who sort and separate waste at the illegal dump sites for sale to recycling firms, residents are also not compelled to sort waste. Failure to sort may be attributed to lack of residents' interest in waste disposal as it did not have a pecuniary interest to them.

According to Guerrero *et al.*, (2013) study carried out in over twenty-two developing countries indicate that when information is availed to citizens on the benefits of sorting and recycling they are more likely to participate in these activities. Social norms influence the change of behaviour and participation in sorting and recycling activities. People are likely to be inclined towards recycling when they observe others in the community do so. It is therefore imperative to reach out to influential members of the community to lead in changing these negative environmental tendencies (O'conell, 2011).

Marshall and Farahbakhsh (2013) opines those issues of public acceptance, changing value systems, public involvement in both planning and implementation and changes in waste behaviour are as important as the economic and technical aspects of management of waste. Capacity building in sorting of pre-disposal waste can therefore be beneficial and facilitate reusing and recycling of waste.

4.2.4 Service Providers of Solid Waste Management

About 53.4% of the household respondents indicated private collectors were mainly responsible for collection of waste at household level. Another 30.5% of the residents indicated Nairobi City County Government was responsible while 7.6% indicated collectors were unknown people to the residents. However, 3.4% of the respondents showed no knowledge on who collects waste in their area (Table 4). According to key informants, waste from the households was put in a central

collection point in sacks, plastic containers, metallic bins as well as in County skips awaiting collection by service providers who included private collectors and Nairobi City County to the designated dump site in Dandora. However, lack of equipments and ever-increasing population was indicated by key informants as the biggest challenge in solid waste management.

Table 4.4: Solid Waste Management Service Providers

Question	Waste Collection	N	Percentage
Who collects waste in your area?	Private Collectors	63	53.4
	Nairobi County	36	30.5
	Government		
	Unknown people	9	7.6
	Self	6	5.1
	Nobody collects the waste at all	4	3.4
	Total		118

In accordance with the National Environment Management Authority (NEMA) the waste providers are either the Government or the private sector. Waste service providers plays a key role in organizing, collecting and transportation of waste in an environmentally friendly manner. Although SWM is mainly vested on the Government through the county authorities, they lack necessary facilities and incentives to deal with the waste generated hence resident seek private service providers. Nairobi City County Government should also provide adequate service, equipment, and regularize collection and disposal to avoid accumulation of uncollected waste.

4.3 Sources of Information on Waste Management

Residents were asked to mention sources of public information on waste management in the area. From the results 81.0% of the respondents indicated waste management information was sourced from county workers; another 4.8% indicated media as the source of information. A small number of respondents (2.9%) cited community volunteers as the source of information, 11.0% of the respondents had no idea on how waste was managed, an indicator of poor knowledge on proper waste management (Figure 7). Although most respondents indicated information on solid waste management was available, observation revealed that it was not reflected in their practices. The County Government and other environmental agencies need to have clear communication channels so that crucial information can reach residents' in order to inform attitude.

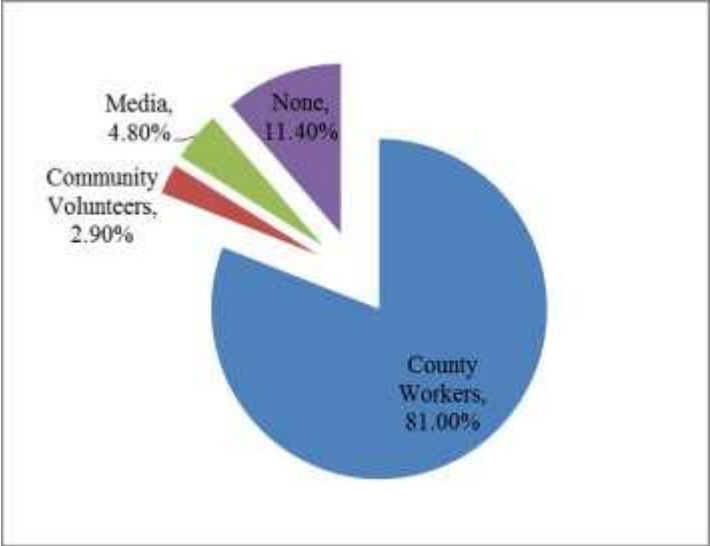


Figure 4.4: Sources of Public Information on Waste Management

4.4 Waste Related Environmental Problems

Respondents' showed good knowledge on the impact of poor waste management which included blocked sewage drainage systems (26.1%), air pollution and health issues both at (23.9%) each, land pollution (21.7%), while water pollution was least at 4.4% (Table 5). Report from key informants showed the main health and environmental effect of poor solid waste management was blockages in sewer lines which consequently lead to water borne diseases such as typhoid that is a risk to human health. The findings of the study indicated residents had knowledge and were aware of the dangers of an unhealthy environment. Enhancing resident's environmental awareness would be the most effective method to improve solid waste issues (Song *et al.*, 2016).

However, these findings may mean knowledge does not always translate to change in practice similar to observation made (Hines *et al.*, 1987). Innovative ways of supporting change may be therefore necessary, for example, nudges (reminders), incentives and dis-incentives to reinforce good practices and deter negative practices and infrastructural investments to support change in practices.

Table 4.5: Environmental Problems Associated with poor Solid Waste Management.

Environmental Problems	N	Percentage
Blockage of sewage drainage	47	26.1
Health issues	43	23.9
Air pollution	43	23.9
Land pollution	39	21.7
Water pollution	8	4.4
Total	180	100

4.5 Residents Attitude on Solid Waste Management

Momoh & Oladebeye (2010) defines attitude as acquisition of values and feelings of concern for something. If positive values towards solid waste management were inculcated in residents, they would get more involved in conserving the environment. According to UN Habitat (2006), attitude is a state of alertness of mind which through experience is organized and directs the individual's behaviour towards something. Attitude has a great influence on how an individual think towards a thing or a situation. It drives an individual's reaction since it tags along with it deep feeling and emotion. This explains why people react to the same situation differently. While some may value a clean environment, others may not and not because they do not know the value, but they simply don't care.

Spector *et al.*, (2014) indicates self report is a good method where members of a group report directly about their attitudes. Self report present the most direct type of attitude assessment and should be used unless the people being evaluated are unable or unwilling to provide the information being sought. Self report incorporates procedures by which an individual is asked to report on their attitudes. This information can be provided orally through interviews, surveys or polls or in written form through questionnaires, rating scales, journals, diaries including logs. Questions like "How do you feel about XT" where X is the attitude construct under study are asked often in reports. According to Encyclopaedia Britannica on attitude, attitude in social psychology is a cognition, in most cases with a degree of aversion or attraction i.e. emotional valence that reflects the classification and assessment of objects and events. While attitudes are hypothetical constructs logically (i.e. they are inferred and not objectively observable), they are manifested in conscious experience, verbal reports, overt behavior and physiological signs.

According to the study findings about 91% of the residents have secondary education and above a clear indication knowledge is abundant. However, owing to their negative attitude, they discard waste indiscriminately. This behaviour appears to give credence to Chekole (2006) argument that the reason for continued increase of waste in urban centres is occasioned by some residents care free attitude who despite knowing what should be done do not care at all. Some residents in Eastleigh South Ward have a don't care attitude and they dispose waste directly to the roadside, in the drainage channels and in open spaces.

4.5.1 Residents Participation in Solid Waste Management

Residents were asked if they have ever participated in environmental clean-up activities. About 48% of the residents indicated they have never participated in any. There was a significance difference ($p < 0.001$) on resident's participation in environmental clean-up activities (Table 7). This is an indication that unclean environment does not bother them further depicting their negative attitude which tends to influence their behaviour on solid waste management. Chekole (2006) attributes continued growth of the amount of waste in urban areas to ignorance of some residents towards the impact of uncontrolled dumping and the don't care attitude displayed by some residents. Eastleigh South Ward suffers greatly from this negative attitude on the part of residence.

Table 4.6: Residents Participation in Solid Waste Management

Attitude		N	Percentage	P-Value
Have you ever participated in Environmental clean-up activities?	Yes	7	30.4	<0.001
	Never	11	47.8	
	Sometimes	5	21.7	
	Total	23	100	

Though majority of residents indicated that heaps of waste in the environment is annoying, it is interesting to note that some residents indicated that the amount of waste seem to keep increasing. This scenario supports the position that people do not appraise or discuss with their neighbours on the need to change their attitude towards waste management (Alem, 2007; Gondo *et al.*, 2010). They argue if a person is seen placing waste in undesignated area, it is imperative to inform the individual instead of displaying annoyance to such a situation. The societal culture, sense of accountability in waste management, mindset and behaviour shift is key in the adoption and implementation of efficient waste management in Kenya (Kenya National Waste Management Policy 2019). Negative attitude is further displayed through some residents indicating waste collection and disposal was not their responsibility.

4.5.2 Residents Responsibilities on Solid Waste

Residents were asked to indicate whether everybody had a responsibility in waste management. Majority of the residents (82.6%) thought that not everybody had a responsibility and 52.6% were very willing to contribute towards better solid waste disposal in their locality. Although majority were very willing to contribute to better waste disposal and if given a chance their attitude significantly ($p=0.317$) did not have a bearing towards solid waste management.

Table 4.7: Residents Responsibilities

Question	Group	Are you willing to contribute towards better solid waste disposal in your locality?			Total
		Very willing	If given a chance I would	No. it's not my responsibility	
Do you think that everybody has a responsibility in proper solid waste disposal and collection?	Number				Total
		%	%	%	%
	Yes - 4	75	25	0	100
		23.1	33.3	0	17.4
	No – 19	52.6	10.5	36.8	100
		76.9	66.7	100	82.6
		56.5	13.0	30.4	100
	Total - 23	100	100	100	100
Chi-Square Tests					
	Value	Df	P Value (Asymp. Sig.- 2-sided)		
Pearson Chi-Square	2.297	2	0.317		
Likelihood Ratio	3.389	2	0.184		
Linear-by-Linear Association	1.383	1	0.24		
N of Valid Cases	23				

Further, residents were asked if they bother to know where waste is taken for disposal after collection. About 63.6% indicated they have never bothered since they think it's not their responsibility to collect and dispose waste. Nairobi City County Government should instil a sense of shared responsibility in the residents through capacity building and sensitize residents on the need for a clean environment and involve them more in waste management.

4.6 Residents Practice on Solid Waste Management

4.6.1 Waste Storage and Collection

Respondent indicated that containers made of plastic (bags and buckets) were the most preferred at 52.3% and 27.6% respectively; evidently these are the most commonly used. The study observed that 14.9% of the respondents did not have any particular storage containers with a paltry 5.2% storing their waste in covered bins. However, the study observed that though some respondents stored their waste in plastic buckets, plastic bags and in metallic bins, most of this waste was disposed at the undesignated dumping sites. This could result to great risk to the environment as it leads to air, water and land pollution. The County Government should provide standardised waste collection and storage equipment while at the same time placing skips in designated collection points.

Table 4.8: Methods used in Waste Storage

Storage Containers	N	Percentage
Plastic containers/buckets	91	52.3
Metallic bins	9	5.2
Plastic bags	48	27.6
No storage containers	26	14.9
Total	174	100

4.6.2 Waste Disposal Methods

Up to 48.0%) discarded waste in any available space and in other undesignated points. About 25.1% indicated storing wastes in dustbins which they eventually took to designated collection points. A small number of residents (4.7%) prefer storing waste in dustbins and later empty it in the county skips usually found in designated sites within the area, with only (8.8%) preferring burning, nature of waste notwithstanding. Out of the total number of respondents interviewed only 3.5% indicated that they recycled some of the waste (Table 8). The study also established waste collection intervals ranged between once in a week at 61.0%, twice a week at 28.8% while 3.4% indicated that waste was irregularly collected. However, 5.1% of the respondents' indicated waste is never collected at all (Table 7).

Table 4.9: Methods of Waste Disposal and Collection Frequency

Methods of Disposal	N	Percent tage	Frequency of Collection	N	Percent age
Discarding waste in any available place/undesignated points	82	48.0	Once a week	72	61.0
Putting in a dust bin	60	35.1	Two times a week	34	28.8
Burning	15	8.8	Everyday	2	1.7
Disposing at designated collection points	8	4.7	Irregular	4	3.4
Recycling	6	3.5	Zero collection	6	5.1
Total	171	100	Total	118	100

From the respondents even if the waste was stored in management services bins it still ends up being discarded on the roadside or in drainage channels. Residents were reluctant to pay for waste to the private waste collectors who charged a monthly fee ranging from Ksh. 100-300 per month. Some residents also defaulted on payment to service providers while others could not afford hence uncontrolled waste disposal. Evidence from field observation revealed that most respondents discarded their wastes in drainage channels and by the roadside. When the discarded waste piles up some residents resulted to burning affecting the air quality within the vicinity an argument supported by Giusti (2009) who contends that continuous burning of solid waste in the open causes health problems to those exposed to inhalation of the ambient gases released into the air and in turn leads to respiratory and eye problems.

According to Ampofo *et al.*, (2016); Oyake-Ombis (2015) several issues identified that rendered solid waste unmanageable, include; resident's reluctance to pay for private service providers, inefficiency over waste collection and disposal services by the relevant county authority, inadequate public awareness and unreliable means of transporting waste to Dandora landfill. According to Moore (2012) waste can be seen to mean different things to different people. In Nairobi some waste pickers see it as a resource while most people in developing countries see it as a nuisance that should be addressed. Although most people in developing countries see waste as a problem it does not deter them from discarding waste carelessly (Moore 2012). This attitude– behaviour is occasioned by a number of reasons that include; Lack of awareness and public participation, convenience, lack of proper waste management techniques and social norms (Milea, 2009; O Conell, 2011). For Giusti (2009), to overcome these challenges, Nairobi county government should adopt sustainable management of solid waste including but not limited to waste minimisation/prevention, waste re-use, recycling and composting. Ampofo *et al.*, (2016),

further argues that waste that is not recyclable, reused or composited other methods such as incineration and landfilling processes can be adopted. In Denmark, Sweden, Netherlands and Austria for instance, organic waste is not subjected to incineration due to its high water content rather, separation of waste at the source allows removal of hazardous waste, complementing composting and recycling options. It is instructive that more information on alternative sustainable management methods of solid waste is key to achieving sustainable, clean and safe environment.

4.7 Reasons for Poor Solid Waste Management

Un-Habitat (2010) report on sustainable cities has identified poor management of solid waste as a major challenge towards promotion of sustainable environment and livelihoods. Table 9 highlights responses on the challenges affecting management of solid waste in the studied area with 37.2% indicating that they were not bothered by the state of poorly disposed waste which is also an indicator of their negative attitude. Another 16.8% identified lateness of service providers in waste collection, 12.4% cited lack of information on appropriate waste management methods while 5.8% indicated reluctance in paying service providers fee with another 9.5% identifying inefficiency by the Nairobi county government as the main challenge. 5.1% indicated high charges of waste collection fee and poor cooperation among residents and service providers as the reason for poor management in waste disposal.

Table 4.10: Responses on reasons for Poor Management of Solid Waste in Eastleigh

Reasons for Poor Management of solid waste	N	Percentage
Lack of concern by residents	51	37.2
Lateness in collection of waste by relevant authorities	23	16.8
Lack of appropriate information on management of waste	17	12.4
Failure by Nairobi County Government to take their responsibility seriously	13	9.5
Reluctance to pay private waste collectors	8	5.8
High charges of waste collection	7	5.1
Poor cooperation among residents and private waste collectors	7	5.1
Informal settlements	6	4.4
Poor storage	2	1.5
Poor transportation	1	0.7
Poorly managed collection points	1	0.7
Increase in population	1	0.7
Total	137	100

Findings conclude that lack of concern by residents on good management practices of solid waste has led to negative effects on solid waste disposal damaging the environment. Ampofo *et al.*, (2016) opines that some residents shun appropriate management methods of waste in order to avoid meeting the costs of service providers. Further findings indicate that some residents in Eastleigh South Ward decry the services rendered by private collectors as unsatisfactory owing to delays and irregular collection hence the unwillingness to pay leaving them with no choice but to use unorthodox means of disposing waste. The County Government should regularize waste collection while at the same time co-ordinate private waste collection service providers to avoid lateness in waste collection. To avoid irregular and lateness in collection of waste by the service provider the county Government should subsidize on the cost.

Ampofo *et al.*, (2016), citing UN-Habitat Report (2010), argues that generation of waste is inevitable due to the rapid increase in urban population, hence the need for concerted efforts by national governments and urban authorities in the development of sustainable cities. According to Tiwari (2019), though most urban authorities developed environmental policies and legislation, implementation remains a pipe dream. To address these challenges Boadi *et al.*, (2005); Parrot *et al.*, (2009) and Henry *et al.*, (2006), highlights the need to adopt sustainable management strategies to enable address negative consequences related to unregulated management of solid waste practices.

CHAPTER FIVE: GENERAL DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 Discussion

Solid waste management is currently a top priority globally as inappropriate garbage disposal may result in an environmental and public health disaster. Most wealthy countries have made significant progress in solid waste management but the situation is different in developing countries, which are still grappling with the problem. To address this issue the study recommends that the Nairobi City County administration begin implementing and adopting best practices in solid waste management. The locals had a high level of MSW management knowledge but a negative attitude, according to the study. Omar *et al.*, (2018) conducted a study on knowledge, practices and attitude in Karan District, Mogadishu, Somalia, and found that while the community had a positive attitude and good knowledge, their practice of SWM was inadequate.

To evaluate resident's knowledge on management of solid waste several parameters were used. Most of the residents were able to classify waste that they generate in their households into both in-organic and organic. Organic solid waste originated mainly from food leftovers and food preparation residues. While for inorganic, plastics at 45% accounted for most of the inorganic waste. These generated quantities of waste did not vary with age, education, marital status or monthly income. Though majority at 66% claimed to sort waste before disposal, observations revealed otherwise. Further probing found that respondents had very little or no knowledge at all or experience in sorting. The little sorting done was for resale to waste buyers. There is need for capacity building in sorting to enhance recycling and reuse of waste.

From the survey, the service providers identified were private companies and Nairobi County Government at 53% and 35% respectively. Waste from households was taken to central collection points in sacks, plastic bags and put in county skips for eventual ferrying to the designated dumping site in Dandora. Information to the public is critical for awareness creation among residents. The study indicated 81% of residents were well informed on waste management. The source of information was mainly from county workers and from media according to 5%. However, 11% of the respondents interviewed did not have information of how waste is managed. Clear channels of information to public are critical for informed residents.

Eastleigh residents associated unhealthy environment with illnesses and poor livelihood. Environmental problems were also linked to poor waste management practices that included blocked sewerage systems at 26%, health issues and air pollution at 24% and pollution of land at 22% with water pollution standing at 4%. However, these environmental problems did not seem to deter them from dumping waste in undesignated places. This may possibly be as a result of residents being socialized to living in such an environment for long periods. Enhancing residents' awareness would be necessary in addition to some drastic measures to improve solid waste issues (Song *et al.*, 2016).

Residents' attitude was inferred from their responses to questions asked. From the findings of the study it was established that 91% of the respondents had attained secondary school education and beyond. However, this did not appear to influence their behaviour towards solid waste management positively. The findings indicate 63% of the respondents did not bother to know where waste was eventually taken for disposal. Perhaps by being socialized to living in an

unhealthy environment, they have become used to living in a dirty environment. The relevant authorities should sensitize the public on the need for shared responsibility through capacity building. The study established many respondents (48%) have never participated in any clean-up exercise, which corresponds to a study by Chekole, (2006), that continued growth of waste in cities is as a result of the don't care attitude displayed by some residents.

Prevailing environmental condition was observed to have an influence on the residents' attitude. Pletzer (2021) while quoting Chambers (an environmental psychologist) intimated that people tend to litter in an already littered place. This argument explains the situation in Eastleigh where residents indicated that the amount of waste dumped in the environment kept increasing yet they went about their business unperturbed. Majority of the residents at 82.6% did not think that everybody had a responsibility in waste management. This would probably explain the reason behind their reluctance to make payment for the services rendered by companies that provide waste collection and disposal services. To address this challenge, Nairobi County Government should involve residents more in waste management policy implementation and carry out increased public awareness on waste management.

The study observed that the residents did not find it necessary to discuss waste management issues with the concerned authorities. The findings observed that waste management was the responsibility of the County Government. There is need to increase resident awareness on appropriate waste management in order to change their behaviour. The study noted that the resident's negative attitude influenced their practices hence dumping waste in open spaces creating many illegal dumpsites.

The study noted that containers made of plastics (bags and buckets) were the most preferred for storing waste at 52% and 27% respectively, only 5% stored waste in covered waste bins. Though residents stored waste in plastic bags and buckets, the waste ended up in undesignated dumpsites. The haphazard dumping is a great risk to the environment and human health. The County Government should provide adequate storing facilities. The study identified waste disposal options used by residents, which include roadside and open drainage tunnels at 48% respectively, while 8% preferring burning. Waste collection and disposal interval was found to be once a week at 61%, twice a week 28%, while 5% indicated waste was never collected. Reason for poor solid waste management were revealed to include lack of concern by residents according to 37% of respondents, lateness in collection (16%) and reluctant to pay for services rendered at 6% among others.

5.2 Conclusion and Recommendations

In conclusion the residents of Eastleigh have good knowledge on management of solid waste. The study findings observed that they had good knowledge on the types of waste they generate. They are also aware of who are the service providers as well as the problems emanating from poor solid waste management. However, this knowledge was not observed to have a positive influence on their attitude, which was found to be negative, consequently having a negative effect on their waste management practices. The results also indicated that most residents did not find it as their responsibility to manage waste. They indicated that they have never participated in any clean up exercise. On practices, the study noted that most of the waste generated was dumped on the roadside and or in the drainage systems. Based on the results of the study the following recommendations are necessary.

- i. The County Government of Nairobi should provide equipment for managing solid waste that are adequate and regularise collection of waste.
- ii. Monthly clean-up exercises that involve residents should be organized as way of creating awareness on appropriate waste management.
- iii. There is need to improve channels for information flow to the local residents on waste management and enforce existing rules and regulations.

5.3 Recommendation for Further Study

The objective of the study was to assess resident's knowledge, attitude and practices on solid waste management (SWM) in Eastleigh in Nairobi City County. The study did not look at the amount of waste generated, which could affect practice and thus there is need to study the amount of waste generated monthly or annually.

REFERENCES

- Aazam, M., St-Hilaire, M., Lung, C., & Lambadaris, I. (2016, October). Cloud-based smart waste management for smart cities. *In 2016 IEEE 21st International Workshop on Computer Aided Modelling and Design of Communication Links and Networks (CAMAD) (pp. 188-193). IEEE.*
- Abdelnaser, O. & Maria, G. (2008). Municipal Solid Waste Management in Developing Countries: A Perspective on Vietnam. *Environmental Engineering and Management Journal, (EEMJ'08) Vol, 7(4), 59-67.*
- Abdel-Shafy, H. & Mansour, M. (2018). Solid waste issue: Sources, composition, disposal, recycling, and valorization. *Egyptian journal of petroleum, 27(4), 1275-1290.*
- Abdul-Rahman, F. & Wright, S. (2014). Reduce, reuse, recycle: alternatives for waste management. Accra Metropolitan Assembly (2009). *Report on state of sanitation in Accra Metropolis-Draft. Accra Metropolitan Assembly. Accra, Ghana.*
- Abdul-Rahman, H., Wang, C. & Yap, X. W. (2010). How professional ethics impact construction quality: Perception and evidence in a fast-developing economy. *Scientific research and essays, 5(23), 3742-3749.*
- Achankeng, E. (2003). Globalization: Urbanization and municipal solid waste management in Africa. *Proceeding of African Studies Association of Australasia and Pacific 2000 Conference proceedings African on a Global Stage, pp: 1-22.*
- Adeyemo, F. & Gboyesola, G. (2013) Knowledge, Attitude and Practices on Waste Management of People Living in the University Area of Ogbomoso, Nigeria. *International Journal of Environment Ecology, Family and Urban Studies, 3, 51-56.*

- Adogu, P., Uwakwe, K., Egenti, K., Okwuoha, A. & Nkwocha, I. (2015). Assessment of Waste Management Practices among Residents of Owerri Municipal Imo State Nigeria. *Journal of Environmental Protection*, 6, 446-456.
- AESSL, (2007). Report on Solid Waste Management in Developed World SIDA Swedish International Development Agency and SI Swedish Institute Thursday, August 30th, 2001.
- Aini, M., Razi, A., Lau, S. & Hashim, A. (2002). Practices, attitudes, and motives for domestic waste recycling. *International Journal of Sustainable Development and World Ecology*, 9(3), 232.
- Ajzen, I. (1991). *The theory of planned behaviour*. *Organisational Behaviour and Human Decision Process*, 50, 179-211.
- Ajzen, I. (2002). Perceived behavioural control, self-efficacy, locus of control, and the theory of planned behaviour. *Journal of Applied Social Psychology*, 32, 665-683. DOI:10.1111/j.1559-1816.2002.tb.00236.
- Alavi, M., Mokhtarani, N. & Mokhtarani, B. (2009). *Municipal solid waste management in Rasht City, Iran*. *Waste Management*, 29(1), 485-489.
- Alem, S. (2007). New partners for local government in service delivery: Solid waste management in Addis Ababa. *Master of Science Thesis in Urban Management, University of Technology, Berlin*.
- Ali, M. (1999). *The informal sector: What is it worth?*. *Waterlines*, 17(3), 10-12.
- Aliu, I., Adeyemi, O. & Adebayo, A. (2014). Municipal household solid waste collection strategies in an African megacity: Analysis of public private partnership performance in Lagos. *Waste Management & Research*, 32(9_suppl), 67-78.

- Al-Khatib, I., Arafat, H., Daoud, R. & Shwahneh, H. (2009). Enhanced solid waste management by understanding the effects of gender, income, marital status, and religious convictions on attitudes and practices related to street littering in Nablus–Palestinian territory. *Waste management*, 29(1), 449-455.
- Al-Khatib, I., Kontogianni, S., Abu Nabaa, H., Alshami, N. & Al-Sari“, M. (2015). Public perception of hazardousness caused by current trends of municipal solid waste management. *Waste Management*, 36323-330.
- Ampofo, S., Soyelle, J. & Abanyie, S. (2016). The Negative Impacts of Poor Municipal Management of solid waste on Livelihoods in Walewale Township, West Mamprusi District, Ghana: A Social Survey and Assessment. International Institute for Science, Technology and Education, 2422-8397: <http://hdl.handle.net/123456789/661> and management in Chittagong, Bangladesh. *Journal of Waste Management* 28, 1688 1695.
- Anomanyo, D. (2004). *Integration of Municipal Solid Waste Management in Accra, Ghana: Biofactor Treatment Technology as an Integral Part of the Management Process*. Presented to Lund University, Sweden.
- Argun, Y., Karacali, A., Calisir, U., & Kilinc, N. (2017). Composting as a Waste Management Method. *Journal of International Environmental Application and Science*, 12(3), 244-255.
- Ariva, S., Sherly, T., Norsiah A., Chin, S. (2015). Sustainable solid waste management practices and perceived cleanliness in a low-income city. *Habitat International*.49 (2015) 197-205.
- Arora, L & Agarwal, S. (2011). Knowledge, Attitude and Practices regarding Waste Management in Selected Hostel Students of University of Rajasthan, Jaipur, *International Journal of Chemical, Environmental and Pharmaceutical Research Vol. 2, No.1, 40-43*.

- Asmawati, D., Nor, B., Abd, K. & Fatimah, Y. (2012). Waste education and awareness strategy: towards solid waste management (SWM) program at UKM. *Procedia-Social and Behavioral Sciences*, 59, 47-50.
- Attigbo, F., Ayim, N. & Martey, J. (2019). Effectiveness of black soldier fly larvae in composting mercury contaminated organic waste. *Scientific African*, 6, e00205.
- Awomeso, J., Taiwo, A., Gbadebo, A. & Arimoro, A. (2021). Waste Disposal and Pollution Management in Urban Areas: A Workable Remedy for the Environment in Developing Countries. *American Journal of Environmental Sciences* 6 (1): 26-32, 2010 ISSN 1553-345X.
- Ayodeji, I. (2012). Waste Management Awareness, Knowledge and Practices of Secondary Schoolteachers in Ogun State, Nigeria. *The Journal of Solid Waste Technology and Management*, 37(3), 221-234.
- Ballantyne, R. (1998). Interpreting 'visions': Addressing environmental education goals through interpretation. In: D. Uzzell and R Ballantyne (Eds) *Contemporary Issues in Heritage and Environmental Interpretation*, pp: 77-9.
- Ballantyne, R. & Packer, J. (1996). Teaching and learning in environmental education: Developing environmental conception. *J Environ Education*, 27(2): 25-32.
- Banga, M. (2013). Household Knowledge Attitudes and Practices in Solid Waste Segregation and Recycling: The Case of Urban Kampala. *Zambia Social Science Journal*, 2, 27-39.
- Bao, Z., Lee, W. & Lu, W. (2020). Implementing on-site construction waste recycling in Hong Kong: Barriers and facilitators. *Science of the Total Environment*, 747, 141091.

- Barloa, E., Lapie, L. & Cruz, C. (2016). Knowledge, attitudes, and practices on solid waste management among undergraduate students in a Philippine State University. *Journal of Environment and Earth Science*, 6(6), 146-153.
- Barr, S. & Gilg, A. W. (2005). Conceptualising and analysing household attitudes and actions to a growing environmental problem: Development and application of a framework to guide local waste policy. *Applied geography*, 25(3), 226-247.
- Baud, I. (2004). Markets, partnerships and sustainable development in solid waste management; raising the questions. In *Solid waste management and recycling (pp. 1-18)*. Springer, Dordrecht.
- Bernad-Beltrán, D., Simó, A. & Bovea, M. (2014). Attitude towards the incorporation of the selective collection of biowaste in a municipal solid waste management system. A case study. *Waste management*, 34(12), 2434-2444. [13].
- Bernstein, J. (2004). Social assessment and public participation in municipal solid waste management. *World Bank Working Paper*, 463617-1202332338898.
- Blight, G. & Mbande, C. (1996). *Some problems of waste management in developing countries*.
- Boadi, K. & Kuitunen, M. (2005). Environmental and health impacts of household solid waste handling and disposal practices in third world cities: the case of the Accra Metropolitan Area, Ghana. *Journal of environmental health*, 68(4).
- Bolaane, B. (2006). Constraints to promoting people centred approaches in recycling. *Habitat International*, 30(4), 731-740. 36
- Booth, W., Booth, W., Colomb, G., Williams, J., Colomb, G. & Williams, J. (2003). The craft of research. *University of Chicago press*.

- Browne, J., Allen, E. & Murphy, J. (2014). Assessing biomethane production from the organic fraction of municipal solid waste in batch and continuous operation. *Biomethane production from food waste and organic residues*, 157.
- Bryman, A. (2004). Encyclopaedia of social science research methods. *Encycl. Soc. Sci. Res. Methods*, 1143-1144.
- Caneer, B. (1997). What recycling means to me? Survey at the Marshal Space Flight Center. *On WWW* at <http://www.recyvle.mcfc.nasa.gov/survey/survey/.html>.
- Castagna, A., Casagrande, M., Zeni, A., Girelli, E., Rada, E., Ragazzi, M. & Apostol, T. (2013). 3R'S from citizens point of view and their proposal from a case-study. *UPB Sci. Bull*, 75, 253- 264.
- Chalmin, P. & Gaillochet, C. (2009). *From waste to resource, an abstract of world waste survey, cyclope, Veolia environmental services. Economica, France.*
- Chaturvedi, A., Arora, R. & Saluja, M. (2015). Private sector and waste management in Delhi: a political economy perspective. *IDS bulletin*, 46(3), 7-16.
- Chekole, Z. (2006). Controlling The Informal Sector: Solid Waste Collection and the Addis Ababa City Administration, 2003-2005'. Masters (Norwegian University Of Science And Technology).
- Chen, T. & Lin, C. (2008). Greenhouse gases emissions from waste management practices using Life Cycle Inventory model. *Journal of Hazardous Materials*, 155(1-2), 23-31.
- Chengula, A. Bahati, K. & Mzula, A. (2015). Assessing the Awareness, Knowledge, Attitude and Practice of the Community towards Solid Waste Disposal and Identifying the Threats and Extent of Bacteria in the Solid Waste Disposal Sites in Morogoro Municipality in Tanzania. *Journal of*

Biology, Agriculture and Healthcare ISSN 2224-3208 (Paper) ISSN 2225-093X (Online) Vol.5, No.3, 2015.

- Chertow, M., Gordon, M., Hirsch, P. & Ramaswami, A. (2019). Industrial symbiosis potential and urban infrastructure capacity in Mysuru, India. *Environmental research letters*, 14(7), 075003.
- Choon, S., Tan, S. & Chong, L. (2017). *The perception of households about solid waste management issues in Malaysia. Environment, Development and Sustainability*, 19(5), 1685- 1700. [16].
- Chu, Z., Wang, W., Wang, B. & Zhuang, J. (2016). Research on factors influencing municipal household solid waste separate collection: Bayesian belief networks. *Sustainability*, 8(2), 152.
- Chung, S. & Lo, C. (2008). Local waste management constraints and waste administrators in China. *Waste Management*, 28(2), 272-281. Community Mobilization: The Experience of Los Baños, Laguna, Philippines. Ritsumeikan Asia Pacific University. composition, health effects and analysis. *Indian journal of medical microbiology*, 26(4), 302.
- Daniel, H. & Perinaz, B. (2012). What a waste: a global review of solid waste management. *World Bank*.
- Daskalopoulos, E., Badr, O. & Probert, S. (1997). Economic and environmental evaluations of waste treatment and disposal technologies for municipal solid waste. *Applied Energy*, 58(4), 209-255.
- Dauda, S., Simon, M. & Agyapong, R. (2015). Residents' perceptions and attitudes towards urban solid waste management in the Berekum Municipality, Ghana. *Oguaa Journal of Social Sciences Volume 7 No. 2 (2015) 25-37*

- De Feo, G., & De Gisi, S. (2010). Public opinion and awareness towards MSW and separate collection programmes: A sociological procedure for selecting areas and citizens with a low level of knowledge. *Waste Management*, 30(6), 958-976.
- Demirbas, A. (2011). Waste management, waste resource facilities and waste conversion processes. *Energy Conversion and Management*, 52(2), 1280-1286
- Dhamija, U. (2006). Sustainable solid waste management: Issues, policies, and structures. Academic Foundation.
- Ding, T., Xiao, J. & Tam, V. W. (2016). A closed-loop life cycle assessment of recycled aggregate concrete utilization in China. *Waste management*, 56, 367-375.
- Ehrampoush, M. & Moghadam, M. (2005). Survey of knowledge, attitude and practice of Yazd University of Medical Sciences students about solid wastes disposal and recycling. *Journal of Environmental Health Science & Engineering*, 2(2), 26-30.
- Eneji, O., Ogar, E., Ngoka, V. & Abang, M. (2016). Attitude towards Waste Management and Disposal Methods and the Health Status of Cross River State, Nigeria, *SCIREA Journal of Agriculture, Volume 1, Issue 2*.
- Ezeah, C., Fazakerley, J. A. & Roberts, C. (2013). Emerging trends in informal sector recycling in developing and transition countries. *Waste management*, 33(11), 2509-2519.
- Firdaus, G. & Ahmad, A. (2010). Management of urban solid waste pollution in developing countries. *International Journal of Environmental Research*, 4(4), 795-806.
- Fytili, D. & Zabaniotou, A. (2008). Utilization of sewage sludge in EU application of old and new methods—a review. *Renewable and sustainable energy reviews*, 12(1), 116-140.

- Gentil, E., Clavreul, J. & Christensen, T. (2009). Global warming factor of municipal solid waste management in Europe. *Waste Management & Research*, 27(9), 850-860. *Geographical Bulletin*, 52(2), 105-118.
- Gertsakis, J. & Lewis, H. (2003). *Sustainability and the waste management hierarchy*. Retrieved on January 30, 2008.
- Gibson, K. & Tierney, J. (2006). Electronic waste management and disposal issues and alternatives. *Environmental Claims Journal*, 18(4), 321-332.
- Giusti, L. (2009). A review of waste management practices and their impact on human health. *Waste management*, 29(8), 2227-2239.
- Goett, J. (1998). Waste and resource: Household management of solid waste on the North Coast of Honduras. Yearbook. Conference of Latin Americanist Geographers, 24, 111-119. Retrieved February 10, 2015, from JSTOR.
- Goh, M., Tong, D. & Ahmed, E. (2013). Extended theory of planned behaviour: Model for measuring households' recycling behaviour in Malaysia. *Advanced Materials Research* 623,1691-1695. DOI:10.4028/www.scientific.net/AMR.622-623.1691
- Goldman, G. & Ogishi, A. (2001). The economic impact of waste disposal and diversion in California. *University of California, Berkeley*.
- Gondo, T., Gumbo, T., Mazhindu, E., Ingwani, E. & Makhanda, R. (2010). Spatial analysis of solid waste induced ecological hot spots in Ethiopia: where ecohydrologists should begin?. *Ecohydrology & Hydrobiology*, 10(2-4), 287-295.
- Gray, N. (2004). Biology of wastewater treatment (Vol. 4). *World Scientific*.

- Grey, C., Nieuwenhuijsen, M., Golding, J. & ALSPAC, Team. (2005). The use and disposal of household pesticides. *Environmental Research*, 97(1), 109-115.
- Guerrero, L., Maas, G. & Hogland, W. (2013). Solid waste management challenges for cities in developing countries. *Waste management*, 33(1), 220-232.
- Gutberlet, J. & Uddin, S. (2017). Household waste and health risks affecting waste pickers and the environment in low-and middle-income countries. *International journal of occupational and environmental health*, 23(4), 299-310.
- Haas, W., Krausmann, F., Wiedenhofer, D. & Heinz, M. (2015). How circular is the global economy?: An assessment of material flows, waste production, and recycling in the European Union and the world in 2005. *Journal of industrial ecology*, 19(5), 765-777.
- Haider, A., Amber, A., Ammara, S., Mahrukh, K., Aisha, B. (2015). Knowledge, perception and attitude of common people towards solid waste management-A case study of Lahore, *Pakistan. International Research Journal of Environment Sciences*, 4(3), 100-107.
- Hamer, G. (2003). Solid waste treatment and disposal: effects on public health and environmental safety. *Biotechnology advances*, 22(1-2), 71-79.
- Hammond, A., & World Resources Institute. (1995). Environmental indicators: a systematic approach to measuring and reporting on environmental policy performance in the context of sustainable development (Vol. 36). *Washington, DC: World Resources Institute*.
- Haregu, T., Ziraba, A., Aboderin, I., Amugsi, D., Muindi, K. & Mberu, B. (2017). An assessment of the evolution of Kenya's solid waste management policies and their implementation in

Nairobi and Mombasa: analysis of policies and practices. *Environment and Urbanization*, 29(2), 515-532.

Hasan, M., Ahmed, M., Mallick, J. & Singh, R. (2018). Impact of Hazardous Wastes on Human Health & Preventive Measures for a Sustainable Environment. *13th Annual Scientific Research Day*, 108.

Henry, R., Yongsheng, Z. & Jun, D. (2006). Municipal management of solid waste challenges in developing countries—Kenyan case study. *Waste management*, 26(1), 92-100.

Hilburn, A. (2015). Participatory risk mapping of garbage-related issues in a rural Mexican municipality. *Geographical Review*, 105(1), 41-60.

Hines, J., Hungerford, H. & Tomera, A. (1987). Analysis and synthesis of research on responsible environmental behavior: A meta-analysis. *The Journal of environmental education*, 18(2), 1-8.

Hofny-Collins, A. (2006). The potential for using composted municipal waste in Agriculture: The case of Accra, Ghana. *Swedish University of Agricultural Sciences, Uppsala*.

Hornweg, D., Bhada-Tata, P., & Kennedy, C. (2013). Environment: Waste production must peak this century. *Nature News*, 502(7473), 615.

<http://www.britannica.com/EBchecked/topic/553362/solid-waste-management> 70

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.

- Ikiara, M., Karanja, A. M. & Davies, T. (2004). Collection, transportation and disposal of urban solid waste in Nairobi. In *Solid Waste Management and Recycling*. Pp 61-91). Springer, Dordrecht. *International Development Planning Review*, 29(4), 433-450. 72
- Isahak, W., Hisham, M., Yarmo, M. & Hin, T. (2012). A review on bio-oil production from biomass by using pyrolysis method. *Renewable and sustainable energy reviews*, 16(8), 5910-5923.
- Jamshidi, A., Taghizadeh, F. & Ata, D. (2011). Sustainable municipal solid waste management (case study: Sarab County, Iran). *Annals of Environmental Science*, 5.
- Jatau, A. (2013). Knowledge, attitudes and practices associated with waste management in Jos South Metropolis, Plateau State. *Mediterranean Journal of Social Sciences*, 4(5), 119.
- Jessica, M. (2015). Factors influencing solid-waste management in the developing world", Utah State University, Logan, Utah, All graduate plan b and other reports.
- Johnston, H. (2010). Shaping Beliefs and Attitudes: A Handbook of Attitude Change Strategies. (online) *Journal of Waste Management* 29, 1227–123
- Kacprzak, M., Neczaj, E., Fijałkowski, K., Grobelak, A., Grosser, A., Worwag, M. & Singh, B. (2017). Sewage sludge disposal strategies for sustainable development. *Environmental research*, 156, 39-46.
- Karak, T., Bhagat, R. & Bhattacharyya, P. (2012). Municipal solid waste generation, composition, and management: the world scenario. *Critical Reviews in Environmental Science and Technology*, 42(15), 1509-1630.

- Karanja, (2005). Solid Waste Management in Nairobi: A Situation Analysis. [http://www.unep.or.jp/ietc/GPWM/.../IS_6_1_Nairobi_SWM_Situation Analysis](http://www.unep.or.jp/ietc/GPWM/.../IS_6_1_Nairobi_SWM_Situation_Analysis). p.. Accessed on 21st June 2013.
- Kasozi, A. & Von Blottnitz, H. (2010). Solid waste Management in Nairobi: A situation analysis. *Report for City Council of Nairobi, contract for UNEP.*
- Kassenga, G. & Mbuligwe, S. (2009). Impacts of a solid waste disposal site on soil, surface water and groundwater quality in Dar es Salaam City, Tanzania. *Journal of Sustainable Development in Africa, 10(4), 73-94.*
- Kassim, S. & Ali, M. (2006). Solid waste collection by the private sector: Households' perspective—Findings from a study in Dar es Salaam city, Tanzania. *Habitat international, 30(4), 769-780.*
- Khatib, A. & Arafat H. (2009). A review of residential solid waste management in the occupied Palestinian Territory: *A window for improvement. DOI: [10.1177/0734242X09345274](https://doi.org/10.1177/0734242X09345274)*
- King'oo, S. (2019). Assessment of household domestic waste management practices, Kiambu County-Kenya (*Doctoral dissertation*).
- Klundert, A. & Lardinois, I. (2005). Community and private (formal and informal) sector involvement in municipal solid waste management in developing countries. *Background Paper for the UMP Workshop in Ittingen, 10-12 April 1995.*
- KNBS. (2019). Kenya Population and Housing Census Volume I: Population by County and Sub-County.

- Koopmans, A. & Koppejan, J. (1997). Agricultural and forest residues-generation, utilization and availability. *Regional consultation on modern applications of biomass energy*, 6, 10.
- Krook, J., Mårtensson, A. & Eklund, M. (2007). Evaluating waste management strategies—A case of metal-contaminated waste wood. *Resources, Conservation and Recycling*, 52(1), 103-118.
- Krosnick, J. (2014). Attitude strength: Antecedents and consequences. *Psychology Press*.
- Kumar, B. (2012). A theory of planned behaviour approach to understand the purchasing behaviour for environmentally sustainable products. *Working Paper, 2012-12-08, Ahmedabad, Indian Institute of Management*.
- Laor, P., Suma, Y., Keawdunglek, V., Hongtong, A., Apidechkul, T. & Pasukphun, N. (2018). Knowledge, attitude, and practice of municipal solid waste management among highland residents in Northern Thailand. *Journal of Health Research*.
- Leton, T. & Omotosho, O. (2004). Landfill operations in the Niger delta region of Nigeria. *Engineering Geology*, 73(1-2), 171-177.
- Licy, C., Vivek, R., Saritha, K., Anies, T. & Josphina, C. (2013). Awareness, attitude, and practice of school students towards household waste management. *Journal of Environment*, 2(6), 147-150.
- Lieder, M. & Rashid, A. (2016). Towards circular economy implementation: a comprehensive review in context of manufacturing industry. *Journal of cleaner production*, 115, 36-51.
- Lombardi, L., Carnevale, E. & Corti, A. (2015). A review of technologies and performances of thermal treatment systems for energy recovery from waste. *Waste management*, 37, 26-44.

- Louis, G. (2004). A historical context of municipal solid waste management in the United States. *Waste management & research*, 22(4), 306-322.
- Lumbreras, M. & Fernández, G. (2014). Comprehensive solid waste management: The Ciudad Saludable model in Peru.
- Magrinho, A., Didelet, F. & Semiao, V. (2006). Municipal solid waste disposal in Portugal. *Waste Management (New York, N.Y.)*, 26(12), 1477–1489. doi: 10.1016/j.wasman.2006.03.009 PMID: 16713239.
- Mahar, A., Malik, R., Qadir, A., Ahmed, T., Khan, Z. & Khan, M. (2007, September). Review and analysis of current solid waste management situation in urban areas of Pakistan. *In Proceedings of the international conference on sustainable solid waste management (Vol. 8, p. 36)*. Citeseer.
- Mahmood J., Marlia M. & Murtadha, S. (2019). Public awareness on solid waste management: A case study in Al-Nassyriah City, Iraq. *AIP Conference Proceedings 2111, 060013 (2019)*; <https://doi.org/10.1063/1.5111275>.
- Malinauskaite, J., Jouhara, H., Czajczyńska, D., Stanchev, P., Katsou, E., Rostkowski, P. & Spencer, N. (2017). Municipal solid waste management and waste-to-energy in the context of a circular economy and energy recycling in Europe. *Energy*, 141, 2013-2044.
- Marcussen, I. (2020). Urban solid waste management, environmental governance, and private sector initiatives: a case from Nairobi, Kenya (Master's thesis, Norwegian University of Life Sciences, Ås).

- Mariwah, S., Kendie, S. & Dei, A. (2010). Residents' perception of the solid waste management problem in the Shama-Ahanta-East Metropolitan Area, Ghana. *Oguaa Journal of Social Sciences*, 5, 1, 21-43.
- Marshall, R. & Farahbakhsh, K. (2013). Systems approaches to integrated solid waste management in developing countries. *Waste management*, 33(4), 988-1003.
- McAllister, J. (2015). "Factors Influencing Solid-Waste Management in the Developing World" *All Graduate Plan B and other Reports. Paper 528.* Available: <http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1537&context=gradreports>
- Menegaki, M. & Damigos, D. (2018). A review on current situation and challenges of construction and demolition waste management. *Current Opinion in Green and Sustainable Chemistry*, 13, 8-15.
- Mihai, F. & Grozavu, A. (2019). Role of waste collection efficiency in providing a cleaner rural environment. *Sustainability*, 11(23), 6855.
- Milea, A. (2009). Waste as a social dilemma: Issues of social and environmental justice and the role of residents in municipal solid waste management, Delhi, India. *Master's thesis, Lund University. Lund, Sweden.*
- Modak, P. Wilson, D. & Velis, C. (2018). Waste management: Global status. In *Global Waste Management Outlook; UNEP: Athens, Greece,; pp. 51–79. ISBN 9789280734799.*
- Momoh, J. & Oladebeye, D. (2010). Assessment of awareness of attitude and willingness of people to participate in household solid waste recycling programme in Abo-Eketi, Nigeria. *Journal of Applied Science in Environmental Sanitation*, 14, 1-12.

- Moore, S. (2012). Garbage matters: Concepts in new geographies of waste. *Progress in Human Geography*, 36(6), 780-799.
- Mrayyan, B. & Hamdi, M. (2006). Management approaches to integrated solid waste in industrialized zones in Jordan: A case of Zarqa City. *Waste Management*, 26(2), 195-205.
- Mugo, S. (2019). Assessment of Solid Waste Management at Wakulima Market in Nairobi City, Kenya (Doctoral dissertation, University of Nairobi).
- Mule, B. (2013). Factors Influencing Household Solid Waste Disposal and Management in Garissa Town, Garissa County, Kenya. Unpublished Postgraduate Diploma in Housing Administration, School of Built Environment, Department of Real Estate and Construction Management of the University of Nairobi.
- Mungure, J. (2008). Governance and community participation in Municipal Solid Waste management, case of Arusha and Dar es Salaam Tanzania.
- Muniafu, M. & Otiato, E. (2010). Solid Waste Management in Nairobi, Kenya. A case for emerging economies. *Journal of Language, Technology & Entrepreneurship in Africa*, 2(1), 342-350.
- Munyaga, N. (2016). Challenges of Solid Waste Disposal in Gachororo Village Juja, Kiambu County (Doctoral dissertation, Doctoral Dissertation, University of Nairobi).
- Musyoka, M. (2019). Assessment of Community Perception, Policies and Land use factors in relation to Climate Change Processes in Nairobi city (Doctoral dissertation, Jomo Kenyatta University of Agriculture Technology-IEET).
- Mwanthi, M. & Nyabola, L. (1997). Solid waste management in Nairobi City: Knowledge and attitudes. *Journal of Environmental Health*, 60(5), 23.

- Mwaura, P. (1991). An assessment of the management of garbage collection and disposal in Nairobi (Doctoral dissertation, University of Nairobi).
- Mwesigye, P., Mbogoma, J., Nyakang'o, J., Afari, I., Kapindula, D., Hassan, S. & Van Berkel, R. (2009). Africa Review Report on Waste Management-Main Report-Integrated Assessment of Present Status of Environmentally-Sound Management of Wastes in Africa. *Proceedings of United Nations Economic and Social Council (Economic Commission for Africa), Sixth Session of the Committee on Food Security and Sustainable Development.*
- Naqvi, S., Prabhakara, H., Bramer, E., Dierkes, W., Akkerman, R. & Brem, G. (2018). A critical review on recycling of end-of-life carbon fibre/glass fibre reinforced composites waste using pyrolysis towards a circular economy. *Resources, conservation and recycling, 136, 118- 129.*
- Narayana, T. (2009). Municipal solid waste management in India: From waste disposal to recovery of resources? *Waste Management, 29(3), 1163-1166.*
- Nasrabadi, T., Hoveidi, H., Bidhendi, G., Yavari, A. & Mohammadnejad, S. (2008). Evaluating citizen attitudes and participation in solid waste management in Tehran, Iran. *Journal of Environmental Health, 71(5), 30-33.*
- Nassar, D. & Elsayed, H. (2018). From informal settlements to sustainable communities. *Alexandria engineering journal, 57(4), 2367-2376.*
- Nathanson, J. (2015). Solid-waste management. *Encyclopaedia Britannica.*
- NEMA (2014). National Management of solid waste Strategy, Nairobi. Kenya.
- NEMA. (2015). National Solid Waste Management Strategy, Nairobi. Kenya.

- Nebiyeleul, G. (2006). African Regional Implementation Review for the Commission on Sustainable Development (CSD-14) Report on the Review of African Sustainable Industrial Development. *African Reg. Implement Rev Comm. Sustain Dev*
- NEMA. (2006). District environment action plan (2006-2010). Narok District. National Environmental Management Authority.
- Nemerow, N., Agardy, F. & Salvato, J. (2009). Environmental engineering: environmental health and safety for municipal infrastructure, land use and planning, and industry. John Wiley & Sons.
- Ngoc, U. & Schnitzer, H. (2009). Sustainable solutions for solid waste management in Southeast Asian countries. *Waste management*, 29(6), 1982-1995.
- Njoroge, B., Kimani, M. & Ndunge, D. (2014). "Review of Municipal Management of solid waste: A Case Study of Nairobi, Kenya", *International Journal of Engineering and Science Vol. 4, No 2, pages 2319-6483*.
- O'Connell, E. (2011). Increasing public participation in municipal solid waste reduction. *The Geographical Bulletin*, 52(2), 105.
- Ogunrinola, I. & Adepegba, E. (2012). Health and economic implications of waste dumpsites in cities: The case of Lagos, Nigeria. *International Journal of Economics and Finance*, 4(4), 239-251.
- Oke, A., Osobajo, O., Obi, L. & Omotayo, T. (2020). Rethinking and optimising post-consumer packaging waste: A sentiment analysis of consumers' perceptions towards the introduction of a deposit refund scheme in Scotland. *Waste management*, 118, 463-470.
- Okot-Okumu, J. & Nyenje, R. (2011). Municipal solid waste management under decentralisation in Uganda. *Habitat International*, 35(4), 537-543.

- Oluoko-Odingo, A. & Mutisya, E. (2019). The Enterprise of Waste management among urban youth for sustainable development in Kenya. *Journal of Sustainability, Environment and Peace*, 1(2), 45-51.
- Omar, A., Hossain, M. & Parvin, M. (2018). Study On Knowledge, Attitude And Practices Towards The Solid Waste Management In Karan District, Mogadishu Somalia. *Age*, 20(25), 74.
- Omofonmwan, S., & Esegbe, J. (2009). Effects of solid waste on the quality of underground water in Benin Metropolis, Nigeria. *Journal of Human Ecology*, 26(2), 99-105.
- Oskamp, S., Harrington, M. J., Edwards, T., Sherwood, D., Okuda, S. & Swanson, D. (1991). Factors influencing household recycling behaviour. *Environment and behavior*, 23(4), 494-519.
- Otieno, T. (2010). Storm clouds of our solid waste may blow us away if we don't act now. *Daily Nation Newspaper*, 25.
- Oyake-Ombis, L., van Vliet, B. & Mol, A. (2015). Managing plastic waste in East Africa: Niche innovations in plastic production and solid waste. *Habitat International*, 48, 188-197.
- Palmer, J. (1995). Environmental thinking in the early years: Understanding and misunderstanding of concepts related to waste management. *J Environ Educ Research*, 1(1) pp: 35- 45.
- Pariatamby, A. & Fauziah, S. (2014). Sustainable 3R practice in the Asia and Pacific Regions: the challenges and issues. In *Municipal solid waste management in Asia and the Pacific Islands (pp. 15-40)*. Springer, Singapore.
- Parrot, L., Sotamenou, J. & Dia, B. (2009). Municipal management of solid waste in Africa: Strategies and livelihoods in Yaoundé, Cameroon. *Waste management*, 29(2), 986-995.
- Pender, N. (2011). Health promotion model manual.

- Pletzer, J. (2021). *The Lived Experiences of Contemplative Practices in the Lives of Social Change Actors: An Analysis with Contemplative Resistance and Transformative Change* (Doctoral dissertation, Northern Arizona University).
- Poswa, T. (2001). A comparison of attitudes towards and practices of waste management in three different socio-economic residential areas of Umtata. Published Master's Thesis, Durban University of Technology, KwaZulu-Natal, South Africa.
- Prakash, R. & Gowtham, M. (2019). Hazardous waste and its treatment process. *In Energy from toxic organic waste for heat and power generation (pp. 119-138)*. Woodhead Publishing.
- Raj, S. C. (2010). An overview of solid waste management in Pacific Island Countries. *In Biennial Conference and Exhibition (pp. 5-7)*.
- Ritchie, H. & Roser, M. (2018). Urbanization. *Our world in data*.
- Rushton, L. (2003). Health hazards and waste management. *British medical bulletin*, 68(1), 183-197.
- Safiuddin, M., Jumaat, M., Salam, M., Islam, M. & Hashim, R. (2010). Utilization of solid wastes in construction materials. *International Journal of Physical Sciences*, 5(13), 1952-1963.
- Sangeetha, J., Thangadurai, D., Hospet, R., Purushotham, P., Manowade, K., Mujeeb, M. & Harish, E. (2017). Production of bionanomaterials from agricultural wastes. *In Nanotechnology (pp. 33-58)*. Springer, Singapore.
- Sasakova, N., Gregova, G., Takacova, D., Mojziso, J., Papajova, I., Venglovsky, J. & Kovacova, S. (2018). Pollution of surface and ground water by sources related to agricultural activities. *Frontiers in Sustainable Food Systems*, 2, 42.
- Scharfe, D. (2010). *Integrated waste management plan. report at*.

- Schultz, P. & Zeleny, L. (2000). Promoting environmentalism. *The Journal of Social Issues*, 56,443-457.
- Sekaran, U. & Bougie, R. (2016). Research methods for business: A skill building approach. John Wiley & Sons.
- Sessa, A., Giuseppe, G., Marinelli, P., & Angelillo, I. (2009). Public concerns and behaviors towards solid waste management in Italy. Short report. *Journal of Public Health* 20: 631–633.
- Shafigh, P., Mahmud, H., Jumaat, M., Ahmmad, R. & Bahri, S. (2014). Structural lightweight aggregate concrete using two types of waste from the palm oil industry as aggregate. *Journal of Cleaner Production*, 80, 187-196.
- Shahzadi, A., Hussain, M., Afzal, M. & Gilani, S. (2018). Determination the level of knowledge, attitude, and practices regarding household waste disposal among people in rural community of Lahore. *International Journal of Social Sciences and Management*, 5(3), 219-224.
- Shekdar, A. V. (2009). Sustainable solid waste management: An integrated approach for Asian countries. *Waste management*, 29(4), 1438-1448.
- Sherburne, S. (2019). Let's Get Sorted: The Path to Zero Waste at Pomona College.
- Singh, J. (2018). Paddy and wheat stubble blazing in Haryana and Punjab states of India: A menace for environmental health. *Environmental Quality Management*, 28(2), 47-53.
- Situmorang, Y., Zhao, Z., Yoshida, A., Abudula, A. & Guan, G. (2020). Small-scale biomass gasification systems for power generation (< 200 kW class): A review. *Renewable and Sustainable Energy Reviews*, 117, 109486.

- Soltani, A., Hewage, K., Reza, B., & Sadiq, R. (2015). Multiple stakeholders in multi-criteria decision-making in the context of Municipal Solid Waste Management: A review. *Waste Management (New York, N.Y.)*, 35, 318–328.
- Song, Q., Wang, Z. & Li, J. (2016). Exploring residents' attitudes and willingness to pay for solid waste management in Macau. *Environmental Science and Pollution Research*, 23(16), 16456-16462.
- Spector, J., Merrill, M., Elen, J. & Bishop, M. (2014). Handbook of research on educational communications and technology (pp. 1-1005). New York: Springer.
- Sreenivasan, J., Govindan, M., Chinnasami, M. & Kadiresu, I. (2012). Solid waste management in Malaysia—A move towards sustainability. *Waste Manag. An Integr. Visions*, 2005(April 2005), 55-70.
- Sudipta, B., Makiko, S. Takashi, M. Bharati, B. (2016). *Resident Knowledge and Willingness to Engage in Waste Management in Delhi, India. Sustainability*.
- Suleman, Y., Darko, E., & Agyemang-Duah, W. (2015). Solid waste disposal and community health implications in Ghana: Evidence from Sawaba, Asokore Mampong municipal assembly. *J Civil Environ Eng*, 5(6).
- Tacoli, C. (2012) *Urbanization, Gender and Urban Poverty: Paid Work and Unpaid Care Work in the City*. International Institute for Environment and Development, *United Nations Population Fund*, London, UK.
- Tchobanoglous, G. & Kreith, F. (2002). *Handbook of solid waste management*. McGraw-Hill Education.

- Telfer, D. (2002). Tourism and development: Change and challenge of tourism in Kenya.
- The Constitution of Kenya. (2010). *Government printers*.
- The EMCA (Act No. 8) Revised Edition 2012. (1999). Published by the National Council for Law Reporting with the Authority of the Attorney-General www.kenyalaw.org
- Troschinetz, A. & Mihelcic, J. (2009). Sustainable recycling of municipal solid waste in developing countries. *Waste management*, 29(2), 915-923.
- Thompson, I. (2010). Domestic waste management strategies in Accra, Ghana and other urban cities in tropical developing nations. *Cleveland: Case Western Reserve University*.
- Tsai, F., Bui, T., Tseng, M. & Wu, K. (2020). A causal municipal solid waste management model for sustainable cities in Vietnam under uncertainty: *A comparison*. *Resources, Conservation and Recycling*, 154, 104599.
- Tucker, P., Murney, G. & Lamont, J. (1998). Predicting recycling scheme performance: A process simulation approach. *J Environ Manag*, 52(1): 31-48.
- Twumasi, A. (2017). Awareness and Practice of Solid Waste Management in the Winneba Municipality of Ghana. *European Journal of Earth and Environment*. Vol. 4, No. 1, 2017 ISSN 2056-5860.
- UNEP. (2011). Tourism: Investing in Energy and Resource Efficiency. *United Nations Environment Programme*. Available at: http://www.unep.org/resourceefficiency/Portals/24147/scp/business/tourism/greeneconomy_tourism.pdf [Accessed: 21/02/2016]

UNEP. (2013). Guidelines for National Waste Management Strategies: Moving from Challenges to Opportunities. Nairobi, Kenya: The Inter Organisation Programme for the Sound Management of Chemicals (IOMC) United Nations Environment Programme.

UNEP and ISWA. (2015). Global Waste Management Outlook. United Nations Environment Programme. Available at: <http://www.unep.org/ietc/Portals/136/Publications/Waste%20Management/GWMO%20report/GWMO%20full%20report.pdf> [Accessed: 03/02/2016]

UNEP. (2012). *21 Issues for the 21st Century: Result of the UNEP Foresight Process on Emerging Environmental Issues. United Nations Environment Programme (UNEP), Nairobi, Kenya.*

UNEP. (2005). 'E-waste: the hidden side of IT equipment's manufacturing and use'. *Early Warnings on Emerging Environmental Threats No. 5, United Nations Environment Programme.*

UNEP. (2011). Resource Efficiency: Economics and Outlook for Asia and the Pacific. Bangkok: *United Nations Environment Programme.*

UN-Habitat. (2009). *Fact sheet.* Global report on human settlement.

UN-Habitat. (2010). Solid waste management in the world's cities. Nairobi: *UNHABITAT, 2010.*

UN-Habitat. (2010). Solid waste management in the world's cities. *Water and Sanitation in the Worlds Cities.*

United Nations Population Fund (UNFPA). (2001). *Management of Municipal Solid Waste:*<http://www.epa.gov/epaoswer/non-hw/muncpl/reduce.htm>.

- Vicente, P. & Reis, E. (2008). Factors influencing households' participation in recycling. *Waste Management & Research*, 26(2), 140-146.
- Wainaina, S., Awasthi, M., Sarsaiya, S., Chen, H., Singh, E., Kumar, A., & Taherzadeh, M. (2020). Resource recovery and circular economy from organic solid waste using aerobic and anaerobic digestion technologies. *Bioresource technology*, 301, 122778.
- Warner, W. (2006). Cultural influences that affect the acceptance of compost toilets, psychology, religion, and gender. Norway: *Jordforsk Centre for Soil and Environmental Research*.
- Williams, P. (2005). Waste treatment and disposal. John Wiley & Sons.
- Wilson, D., Rodic, L., Cowing, M., Velis, C., Whiteman, A., Scheinberg, A. & Oelz, B. (2015). 'Waste aware 'benchmark indicators for integrated sustainable waste management in cities. *Waste Management*, 35, 329-342.
- Wilson, D., Rodic, L., Scheinberg, A., Velis, C., & Alabaster, G. (2012). Comparative analysis of solid waste management in 20 cities. *Waste management & research*, 30(3), 237-254.
- Wilson, D., Velis, C., & Cheeseman, C. (2006). Role of informal sector recycling in waste management in developing countries. *Habitat international*, 30(4), 797-808.
- Wilson, D., Velis, C., & Cheeseman, C. (2006). Role of informal sector recycling in waste management in developing countries. *Habitat international*, 30(4), 797-808.
- World Bank. (2015). What a Waste: Solid Waste Management in Asia, Urban Development Sector.

- Xu, X., Liao, W., Lin, Y., Dai, Y., Shi, Z., & Huo, X. (2018). Blood concentrations of lead, cadmium, mercury, and their association with biomarkers of DNA oxidative damage in preschool children living in an e-waste recycling area. *Environmental geochemistry and health*, 40(4), 1481-1494.
- Yang, H., Xia, J., Thompson, J. & Flower, R. (2017). Urban construction and demolition waste and landfill failure in Shenzhen, China. *Waste management*, 63, 393-396.
- Yousif, D. & Scott, S. (2007). Governing solid waste management in Mazatenango, Guatemala.
- Zohoori, M. & Ghani, A. (2017). Municipal solid waste management challenges and problems for cities in low-income and developing countries. *Int. J. Sci. Eng. Appl*, 6(2), 39-48.

APPENDICES

APPENDIX I: (GLOSSARY) DEFINITION OF TERMS

Knowledge: The fact or condition of having information through experience or association.

Attitude: This is the process of acquiring values and the feeling of care for something.

Solid Waste Management: This is collection and treatment of solid wastes. At the same time, it provides solutions for recycling items that can be put into use again and do not belong to garbage or trash.

Waste: Any unwanted material that has been released into the environment in a volume, method, or composition that is likely to affect or alter the environment whether it is solid, liquid, gaseous, or radioactive.

Waste Generation: The process production of material that is not useful into the environment.

Waste Segregation: Separating waste according to different streams.

Recycling of Waste: Return material into its original form or into a different form for a different purpose.

APPENDIX II: QUESTIONNAIRE

Instructions to respondents

The purpose for this questionnaire is to collect data on knowledge, attitudes and practices of Eastleigh estate residents on solid waste management, Nairobi County.

Please fill in the questions by ticking (✓) your appropriate response.

Please answer all questions to the best of your ability; there are no correct or right answers, provide your considered response.

The data collected through this questionnaire will be used only for the purposes of the study.

SECTION I: DEMOGRAPHIC INFORMATION OF THE RESPONDENTS

1. Gender Male Female

2. Age (*Tick where appropriate*)

18-24 years 25-34 years 35-44 years 45-54 years Over 55 years

3. Marital Status

Single Married Separated Divorced Widowed

4. Level of Education (*Tick where appropriate*)

College/University Diploma bachelor's degree master's degree PhD

Other (Specify).....

5. For how long have you lived in Eastleigh Estate? State your answer in years (*Tick where appropriate*)

Ksh. 10000-200000

Ksh. 20 Less than 1 year 1-2 years 3-4 years over 4 years

6. Number of children in the household.....

7. Number of people in the household

8. Monthly income

>Ksh.10000

Ksh.10000-50000

Ksh. 50000-100000

>Ksh.100000

SECTION II: KNOWLEDGE ON WASTE MANAGEMENT

9. State the nature of the waste you generate.

10. How do you rate the level of amount of waste found in your neighbourhood?

11. Do you perform any sorting of waste in your household before disposal?

b. If yes, how is separation done?

12. Are you compelled to carry out sorting or you do it voluntarily?

13. Who collects the waste for disposal?

- Private collector Nairobi County Council self Nobody Others

14. Do you find the solid waste disposal and management by the Nairobi County government convenient?

- Yes No

If YES, explain

15. How would you describe the general solid waste situation in your neighborhood and Eastleigh South Ward in general?

.....
.....
.....

16. Please indicate how you usually dispose off your solid waste whenever the service providers fail to collect the solid waste.

- I don't bother about the trash
- I usually burn the waste
- I dispose the solid waste in the bush/ roadside/ drainage
- Other methods (specify).....

17. What is the source of information on solid waste management?

- Media Community volunteers County Workers None

18. Which are the environmental problems associated with poor solid waste management in your area?

SECTION III: RESIDENT ATTITUDE ON SOLID WASTE MANAGEMENT

19. Are you eager to know where waste is disposed of after collection?

b. If No, why don't you bother?

20. How do you feel when you find solid waste disposed in open spaces?

b. If annoying, have you ever talked about it among your neighbors or relevant authorities?

21. Are you willing to contribute towards better solid waste disposal in your locality?

22. Do you pay for your solid waste disposal services?

Yes No

If yes, how much per month?

If NO, are you willing to pay for your solid waste disposal service?

23. Do you think the Nairobi County environment department is doing enough in solid waste management?

24. Which ways do you think are most effective in making sure solid waste is effectively managed?

25. Do you think that everybody has a responsibility in proper solid waste disposal and collection?

26. Do you think the amount of waste in open places is increasing?

- b. If yes, have you ever complained to relevant authorities?
- c. What was the response?

27. How did the response you got influenced the way you dispose your waste?

28. Are you eager to know where waste is disposed of after collection?

SECTION IV: RESIDENT PRACTICES ON SOLID WASTE MANAGEMENT

29. What type of waste storage and collection containers do you use for your household waste?

30. What methods do you think is most effective for disposing generated waste?

31. How far is it from your residence to the nearest dump site/collection point?

32. How often is the solid waste picked from the collection point?

33. What do you think is the reason why more people are dumping their solid waste in open places?

34. 21. In your view, what should be done to improve on solid waste disposal in Eastleigh?

.....

.....

.....

35. 22. Would you like to make some further comments or recommendations for the national and county governments with regard to solid waste management?

.....

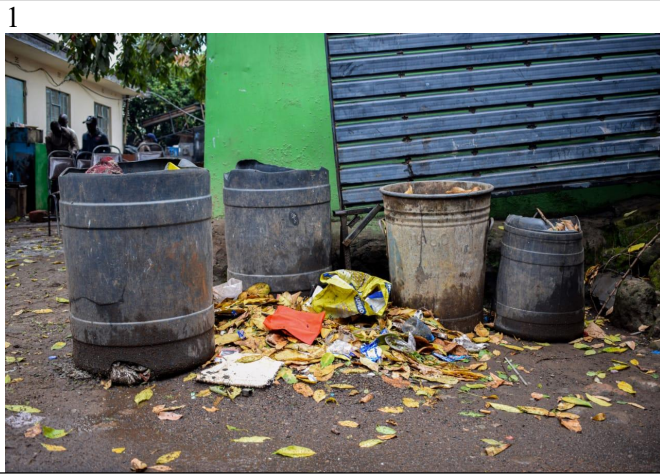
.....

KEY INFORMANT

1. Administrative unit.....
2. Age.....
3. Gender.....
4. Level of Education.....
5. Designation.....
6. What is the relative abundance of solid waste generation streams in construction sites percentage?
7. Which are the specific types of solid waste generated in household?
 - b. Which are the specific types of solid waste generated in commercial premises?
 - c. Which are the specific types of solid waste generated in markets?
 - d. Which are the specific types of solid waste generated in institutions?
 - e. Which are the specific types of solid waste generated in industries?
 - f. Which are the specific types of solid waste generated in healthy care facility?
 - g. Which are the specific types of solid waste generated in construction sites?
8. Which are the solid waste collection modes do you rely on?
9. What is the frequency of solid waste collection within your area of jurisdiction?
10. How is solid waste collected, stored, and transported from the source?
11. Who pays for the collection, storage, and transportation resident' waste generated within yourarea?
12. Is the solid waste collected separated?

13. If yes, where, and how is it done?
14. What are the health and environmental impacts of poor solid waste management in your administrative area?
15. Is there significant threat to human and environmental posed by e-waste disposal within your area?
15. Is there a policy document on solid waste management for the Nairobi?

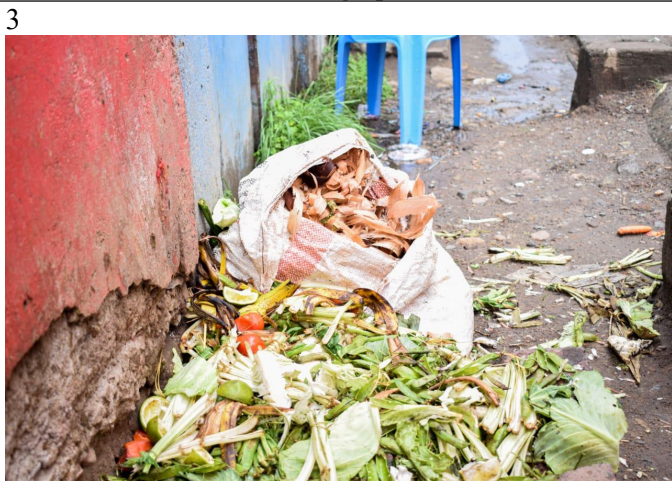
APPENDIX III: PHOTOGRAPHS OF SW IN EASTLEIGH WARD



Photograph 1



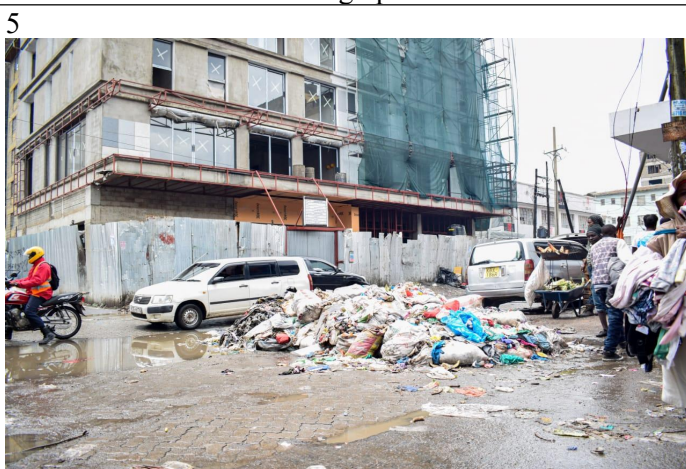
Photograph 2



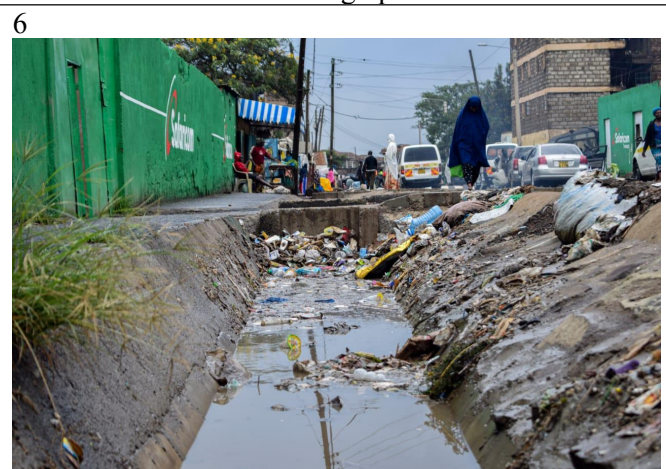
Photograph 3



Photograph 4



Photograph 5



Photograph 6

APPENDIX IV: CERTIFICATE OF ORIGINALITY



**UNIVERSITY OF NAIROBI FACULTY OF SCIENCE AND
TECHNOLOGY**

DECLARATION OF ORIGINALITY FORM

This form must be completed and signed for all works submitted to the University for examination.

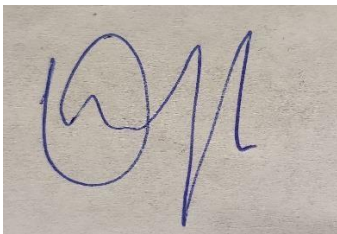
<p>Name of Student: ...JOSEPH MBIRO MUIRURI ...</p> <p>Registration Number: ... A82/96267/2014.....</p> <p>College: ... WANGARI MAATHAI INSTITUTE FOR PEACE AND ENVOROMENTAL STUDIES</p> <p>Faculty/ School/ Institute: ...WANGARI MAATHAI INSTITUTE FOR PEACE AND ENVOROMENTAL STUDIES.....</p> <p>Department:</p> <p>Course Name: ...DOCTOR OF PHOLOSOPHY DEGREE IN ENVIROMENTAL GOVERNANCE AND MANAGEMENT...</p>
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Title of the work

<p>ASSESSMENT OF RESIDENTS' KNOWLEDGE, ATTITUDE AND PRACTICES ON SOLID WASTE MANAGEMENT IN EASTLEIGH SOUTH WARD, NAIROBI, KENYA.</p>

DECLARATION

1. I understand what Plagiarism is and I am aware of the University's policy in this regard
2. I declare that this ...**Thesis**..... (Thesis, project, essay, assignment paper, report. etc) is my original work and has not been submitted elsewhere for examination, award of a degree or publication. Where other people's work, or my own work has been used, this has properly been acknowledged and referenced in accordance with the University of Nairobi's requirements.
3. I have not sought or used the services of any professional agencies to produce this work
4. I have not allowed, and shall not allow anyone to copy my work with the intention of passing it off as his/her own work
5. I understand that any false claim in respect of this work shall result in disciplinary action, in accordance with University Plagiarism Policy.

A handwritten signature in blue ink, consisting of a large, stylized 'W' or 'M' followed by a vertical line and a small flourish.

Signature:

Date: 16th MAY 2022

