CHALLENGES AND POSSIBLE SOLUTIONS FOR EFFECTIVE SOLID WASTE MANAGEMENT IN GITHUNGURI TOWN, KIAMBU COUNTY

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ABSTRACT

Municipal solid waste management constitutes a serious problem in our world. Cities, towns, and even villages are often grappling with this huge problem. Most cities and towns do not collect all the wastes generated, and of the wastes collected, only a fraction receives proper disposal. The insufficient collection and inappropriate disposal of solid wastes represent a source of water, land and air pollution, and pose risks to human health and the environment. Over the next several decades, the rapid urbanization in the developing world will further deteriorate this situation. Information on what is happening in different intermediate towns is not available for planning purposes. This study was undertaken to profile the various indicators of urban development, determine the character of solid waste, examine solid waste disposal methods, determine the level of awareness on solid waste management, identify the key challenges to effective solid waste management and recommend possible options of improving solid waste management in Githunguri town. A sample of 110 households, 30 business enterprises and 5 key informants were interviewed. The households and business enterprises were sampled randomly while key informants were selected purposively due to their expertise and specific area of responsibility. Transect walks and non-participant observations of the study area were also carried out. The data was analyzed using mapping tools and SPSS software. The findings revealed 5 key indicators of urban development in the town ranging from improved shelter provision, social development and eradication of poverty, environmental management, enhanced economic development and good governance. These five key indicators were crucial focal points on how Githunguri town is able to manage solid waste through civic education, technology, job creation, public participation, adequate funding among other factors which all fall under any one of the key five indicators of urban development in any urban set-up. The character of the waste generated included 40% paper and plastic, 30% food waste, 20% textiles, 5% glass and metals and 5% e-waste. Seventy-five (75%) of the solid waste was disposed to the main dumpsite, 10% recycling, 7% open burning, 5% hog feeding, and 3% composting. Ninety (90%) of respondents were conversant with the term solid waste management and its associated processes while 10% were not. The main challenges to effective solid waste management were lack of law enforcement, limited funding, low literacy levels and low technology levels. The study recommends the adoption and implementation of the zero-waste theory, use of 3Rs, polluter pay principle, waste segregation measures at source, public private partnerships among others. Further research should be done on modern ways of managing and utilization of solid waste.

DECLARATION

I declare that this is my original work. To the best of my knowledge, this document has not been presented to this or any other University or institution of higher learning for examination or other purposes.

This work comprises part of the requirements for the award of the Degree of Masters in Planning at the University of Nairobi.

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This thesis has been submitted for the purpose of examination with my approval as the university supervisor.

Signed  (Supervisor)

Dr. Fridah Wilumila Mugo

Date 20/11/2023

DEDICATION

This report is dedicated to my loving mum, who through her undying assistance and effort made my research a huge success. May the Almighty God bless her abundantly.

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LIST OF ABBREVIATIONS AND ACRONYMS

SW	Solid Waste
SWM	Solid Waste Management
MSW	Municipal Solid Waste
ISWM	Integrated Solid Waste Management
CGK	County Government of Kiambu
3Rs	Reduce, Reuse, Recycle
MDGs	Millennium Development Goals
SDGs	Sustainable Development Goals
CBOs	Community Based Organizations.
NGOs	Non-Governmental Organizations
SPSS	Statistical Package for the Social Sciences
SSA	Sub-Saharan Africa

CHAPTER 1: INTRODUCTION

1.1 Background to the Study

Rapid urban growth induces global environmental change, particularly when it comes to production, consumption, and generation of waste. According to the United Nations, most of the world's population will be living in cities by the year 2030. Kenya's Vision 2030 anticipates that over 50% of Kenyans will be living in urban areas by 2030. (National Spatial Plan, 2015-2045). In developing countries, urban agglomerations are growing at twice the rate of overall population growth. Each day, approximately 160,000 people migrate from rural to urban areas. The estimated urban growth rate for more developed regions is 0.5%, compared to 2.7% in less developed regions, and 4.5% in least developed regions.

One of the consequences of this urban explosion is the generation of an enormous amount of waste. Despite the many social, environmental, and economic differences between large cities, there are some obvious similarities in terms of environmental quality. Cities worldwide produce much more garbage and other waste than they can manage. Often, solid waste is transported over long distances, transferred into other regions, or not collected at all.

Many cities in developing countries fail to collect significant proportions of the cities' household waste. In most South American cities, 20 to 50% of the household waste is not collected (Ferguson & Maurer, 1996: 120). Similar figures are reported from other parts of the world. In Calcutta, the capital city of India's West Bengal State, about 82% of the waste is collected, while other municipalities within the metropolitan area of Calcutta only collect between 20 and 50% of the waste generated (Hasan and Khan, 1999: 104). The overall efficiency of waste collection in India is reported to be 72.5% (Gupta *et al*., 1998: 139).

The steady increase in per capita consumption makes it difficult to keep up with the growing volume of generated waste. Even though waste has direct negative impacts on human well-being, adequate solid waste management is still lacking in most city administrations. Uncollected waste can bring about serious threats to human health. Further threats can come from waste incineration or leachate from waste dumps. Often, land use conflicts arise when the government decides on new locations for sanitary landfills or for the operation of incinerators. In most cases, the local population is opposed to having sanitary landfills in their neighborhoods.

Environmental awareness and social mobilization is a growing issue, particularly in the South. The environmental justice movement specifically addresses the unequal distribution of environmental burdens from waste management in the community. Bullard (1994), Pulido (1996), Markham and Rufa (1997), among others, highlight the decisive role of race, class, and poverty levels as determinants for hazardous waste site locations.

High consumption levels generally correlate with intense resource use and waste production. A person in regions considered as High Human Development zones generates up to 2 kg of waste per day. Among the largest waste producers are industrialized nations, in particular the United States and Canada, with respectively 2 and 1.7 kg of solid waste per person per day, approximately double that generated among the urban population in Latin America (1 kg/person/day), Hong Kong (1.01 kg/person/day), or Guangzhou, China (1.09 kg/person/day) (Chung and Poo, 1998: 207). According to Cotton *et al*. (1999), cities in low-income countries generate on average between 0.3 and 0.6 kgs of waste per person per day. Over the past 10 to 15 years, per capita solid waste generation has increased in almost every city around the world.

The annual volume of waste generated in sub-Saharan Africa (SSA) increased from 81 million tonnes to 174 million tonnes per year between 2012 and 2016 and is projected to reach 269 million tonnes in 2030. In 2018, SSA's municipal solid waste (MSW) collection coverage was estimated at 44%. Concerned that the waste generation rate outweighs the collection pace, we conducted a systematic review of studies on MSW collection to examine the current situation in the region concerning the waste collection and coverage rates and to highlight the impediments to rapid progress in waste collection using the lens of four cities. Findings reveal that, despite the involvement of private waste collectors, collection and coverage rates are still below the desired 100% with backlogs of uncollected waste in public spaces, especially in low-income neighborhoods where coverage remains abysmally low. Despite the reported myriad of challenges with WM in the sub-Sahara, individual cases of improvements in some countries show that these challenges can be overcome with political will and the commitment to developing local solutions. For instance, the small community of Moshi in Tanzania was able to maintain the status of a 'top clean city' through the efficient collection of waste from its informal settlements, owing simply to the city council's commitment and residents' determination towards the success of the project. (Adedara, 2022).

It is estimated that Kenya generates between 3,000 to 4,000 tons of waste per day, majority of which originates from urban areas. According to World Bank, the country's capital, Nairobi generates between 2,000 to 2,500 tons of waste day. The portion is significant to the total waste generated in the country as a result of the city's dense population and high rate of urbanization. 70-80% of the waste generated in the country is organic, consisting of food waste, agricultural waste and yard waste, with the remaining waste consisting of inorganic waste such as plastic, paper and metal waste. Of the total waste generated, United Nations Environment Program (UNEP) reports that only about 10% of it is taken to designated disposal sites. A similar study by (UNEP, 2018) revealed that Kiambu County which neighbors, Nairobi City, the capital of Kenya, generated about 2,500 tons of waste per day of which only 38% were collected and 10% recycled.

Githunguri town is located in Kiambu County, and is about 42 kilometers west of Nairobi the capital city of Kenya. Githunguri is one of the twelve constituencies in the county, together with Kiambaa, Lari, Limuru, Kabete, Kiambu, Ruiru, Juja, Thika Town, Gatundu South, Gatundu North, and Kikuyu. According to the 2019 population census the population of Githunguri constituency was approximately 150,000 people, with the town itself having an estimated population of about 10,000 people. (Kiambu CIDP, 2013-2018).

Githunguri town traces its history from the early 1920s when the town served as a local focal point for trade between the surrounding communities such as the Kamba and the Maasai. The town itself and the surrounding areas such as Ikinu, Githiga, Ngewa and Komothai (currently administrative wards) are rich in loam soils that support the growth of various crops such as coffee, tea, maize, beans and bananas. In addition to the fertile soils the constituency enjoys a cool wet climate that facilitates dairy farming.

The name 'Githunguri' which in Kikuyu means a high point was a very strategic point for the Mau Mau fighters association that started in 1946. This was a rebellious group against the British rule in the country during the colonial era. The town had several strategic towers that were used to monitor the entry of new traders or enemies in to the town which served as the main market centre. Over the years the town has continued to grow and develop from its historical status as a trading centre to a thriving urban centre in the constituency.

The town serves as a commercial center, transport hub, industrial center, educational center, as well as an administrative center. Due to these land uses, there is a huge influx of people from the rural areas towards the town. The town being at a central point between Kiambu (town) and Limuru has rapidly developed with a big milk plant (Fresha Dairies), a large market center, several banks, prestigious health facilities, learning institutions as well as hosting key government institutions such as the Githunguri Law courts. With the great influx of investors from within and others from distant places, willing to open up more residential, commercial, educational, industrial, transport, agricultural and other service industries such as entertainment joints, the town has undergone various land transformations ranging from change of use, amalgamations and subdivisions, all which are meant to cater for the various activities in the town to support the day to day activities of the people depending on the town for a living. Change of use from agricultural to other uses has been on the rise, followed by many subdivisions as the locals tend to sell part of their land to potential investors due to the ever-rising land prices in the area.

While all the above factors have contributed to rapid development of the town in terms of economic growth, the general environmental condition of the town has greatly been overlooked. Over the last decade, the town authorities responsible for garbage collection and disposal in the town (Kiambu County Government) have often grappled with the challenge of managing the solid waste which includes; biodegradable solid waste such as food remains, plants and animal waste and the non-biodegradable solid waste such as broken glass, plastic bags and rubber.

The ever-rising population growth rate in the town has always made the scenario worse. Increase in population, which necessitates the provision of more land uses for provision of various services, has led to the increased consumption of resources such as food, energy, water, timber and to the greatest extent land itself which is the basic factor of production. With this consumption, a lot of solid waste is generated within the town ranging from broken glass, left over foods, clothing, and plastic paper bags all of which are produced from the shops, butcheries, industries, churches and schools found within the town.

The three designated dumping sites (Market, Diplomat and Township) cannot hold the huge amounts of waste generated and are only set close to the market center while there are none towards

the out-skirts of the town. As a result, many smaller and informal dumping sites have emerged in the outskirts of the town. This has resulted in a number of challenges which include:

- Encroachment on other land uses such as roads which reduces the efficiency of the transport system in and out of the town.
- Breeding areas of mosquitoes which spread Malaria.
- Water pollution, arising from spillage of the solid wastes into the urban drainage system ending in streams.

The town also lacks a conventional liquid waste disposal system. All the developments in the town comprising of lodges, shops and food kiosks empty their effluents into the available septic tanks and road sides or just on any available open spaces. Pit latrines have turned to waste disposal areas. The main stadium in the town which hosts various sporting activities ranging from soccer, volleyball, athletics, and netball has not been spared either. Large deposits of solid waste are delivered there by street urchins at night. This has led to several conflicts between the authorities and the sporting teams who pay maintenance fees for the stadium but are always operating in a dirty environment.

Owing to the above discussion regarding how the town has developed over the years, and with the issue of solid waste in the town proving a menace to the authorities, there is need to come up with a policy on efficient solid waste management mechanism in Githunguri town in order to formulate a good solution to solid waste disposal challenges in Githunguri town.

1.2 Problem Statement

In spite of the huge steps most of the developing countries have taken towards encouraging urban development, many local authorities still grapple with challenges of solid waste management which arise out of development activities. The ever-rising demand for land to set up commercial enterprises, educational facilities, public utilities, transport and communication hubs, industries and other development-oriented activities, there has been a global concern due to the waste generated from these activities. The challenges range from reducing generation of waste, separation, change of practices in collection, transport, treatment, reuse and disposal of the waste. UNEP (2005) sees the challenges as different for different levels of industrial development. In an attempt to accelerate the pace of its industrial development through rapid urbanization and to cut costs on solid waste management, an economically developing nation may pay inadequate attention to solid waste

management. In Kenya, the challenge of inefficient solid Waste management is real (Gakungu, 2011). There is lack of information on the type, volume, and nature of waste generated in Githunguri town and how it can be managed efficiently. This makes planning for its efficient disposal difficult hence the need for this study.

1.3 Research Questions

To help determine whether the challenges posed by urban development have any effects on the management of solid waste in Githunguri Town, this study was designed to answer the following questions:

i. What are the various indicators of urban development and how do they influence solid waste management practices in the town
ii. What is the type/character of solid waste produced in Githunguri town?
iii. What are the solid waste disposal methods in Githunguri town?
iv. What is the level of solid waste management awareness in Githunguri town?
v. What are the main challenges to effective solid waste management in Githunguri town?
vi. What actions can be taken to ensure effective solid waste management in Githunguri town?

1.4 Objectives

1.4.1 Main Objective

To analyze the challenges of rapid urban development on effective solid waste management in Githunguri Town.

1.4.2 Specific Objectives

i. To profile the various indicators of urban development in Githunguri town.
ii. To determine the character of solid waste in Githunguri town.
iii. To examine solid waste disposal methods in Githunguri town.
iv. To determine the level of awareness on solid waste management in Githunguri town.
v. To recommend possible options of improving solid waste management in Githunguri town.

1.5 Justification of the Study

The natural environment has long been a constant source of natural resources to both human kind and other living organisms. The natural environment supplies food, water, air and energy which have all contributed to us living a comfortable life. The high levels of consumption of these resources have brought a lot of waste generation which when inappropriately handled has negative

consequences on the environment, thus creating a serious threat to almost every living organism in the world. Pollution has manifested itself in air, land and water owing to the poor disposal methods of such wastes.

It is important to note that these changes have resulted from the various forms of urban development processes that man has adopted. For example, changing a given land use from one use to another has its impact on land in terms of the type, volume, and nature of disposal of the type of solid waste generated.

The researcher therefore expects output from this study to be concerned with the issues of solid waste management from Githunguri town and unravels the mystery of how urban development and solid waste management are tied to one another. This study will also go a long way in explaining that solid waste management is not only an urban management issue but is also a land use planning issue.

CHAPTER 2: LITERATURE REVIEW

2.1Theoretical Framework

2.1.1 Definition of Urban Development

Urban development refers to the rate at which the population, land area, or significant urban land-use increases. (Caves, 2004). Also defined as the growth of metropolitan areas or cities, it is something that started way back between the 5000 and 6000 B.C., especially due to the movement of people from rural areas to urban areas – places with high human population, economic activities, and infrastructure. The 19th century, in particular, was a mark of actual urban growth.

Urban development results from concentration of expansion of industrial, residential, commercial and transportation facilities on specific geographical areas that create towns and cities. Residential areas are the primary focus of urban development. Urban development occurs through expansion into unpopulated areas and/or the renovation of decaying regions.

This results from urbanization through the movement of people from rural areas to urban areas. Urban development may lead to a rise in the economic development of a country. Urban development is also referred to as the expansion of a metropolitan or suburban area into the surrounding environment. It can be considered as an indicator of the state of a country's economic condition as the effect of urban growth directly impacts the country's economic development. The more the metropolitan area grows, the more employment it generates, and in this way economic growth also takes place. (Caves, 2004).

2.1.2 Drivers of Urban Development

i. The natural increase in population

The rate of death and births characterizes the natural expansion of an area. In areas where births are more than the deaths, the population is bound to increase. People who migrate to town and cities tend to be young people who are in search of housing, jobs, or better education. Young men and women have a high fertility rate. Therefore, they increase in numbers quickly and will eventually look for new spaces within the urban area to settle and fend for their kind (Tong, 2020).

ii. Migration

Immigration is a major contributor to the increase in the population of a place. Many people are forced to move to urban areas in search of jobs, education, and housing. Inadequate funding and social infrastructure in rural areas have also driven people to urban areas. In other cases, political, racial, economic, or religious conflicts have forced people to move to neighboring urban areas. (Tong, 2020).

iii. Industrialization

The industrial revolution brought about new production techniques. Through this, manufacturing has created more job opportunities by providing people with employment in new sectors. With modern farm machinery, employment in the rural areas reduced, forcing workers to move to urban areas in search of new jobs in tertiary and manufacturing industries. In pursuit of increased wages, men and women continue to abandon jobs in rural areas by moving to industrial cities. Many people move to urban centers to look for well-paying industrial jobs as urban centers have more opportunities (Caves, 2004).

iv. Commercialization

Whereas industrialization has played an essential role in the growth of urban areas, commerce and trade have profoundly influenced the growth of cities. In ancient times, cities like Athens, Sparta, and Venice were great commercial centers. In modern life today, the commercial activities in city and industrial areas continue to attract more and more people as traders and workers, thereby contributing to the growth of cities and town areas. Business people prefer going to the cities to sell their commodities and in search of higher profits. The kind of economic pull urban centers have is one that attracts more and more people to move to urban areas (Berkie, 2006).

v. Advancement of transport and communication

When factories were introduced, the local transportation was weak, forcing the factory laborers to reside near their place of work. The cities were partitioned into dwelling areas, market area, factory area, slums, and so on. Increased population leads to congestion of housing and adds to the already existing community by extension of boundaries.

Today, people prefer to live near their place of work not because of poor transport but to shorten travel distance and avoid the traffic jam on their way to work. Active transportation helps make the cities more habitable by easing communication, transportation, and creating convenient accessibility. (Caves, 2004).

vi. Availability of educational and recreational facilities

Most training institutions, colleges, elementary schools, and technical institutions are in urban areas. Also, most libraries are located in the cities. Recruiting agencies, as well as the examination councils, are situated in the cities. Clearly, due to the location of these facilities, most students and adult learners are attracted to the town for easy accessibility of higher education. Opera and Amusement Theaters are also in urban areas, drawing more people to the cities. (Berkie, 2006).

vii. Urban planning policies

Urban planning typically forces city leaders to find ways of making a sustainable city, including proper town development and expansion plans. As a strategy aimed at converting vision into implementation, it acts as a guide for making the most out of a city by improving infrastructure and building its economic growth and enhancing the city's living standards as well as the resident's well-being. With better living standards and infrastructure in the city, more people are attracted to live in the municipality, consequently increasing its population. (Berkie, 2006).

viii. Topographical factors

The topography of an area has huge impacts on the growth of a city. An area with a suitable topography is usually easy to develop and expand. Urban areas in or around an excellent topographical area are easily extended and refined, thus drawing more people to such areas. (Seto, 2011).

ix. Unbalanced spatial development

In many countries around the world, there are developed regions and less developed regions. Many people tend to move to more developed areas. Occasionally, urban centers (cities) are more developed than rural areas because of the available facilities and opportunities offered in urban areas. On this account, the population and size of the metropolitan area will automatically increase within a given period. (Seto, 2011).

x. Presence of functional administrative and social support offices

The presence of administration dominance in an urban center promotes its growth. Many cities today hold offices for various administration and governance functions, which influence people to live in these areas for access to better governance and social amenities like security, sanitation, housing, education, and healthcare. (Hypko, 2010).

xi. Mining and investments

As more urban areas continue being successful and well-off due to the discovery of minerals, resource exploitation, agricultural activities, or business operations, urban areas continue to grow economically. Societies continue being financially liberal due to the availability of jobs in urban areas. As a result, more investors are attracted to invest in such cities, promoting their growth. (Hypko, 2010).

2.1.2 Definition of Solid Waste

Solid waste is the unwanted solid materials generated from combined residential, industrial and commercial activities in a given area. It may be categorized according to its origin (domestic, industrial, commercial, construction or institutional); according to its contents (organic material, glass, metal, plastic paper); or according to hazard potential (toxic, non-toxin, flammable, radioactive, infectious). It is broadly classified into organic and inorganic. In this study, waste composition is categorized as food wastes; papers, cardboards & plastics; glass and metals; textiles; and yard wastes. These categories can be further refined; however, these five categories are sufficient for general solid waste management purposes. (Heather, 2006).

According to the County Government of Kiambu Solid Waste Management By-laws, solid waste is defined as "all waste materials generated by households, institutions, commercial establishments and industries or litter and clandestine piles of such waste" (MCK, 2008). Solid waste management is increasingly becoming a global concern as urban centers continue to grow and expand and populations increase. In this global waste sector, Municipal Solid Waste also refers to the waste generated by residential, commercial and institutional activities. According to Rotich et al (2005), the fundamental purpose of solid waste management is to protect the health of the population, promote environmental quality, develop sustainability and provide support to economic productivity through utilization of waste as a resource through generation of employment and income. These objectives should be attained in a viable manner that is affordable by the residents over the long term with minimum risks involved to the persons doing it.

Solid Waste Management (SWM) is one of the important obligatory functions of any urban local authority. It refers to all activities pertaining to the control, collection, transportation, processing and disposal of those in accordance with the best principles of public health, economics, engineering, conservation, aesthetics and other environmental considerations. As the world continues to urbanize and develop economically, the developing countries are not left behind. Waste production is growing steadily, with stronger trends in developing countries mainly due to the rapidly growing population and rural-urban migration rates. This essential service, however, is not efficiently and properly performed by many cities in developing countries. For instance, many urban centers in Kenya are grappling with increasing piles of waste, disposal technologies and methodologies, and overflowing dumping sites.

2.1.3 Principal Classification of Solid Waste

Solid waste may be classified as bio-degradable or non-biodegradable. Waste which can be decomposed by biological processes is known as biodegradable waste while the waste which cannot be decomposed by biological process is known as non-biodegradable wastes. (Giegrich, 2005).

Table 2.1 Principal Classification of Solid Waste

Biodegradable and Recyclable	Non-Biodegradable	
	Recyclable	**Non-Recyclable**
Food wastes Yard Wastes (leaves, grass)	Plastics – carry bags, milk covers PVC pipes etc. Syringes, Glucose bottles etc. Cotton and nylon cloth, Tyres & Tubes	Thermal Cal Carbon paper Plastic coated visiting cards Sachets Modern packing materials (plastic) for food packing
Paper Scraps Cardboard Newspapers Magazines Wrapping Paper Paper Beverage Cups	Bottles Glass Wires Caps of mineral water Bottles Plastic Tin can Metal Ash/dirt	

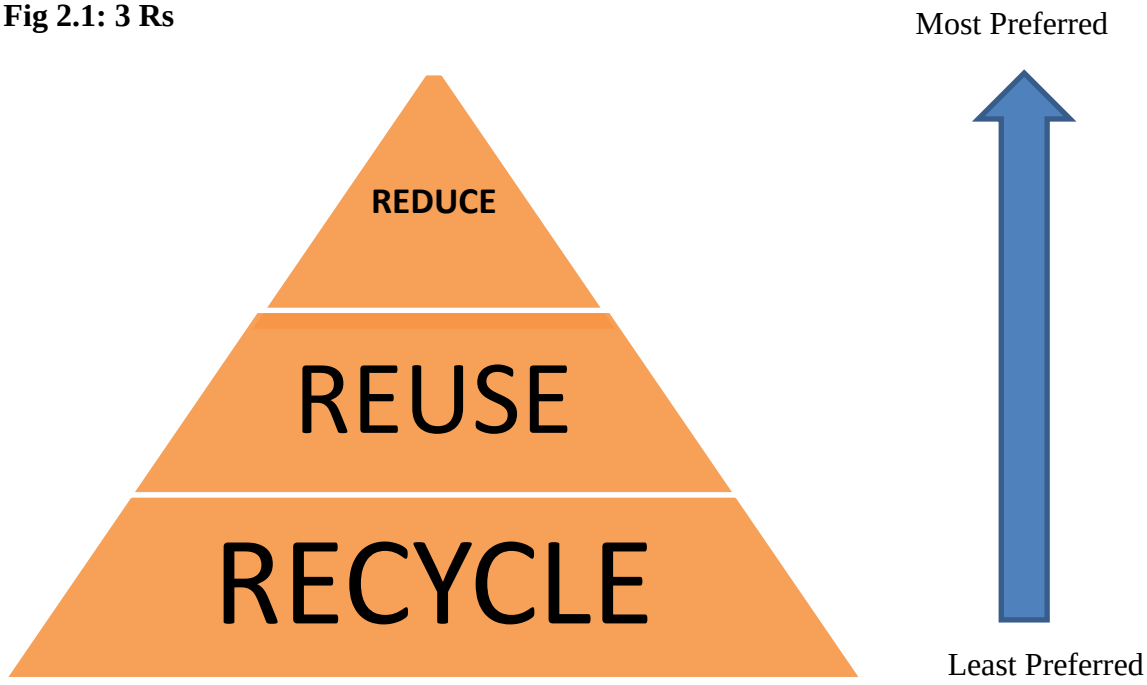
2.1.4 Solid Waste Management Options/Processes

Management of solid waste reduces or eliminates adverse impacts on the environment and human health and supports economic development and improved quality of life. A number of processes are involved in effectively managing waste for a municipality. These include monitoring, collection, transport, processing, recycling and disposal. (Galle et.al, 2001).

2.1.5 The 3 R's

Methods of waste reduction, waste reuse and recycling are the preferred options when managing waste. There are many environmental benefits that can be derived from the use of these methods. They reduce or prevent greenhouse gas emissions, reduce the release of pollutants, conserve resources, save energy and reduce the demand for waste treatment technology and landfill space. Therefore, it is advisable that these methods be adopted and incorporated as part of the waste management plan. (Giegrich, 2005).

Fig 2.1: 3 Rs



The 3'Rs

Waste reduction and reuse - Waste reduction and reuse of products are both methods of waste prevention. They eliminate the production of waste at the source of usual generation and reduce the demands for large scale treatment and disposal facilities. Methods of waste reduction include manufacturing products with less packaging, encouraging customers to bring their own reusable bags for packaging, encouraging the public to choose reusable products such as cloth napkins and reusable plastic and glass containers, backyard composting and sharing and donating any unwanted items rather than discarding them. All of the methods of waste prevention mentioned require public participation. In order to get the public onboard, training and educational programs need to be undertaken to educate the public about their role in the process. The government may need to regulate the types and amount of packaging used by manufacturers and make the reuse of shopping bags mandatory. (Huang, 2006).

Recycling - This is the process whereby the materials are recovered and processed such that the materials can be converted into new products. (Price, 2001).

Waste Collection

Waste from homes is generally collected by our local authorities through regular waste collection, or by special collection for recycling. Within hot climates such as that of the Caribbean and the coastal regions in Kenya, the waste should be collected at least twice a week to control fly breeding, and the harboring of other pests in the community. Other factors to consider when deciding on frequency of collection are the odors caused by decomposition and the accumulated quantities. (Yamakawa, 2002).

Solid Waste Treatment

Waste treatment techniques seek to transform the waste into a form that is more manageable, reduce the volume or reduce the toxicity of the waste thus making the waste easier to dispose of. Treatment methods are selected based on the composition, quantity, and form of the waste material. Some waste treatment methods being used today include subjecting the waste to extremely high temperatures, dumping on land or land filling and use of biological processes to treat the waste. (Morris, et.al, 2000).

Integrated Solid Waste Management

Integrated Solid Waste Management (ISWM) takes an overall approach to creating sustainable systems that are economically affordable, socially acceptable and environmentally effective. An integrated solid waste management system involves the use of a range of different treatment methods, and key to the functioning of such a system is the collection and sorting of the waste. It is important to note that no one single treatment method can manage all the waste materials in an environmentally effective way. Thus, all of the available treatment and disposal options must be evaluated equally and the best combination of the available options suited to the particular community chosen. Effective management schemes therefore need to operate in ways which best meet current social, economic, and environmental conditions of any given environment. (Idris, 2003).

2.2 Theories Related to Solid Waste Management

Policy and legislation enhance solid waste management

2.2.1 Top-down and, Bottom – up theories

Top-down approach relates to status-quo where policies and decisions follow an executive order from the top leadership to the junior support staff. Decisions made in this approach are usually authoritative and contrary (matland1995, 146). The bottom-up approach is where issues are handled from the ground up to the top leadership/administration level. Those in charge of implementation are given powers to make decisions in issues affecting them. In the management of solid waste in Kenya, policy and legislation follow a top-down approach where policies are implemented without any regard to affected groups. This leads to misunderstandings thus turning that strategy to a ―tactic‖ (De Leon and Delion, 2001).

The top-down approach in SWM has led to a total failure thus the reasons why waste management is still a challenge. Bottom-up approach should be encouraged since it involves most affected stakeholders. It will also lead to public private partnership programs which contribute immensely in solving this problem. When directly affected people are given the mandate to decide on strategies, they effectively exhaust all areas and come up with best solutions, implying that it is the wearer of the shoe who knows where it pinches. Bottom-up approach relates well with the implementation of policies and regulations since it leads to legislation of the best policies and regulations. The implementation will also be easier because no resistance will be experienced during implementation instead the project will attract full support.

Urbanization increases solid waste production

2.2.2 Economic Theory

Todaro and Smith (1970) agreed that migration in the earlier days was a good idea. It is only in recent times that migration is perceived negatively due to the fact that increased migration is more than the creation of jobs and provision of other essential social services, like sanitation and clean environment. In this regard Michael Todaro and Stephen C. Smith in their economic theory concur that urbanization is one key factor in solid waste management. Increased population caused by urbanization has created challenges to the unprepared local authorities both in planning and management of solid waste in urban areas. (Todaro, 1970).

Technical and financial capacity is important in solid waste management

2.2.3 Conflict theory

In conflict theory those who have and those who don't have seem to live in two worlds apart where the political elites and economically well of use their financial strength to channel benefits from both the local government and the national government to their well-developed areas. This leaves the less fortunate struggling with a number of issues including solid waste management. This usually creates conflict between the two groups because policy and legislation developed tend to favor the rich. In case of any implementation of technology on solid waste management, the areas occupied by the rich are usually given first priority leaving the poor in the slums where much of the waste is produced suffocating in heaps of garbage. (Smith, 1993).

Embracing technology helps in waste management factionalism theory

2.2.4 Factionalism Theory

This theory gives the good and the bad side of cities. While a number of good ideas like innovations diversity and creativity happen in cities we also have issues like impersonality and crimes in cities. Dumping sites might appear to be a curse in the city while in some areas within the city dumping sites are a blessing. Some people look at urbanization as the problem on SWM while others feels that due to urbanization they are able to make a living. For instance, groups involved in waste collection and those families who live by scavenging for food from dumping sites see urbanization as a blessing. This is because their lives depend entirely from income generated from selling various materials collected from dumping sites i.e. metals and plastic bottles. (Gregory, 1996).

2.2.5 Zero Waste Theory

Zero Waste is a set of principles focused on waste prevention that encourages the redesign of resource life cycles so that all products are reused. The goal is for no trash to be sent to landfills, incinerators or the ocean. Zero Waste can also be defined as the conservation of all resources by means of responsible production, consumption, reuse and recovery of all products, packaging, and materials, without burning them, and without discharges to land, water or air that threaten the environment or human health. Zero Waste refers to waste prevention as opposed to end-of-pipe waste management. It is a whole systems approach that aims for a massive change in the way materials flow through society, resulting in no waste. Zero waste encompasses more than eliminating waste through recycling and reuse. It focuses on restructuring production and

distribution systems to reduce waste. Zero waste is more of a goal or ideal rather than a hard target. (Davidson, 2011).

Zero Waste provides guiding principles for continually working towards eliminating waste. California is a leading state in the United States for having zero waste goals. California is the state with the most cities in the Zero Waste International Alliance. According to the United States Environmental Protection Agency, multiple cities have defined what it means to be a Zero Waste community and adopted goals to reach that status. Some of these cities include Fresno, Los Angeles, Oakland, San Francisco, Pasadena, Alameda, and San Jose. San Francisco has defined Zero Waste as "zero discards to the landfill or high-temperature destruction." Here, there is a planned structure to reach Zero Waste through three steps recommended by the San Francisco Department of the Environment. These steps are to prevent waste, reduce and reuse, and recycle and compost. Los Angeles defines zero waste as "maximizing diversion from landfills and reducing waste at the source, with the ultimate goal of striving for more-sustainable solid waste management practices." Los Angeles plans to reach this goal by the year 2025. To reach this goal, major changes will have to be made on product creation, use, and disposal. (Hubka, 1988).

Simple Framework for Zero Waste Management

Fig 2.2: Zero Waste Illustration

Source: *Davidson, 2011*

2.3 Policy Frameworks

a) Agenda 21

The earth summit was so ambitious in its major theme of sustainable economic development. The meeting produced an overall plan called agenda 21; large developing countries promised protecting the environment. Environmental sustenance is a crucial ingredient in ensuring economic take off. Various literature has illustrated how a well-designed and maintained, aesthetic environment plays a vital role in the control of crime and insecurity. The development aims at proposing a sustainable model of space use in the informal economy that will sustain environmental ambience. This will be done through use of environmentally friendly materials, environmental impact assessments and environmental audits in the development area.

b) Environmental Management and Coordination Act

Section 3 of EMCA, 1999 stipulates that - Every person in Kenya is entitled to a clean and healthy environment and has a duty to safeguard and enhance the environment.

Section 9 of EMCA, 1999 further states that:

(1) The object and purpose for which the Authority is established is to exercise general supervision and co-ordination over all matters relating to the environment and to be the principal instrument of Government in the implementation of all policies relating to the environment.

(2) Without prejudice to the generality of the foregoing, the Authority shall –

(a) co-ordinate the various environmental management activities being undertaken by the lead agencies and promote the integration of environmental considerations into development policies, plans, programmes and projects with a view to ensuring the proper management and rational utilization of environmental resources on a sustainable yield basis for the improvement of the quality of human life in Kenya;

Section 86 of EMCA, 1999 provides that: The Standards and Enforcement Review Committee shall, in consultation with the relevant lead agencies, recommend to the Authority measures necessary to:-

(1) Prescribe standards for waste, their classification and analysis, and formulate and advise on standards of disposal methods and means for such wastes; or

(2) Issue regulations for the handling, storage, transportation, segregation and destruction of any waste.

Section 87 of EMCA 1999 states that:

(1) No person shall discharge or dispose of any wastes, whether generated within or outside Kenya, in such manner as to cause pollution to the environment or ill health to any person.

(2) No person shall transport any waste other than –

(a) In accordance with a valid licence to transport wastes issued by the Authority; and

(b) To a wastes disposal site established in accordance with a licence issued by the Authority.

(3) No person shall operate a wastes disposal site or plant without a license issued by the Authority.

(4) Every person whose activities generate wastes shall employ measures essential to minimize wastes through treatment, reclamation and recycling.

Environmental Management and Coordination (Waste Management) Regulations of 2006

On the Responsibility of the Generator, Regulation 2 states that – Any person whose activities generate waste shall collect, segregate and dispose or cause to be disposed off such waste in the manner provided for under these Regulations.

Regulation 5 on the Segregation of waste by a generator states that ―(1) Any person whose activities generate waste, shall segregate such waste by separating hazardous waste from non-hazardous waste and shall dispose of such wastes in such facility as is provided for by the relevant Local Authority.

(c.) Constitution of Kenya

The constitution of Kenya (2010) under article 184, states the places of urban areas and cities is recognized with the presupposition for the development of national legislation that shall provide for the governance and management of urban areas and cities. This initiates the formation of the Urban Areas and cities act 2013.

The bill of rights also clearly provides for the respect, protection and fulfillment of human rights for all citizens regardless of their place of residence, ethnic origin, gender or any other status. It safeguards the rights to food, health, education, housing, water and sanitation and above all a clean environment.

In the Constitution of Kenya, Article 42 on the Environment provides that:

Every person has the right to a clean and healthy environment, which includes the right
(a) To have the environment protected for the benefit of present and future generations through legislative and other measures, particularly those contemplated in Article 69; and
(b) To have obligations relating to the environment fulfilled under Article 70.
Article 69 on Obligations to the Environment, the Constitution provides that –

(1) The State shall—
(c) Encourage public participation in the management, protection and conservation of the environment;
(d) Establish systems of environmental impact assessment, environmental audit and monitoring of the environment;
(e) Eliminate processes and activities that are likely to endanger the environment; and
(f) Utilize the environment and natural resources for the benefit of the people of Kenya.

(2) Every person has a duty to cooperate with State organs and other persons to protect and conserve the environment and ensure ecologically sustainable development and use of natural resources.
Part 2 of the fourth Schedule in the Constitution of Kenya also explicitly provides that the County Governments shall be responsible for; refuse removal, refuse dumps and solid waste disposal.

(d) Physical and Land Use Planning Act, 2019

It outlines the standards, regulations and the procedures that must be followed by planners when planning for various sectors. It provides for a sectoral approach to development and measures for the implementation and coordination in sectors such as infrastructure sector. Planning, zoning and designing are all vital components that determine the vulnerability of an area to crime. Proper designing of streets for instance improves visibility and hence making a space defensible.

(e) The Urban Areas and Cities Act of 2011 (Amended Act 2019)

This is an Act of Parliament that gives effect to Article 184 of the Constitution; to provide for the classification, governance and management of urban areas and cities; to provide for the criteria of establishing urban areas, to provide for the principle of governance and participation of residents and for connected purposes. Section 36 (1) States that every city and municipality established under this Act shall operate within the framework of integrated development planning which shall bind, guide and inform all planning development and decisions and ensure comprehensive inclusion of all functions including solid waste management.

2.4 Solid Waste Management Best Practices

Effective management of solid waste in urban areas is witnessed/realized in urban areas where:

i. Residents are actively involved (public participation) in solid waste management issues

ii. Emphasis on educational awareness with regards to solid waste management is addressed.
iii. Solid waste management activities are sources of incentives to the targeted populations.
iv. Those involved have a positive attitude and behavior change towards solid waste management.

a) Incentives

The major social intervention cited by researchers to increase the effectiveness of waste management systems is through incentives. One of the major motivators for behavior change is the use of incentives. Incentives, both economic and socio-psychological, can be incredible tools to help change behavior and are considered an effective social intervention in developing countries by many researchers (Bolaane, 2006; Mrayyan and Hamdi, 2006; Milea, 2009; O'Connell, 2011). Socio-psychological incentives are referred to as incentives that change attitudes and behavior through disseminating information, persuasion by relating waste minimization to the achievement of valued goals and making use of social pressure, among others (Milea, 2009). Media can play an important role in increasing public participation and awareness and can serve as an instrument for many socio-psychological incentives. A study conducted in Cuba (Mosler et al., 2008) found that mass media involvement, through the use of advertisement and campaigns geared towards recycling and reusing products, was seen as a useful incentive to public participation in waste management

informational sessions and activities. Television campaigns involving local celebrities or other influential people participating in these SWM activities could also prove useful in developing countries where television usage has become popular and widespread, such as Peru. However, information is not enough. People have to believe that the particular action is a contribution and feel it is their own responsibility to do it. Therefore, when the media is used to create these awareness campaigns, they should endeavor to create a common goal around solving the waste problems and be very clear on how people can contribute to this and why it is urgent and important to do so (Mosler et al., 2008).

Many researchers have also cited economic incentives as an important tool in changing behavior and in some cases market and financial incentives can be even more effective in modifying public behavior and increasing waste diversion. Economic incentives are those that give financial rewards for cooperation (Milea, 2009). Waste-picking or scavenging activities are commonplace in developing countries. These waste-pickers have little education and limited opportunities to make a stable income. The existence of waste pickers/scavengers often creates an obstacle to the operation of solid waste collection and disposal services (Schübeler et al., 1996). This has to do with the fact that these scavengers are taking out all the recyclable materials from waste piles to make money—which many local governments depend on for funding SWMS.

However, if organized properly, their activities can be effectively incorporated into a waste recycling system. This type of an opportunistic approach is required for sustainable development of SWM programs in developing countries (Schübeler et al., 1996). A successful example of an economic incentive program can be seen in Gaborone, Botswana (Bolaane, 2006). Most stores in the city accept empty beverage bottles from customers in exchange for the return of their deposit. The results of the effectiveness of both of these incentive approaches have varied. An evaluation of Mexican projects showed that economic benefits had more influence on behavior changes such as source separation than environmental education (Bolaane, 2006).

However, a review of literature conducted by Cercere et al. (2013), revealed that if motivations are extrinsic from the beginning, the increase of external incentives will be likely to increase effort as predicted by many researchers. According to Cercere's findings, the importance of non-monetary incentives in waste recycling has been emphasized in the literature (as cited in Cercere et al., 2013), and this suggests that recycling is increased more by social incentives than by economic ones, to

the point that households may even be willing to pay for the opportunity to recycle. Non-monetary incentives must also be considered when waste reduction is the aim.

b) Public Participation

Another major social intervention for more effective SWM is increasing community involvement in waste management activities such as recycling, and increasing participation in decision making when it comes to waste management programs. The issues of public acceptance, changing value systems, public participation in planning and implementation stages, and changes in waste behavior are equally as important as the technical and economic aspects of waste management (Marshall and Farahbakhsh, 2013).

Effective waste management must be fully embraced by local authorities and the public sphere, and must include all stakeholders in the entire waste management decision-making process. Key elements to the success of these integrated programs are public participation and empowerment, decision transparency, networking, cooperation and collective action, communication, and accessibility of information (Marshall and Farahbakhsh, 2013). In a study conducted in India (Milea, 2009) researchers found that although the majority of respondents perceive garbage as a big problem in Delhi, there is little knowledge on the ways one could contribute to solving it. The sense of responsibility for one's waste was found to be the major factor determining littering and waste separation, but waste minimization is mainly associated with income and not perceived as part of the waste problem. Researchers suggested that public campaigns should emphasize residents' responsibility for their waste and the importance of each and every citizen's cooperation, thus creating a sense of a shared community goal around solving the waste problem. The information and motivation campaign should be supplemented with measures that would facilitate citizen participation.

According to another study (WRC, 1995), communities should be required to take responsibility for their own waste collection and disposal. Through community self-help, waste management costs are reduced and community self-interest is increased. The advantage of this strategy is its emphasis on community involvement in the reuse of waste materials. The study suggested the following steps to encourage community involvement:

i) Promotion of environmental education, information and capacity building in communities.

ii) Promotion and provision of support for community-based initiatives to seek solutions to waste management, sanitation, and access to resources; and

iii) Creation of community fora responsible for developing integrated environmental, developmental and spatial plans.

c) Improvements in Education and Awareness

When reviewing current research on the topic of social interventions, recycling is often emphasized when talking about education and awareness programs as they relate to SWM. The low level of awareness regarding the health and environmental impacts of improper management of solid waste makes it difficult to implement recycling and disposal programs in many developing countries (Mrayyan and Hamdi, 2006). Recycling requires community involvement and social awareness to be successful. In recognition of the importance of public participation in the success of recycling programs, recycling policy and legislation need to be geared toward promoting people centered approaches to recycling with public education as the main driver towards increasing public participation. (Bolaane, 2006).

A study done in Palestine focused on this educational gap came to the conclusion that there was a positive relationship between the level of education and the participatory behavior of the people in recycling activities (Al-Khatib et al., 2015). Unfavorable results present local authorities with the challenge to educate citizens and disseminate sustainable measures and practices aiming to:

(i) Reinforce environmental sustainability, public health, family and child safety; and

(ii) Practice the principles of waste management: reduction and segregation at the source, reuse and commitment to participate in recycling schemes.

A similar study conducted in Jordan found similar results that by implementing proper environmental awareness programs public understanding will be enhanced and achieving greater efficiency of waste management practices will yield positive results (Mrayyan and Hamdi, 2006). These are just two findings of many that identify public awareness and education of SWM as vital in achieving waste segregation that would, in turn, reduce solid waste pollution. Also incorporating health messages, such as communicating the negative health effects of open-burning of waste on air quality and human health, in the education and awareness campaigns may prove to be the push many community members need to change their waste management behaviors.

Another study conducted in Malaysia, found that educational programs affect the relationship between people's attitudes towards SWM and their recycling motives. Consequently, attitudes toward recycling were found to have a significant effect on waste recycling. In terms of extrinsic (i.e. social reinforcement and monetary reward) and intrinsic motivation (i.e. personal satisfaction) both were found to affect recycling behavior. However, having a sufficiently high level of motivation itself and positive attitudes toward recycling do not guarantee that an individual will act accordingly (Ainiet al., 2002). Systematic and holistic approaches and efforts should be undertaken by various government and non-governmental agencies to educate the public by focusing on the underlying reasons for recycling and the adverse effects of mounting garbage on the environment. The intrinsic motives, which were found to be higher motivational factors among the respondents, should be nurtured and developed so as to encourage recycling participation specifically and be more environmentally responsible behavior in general.

When people understand the connection between their behaviors and environmental harm, they are more likely to engage in pro-environmental behaviors. Recycling behavior is strongly influenced "by the knowledge of where, when, and how to recycle" as stated by O'Connell (2011). The findings of a study conducted in over twenty-two developing countries (Guerrero et al., 2013) suggests that when citizens receive information about the benefits of recycling and how to sort the waste, and they participate in the designing of the programs, they are more likely to participate in recycling campaigns. Social norms can also play an important role in changing waste behavior and participation in recycling activities. People are more likely to recycle when they observe others in their community recycling, so it would be beneficial to reach out to key members of the communities to take the lead on changing these negative environmental behaviors (O'Connell, 2011).

While recycling is a very important aspect of waste management, authorities in developing countries tend to overlook the significance of waste minimization strategies, leading to situations where more waste than necessary is sent to disposal sites or recycling facilities. According to the EPA (1988), waste minimization is a process of elimination that involves reducing the amount of waste produced in society and helps eliminate the generation of harmful and persistent wastes, supporting the efforts to promote a more sustainable society. Waste minimization involves redesigning products and/or changing societal patterns, concerning consumption and production, of waste generation, to prevent the creation of waste. There has not been a lot of research on this

topic especially in developing countries, but the few studies that have been conducted have found waste minimization both an effective and economically viable option in managing solid waste (O'Connell, 2011).

One such study conducted in Ghana yielded interesting results (Yire, 2012). As a result of rapid urbanization, Ghana is currently suffering from an abundance of waste, specifically plastic bag pollution. These bags are creating drainage issues and have proved to be hazards to local livestock that feed upon them. Ghana is taking active steps to ban the use of plastic bags to help alleviate this issue. Somalia, Botswana, Uganda, Kenya, Tanzania, Eritrea, and Ethiopia, among others, have already placed an outright ban on plastic bag use. This is a great example of attacking waste at the source. Waste minimization is an excellent opportunity for all countries, both developing and developed, to stop waste at its source (Yire, 2012). Educating the public about the benefits of waste minimization is key to reducing waste on the long-term scale.

Waste minimization is a new concept in the developing world where residents' consumption levels are only starting to rise. However, addressing this problem directly may be the most cost-effective way to address waste management in the developing world. There are several methods to increase participation in solid waste minimization efforts and these include: using the power of social norms, emphasizing environmental benefits, providing convenient access to facilities and adequate information, appealing to positive emotions surrounding waste minimization, and waste minimization through responsible consumption. Including social and cultural norms, involvement at the household level and analysis of individual needs are crucial to the success of recycling and waste-reduction interventions in which change of individual behavior is the key factor and main focus. These may all prove to be effective in different situations and in different countries. Many of these methods are similar to or modified versions of methods to encourage recycling, and many options can be implemented in conjunction with one another to provide a more effective program of waste management that focuses on waste minimization as a major priority.

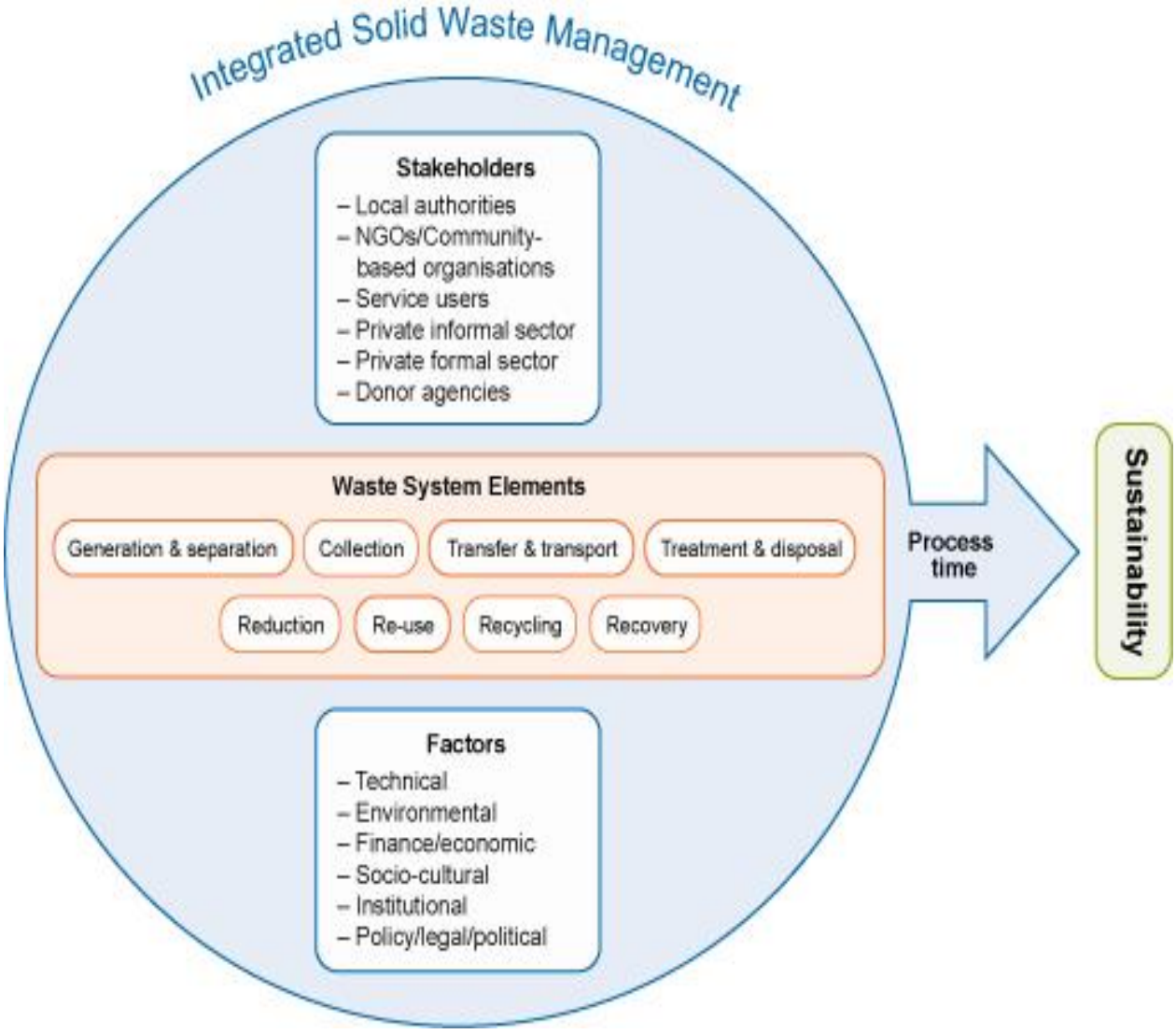
SOLID WASTE MANAGEMENT STRATEGIES IN THE NORDIC COUNTRIES

The Nordic countries or the Nordics are a geographical and cultural region in Northern Europe and the North Atlantic, where they are most commonly known as Norden (literally "the North"). The term includes Denmark, Finland, Iceland, Norway, and Sweden, as well as Greenland and the Faroe Islands which are both part of the Kingdom of Denmark and the Åland Islands and Svalbard and Jan Mayen archipelagos that belong to Finland and Norway respectively, whereas the Norwegian Antarctic territories are often not considered a part of the Nordic countries, due to their geographical location. Below are the most commonly used methods of solid waste management used by the Nordic countries and in particular, Sweden: (Guerrero et al., 2013).

a) **Material Recycling**-Product recycling encompasses alternative uses of a product once the main use of that product has been exhausted, rather than disposing off that product. Old and used plastic containers, could are used as flower pots in the flower farms in Sweden.
b) **Biological Treatment**-This involves the use of renewable environmentally friendly energy sources such as biofuels such as biogas. Denmark in particular is sensitizing its dairy farmers to build biogas chambers so that they are able to produce their own energy to run their day-to-day activities.
c) **Waste to Energy**-Sweden for instance, has invested heavily on solid waste to provide electrical energy in industries, schools, hospitals, homes and so on. The waste is put through chemical reaction chambers to produce electricity.
d) **Landfill-**Waste is transported to designated collection points where it is first segregated into various categories before being managed into the landfills.

2.5 Conceptual Framework

Figure 2.5: Conceptual Framework



Source: Adopted from Kiambu County CIDP 2018-2023

2.5.1 Operationalization of Variables

a) Capacity

With population growth reaching higher levels waste generation has tremendously increased beyond the capacity of local municipalities to effectively handle the situation. The higher waste generation calls for more advanced systems in its management. This should include more funding which should go beyond what is financed by the County Government of Kiambu through land rates, general fees and taxes charged to residents for various services. Records available for the year between 2012/2013 and 2016/2017 indicate minimal allocation of only 10% of the County Government's total annual expenditure towards SWM. This is far below what is expected if any meaningful success on SWM progress is to be achieved. (Gregory, 1996).

b) Policy and Legislation

In Kenya a number of legislations and policies have been put up to handle solid waste management. They include The Constitution of Kenya (2010), EMCA 1999, The Water Act, Physical and Land Use Planning Act (2019), among many others. Lack of a single oversight body to issue policy and regulations affects the management of SWM. For instance, NEMA laid down regulations in September 2006 which were to be adhered to by all parties handling SWM. The regulations touched on collection, disposal, revenue collection and project implementation, regulations were not properly enforced and thus NEMA never achieved its target. For the sustainable management of waste, policy and regulations need to be clear and implementable. It is also important to have a single oversight body to oversee the enactment and the implementation of those policies and implementation. (Morris et.al, 2000).

c) Technology

There is no any other better time to embrace technology than now. Technology in SWM involves re-use, reduce and recycling of used materials. This will decrease waste produced as well as increase innovation on using materials which have otherwise been rendered useless. (Pongcracz, 2002).

d) Urbanization

In functionalism theory, growth of cities is both a blessing and a curse depending on where one stands. Increase in population means growth in GDP which is positive to the economy. But it also means increase in generation of waste which comes in with a number of challenges. This shows that urbanization directly impact on the management of solid waste. (Price, 2001).

e) Solid Waste Management

Since solid waste management must be a responsibility of all of us, a number of ways of reducing solid waste should be adopted. Some of the best ways of dealing with this challenge is to go green, reduce use of petroleum products and adopt electric cars and machines, reduce waste to zero levels and deal with the dark truth of palm oil and get its alternative. (Huang, 2006).

CHAPTER 3: METHODOLOGY

3.1 Introduction

This chapter presents the research methodology used in the study as guided by research objectives. The chapter covers research design, target population, sample size, the sampling procedure, data collection instruments, data collection procedures, data analysis, interpretation of data and ethical issues involved.

3.2 Research Design

The study adopted a descriptive research design in order to provide a framework to examine current conditions, trends and status of events. Descriptive research design is more investigative and focuses on a particular variable factor. It is analytical and often single out a variable factor or individual subject and goes into details describing them. According to Cooper & Schindler (2011), such a study is concerned with finding out who, what, when, where and how of the relevant phenomena.

This is a plan for conducting which includes the specification of the elements to be examined and the procedures to de used. It's "the plan, structure and strategy of investigations so conceived as to obtain answers to research questions" (Rukwaro, 2016)

The study involved a casual-comparative approach in design as there was no experimental manipulation that was used to explore the relationship between variables. (Olive & Abel, 2003). The study related the implications of urban development on the sustainable management of solid waste. Notably, the various ways in which urban development manifests itself was considered. During the study, both qualitative and quantitative data was collected. Quantitative information refers to numerical data while qualitative information refers to non-numerical data in form of words and phrases. (Olive & Abel, 2003)

Qualitative data was used to obtain and give explanations on the status and availability of infrastructural services within the area of study. Quantitative studies were applied when getting numerical facts on figures for example income, number of members per household etc.

Consent was sought from the respondents as well as application of research ethics to ease the process of obtaining required information as well as portraying a professional outlook. This was meant to enhance smooth collection of data.

3.3 Target Population

A target population is classified as all the members of a given group to which the investigation is related, whereas the accessible population is looked at in terms of those elements in the target population within the reach of the study. The first target population was the households within the study area. As per the 2019 census report, Githunguri Ward had a total population of 44,388 with a total approximate number of 10,000 households. The second target population was government officials concerned with solid waste management affairs, and private solid waste management actors who were key informants while the third target population involved businessmen within the study area.

3.4 Sample Size and Sampling Procedures

Sampling is a deliberate choice of a number of people who are to provide the data from which a study will draw conclusions about some larger group whom these people represent (Jankowicz, 2012). The sample size is a subset of the population that is taken to be representatives of the entire population (Mugenda & Mugenda, 2012). A sample size of 110 households was arrived at by using the target population of 10,000 households with a 95% confidence level and an error of 0.095 using the below formula taken from Kothari (2004).

Sampling Formula; $n = N/(1+N(e)^2$.

The variables in this formula are:

n = the sample size

N = the population of the study e = the margin error in the calculation

Sample size=10,000/ (1+10,000 (0.095*0.095) =110

Table 3.4: Target Population

Categories	**Number**	**Percentage**
Kiambu County Environment Staff (Githunguri Town)	3	2.00
Kiambu County Planning Department (Githunguri Town)	1	0.70
Solid waste Management Private Firm	1	0.70
Households	110	75.86
Businesses/Businessmen	30	20.69
Total	**145**	**100**

3.4.1 Sampling Procedures

This study adopted a stratified and simple random sampling technique. Stratified random sampling is an unbiased sampling method of grouping heterogeneous population into homogenous subsets then making a selection within the individual subset to ensure representativeness. Two of the respondents were selected from the County Government of Kiambu, 30 were from businesses in the town, 1 was from a private firm dealing with solid waste management in the town, while 110 were from the households that made up the study area.

Table 3.4 Sample size

Categories	**Number**	**Percentage**
Kiambu County Environment Staff (Githunguri Town)	3	2.00
Kiambu County Planning Department (Githunguri Town)	1	0.70
Solid waste Management Private Firm	1	0.70
Households	110	75.86
Businesses/Businessmen	30	20.69
Total	**145**	**100**

3.5 Data Collection Methods

The research applied the following data collection methods:

i. **Review of secondary data-**The researcher reviewed all available data from journals, books, magazines, websites, maps and other sources.
ii. **Observation-**The researcher conducted transect walks and gathered data using an observation checklist and a camera for taking pictures and videos.
iii. **Interviews-**Household and business questionnaires were administered to collect data that could not be obtained via observation or secondary methods.
iv. **Administration of instruments-**The research employed tools such as modern mobile phones to record data such as location points of key focus areas. E.g., Location of the main dumpsites and dustbins within the town.
v. **Key informant interviews-**Interview schedules were used to collect data from key informants such as the county government personnel.

3.6 Pilot Testing

The purpose of the pilot testing was to establish the validity and reliability of the research instrumentation and to enhance face validity. From the pilot results, reliability and validity was tested. The pilot testing was conducted in Ikinu market centre (a few kilometers from Githunguri town) by administering the questionnaire to 15 respondents from the county staff and households. Sekaran and Bougie (2010) recommends that questionnaire pre-tests should be done by personal interviews in order to observe the respondent's reactions and attitudes. All aspects of the questionnaires were pre-tested including question content, wording, sequence, form and layout, question difficulty and instructions. The feedback obtained was used to revise the questionnaire before administering it to the study respondents.

3.7 Validity of Research Instruments

According to Golafshani (2003), validity is the accuracy and meaningfulness of inferences, based on the research results. One of the main reasons for conducting the pilot study is to ascertain the validity of the questionnaire. The study used both face and content validity to ascertain the validity of the questionnaires. Content validity draws an inference from test scores to a large domain of items similar to those on the test.

3.8 Reliability of Research Instruments

Instrument reliability is the extent to which a research instrument produces similar results on different occasions under similar conditions. It is the degree of consistency with which it measures whatever it is meant to measure. Reliability is concerned with the question of whether the results of a study are repeatable. A construct composite reliability co-efficient (Cronbach's alpha (o)) of 0.6 or above is generally acceptable (Rousson, Gasser & Seifer, 2012).

A Co-efficient of 0.7 or above for all the constructs will be considered adequate in this study. Reliability coefficient of the research instrument was assessed using Cronbach's alpha (o) which is computed as follows:

$o = k/k\text{-}1 \times [1\text{-}Z\ (S^2)' Z\ S^2 sum]$

Where:

o = Cronbach's alpha

k = Number of responses

Z (S') = Variance of individual items summed up

ZS^2sum = Variance of summed up scores

Reliability Analysis

The reliability is expressed as a coefficient between 0 and 1.00; where the higher the coefficient, the more reliable the test is.

Table 3.8: Reliability Analysis

	Reliability Alpha
Type of house solid waste generated	**0.842**
Availability of household solid waste equipment and facilities	**0.721**
Household solid waste management awareness	**0.742**
Waste management laws and policies	**0.738**

The findings indicated that type of household solid waste generated had a coefficient of 0.842, Availability of household solid waste equipment and facilities had a coefficient of 0.721, household solid waste management awareness had a coefficient of 0.742 and Waste management laws and policies had a coefficient of 0.738. All constructs depicted that the value of Cronbach's alpha is above the suggested value of 0.7 thus it can be concluded that the study was reliable to capture the constructs (Jankowicz, 2012).

3.9 Data Collection Procedures

The researcher obtained an introduction letter from the university which was presented to the respondents for the purpose of data collection. The drop and pick method was preferred for questionnaire administration so as to give respondents enough time to give well thought out responses. The researcher booked appointments with respondent organizations at least two days before visiting to administer questionnaires. The researcher personally administered the

research instruments to the respondents. This enabled the researcher to establish a rapport, explain the purpose of the study and the meaning of items that may not have been clear as observed by Sekaran and Bougie (2010).

3.9.1 Data Analysis Techniques

Data was analyzed using Statistical Package for Social Sciences (SPSS Version 22.0). All the questionnaires received were referenced and items in the questionnaire were coded to facilitate data entry. After data cleaning, which entailed checking for errors in entry, descriptive statistics such as frequencies, percentages, mean score and standard deviations were estimated for all the quantitative variables and information presented inform of tables and graphs. Descriptive statistics were used because they enabled the researcher to meaningfully describe distribution of scores or measurements using few indices (Mugenda & Mugenda, 2003). The qualitative data from the open-ended questions was analyzed using conceptual content analysis. Based on Bryman (2015) recommendation on the analysis of qualitative data, data collected was organized, sorted, coded and thematically analysed, searching for meaning, interpreting and drawing of conclusions on the basis of concepts.

Inferential data analysis was done using Pearson correlation coefficient and regression analysis (multiple regression analysis). According to Creswell (2013), correlation technique is used to analyse the degree of association between two variables. Pearson correlation coefficient was used to determine the strength and the direction of the relationship between the dependent variable and the independent variable. The analysis using Pearson's product moment correlation was based on the assumption that the data was normally distributed and also because the variables are continuous.

Multiple regression analysis was used to establish the relations between the independent and dependent variables. Multiple regression was used because it is the procedure that uses two or more independent variables to predict a dependent variable. According to Babbie (2015), multiple regression attempts to determine whether a group of variables together predict a given dependent variable. Since there were four independent variables in this study the multiple regression model generally assumed the following equation;

0 + I XV + 2X 2 + 3X 3 + 4X 4 +

Where:

Y= Represents the dependent variable, functional solid waste management

fly fl — Constant

X Type of household solid waste generated

X = Availability of household solid waste equipment and facilities X3 Household solid waste management awareness

= Waste management laws and polices C=Error Term

In testing the significance of the model, the coefficient of determination (R^2) was used to measure the extent to which the variation in functional solid waste management is explained by the variations in the type of household functional solid waste generated, availability of household functional solid waste equipment and facilities, household functional solid waste management awareness and waste management laws and policies. F-statistic was also computed at 95% confidence level to test whether there was any significant relationship between the variables. This analysis was done using SPSS software and the findings presented in form of a research report. All necessary diagnostic tests were performed.

3.9.2 Ethical Considerations

Considering that the research subjects in qualitative research interviewing were human beings, great care was taken to prevent harm to these people. In this research, consent was obtained, first, by talking to the administration, to gain their trust, support and permission to conduct the research in the organization. The nature of the research was explained to them and any questions on anonymity and confidentiality were answered. The participants were reassured that their identities as well as the information shall remain confidential.

Table 3.9 Operationalization of variables

Objective	Variable	Indicators	Measurement scale	Tools of analysis	Type of data analysis
To determine how the type of household solid waste generated influences functional solid waste management.	Independent: Type household solid waste generated	• Industrial waste • Organic waste • Inorganic waste • Recyclable waste	Ordinal Ordinal Internal Ordinal	Mean Percentage	Descriptive Correlation Regression
To assess how availability of household solid waste equipment and facilities influence functional solid waste management	Availability of household solid waste equipment and facilities	• Availability of equipment • Availability of trash bins • Availability of recyclingand composting plants • Availability of adequatelandfill	Ordinal Ratio Ordinal Ordinal	Mean Percentage	Descriptive Correlation Regression
To ascertain how household solid waste management awareness, influences functional solid waste management	Household solid waste management awareness	• Public awareness and attitudes • Public participation initiatives • Effective waste management awareness • Environmental harm awareness • Non-littering initiatives • Littering prevention program	Nominal Ordinal Ordinal Interval	Mean Percentage	Descriptive Correlation Regression

To find out how waste management laws and polices influence solid waste management.	Project design factors	• Policy on environmental health • Policy on environmental protection • Capacity to implement building • Unambiguous legal and regulatory framework • Enforcement procedures	Ordinal Ratio Interval Ordinal	Mean Percentage	Descriptive Correlation Regression
	Dependent: Functional solid waste management	• Cleanliness of Githunguri town • Availability Dumpsites • Working drainage system • Recycling of waste • Prompt collection of waste. • Timely emptying of septic	Ordinal Ordinal Interval	Mean Percentage	Descriptive Correlation Regression

CHAPTER 4: STUDY AREA

4.1 History of Study Area

Githunguri town traces its history from the early 1920s when the town served as a local focal point for trade between the surrounding communities such as the Kamba and the Maasai. The town itself and the surrounding areas such as Ikinu, Githiga, Ngewa and Komothai (currently administrative wards) are rich in loam soils that support the growth of various crops such as coffee, tea, maize, beans and bananas. In addition to the fertile soils the constituency enjoys a cool wet climate that facilitates dairy farming. (East African Magazine, 2015).

The name 'Githunguri' which in Kikuyu means a high point was a very strategic point for the Mau Mau fighters association that started in 1946. This was a rebellious group against the British rule in the country during the colonial era. The town had several strategic towers that were used to monitor the entry of new traders or enemies in to the town which served as the main market centre. Over the years the town has continued to grow and develop from its historical status as a trading centre to a thriving urban centre in the constituency. (East African Magazine, 2015).

The town has a unique aura of history with regards to early education and religious institutions. The Kenya African Teacher's College was first established in Githunguri in 1939. This helped to accelerate the town's development, as demand for other services which were crucial in supporting the growth of the institution began to spring up. These included shops, health centres, recreation joints, accommodation hubs amongst many other services.

The Kenya African Teachers College, as it was called, trained African teachers for East and Central Africa. Githunguri independent school was the biggest of all independent schools providing education from elementary through primary to secondary and college. By 1947 the school had an enrollment of over 1000 pupils with Mbiyu Koinange, the first Kenyan to hold an MA degree, as the principal, Kenyatta as an administrator and other Kenyan luminaries like James Gichuru as a teacher. (East African Magazine, 2015). Githunguri became the hub and center of learning with the establishment and growth of the school. Students came from all over the country to further their education and train as teachers.

4.2 Location and Size

Githunguri Town is in Githunguri constituency which is one of the twelve constituencies that form Kiambu County and covers an area of approximately 147,763 $Km^{2.}$ Githunguri Constituency borders Lari Constituency to the North, Limuru to the West, Kikuyu to the South West and Kiambaa to the South as indicated by the map below. The constituency lies between latitudes 00 55'South of the Equator and 37° 5' 0" East.

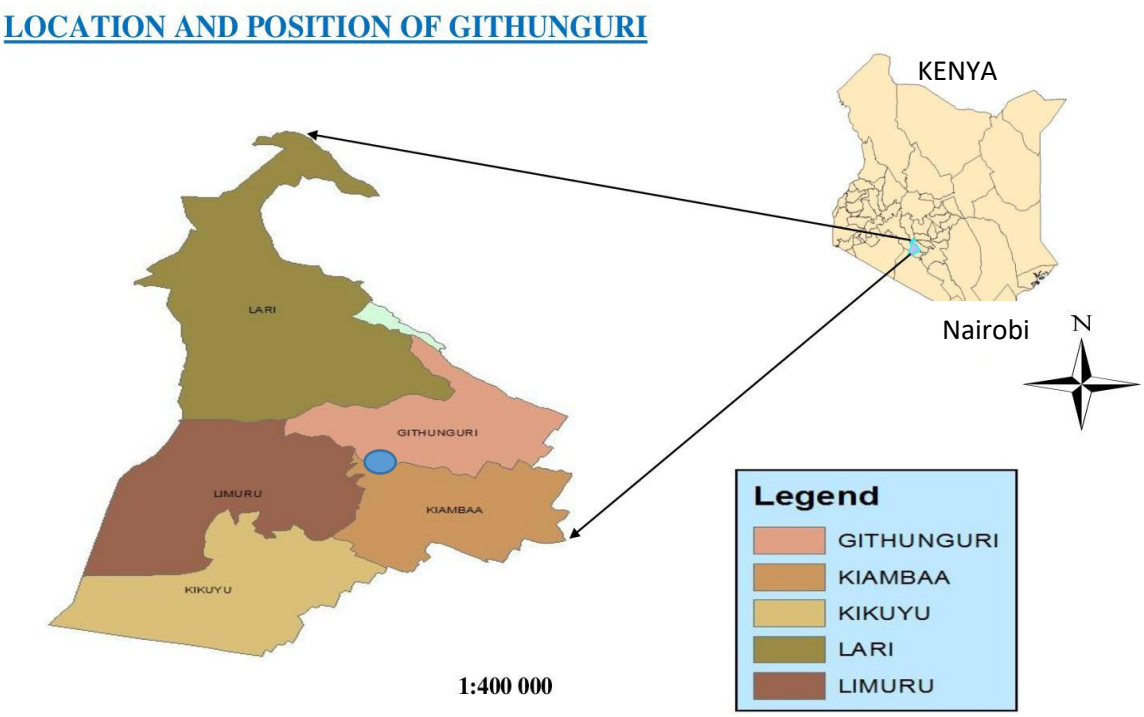


Figure 4.1: Location and Position of Githunguri.

Source: Kiambu County Integrated Development Plan (2018-2023).

4.3 Population Size

The constituency has an estimated population of about 150,000 with about, 11 000 living in the town (2019 census). The town is projected to have an approximate population of about 20,500 people by the year 2029. (Kiambu CIDP, 2018-2023). The table below gives a summary of the past and future projected population size of the town.

Table 4.1 – Past and future population size of Githunguri town

	2009 Census			**2019 Census**			**2029 Projections**		
	Male	Female	**Total**	Male	Female	**Total**	Male	Female	**Total**
	3,843	4,164	**8,007**	5,732	6,112	**11,845**	9,536	10,970	**20,506**

4.4 Climatic Conditions

The town experiences bi-modal type of rainfall. The long rains fall between Mid-March to May followed by a cold season usually with drizzles and frost during June to August and the short rains between Mid-October to November. The average rainfall received by the town is 1,200 mm.

The mean temperature in the town is 26^{o}C.

With such favorable climatic conditions, the town has proved to be an attractive business hub ranging from agriculture, trade and commerce, transport, industry, residence node, education, recreation among other key land uses.

While all the above land uses are crucial elements of urban growth and development of the town, they lead to increased consumption patterns which result in the production of solid waste hence proper land use planning needs to be incorporated to manage the waste produced.

4.5 Soils

The town has well drained red volcanic soils favorable for the growth of crops such as beans, maize, and bananas. The good soils have promoted agricultural production in the town and the adjacent towns such as Githiga, Ikinu and Ngewa which have led to an influx of people to the town especially on Market days as Githunguri hosts the main market in the constituency there by encouraging the growth of other commercial activities.

4.6 Administrative Units

The town which also serves as a constituency has 3 Divisions, 5 Locations and 10 sub-locations. The administrative part of the town has influenced the growth of milk two key milk industries, a court, stadium, schools, banking institutions, a modern bus park, restaurants, gas stations, hospitals, religious institutions among other key facilities in the town.

4.7 Social Cultural Profile

The town is predominantly inhabited by the kikuyu community with a few people from the other communities such as the Luo, Kamba, Luhya, Somali, Kisii and Kalenjin and other communities making up the rest of the population. Inter-marriages have taken place among the communities living there. The town is slowly adopting a cosmopolitan nature.

4.8 Economic Activities

The main economic activities in the town revolve around agriculture and trade. The large Githunguri market situated right at the center of the town facilitates the sale of agricultural products such as tomatoes, potatoes, maize, beans, onions and the rest as well as providing an environment for the trade of farm equipment such as pangas, jembes, hoes, wheelbarrows and many others. Major financial institutions such as banks are well distributed around the town to facilitate the smooth operations of businesses by offering saving and credit facilities. Other important activities in the town include food processing industries such as the Fresha Milk (see photo below) Processing factory.

Photos of Githunguri Fresha Plant and Githunguri Kenya Commercial Bank.

Source: Field Survey, 2021

CHAPTER 5: DATA ANALYSIS, PRESENTATION AND INTERPRETATION OF FINDINGS

5.1 Introduction

This chapter presents the information processed from the data collected during the study on the challenges of urban development influencing household functional solid waste management in Githunguri town. Primary data was collected through questionnaires which were administered to the county government management team and supervisory staff of solid waste management companies in Githunguri town as well as household heads. The data was afterwards scrutinized based on the objectives of the study and the findings are as presented as per the different classes featured below.

5.1.2 Response Rate

The researcher Administered 110 questionnaires to the management and supervisory staff of Kiambu County Government as well households in Githunguri town. From these, 100 respondents were able to return fully filled questionnaires which represented a response rate of 91 percent. This response rate was good representation and conformed to Lacobucci (2010) stipulation that a response rate of 50 percent is adequate for analysis which meant that 92 percent was much better.

5.1.3 Respondents Gender

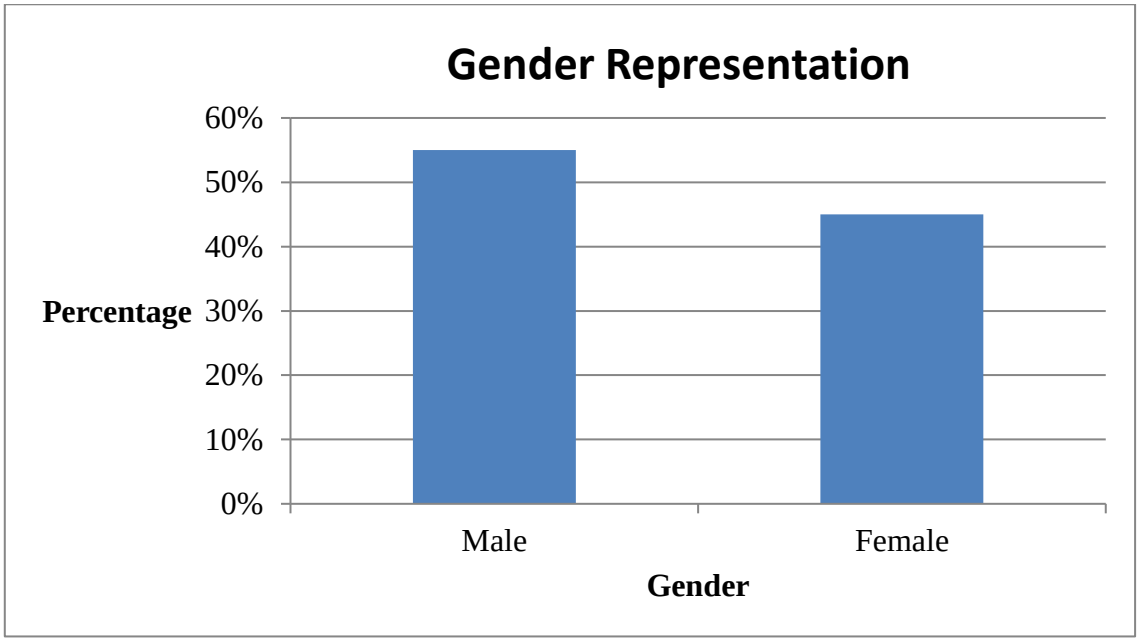
It was important to take gender into consideration for the purpose of inclusivity and gender balance from the respondents. This information was tabulated as below:

Table 5.1: Respondents Gender

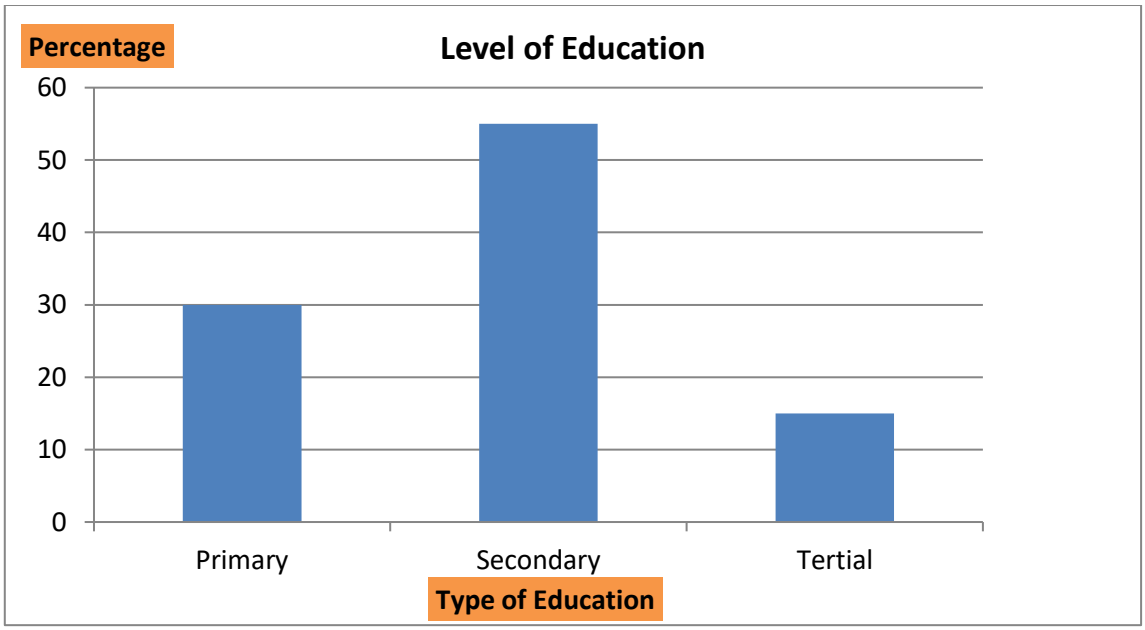
Gender	**Total**	**Percentage**
Male	60	55
Female	50	45
Total	**110**	**100**

Figure 5.1 and table 5.1 show gender response indicating that male respondents represented about 55% of the total respondents while female respondents represented 45% of the total respondents.

Figure 5.1.4: Gender Representation



5.1.5 Level of Education



Approximately 55% of respondents interviewed had secondary level education followed by primary at 30% and those from the tertiary institutions at 15%. These findings indicate that majority of the respondents were literate enough and with the right attitude and motivation these respondents can improve solid waste management in Githunguri Town.

5.2 Indicators of Urban Development in Githunguri Town

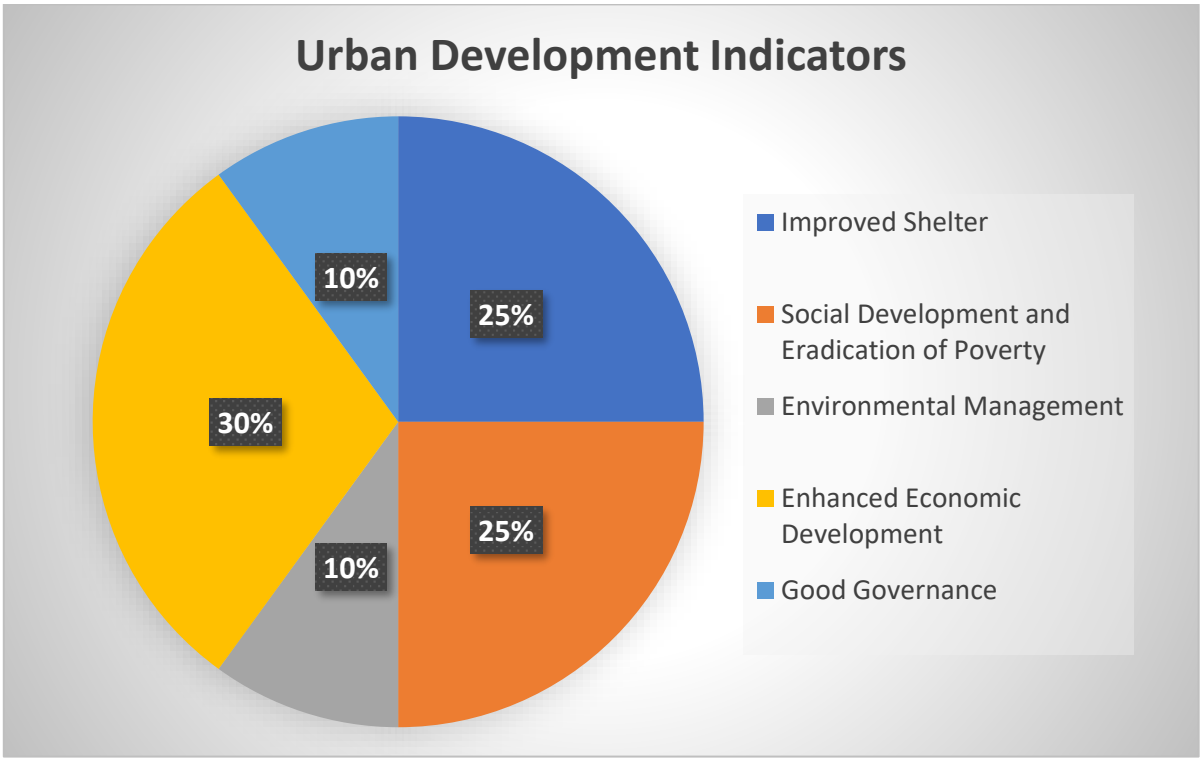
Indicators are statistics used to measure current conditions as well as to forecast future trends.

Cities represent the driving force of development in economic, social, and cultural life, reflecting also the spatial organization of human society.

During the data collection stage five key categories of urban indicators were identified in the town.

They included the following; improved shelter provision, social development and eradication of poverty, environmental management, enhanced economic development and good governance.

Key informants ranked the categories as per illustrated by figure 5.2



10% of the respondents identified the town had made major strides in improved shelter or housing, 25% felt efforts had been made to eradicate poverty and improve on social development aspects such as improved health care, sanitation, education, cosmopolitan nature of the town among others.

10 % felt efforts were being put in place to address environmental concerns such as segregating waste at source, improved public participation on waste management, adoption of the 3Rs amongst other many solid waste intervention measures.

Lastly, those that felt that the town was taking the direction of improved governance systems and enhanced economic development stood at 25% each. Improved governance systems involved core values such as transparency, accountability, team work, honesty, innovation and so on.

Enhanced economic development mainly encompassed issues of industrialization and job creation.

The town being a rich agricultural hub boasts of Fresha dairies, one of the largest milk producing cooperatives in the country that has provided thousands of job opportunities directly and indirectly.

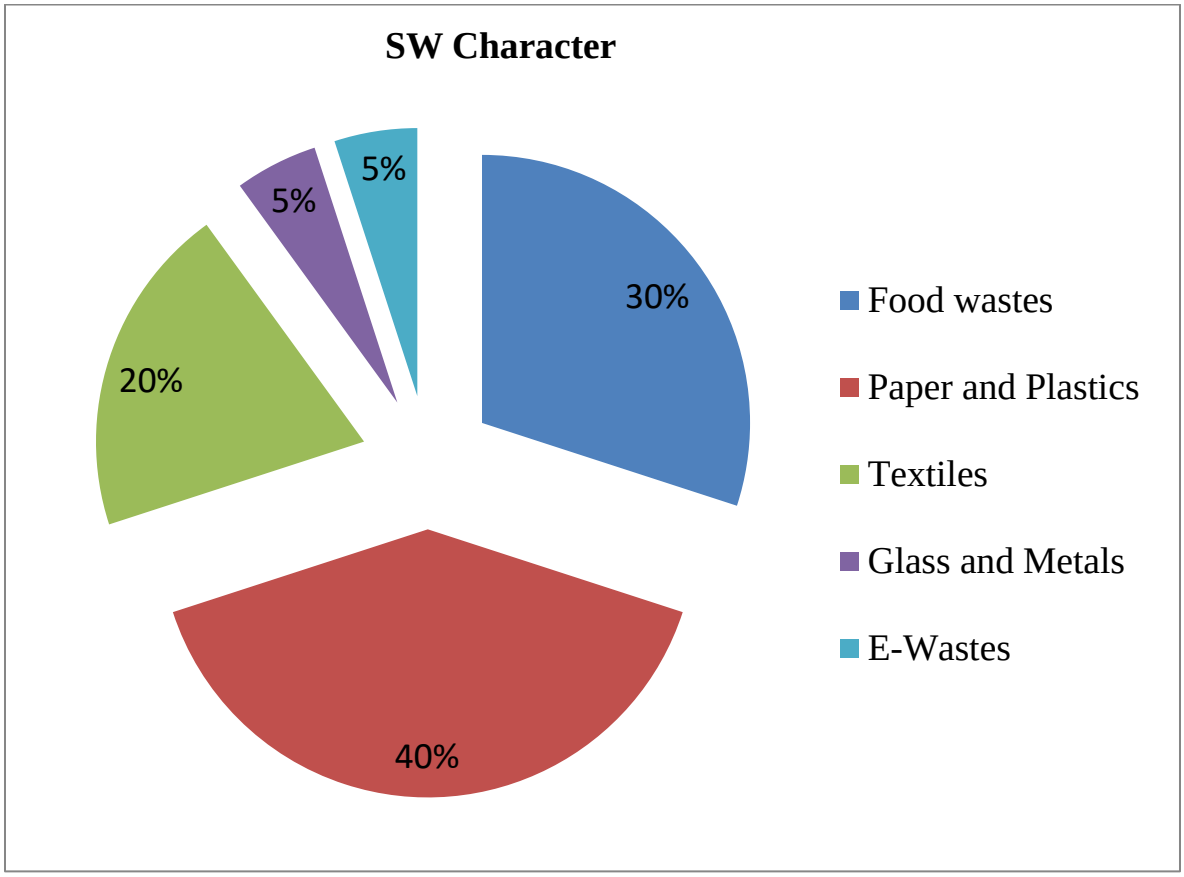
As per the informants, these factors of urban development affect solid waste management of in the town as highlighted:

- **Improved Shelter**-Modern housing etiquette dictates provision of waste management measures such as designated dust bins to manage the various waste categories and encourages segregation at source.
- **Social Development and Eradication of Poverty**-Solid waste management practices should provide job opportunities through initiatives such as waste recycling.
- **Environmental Management**-This encompasses all the good practices with regards to waste management. Adoption and implementation of the zero-waste theory is a key plan to be followed at this particular phase.
- **Enhanced Economic Development**-As the town continues to expand owing to the various land uses ranging from commerce, industry, transport, residence, provision of public utilities, education among others, there is great need for the users in each land use to device mechanisms to manage their own solid waste.
- **Good Governance-** This encompasses nine key characteristics; consensus-oriented, accountable, transparent, responsive, effective, efficient, equitable, and law-abiding and demonstrates a strategic vision. All these characteristics have to be observed when managing solid waste.

5.3 Solid Waste Character

With the high demand and consumption of food in Githunguri town, it was not surprising to find paper and plastics as the largest contributor of waste within the town as they were commonly used as food wrappers. Textiles such as old worn-out clothing including used facial masks occupied third spot since their rate of recycling is low. Metals and broken glass as well as e-wastes (broken computers and mobile phone cases) occupied the lowest contributors of solid waste as the town is not highly industrialized.

Figure 5.3 illustrates the composition of solid waste in Githunguri town.



5.4 Solid Waste Disposal Methods

- Majority of the residents of the town used different methods of solid waste disposal owing to different factors such as ease of use, cost and availability of space.

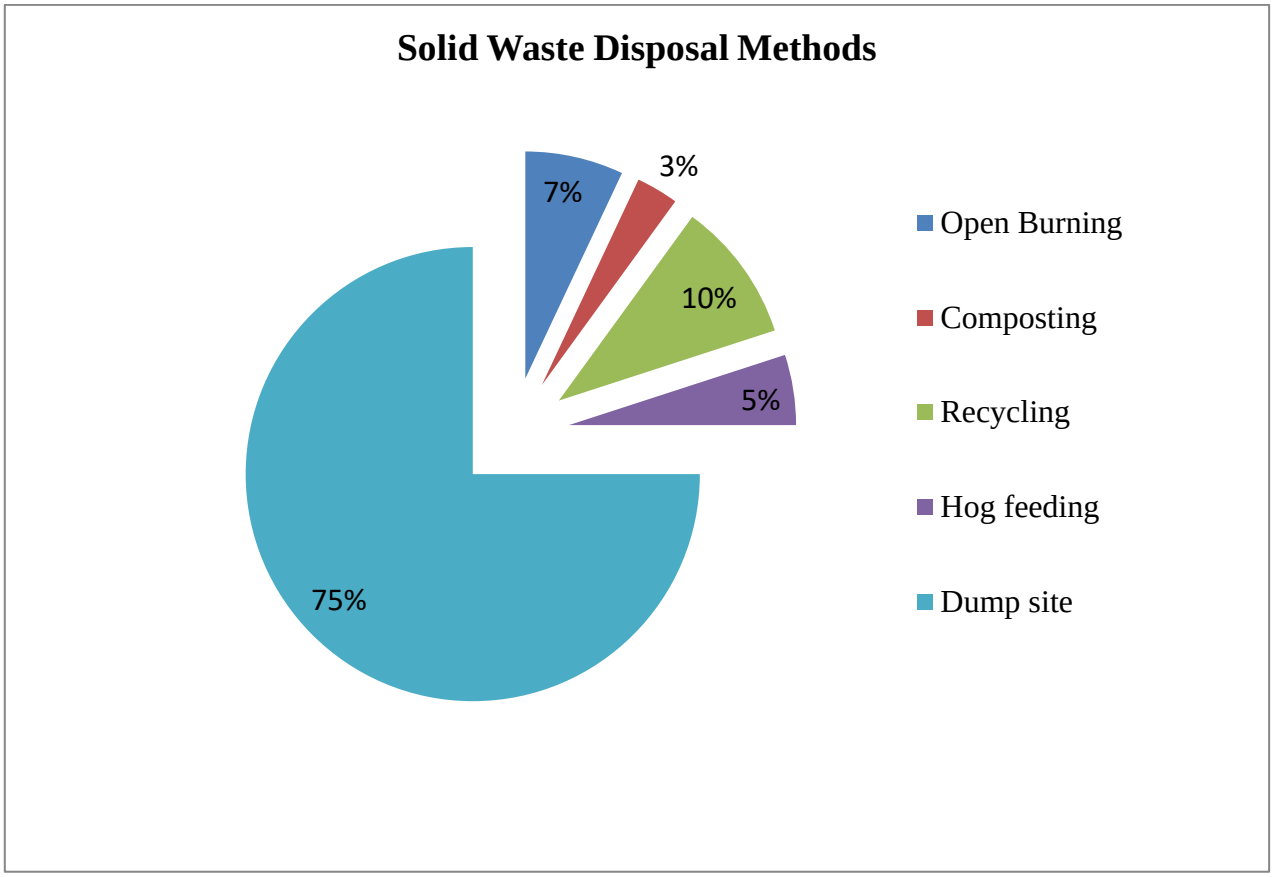
- Use of dumpsites was highly considered as it was readily available as a service provided by the County Government of Kiambu, while composting came in last due to the fact that it consumes a lot of land, and is a very slow method of managing the waste in terms of decomposition.

- Recycling of material such as rubber and plastics was another form of solid waste management that was used in the town (Informal business men such as cobblers).

- Hog feeding was used to handle food residues especially by the residents who were engaged in urban agriculture.

The figure below, gives a summary of the above findings:

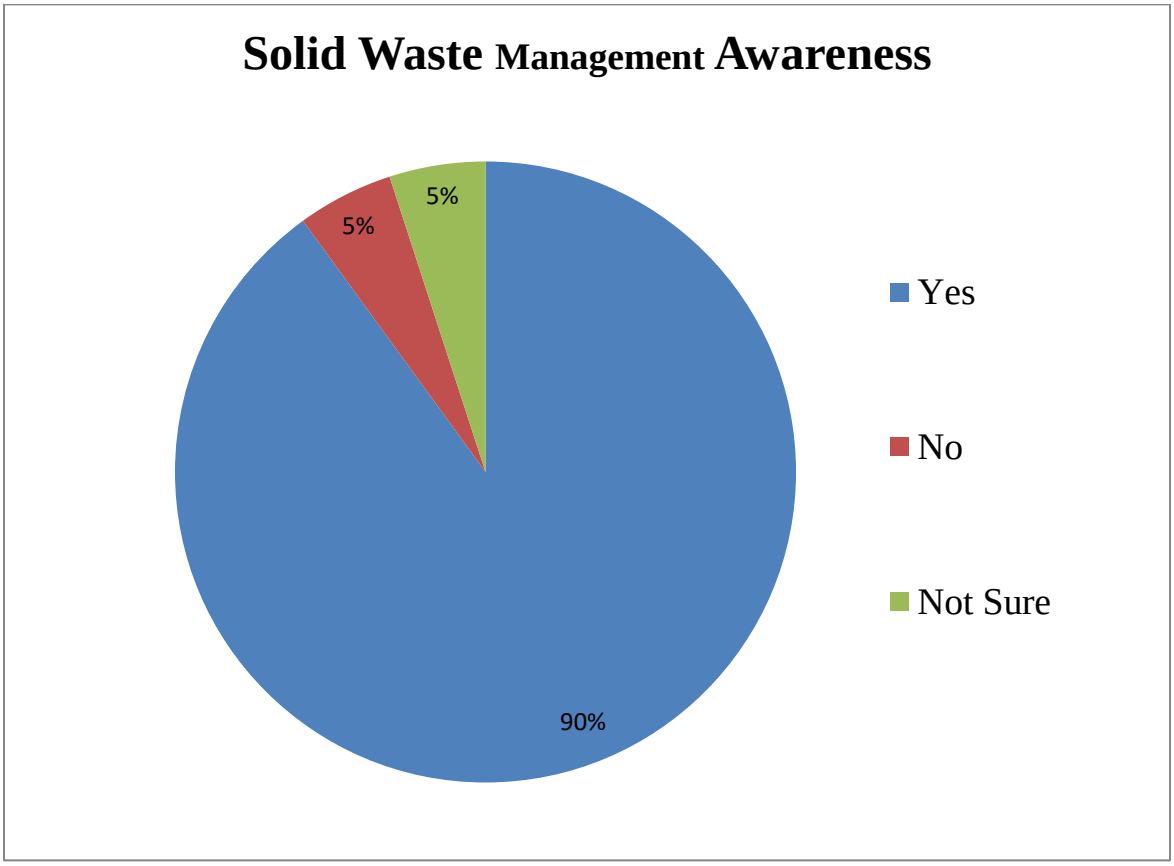
Figure 5.4: Solid Waste Disposal Methods



5.5 Solid Waste Management Awareness

Raising awareness about municipal solid waste management is a critical component of effective waste management. It is important for key stakeholders to be aware of a city's waste management activities and have a strong understanding of the benefits of proper solid waste management. The following was observed during the study with regards to solid waste management awareness in Githunguri Town.

Figure 5.5: Solid Waste Management Awareness



- About 5% of the total respondents interviewed were not aware of what solid waste management meant, while another 5% were hearing the term for the very first time.
- On the contrary though, a large number (90%) of the respondents were actually conversant with the term (collecting, treating and disposing of solid material that is no longer useful).

From the findings, it was evident that a majority of the stakeholders were aware of solid waste management; hence this symbolized a great milestone towards achieving a sustainable solid waste management plan for Githunguri Town.

5.6 Challenges Affecting Solid Waste Management

The below challenges were observed to be great hindrances towards achieving sustainable solid waste management in Githunguri Town. They included: Lack of laws/policy enforcement was reported as the highest contributor (35%) while low literacy levels and inadequate funding to the county government in terms of waste management were ranked lowest at 10 %. The photos obtained from the field survey further demonstrate the challenges facing solid waste management in the town.

Figure 5.6 Challenges Affecting Solid Waste Management

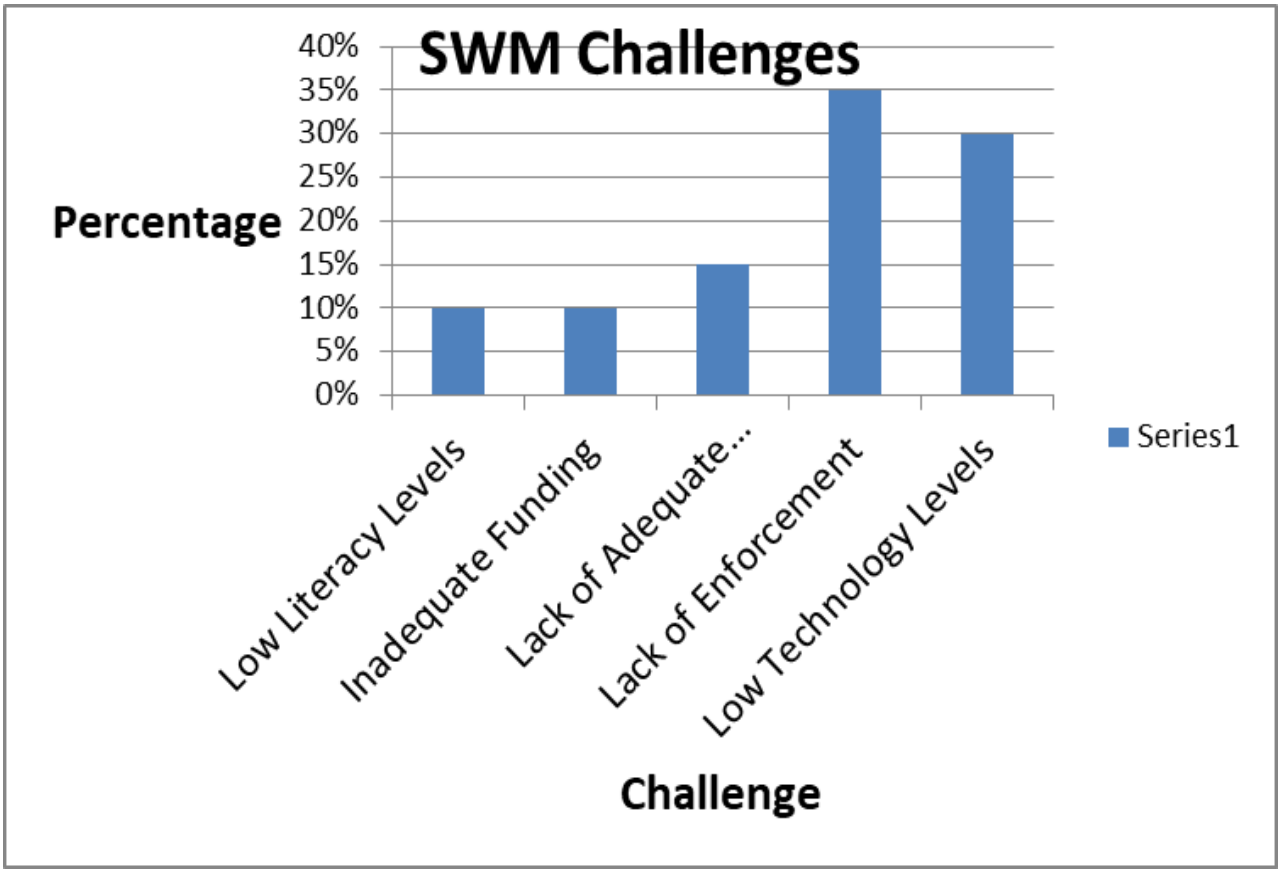


Figure 5.6.1 : Careless Dumping of Wastes by Households.

Source: Field survey (2021)

Figure 5.6.2 : Open dumping of wastes on an access road in the town.

Source: Field survey (2021)

Figure 5.6.3: Vandalized Dumpsite Accompanied by Poor Disposal of Solid Waste.

Source: Field survey (2021)

Figure 5.6.3: A Heap of Waste Lying Next to Githunguri-Ngewa Main Road

Source: Field survey (2022)

CHAPTER 6: CONCLUSIONS, RECOMMENDATIONS AND TOPICS FOR FUTURE RESEARCH

6.1 Introduction

This study was undertaken to profile the various indicators of urban development, determine the character of solid waste, examine solid waste disposal methods, determine the level of awareness on solid waste management, identify the key challenges to effective solid waste management and recommend possible options of improving solid waste management in Githunguri town. This chapter presents the conclusions as well as recommendations of the study.

6.2 Conclusions

6.2.1 Type of Household Solid Waste Generated

With the high demand and consumption of food in Githunguri town, it was not surprising to find paper and plastics as the largest contributor of waste within the town as they were commonly used as food wrappers. Of the total waste generated paper and plastics accounted for about 40%. Food wastes 30%, textiles such as old worn-out clothing including used facial masks accounted for 20%, metals and broken glass as well as e-wastes (broken computers and mobile phone cases) occupied the lowest position of contributors of solid waste at 5% each.

6.2.2 Solid Waste Management Awareness

About 5% of the total respondents interviewed were not aware of what solid waste management meant, while another 5% were hearing the term for the very first time. On the contrary, a large number (90%) of the respondents were conversant with the term (collecting, treating and disposing of solid material that is no longer useful). This symbolized a great milestone towards achieving a sustainable solid waste management plan for Githunguri Town if stakeholders are effectively involved.

6.2.3 Waste Management Challenges

Respondents indicated that the main challenges to effective solid waste management is lack of enforcement of laws as reported by 35% who felt that legislations and policies touching on either urban development or solid waste management greatly affect the management of solid waste. They argued that it is lack of policy and legislation enforcement and implementation which is the problem. Although those who agreed that policy and legislation affects the management of, solid waste were quick to verify that without policy and legislation which regulates on how operations will be carried out, it would be difficult to have order. They also argued that for policies to be

implemented they must be in existence and supported by existing laws. This leads to a conclusion that policy and legislation are important in the management of solid waste in urban areas in Kenya.

6.2.4 Availability of Household Solid Waste Equipment and Facilities

(i)The findings showed that availability of trash bins enhanced cleanness of Githunguri town and that availability of adequate landfill prompted collection of waste. According to Al-Khatib, et.a1 (2015), local authorities should increase the number and optimize the distribution of litterbins on the streets and other public places as a measure to discourage people from littering. It was also revealed that availability of composting plants enhances recycling of waste and that availability of equipment lightly prompts collection of waste. These were in line with White, Dranke and Hindle (2012) who argue that limited developments of a market for recyclables, financial constraints, and absence of skilled technical personnel to manage these systems have been observed in many developing countries.

(ii) The study concluded that management of municipal solid waste is a global problem and is faced by all developing countries. The rapid rate of increase in population, economic growth, urbanization and industrialization is coupled with accelerated solid waste generation. The lack of infrastructure for collection, transportation, treatment and disposal of solid waste, proper solid waste management planning, insufficient financial resources, technical expertise and public attitude have made the situation exasperating due to which several environmental and health related problems are increasing.

(iii) The type of household solid waste generated positively and significantly influenced household functional solid waste management in terms of the method used for disposal.

(iv) The study also concluded that availability of household solid waste equipment and facilities positively and significantly influenced household functional solid waste management. The study deduced that availability of trash bins enhances cleanness of Githunguri town and that availability of adequate landfill prompts the collection of solid waste. It was also revealed that availability of composting plants enhances recycling of waste.

(iv) Further the study concluded that household solid waste management awareness positively and significantly influenced household functional solid waste management. The study deduced that public participation initiatives would go a long way in ensuring sustainable solid waste management in Githunguri town.

(v) Finally, the study concluded that waste management laws and policies positively and significantly influenced household functional solid waste management.

6.3 Recommendations

Based on the findings, the study makes the following recommendations: -

6.3.1 Indicators of Urban Development

- **Improved Shelter-**Modern housing etiquette dictates provision of waste management measures such as designated dust bins to manage the various waste categories and encourages segregation at source.
- **Social Development and Eradication of Poverty-**Solid waste management practices should provide job opportunities through initiatives such as waste recycling.
- **Environmental Management-**This encompasses all the good practices with regards to waste management. Adoption and implementation of the zero-waste theory is a key plan to be followed at this particular phase.
- **Enhanced Economic Development-**As the town continues to expand owing to the various land uses ranging from commerce, industry, transport, residence, provision of public utilities, education among others, there is great need for the users in each land use to device mechanisms to manage their own solid waste.
- **Good Governance-** This encompasses nine key characteristics; consensus-oriented, accountable, transparent, responsive, effective, efficient, equitable, and law-abiding and demonstrates a strategic vision. All these characteristics have to be observed when managing solid waste.

6.3.2 Type/Character of Solid Waste Generated

- Wide use of plastics and non-degradable products should be discouraged. Emphasis should be given at source reduction and adopting alternative waste management practices to the possible extent, like composting, recycling etc. as described in the integrated solid waste management framework.

- Segregating waste should be started from household level and the County should also segregate the organic, inorganic, hazardous and non-hazardous wastes for treatment or disposal, which could protect environmental degradation and create employment opportunities.

  Below is a pictorial representation of a segregation initiative.

- **Adoption of the 3Rs-**Waste should be recycled or reused wherever possible. The waste management strategy to be employed should promote waste minimization at source. Where waste generation is unavoidable then the potential for recycling or reuse should be explored and opportunities taken.

- **Public awareness and re-orientation**-The society is a major producer of solid waste regardless of category whether municipal, agricultural, industrial or hazardous waste but only a little percentage of these people have knowledge of the impact of waste disposal in society either positive or negative. Therefore, changes in people's perspectives on waste management can be achieved through consistent dissemination of information on waste management issues and proper finance of development capacity building programmes that will enhance knowledge and capability of people to perform all waste activities in order for sustainability to be attained in the society.

6.3.3 Solid Waste Management Disposal Methods

- **Adoption of the Zero-Waste Theory-** Zero Waste is a set of principles focused on waste prevention that encourages the redesign of resource life cycles so that all products are reused. The goal is for no trash to be sent to landfills, incinerators or the ocean. Zero Waste can also be defined as the conservation of all resources by means of responsible production,

consumption, reuse and recovery of all products, packaging, and materials, without burning them, and without discharges to land, water or air that threaten the environment or human health. Zero Waste refers to waste prevention as opposed to end-of-pipe waste management. It is a whole systems approach that aims for a massive change in the way materials flow through society, resulting in no waste. Zero waste encompasses more than eliminating waste through recycling and reuse. It focuses on restructuring production and distribution systems to reduce waste. Zero waste is more of a goal or ideal rather than a hard target.

- **Waste Recycling**- The waste produced in Githunguri Town has some materials that can be successfully recycled. Approximately 60 to 65% of the total generated waste being organic, enormous recycling opportunities exists for farm use. Incidentally, the benefits of recycling do not lie solely in diversion of waste away from disposal – the filling of dumpsites unnecessarily - but, even more importantly, in the reduction of the number of new materials that need to be harvested and processed for the manufacture of new products. Given that there is potential and possible demand, recycling and resource recovery offers good scope for employment generation, and potentially has both positive economic and environmental impacts.
- **Polluter Pays Principle** - The Polluter Pays Principle is a principle where the polluting party pays for the impact caused to the environment. With respect to waste management, this generally refers to the requirement for a waste generator to pay for appropriate disposal of the waste. The county government should introduce tax on all waste producers, penalties and fines on waste polluters, high charges on landfills users and hazardous waste disposal.
- Set up temporary refuse collection facility to store domestic waste and the waste should be collected frequently.
- Implement appropriate measures to minimize windblown litter and dust during transportation by covering trucks or transporting wastes in enclosed containers.
- Collection of the town wastes should be carried out frequently, say on a daily basis.
- **Public-Private Partnerships**-This approach will establish partnership among all stake-holders, including foreign agencies, private sectors, national and local government that will produce accurate statistics on waste generated in the town for sustainable management plans to be implemented and achieved.

- Reputable waste collectors authorized to collect the specific category of waste should be used to collect and transport the wastes to the appropriate disposal points.
- Provision of more vehicles for solid waste collection. E.g., Tractors, pick-ups and trucks.
- Increased funding and efficient release of funds meant to ensure the timely payment of staff, repair and maintenance of machinery and equipment.
- Adherence to the above measures will not only make Githunguri town achieve the objectives of waste management system based on the zero-waste theory, but will as well improve the quality of public health, conserve natural resources and reduce the emission of greenhouse gases. Last but not least, environment, economic and social benefits of waste management will be experienced in the town.
- Enact and/or amend laws and policies that need to cover some basic issues like segregation of waste, clear cut responsibilities of the authorities, prohibiting dumping waste near river banks, around residential areas and taking strong actions on those who fail to comply with the law. Hefty penalties and empowering the County to arrest and punish the law breakers would go a long way in managing solid waste in the town.

6.3.4 Level of Solid Waste Management Awareness

- Thorough public participation to sensitize everyone in the town on matters dealing with solid waste management. This could involve public barazas, radio and television adverts, door-to door approaches, circulars, posters, incorporating solid waste management classes in schools among many other strategies.
- **Public- Private Partnership**- This approach will establish partnerships among all stake-holders, including foreign agencies, private sectors, national and local government that will produce accurate statistics on waste generated in the town for sustainable management plans to be implemented and achieved.
- **Waste Processing**- Solid waste processing was observed to be done at small-scale, evidenced by activities like product reuse - rethreading tyres, recovery of demolition materials, re-use of plastic bags, second-hand clothing, reconditioning and repair of furniture and appliances in the estates. Value-addition from these activities is minimal.
  Between 60 % and 65 % of the waste that is biodegradable needs to be pre-treated before discarding at the dumpsite. This pre-treatment will turn fermenting, rotting and foul-smelling residues into substances resembling soil. When this pre-treated residue is disposed

of to dumpsites, it will no longer be harmful to the environment and public health. This is critical in protecting the land for future reclamation and the groundwater resources that are critical for wells and springs. Pre-treatment further reduces methane gas that would have been released into the atmosphere as a green gas.

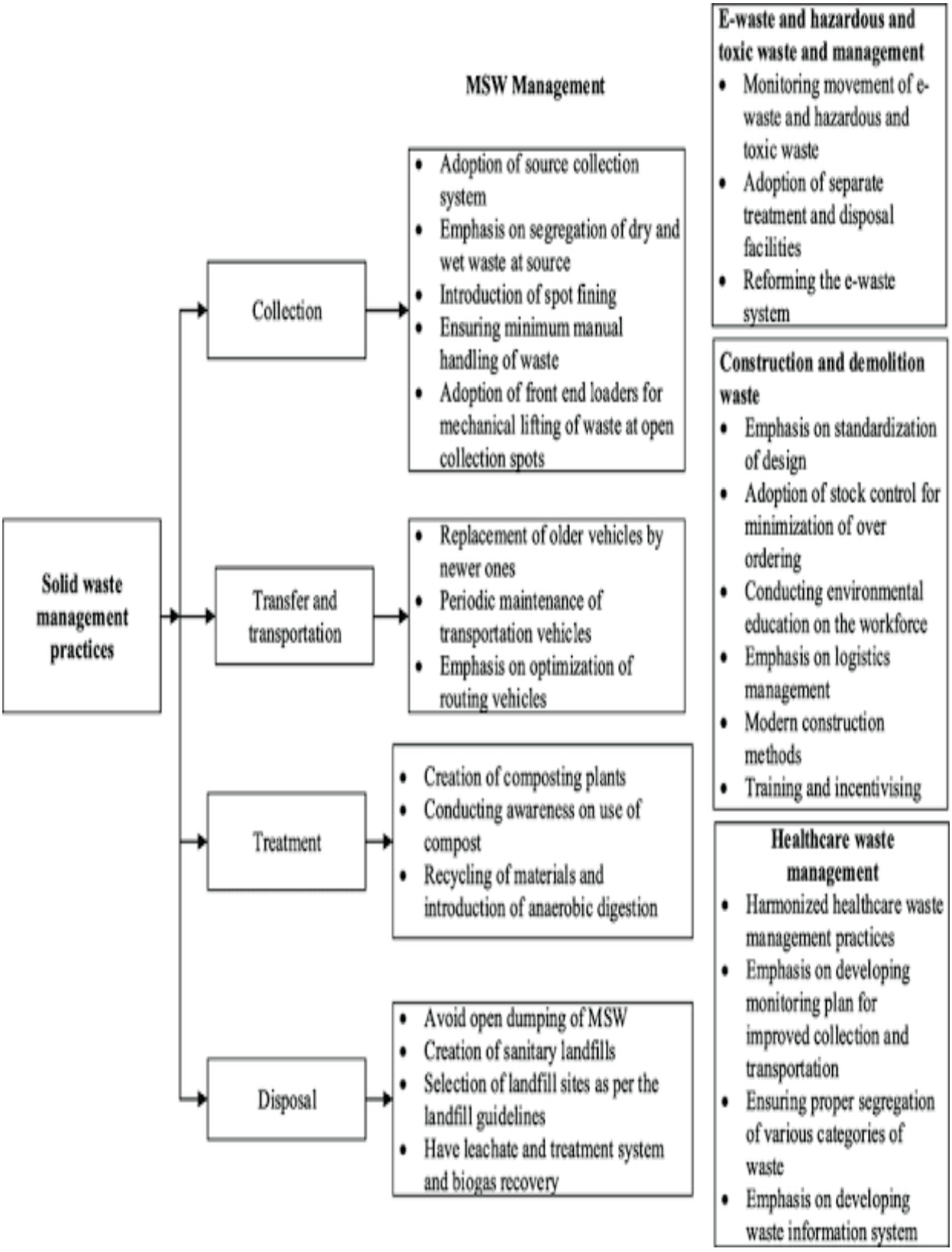
When successfully done, waste processing comes with benefits including more effective use of resources, employment opportunities in the service and repair industries and a change in attitudes towards disposable products and the campaign of keeping the environment green. What is needed is the recognition and incentives within the policy framework.

6.4 Topics for Future Research

The study suggests the following as areas of interest for future studies:

1) Replication of this study in other contexts would strengthen the findings on how urban development impacts on effective solid waste management. This is premised on the fact that business performance could be influenced by contextual factors which might differ from one town to another.
2) Studies can also be done on factors impacting on sustainable solid waste management.

RECOMMENDED SOLID WASTE MANAGEMENT PLAN FOR GITHUNGURI TOWN



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APPENDICES

Appendix 1: The Household Questionnaire

THE UNIVERSITY OF NAIROBI

SCHOOL OF THE BUILT ENVIRONMENT

DEPARTMENT OF URBAN & REGIONAL PLANNING

This study aims to analyze the challenges of urban development on effective solid waste management in Githunguri town.

Information obtained shall be held confidential and shall strictly be used for the purpose of academics only.

QUESTIONNAIRE NUMBER…….

ESTATE/AREA OF RESIDENCE……

DATE……

SECTION A: BIO-DATA

Name of the respondent…….

Contacts……

1) Gender of the respondent.

☐ Male ☐ Female

2) Occupation:

☐ Employed ☐ Self –employed

☐ Un–employed ☐ Other (specify)

☐

SECTION B:

3) What is the major solid waste generator in your household?

Food wastes ☐

Papers, cardboards & plastics/polythene ☐

Textiles ☐

Yard wastes ☐

Glasses & metals ☐

Other (Specify)…….

4a) Which method do you use in managing your solid wastes?

Burning ☐

Dumping (Dumping site) ☐

Recycle ☐

None ☐

Other (Specify)……...

4b) What challenges do you face in managing your solid waste?.....
.....
.....

4c) If dumping, do you have any official dumping site provided by the County Government of Kiambu?

Yes ☐ No ☐

4d) If yes, how do you rate the service provided by the County Government of Kiambu?
Excellent ☐ Good ☐ Average ☐ Poor ☐

4e) Is there a service charge levied by the County Government for solid waste management in your area?

Yes ☐ No ☐

4f) If yes, how much?.....`.....

5)What do you think the County can do to improve on their service delivery with regards to solid waste management in the
town?.....
.....
.....

6) Where do you dispose your waste? (Tick/circle your appropriate choice)

a) Dust bin
b) Compost pit
c) Pit latrine
d) Other (please specify) ……....

7) At what intervals do you collect and dump your solid wastes (Tick/circle your appropriate choice)

a) Daily
b) 2-7 days
c) 8-14 Days
d) 15-21 days
e) Monthly

8) Is there any community Solid Waste Management Group around your area?

Yes ☐ ☐ No

9) Which is the most prevalent disease associated with poor solid waste management in your area? (Explain)……
……
……

10) What do you think you as an individual can do to ensure the proper management of solid waste in
the town?.....

Appendix 2: Environmental Officer Questionnaire

THE UNIVERSITY OF NAIROBI

SCHOOL OF THE BUILT ENVIRONMENT

DEPARTMENT OF URBAN & REGIONAL PLANNING

This study aims to analyze the challenges of urban development on effective solid waste management in Githunguri town.

Information obtained shall be held confidential and shall strictly be used for the purpose of academics only.

Name of the officer…….....

Gender: Male ☐ Female ☐

Area of jurisdiction……

1) What are some of the sources of solid wastes in Githunguri Town?
……
……
……
……

2) Which methods do you use in collection and disposal of solid wastes in Githunguri Town
……
……
……
……
……
……

3a) Do you have an official solid waste collection site for the residents
Yes ☐ No ☐

3b) If yes, what is the name and/or the location of the collection site?
……
……
……

4a) Do you have a solid waste treatment plant for the Town?

Yes ☐ No ☐

4b) If yes, what is the name and/or the location of the treatment plant?
……
……
……

5) How often do you inspect the state and issues of solid wastes in the town?
……
…….....

6) Are there private firms, NGOs or CBOs in support for solid waste management in the town?
YES ☐ NO ☐

7) How do you involve Githunguri Town residents in solid waste management?
……
……
……
……
……

8) What are some of the challenges you are facing in solid waste management in the town?
……
……
……
……
……

Appendix 3: County Government of Kiambu Questionnaire

(DEPARTMENT OF LAND, HOUSING, PLANNING AND URBAN DEVELOPMENT)

THE UNIVERSITY OF NAIROBI

THE SCHOOL OF BUILT ENVIRONMENT

DEPARTMENT OF URBAN & REGIONAL PLANNING

This study aims to analyze the challenges of urban development on effective solid waste management in Githunguri town.

Information obtained shall be held confidential and shall strictly be used for the purpose of academics only.

Name of officer…….....

Gender: Male ☐ Female ☐

Area of jurisdiction……

1a) Does the County Government of Kiambu have a solid waste treatment plant?

Yes ☐ No ☐

1b) If yes, what is the name and the location of that solid waste treatment plant?
……..

2a) Does the County Government of Kiambu have official dumping site for Githunguri residents?

Yes ☐ No ☐

2b) If yes, what is the name and/or the location of that dumping site?
……

2c) If no, how does the County Government of Kiambu manage the solid waste in Githunguri Town?
……

3) Does the County Government of Kiambu provide solid waste collection points (bins) to the residents of Githunguri Town?

Yes ☐ No ☐

4a) Are there some private firms, NGOs or CBOs in collaboration with the County of Kiambu in the management of solid waste in Githunguri Town?

Yes ☐ No ☐

4b) If yes, which ones are they?

……
……
……
……

5) What are some of the requirements for a private firm to be authorized by the county government to offer such services?

……
……
……

6) At what intervals does the county government carry out garbage collection in Githunguri Town?

……
……
……...

7) How does the county government involve Githunguri residents in solid waste management?

……
……
……

8a) Does the county government have solid waste management by-laws or regulations?

Yes ☐ No ☐

8b) If yes, which ones are they?

……
……
……
……
……
……

9) What are some of the challenges you are facing in solid waste management in Githunguri Town?

……
……
……
……
……
……

10) Give your comments on the state and issues of solid waste management in Githunguri Town

……
……
……

……
……

11) What factors have contributed to urban development in Githunguri Town?
……
……
……
……
……