EFFECTS OF SOLID WASTE MANAGEMENT IN KITENGELA WARD: A CASE STUDY OF KAJIADO COUNTY.

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A PROJECT PAPER SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTERS OF ARTS IN ENVIRONMENTAL PLANNING AND MANAGEMENT IN THE DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES, UNIVERSITY OF NAIROBI

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DECLARATION

This research project report is my own original work and has not been presented for an award at any other university.

Signature…… Date……..

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Reg No.:C50/79734/2015

This research project report has been presented for examination with our approval as university supervisors.

Signature…… Date……
Prof. Elias Ayiemba

Signature…… Date……
Dr. Martin Marani

DEDICATION

This research projects is dedicated to the following people;

My parents, Mr Mohamed Eddle Ibrahim and Amina Farah Mohamed. To my brothers Adam Mohamed, Ahmedqadar Ibrahim, and Mohamed Ibrahim.To my sisters, Fatuma Ibrahim , Hawa Ibrahim and Samira Ibrahim.

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ABSTRACT

As the world becomes more urbanized and developed, consumption rates are on the rise. An inevitable consequence of more consumption is the rapid increase in the amount of solid waste that is produced. Today, solid-waste management (SWM) conditions in the developing world are often quite dire and reminiscent of those found in the developed world several generations ago. The impact of inadequate SWM practices on natural and human environments is now being acknowledged. This research intended to study the effects of solid waste management in Kitengela Ward, a case study of Kajiado County. The general objective of the study was to examine the effects of solid waste management in Kitengela. However, the study also focused on the following specific objectives as well: - to determine the sources contributing to solid waste in Kitengela; to examine the methods of solid waste disposal in Kitengela; to examine the effects of solid waste management on commercial institutions and households in Kitengela, and to investigate barriers in solid waste management in Kitengela. The study tested three null hypothesis; Household waste types does not affects solid waste management, secondly, there is no relationship between household waste types and the reason for household disposal preference method, and lastly, there is no relationship between age and household waste types. Using a survey research design, the study collected data from a systematic random sample of 100 households selected from a population of 58208 households in the study area. The sample size was 100 randomly selected households. Data collection instruments for this research were questionnaires, interviews and observation. Further the researcher used both qualitative and quantitative methods to collect data. The quantitative method employed was to present data in tables and percentages. Data were analyzed by first generating an SPSS dataset on which various analytical operations, within SPSS; IBM version 21, were done including generation of percentages, and descriptive and inferential statistics. The findings of this research supports results of test hypothesis, that indeed Household waste types affects solid waste management, secondly, there is a relationship between household waste types and the reason for household disposal preference method, and lastly, there is a relationship between age and household waste types. Conclusion of the study were that there should be storage receptacles in the households and commercial institutions; availability of land properly selected and demarcated for use as dump site, engage and improve public awareness of and community participation in waste management. The recommendations of the study were in terms of policy and future recommendations; recommendation for policy are; bylaws concerning waste in the Ward should be enacted; existence of public health offices and officers should be present in the study area, whereas recommendation for future are; waste minimization through waste management value chains should be encouraged; develop a properly engineered landfill site at a suitable location; allocation of skips in households and within the Ward; waste segregation and recycling should be encouraged; increase in the personnel who are engaged in the solid waste management process; route optimization using geolocation and big data to reduce garbage runs and transport costs.

ABBREVIATIONS

CDM- Clean Development Mechanisms

CSR- Corporate Social Responsibility

DRM- Disaster Risk Management

EAC- East African Countries

GHG- Green House Gases

GOK- Government of Kenya

GPOBA- Global Partnership on Output-Based Aid

IWMA- International Waste Management Association

MBT- Mechanical Biological Treatment

MSWM- Municipal Solid Waste Management

NEMA- National Environmental Management Authority

OBA- Output-Based Aid

OCC- Olekajiado County Council

OECD- Organizations for Economic Corporation and Development

PPS- Public-Private Partnership

RBF- Results-Based Financing

SCP- Sustainable Consumption Partnership

UN HABITAT- United Nations Habitat

UNEP- United Nation Environmental Programme

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

CHAPTER ONE
INTRODUCTION

1.1 Background

Throughout history, human advancement has been intrinsically linked to the management of solid waste due to its effect on both public and environmental health. Solid waste management (SWM) has a long and convoluted history. Systems of SWM can trace their roots all the way back to ancient times. One of the first instances of waste management occurred in the 4th century A.D. with the Ancient Greeks. The Greeks had to deal with the multiple challenges of aligning waste removal systems with a growing population, lack of space, and sanitation problems. Waste management practices were very rudimentary with trash just being collected and transported to pits outside the city (Barles, 2014). It was not until urban populations boomed that garbage was viewed as a threat to human and environmental health. Cities began to grow rapidly to accommodate the growing population and conditions began to worsen for these cramped communities. The plagues that affected Europe between the 14th and 16th centuries were often perpetrated by vermin that thrived in the unsanitary urban conditions that were common during this time. Early waste-management techniques were developed during this period to combat the spread of disease but the political and social problems of the time did not see great strides in waste management (Nathanson, 2015).It was not until the 18th century that municipal collection of garbage had begun in some of the world's major cities, but the methods were still fairly crude (Metzger, 2009).

During the Industrial Revolution, Europe and the United States were experiencing rapid development that created greater amounts of waste. Waste started to become a concern and this "Age of Sanitation" began. Communities began to organize waste collection and disposal to help maintain public health. In the latter part of the 19th century and into the 20th century, technological advances included the use of garbage cans and creation of incinerators and sanitary landfills; the latter replaced the practice of open dumping and has become a common practice in the developed world (Hoornweg and Giannelli, 2007). Waste systems took on a more organized approach to waste management, and technology, industry, and new policies and regulations imposed on waste helped to dramatically improve the waste management industry. With the passage of the Clean Air Act in the United States in 1970, many early incinerators without air pollution controls

were shut down and replaced by modern waste-to-energy plants (Tangri, 2003). In recent years, the solid waste industry has employed other technologies, such as recycling and composting to combat our ever-growing waste issue. Processes of SWM have affected human history in many ways, just as they will continue to do so in the future.

Solid waste is generated universally and is a direct consequence of all human activities. It is estimated that on a global scale, the amount of solid waste generated per day reached 1.84 billion tonnes in 2004, this representing a 7% increase in 2003 (UNEP Paper, 2012) . Further estimates between 2004 and 2008 generation of municipal solid waste worldwide rose by 31.1% representing an annual increase of some 7 %. (Palczynski, 2002).

Generally, the higher the economic development and rates of urbanization, the greater the amount of solid waste produced. Income level and urbanization are highly correlated and as disposable incomes and living standards increase, consumption of goods and services correspondingly increases, as does the amount of waste generated. Urban residents produce about twice as much waste as their rural counterparts (Hoornweg and Bhada-Tata, 2012)

Consequently, solid waste management is an environmental concern which requires coordinated efforts. The main reason for waste management is to protect the health of the population, promote environmental quality and equity, and boost economic productivity through recycling and sustainable development (Rotich *et al* 2005). However, waste generation varies as a function of affluence, regional and country variations can be significant, as can generation rates within the same city.

In the developed countries, the last two decades (from the 1990s) has seen waste generation increasingly nearly threefold, For example in the United Kingdom and America produce approximately 434 million tons and 11 million tons of solid waste, this increased between 1990 and 2000 (Themelis *et al*, 2004) whereas as compared to the developing countries waste generation increased to approximately 522,000 tons of solid waste on a daily basis and its average of 0.90 kg/day per person (Waste Management World, 2012).

On the other hand, solid waste generation varies between countries, cities, and other parts of Africa. Nevertheless generation rates for the continent's major cities are

estimated to range from 0.3-1.4 kg per person per day (Achankeng, 2003) this gives an average of 0.78 compared to an average of 1.22kg per capital for developed countries (Beukering *et al*. 1999:9).

In addition, waste management in urban centres of East Africa has for long time been centralized (Liyala, 2011), with the use of imported refuse truck (Rotich *et al*., 2006; Okot-Okumu & Nyenje 2011) that collect wastes from sources or transfer point and deliver to designated waste dumps. Overall waste generation rate for EAC urban centres vary on average between 0.26 (low income) and 0.78 (high income) kg/cap/day (Kibwage 2002; Kaseva & Mbuligwe 2005; Rotich et al.,2006; Oberlin 2011; Okot-Okumu & Nyenje 2011; Oyoo *et al*., 2011;; Scheinberg 2011).

In Kenya for example it is estimated that 4 million residents in Nairobi generate approximately 2000 tons/day (Jica, 2010). Only a half of 2000 tons/day of waste generated daily is collected with no means of a safer disposal (Jica, 2010).

Moreover, the increasing volume and complexity of waste possess serious risks to human health and the environment. These risks are most obvious in situations where waste collection and treatment is insufficient or even where collection and treatment methods are obviously established. In industrialized countries, despite progress on sanitary landfill technology and incineration, there are concerns over human exposure to waste disposal related syndrome (UNEP, 2011), These health related effects include cancer incidences, mortality, birth defects and low birth weight (WHO ,2007). Other related problems are the falling property values or the loss of livelihood (example related to Agriculture, Tourism) around the landfill areas. In developing countries, owing to low or inappropriate collection, deficient waste treatment and disposal infrastructure, limited financial resources, and weak enforcement of laws, open, uncontrolled and unsecured dumps are the most commonly-used methods of managing waste, all these results in harmful health effects such as skin and eye infections, respiratory problems, vector-borne diseases like diarrhea, dysentery, typhoid, hepatitis, cholera, malaria and yellow fever. There are, however, no global estimates of wastes related health costs or economic costs of waste, and only a limited number of country studies exist. (UNEP, 2011)

UNEP (2007) study carried out at a 30-acre Kenyan dumpsite called Dandora and found that about 50 percent of the examined children and adolescents living close to the

dumpsite (from a total of 328) had respiratory ailments and blood lead levels exceeding international threshold (10 micrograms per decilitre of blood). Further 30 percent were confirmed to have high exposure to heavy metals poisoning detected by red blood cell Abnormalities. Other severe effects observed in India include worm infestation, scabies, xerophthalmia and lymph-node enlargement (Hunt 1996).

On the other hand, environmentally significant behavior is a term used for describing a behavior that brings consequences for the environment, either positive or negative. Stern (2000) argues about two different perspective of environmentally significance behavior, one is impact oriented and the other one is actor-oriented. The impact oriented tries to identify behaviors that cause a negative environmental impact and is the most important perspective, whereas actor-oriented being the one focusing on the individuals' motives for their certain behavior. Furthermore, pro-environmental behavior brings positive impacts on the environment these include recycling and re-using materials and waste, choosing ecologically produced food/products with environmental labels and instead of using the car, choosing public transportation.

Consequently, solid waste management is becoming a major public and environmental concern in urban areas in many developing countries. This is contrary to developed countries which spend less than 0.5 percent of their GNP on urban waste services (Rushbrook and Pugh, 1999). In Latin American, for example the cost of waste collection is about 46 percent of the municipal solid waste management cost, yet in Sub-Saharan Africa during the 1980s economic crisis which resulted in increased environmental degradation among poor countries in the region, governments were forced to realign their policies on environment. This has been in conformity with Agenda 21 of the earth summit (UNCED, 1992).

Taking into consideration advances in technology, modern approaches to solid waste management have included strategies to reduce waste generation, encourage recycling and recovery of energy on an industrial scale. In Nairobi more than 2000 people eke a living through their engagement in garbage collection ,Waste pickers and dealers earning their living off the recovery and sale of recyclables at the Dandora dumpsite alone, number over 2000 (Karanja, 2005), although less than 200 tons per day of recycled material is recovered. It is therefore evident that there is urgent need for a properly managed and coordinated waste management programme. In high density and

low income areas such as Kitengela, there is severe environmental degradation which is as a result of poor waste management system.

Currently, Olekajiado County Council (OCC), is one of local Authorities in Kajiado County. Its mandate is to meet and deliver essential services particularly in the Management of solid waste in Kajiado County. But this has not been the case, Olekajiado County Council (OCC) has not been able to meet the demands of the growing population and human activities especially in regards to waste management. Its main focus is majorly on revenue collection. It has therefore engaged in Public-Private Partnership (PPPs) initiatives to address and overcome some of these problems. For instance, outsourcing of garbage collection has been undertaken in Kitengela and other areas within Kajiado County but the initiative has not been able to curb the problem. The youths and the private service providers supplement the municipality's effort to collect and finally dispose of solid waste in Kitengela. After collection, the municipal solid waste is transported to Noonkopir dumpsite site which is already full. The solid waste disposal mechanism is not thoroughly systematic and it is dumped at low lying areas. In the study area, the solid waste which is collected continue to be an outdated practice and inefficient. Due to shortage of financial resources, even the vehicles used by the private service providers and youths, are often used beyond their economical life resulting in inefficient operation. The equipment and machinery presently used in the system are generally outdated Almost 99 % of the solid wastes collected by the youths and the private service providers are disposed off through the method of sanitary land filling.

Waste management therefore seeks to deliver clean, safe and healthy environment for human habitation. The primary objective of solid waste management is the protection of public health (Ross, 2013) and environmental safety. Schübeler, Christen & Wehrle (1996) elaborated further that the goals include: to protect public health and safety, promote environmental quality and sustainability, support economic productivity and employment generation. Therefore, solid waste management has a crucial role in human wellbeing and sustainable development.

However, in the absence of efficient and effective methods of disposing refuse worsen the quality of air which has detrimental impacts on human health. The most common problems associated with improper management of solid waste include disease transmission, odor, nuisance, atmospheric, land and water pollution, fire hazards,

aesthetical nuisance and economic losses (Yeny and Yulinah, 2012) , All these results in harmful health effects such as skin and eye infections, respiratory problems, vector-borne diseases like diarrhea, dysentery, typhoid, hepatitis, cholera, malaria and yellow fever. Effects on environment include waste breaks down in landfill to form methane, increase in mercury level both on soil and water in rivers near landfills, high algal population in rivers and seas, soil and water quality degrades (Yeny and Yulinah, 2012).

1.2 Statement of the Problem

Population pressure in Nairobi County has several consequences on the environment; among the biggest problems is sanitation, human congestions, houses that are sprawling, slums and improper waste management and disposal mechanisms. The growth is largely due to rural-urban migration and the natural rate of increase, and the population of the city is presently estimated at 4 million.

This has then led to an increased waste generation in the county and the neighboring metropolitan areas such as Kitengela. Much of waste disposal has taken place in Nairobi and in different areas, but when it comes to Kitengela, little has been done on the case of solid waste management; waste management programs are done by the private service providers who have been licensed by the Kajiado County Government to undertake the collection, transportation and disposal of solid waste in Kitengela with the help of the youth seeking employment.

This increase has not been accompanied by an equivalent growth in the capacity to address the problem of solid waste management in the study area, thus becoming one of the most pressing and challenging environmental problems. Kitengela town does not have a sewerage system and the management of the environmental pollution from Noonkopir dumpsite is a big problem. The garbage dumpsite serves Kitengela Ward is about 5 acres; it's already full. Moreover, the presence of a medical incinerator in the middle of the town raises the pollution level a notch higher.

If the issue of solid waste in kitengela is not treated with the seriousness it deserves and its increase curbed, opportunities that would have otherwise been avoided for its effect will become foreclosed due to environmental complications. Therefore this study examines the effects facing solid waste management in Kitengela such as collection,

transport, and disposal and considers possible avenues that would lead to improved and efficient solid waste management in Kitengela.

1.3 Research Question.

1. What are the sources that contribute to solid waste in Kitengela?
2. What are the methods of solid waste disposal in Kitengela?
3. What are the effects of solid waste management on commercial institutions and households in Kitengela?
4. What are the barriers of solid waste management in Kitengela?

1.4 General Objective

The study will be guided by one general objective which is to examine the effects of solid waste management in Kitengela.

1.4.1 Specific Objectives of the Study

The specific objectives of the study are to;

i. Determine sources contributing to solid waste in Kitengela.
ii. Examine methods of solid waste disposal in kitengela.
iii. Examine effects of solid waste management on commercial institutions and households in Kitengela.
iv. Investigate barriers in solid waste management in Kitengela.

1.5 Hypothesis of the study

H_0; Household waste types does not affect solid waste management.

H_1; Household waste types affect solid waste management.

H_0: there is no relationship between household waste types and the reason for household disposal preference method.

H_1: there is a relationship between household waste types and the reason for household disposal preference method.

H_0: there is no relationship between age and household waste types

H_1: there is a relationship between age and household waste types

1.6 Justification of the study

As countries develop economically, socially, and technologically waste generation also increases. Both developed and developing countries face the problems associated with solid waste generation and its management. Rapid urbanization directs to the densification and an increase of large amounts of solid waste within a concentrated area.

This research is equally important and justified by the need to highlight the effects of poor solid waste management in Kitengela ward. In particular the process of solid waste management in Kitengela, the rate of generation of solid waste has increased with the increase in population, so much that the local agencies responsible for the collection and disposal of wastes are unable to deal with the total quantity produced every day. As a result, a major part of the waste remains uncollected and accumulates in the form of heaps at various locations within the inhabited study areas that soon begins to rot and becomes an environmental hazard. Effect of environmental pollution from Noonkopir dumpsite is also a big health hazard. The garbage dumpsite that serves Kitengela Ward is about 5 acres; it's already full. The main problem in adopting sanitary landfills for solid waste disposal is of land acquisition. The requirement of land to accommodate increasing solid waste has been increasing day by day.

Sanitary land filling are diverted to other uses and these results to unplanned dumping on any available government land. Moreover, as the time passes by and the existing sites get exhausted i.e., Noonkopir dumpsite, new sites can be found only at increasing distance from the area which generate most of the solid waste. The value of land goes up due to the fast development, sometimes uncontrolled and has continued to put much pressure on land and substantially enhanced financial resources that have to be raised for land acquisition. Not only that, increasing distances means lesser number of trips per vehicle, and to cater to the same area, a larger fleet of vehicles and bigger manpower .i.e. more private service providers and more youths for the entire process to be successful and dealing with the public demands becomes an intractable problem by itself. Currently there are 11 companies and as many youths being involved as compared from 9 private service providers and less youth that were there in 2009. The garbage composition at the dumpsite is inorganic (mainly composed of plastics use by shoppers) and organic materials generated from kitchen wastes. The decomposed organic portions emits a foul smell, the liquid oozing from the garbage dumpsite is potentially toxic and has burnt all vegetation on contact. During the rains, this effluent eventually pollutes Athi River

which provides water downstream for millions. Furthermore, waste from Slaughterhouse effluents are discharged to the environment e.g. open drains and water, thereby causing pollution. The effluents also emit objectionable odour to the surrounding. Besides the effluents of the slaughter houses being discharged collection, transportation process rarely happens. Consequently, Kitengela town does not have a sewerage system, and this situation becomes worst in rainy seasons where most buildings in Kitengela have septic tanks merely for sewage tanks and not cesspit or soakpits tanks; that are not properly constructed, and the sewage waste comes out and mixes with waste dumped just outside resulting in serious health implications. The only two new public toilets are yet to be commissioned that have proper sewage lines.

There are however, many existing literature on different issues but very little or none addressing solid waste management in Kitengela ward in particularly collection, transport and disposal, produced by households, and commercial institutions such as markets, slaughter houses and industries. Residents of the study area are becoming more and more ignorant of their environment; they have actually succumbed into the acceptance of living with dirt. The most common problems associated with improper management of solid waste include disease transmission, odor, nuisance, atmospheric, land & water pollution, fire hazards, aesthetical nuisance and economic losses (Yeny and Yulinah, 2012).

Secondly, the study is justified by the need to add to the existing research knowledge on solid waste generation and management in general mostly in Kitengela Ward and especially adding literature on addressing solid waste management in present and in the future. It is expected that future researchers may find this research helpful in investigating similar fields of study.

1.7 Scope of the study

The study area is in Kitengela ward, Kajiado County. The scope of the study focused on solid waste management produced by households and commercial institutions such as markets, slaughter houses, and industries, with the aim of establishing a better means of solid waste management process which will benefit Kitengela Ward. Issues that the study looked at were; determining the sources contributing to solid waste in Kitengela, Examining methods of solid waste disposal in Kitengela, Examining effects of solid

waste management on commercial institutions and households in Kitengela and lastly, Investigating barriers in solid waste management in Kitengela.

Other areas could not be covered because of financial implications and resource availability was not enough; therefore the research dealt on Kitengela Ward alone.

1.8 Limitations of the study

There is no study without limitations, however, limitation of the study were lack of weight scales at landfill sites to record waste quantities, especially from commercial institutions.

Consequently, due to financial constraints and time to the research project, it was unlikely that the study would have solved all the problems associated with the study area. Furthermore, the study only identified in reference with the first objective in chapter one, determining the sources contributing to solid waste in Kitengela i.e. types of waste generated in commercial establishments e.g. Markets, Slaughterhouse and industries in the study area.

Therefore, in relation to the above statements, the study narrowed down to Household as the unit of analysis and only identified what types of waste is generated at the household level. Furthermore, due to measuring the volumes of waste generated in the commercial institutions e.g. Markets, Slaughterhouse and industries; the study again could not embark on measuring the volumes of waste generated as it entailed huge financial aspects and time again for measuring the various types of wastes generated, which would have been available for subjection in hypothesis testing.

And lastly, respondents withholding information and inaccessibility of some areas where security of the researcher was not guaranteed.

1.9 Operational Definitions of Terms

In this study the following terms will be used**:**

Dumping -This involves discarding of waste on open ground without environmental consideration.

Enumeration area - Small area composed of one or more neighboring blocks, used by Statistics for distributing questionnaires to households and dwellings (census collection).

Environment – It is the Biophysical and social-economic and cultural factors that surround and influent the life of both organism.

Generate - Production of waste.

Municipal Solid Waste- This include refuse from households , non-hazardous solid waste from industrial , commercial and institutional establishments, markets waste , yard waste and MSWM encompasses the functions of collection, transfer, treatment, recycling, resource recovery and disposal of municipal solid waste.

Municipal Solid Waste Management – Refers to the collection, transfer, treatment, recycling, resource recovery and disposal of solid waste in urban areas.

Recycling – Changing from one form to another.

Solid waste – **(Rubbish, Trash, Refuse, Garbage, or Junk)** that is Unwanted / Unusable materials that are not liquids nor gaseous in nature.

Solid Waste Management – Is the collection, transportation, processing, recycling / disposal and monitoring of waste.

Waste – That which is discarded and considered not of any use to any person

Waste Disposal - Ways of getting rid of various methods of discarding waste such as by burning, dumping or use of bins/ plastic bags.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

Organization of the literature review is done empirically in thematic/ sub-topics.

Generation of waste requires proper management of waste that will help safeguard the increasing volume and complexity of waste which poses serious risks to human health and the environment as well. Rapid industrialization, urbanization, population growth and migration from the country side to towns, such as Kitengela, have resulted in solid waste generation, which is commonly considered as an urban issue. It is highly related with economic growth, degree of industrialization and consumption pattern and lavish lifestyle of city dwellers. Solid waste generation and management is a burning issue all over the world and the planners and policy formulators are finding it extremely difficult to handle this problem mainly because of slapdash and unchecked urbanization. More or less every human activity creates some kind of waste, and rapid urbanization directs to the densification and an increase of large amounts of solid waste within a concentrated area.

2.2 Status of Solid waste in the world

Hoornweg and Bhada-Tata (2012) claimed that world cities generate about 1.3 billion tons per year of solid waste and this volume is expected to increase to approximately 2.2 billion tons per year by 2025 which will be more than double over the next 20 years in lower income countries. This represents a significant increase in per capital waste generation rates, from the current 1.2 to 1.4kg per person per day in the next fifteen years. Solid waste management costs will increase from the current's annual $ 205.4 million to about $ 375.5 billion in 2025. Costs increase will be most severe in low income countries i.e. more than 5 fold increase and lower middle income countries i.e. more than 4 fold increase.

Moreover, waste generation varies as a function of affluence, and that regional and country variations can be significant as does generation rates of solid waste management. Sub-Saharan Africa was believed to approximately generate 62 million tons of waste per year, and that per capita waste generation was generally low in this region, but spanned to a wide range, from 0.09kg to 3.0kg per capita person per day with an average of

0.65kg per capita per day. The countries with the highest per capita rates were islands due to waste generated by the tourism industry.

However, Hoornweg *et al*, (2005), estimated the annual waste generation in East Asia and the Pacific Region is approximately 270 million tons per year. This quantity is mainly influenced by waste generation in China, which makes up 70% of the regional total. Per capita waste generation ranges from 0.44 to 4.3 kg per person per day for the region, with an average of 0.95 kg/capita/day.

In addition Hoornweg and Bhada-Tata (2012) also observed that in Eastern and Central Asia, the waste generated per year is at least 93 million tons. Eight countries in this region have no available data on waste generation in the literature. The per capita waste generation ranges from 0.29 to 2.1 kg per person per day, with an average of 1.1 kg/capita/day.

Latin America and the Caribbean, on the other hand, have the most comprehensive and consistent data (i.e. PAHO's Regional Evaluation of Solid Waste Management, 2005). The total amount of waste generated per year in this region is 160 million tons, with per capita values ranging from 0.1 to 14 kg/capita/day, and an average of 1.1 kg/capita/day.

In the Middle East and North Africa, however, solid waste generation is 63 million tons per year. Per capita waste generation is 0.16 to 5.7 kg per person per day, and has an average of 1.1 kg/capita/day. The OECD (Organizations for Economic Co-operation and Development) countries generate 572 million tons of solid waste per year. The per capita values ranges from 1.1 to 3.7 kg per person per day with an average of 2.2 kg/capita/day. In South Asia, approximately 70 million tons of waste is generated per year, with per capita values ranging from 0.12 to 5.1 kg per person per day and an average of 0.45 kg/capita/day. Uruguay has the distinction of generating the least MSW that is 0.11kg/capita/day while Trinidad and Tobago generates 14.40 kg/capita/day, which is the highest in the world. And surprisingly both the countries lie in Latin America and the Caribbean Region. In other words, the study demonstrated that the higher the income of a country the most per capita waste produced as compared to the lower the income of a country the least solid waste produced, which then translates to 41 per cent of waste collected in low income countries as compared to that of 98 per of waste collection in high income countries.

Consequently, Hoornweg *et al*, (2012) also said that globally, we live in a "throw-away" societies in which we consume packaged products that often do not last past a single use or even a year, and we discard as waste what we no longer want. This wasteful lifestyle seriously impacts the environment, public health, and produces social and economic problems. Waste disposal can have serious environmental effects: landfills consume land space, and cause air, water and soil pollution - including the emission of greenhouse gases, while incineration results in emissions of dangerous air pollutants. Our consumptive and often wasteful behavior needs to be examined, and changed, so that we can live more sustainably.

However, according to Hoornweg and Bhada-Tata, (2012) makes a credible estimate on current generation and composition of solid waste and how the situation will look like in 2025. Such projections are made in order for decision makers to prepare plans and budgets for solid waste not only at present but also in the coming years. This study is a follow-up of a previous study done by Daniel Hoornweg and Laura Thomas, (1999); on the estimates of waste quantities and compositions for South and East Asia.

UN-HABITAT's State of Water and Sanitation in the World Cities series, third edition is another study which aimed to capture the world's current waste management trends and drew attention to the importance of waste management. The study acknowledges the escalating obstacles/barriers in solid waste management across the globe. It seeks to showcase the good work that is being done on solid waste by cities around the world, large and small, rich and poor. In addition the study points out that it achieved this by looking at what drives change in solid waste management, how cities find local solutions and what seems to work best under different circumstances. Endeavors of the study were to help decision-makers, practitioners and ordinary citizens understand how a solid waste management system works and to inspire people everywhere to make their own decisions on the next steps in developing a solution appropriate to their own city's particular circumstances and needs. However the study suggests that most readers will never travel to all the 20 cities featured in the study, but they will have access to real literature of the study with the help of experienced people who worked on the ground (Habitat, U.N, 2010)

According to (Habitat, U.N, 2010), it had four main aims which were : firstly, to showcase the good work that is being done on solid waste by cities around the world,

large and small, rich and poor; secondly, to look at what drives change in solid waste management, how things work in cities and what seems to work better under which circumstances ; thirdly to help decision-makers, practitioners and ordinary citizens understand how a solid waste management system works; fourthly, and to inspire people everywhere, in good communication with their neighbors, constituents and leaders, to make their own decisions on the next steps in developing a solution appropriate to their own city's particular circumstances and needs. The study was designed both to fill a gap in the literature and knowledge base about solid waste management in low-, middle- and high-income countries, and to provide a fresh perspective and new data.

Furthermore, a collective effort by the UNEP, ISWA, (2015), Global Waste Management Outlook; a pioneering scientific global assessment on the state of waste management and a call for action to the international community is another study. The study was prepared as a follow up to the Rio+20 Summit and as a response to UNEP Governing Council decision GC 27/12, however, the study establishes the rationale and the tools for taking a holistic approach towards waste management and recognizing waste and resource management as a significant contributor to sustainable development and climate change mitigation. The study however is primarily focused on the 'governance' issues which need to be addressed to establish a sustainable solution – including the regulatory and other policy instruments, the partnerships and the financing models. Broad in scope and global in coverage, the study includes a series of Topic Sheets and case studies addressing specific issues and illustrating featured initiatives. In addition to, the study provides an inspiring possible way forward on waste management, drawing conclusions and making recommendations to assist policy makers and practitioners to develop local solutions for waste management. To complement the Sustainable Development Goals of the Post-2015 Development Agenda, the study also sets forth Global Waste Management Goals and a Global Call to Action to achieve those goals.

In other words, the study has been developed to provide an overview of waste management around the world – how it has developed over time, what the current status is and where the current thinking on "state of the art" indicates that the future lies over the medium term. To reflect UNEP's mandate, the study presents waste management as an essential for ensuring public health and environmental protection once waste has been generated, and also, in the wider context of 'waste and resource management', highlights

the need to consider the entire life-cycle of materials and products in order to prevent and minimize waste.

Therefore the study's aims are to provide the rationale and the tools for taking a holistic approach towards waste management and for recognizing waste and resource management as a significant contributor to sustainable development and climate change mitigation.

In another study that was inspiring, done by UNEP, (2011) Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication; found out that the increasing volume and complexity of waste is posing threats to ecosystems and human health, but opportunities do exist to green the waste sector. These opportunities come from the growing demand for improved waste management and for resource and energy recovery from waste. This change in demand is driven by cost savings, increased environmental awareness and increasing scarcity of natural resources. The development of new waste-related technologies on three R's and technologies such as MBT (Mechanical biological treatment) and advanced biomethanation has facilitated the greening of the sector. The growth of the waste market is a reflection of the underlying demand for greening the sector – especially the new paradigm of linking waste to resource use across the life-cycle of products.

The study further argues that change in consumer demand is a major determinant underlining the potential "Greening" of waste sector. With increased environmental awareness, more and more consumers have started demanding recycled products and waste-derived compost. A good example of these, Increased consumer demand for recycled products has compelled many companies to refurbish their product packaging to reduce the impact on the environment. Examples in North America include Hewlett Packard (HP), EnviroPAK (St. Louis) and Oxobioplast Inc. (Toronto). HP insists that all its packaging be recycled and labelled as such. EnviroPAK has shown great interest recently in using complex recycled paper pulp for packing electronic, small household appliances, medical products, consumer goods, CDs and DVDs, automotive parts and food and bottled goods. By opting for paper pulp in the place of expanded polystyrene, the company has claimed to save 70 per cent in packaging and shipping costs. Oxobioplast Inc. uses an additive called "Revert" to render its plastic products biodegradable by breaking apart their polymer chains after a permitted period of use.

Another example is The Prostheses Foundation in Chiang Mai, Thailand conducts a sensational programme using recycled materials. The foundation produces artificial limbs from aluminium ring-pulls collected from beverage canisters. The ring-pulls contain titanium, a light, strong, lustrous, corrosion-resistant and valuable metal. They are collected from across the country, including from several large companies. Some 35,000 ring-pulls produce 1 kg of useable metal, from which two artificial limbs can be fashioned. The foundation has recycled nearly 5,000 tons of ring-pulls and has created a positive net socio-economic impact. Prosthetics made of recycled aluminium are much cheaper (typically Thai Baht (THB) 5,500 (US$160) a piece) than similar imported ones (THB 90,000 (US$ 2,650). Furthermore, an artificial leg made from recycled ring-pulls weighs just 6 kg, while many similar imported products weigh about 11 kg. (UNEP, 2011)

The study **(**UNEP, 2011) further observes that, different countries face different waste related problems, but the path to greening the waste sector shares common milestones. Prevention and reduction of waste at source is essential for all countries, although this is particularly important in developing countries given their higher level of population growth and increasing material and resource consumption. The absolute growth of population and income implies that the absolute volume of waste is unlikely to decline. Greening the sector is therefore the only way to decouple. It is important to reduce conversion of used materials into municipal waste. Proper collection, segregation, transport, and recycling of waste as well as the construction of basic facilities are essential steps in many countries of the world. In relation to the study area, innovative measures of reusing waste products are currently underway, waste materials such beer bottles, plastic bottles and any non-biodegrable products are converted to useful products. A good example of such is the conversion of beer bottles to a glass of drinking water is done in the study area. Basically the bottom part of the bottle is removed and the top part of the bottle is attached with a small sourcer to give it a form of a stand.

The study (UNEP, 2011) concludes by noting that, indeed, there are multiple benefits from greening the waste sector. These benefits include resources recovered from waste helping to avoid extraction of raw materials, new products such as compost and energy derived from waste, lower cost of reducing GHG emissions, carbon credits, avoided health costs, and job creation. Greening of the sector will involve formalization of the informal sector in many developing countries, including the provision of proper training,

health protection, and decent level of compensation for waste workers, and thereby contribute to improving equity and poverty alleviation. Accordingly the study did not put more emphasis on additional efforts needed at addressing greening of waste at the country level and enable policy makers to design their own strategy for greening the waste sector on a more informed basis.

In relation to the study area, Non-organic waste can be recycled and useful products can be made out of plastics, glass, enamel, rubber, clothes. Such initiatives are being undertaken by the private service providers and the youths helped by the Kitengela Water & Sewerage Co. Ltd (KITEWASCO LTD). Besides Non-organic waste being recycled, Introduction to dry latrines is also another initiative being undertaken by the same private service providers and the youths helped by the Kitengela Water & Sewerage Co. Ltd (KITEWASCO LTD); it is a type of latrine that is familiar to many. It consists of portable metal super structure with blue fiberglass for walls and clear fiberglass for the roof to allow sunlight into the waste collection area. Equipment to harvest and separate liquid and solid human waste can be emptied daily and transported to the waste recycling plant. These dry latrines will be located in strategic places and may be used by the public free of charge. Which is still yet to be seen in the study area.

Furthermore, garbage separation equipment; garbage at the Noonkopir dumpsite is composed of packages of decomposed organic materials from human food sources in plastic bags, rubber, glass, paper, fabrics materials and metals. These are heaped to about 3 meters high and have a foul smell after years of decomposition. Solutions as to evaluate the best method to decongest the dumpsite using the 3-phase electric run machine to perform the task will be assembled locally at Kshs. 15 million, with an economic life span of 5 years. However, this estimates that the time required to complete that task would be about two months for the 5 acre dumpsite as part of the initiative being undertaken by the same private service providers and the youths helped by the Kitengela Water & Sewerage Co. Ltd (KITEWASCO LTD).

In addition, to recycling of waste in the study area, is the production of organic manure ; organic manure from the dump site requires analysis to determine suitability for composting. Such process requires a laboratory and qualified personnel to ensure that heavy metals are safely discarded. However, as for human waste from dry latrines, can

be separately treated by a bio-digester and products mixed with organic manure obtained from garbage to yield rich organic manure that can be useful for tree planting and floriculture. 15 ton rapid thermophilic bio-digesters and use of Effective Microorganisms (E-M) are such examples that can be indispensable in the process of conversion of human waste into manure to be blended with organic manure that is obtained from the dumpsite. Pelleting and packaging can be the final phase for easy product handling and marketing to various market outlets.

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: 1) reinforce environmental sustainability, public health, family and child safety; and 2) 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 result (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 (Aini *et 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. Furthermore, 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.

Consequently, according to Schubeler**,** (1996) in his study that provided brief definitions of the main concepts of municipal solid waste management; identified the goals and principles that normally guide MSWM system development. He discussed key objectives and issues which should be addressed by MSWM strategies with regards to political, institutional, social, financial, economic and technical aspects. In addition, the study further suggested that MSWM is an important entry point for integrated urban management support.

The overview of the study for MSWM were goals believed to (i) promote the health and well-being of the entire urban population, (ii) to protect the quality and sustainability of the urban environment, to promote the efficiency and productivity of the urban economy, and lastly (iii) to generate employment and income. However, the overall aim was to establish sustainable MSWM systems which meet needs of all citizens, including the poor, and concluded by outlining possible directions for development cooperation.

Therefore the study proposed strategies to address MSWM with regards to political, institutional, social, financial, economic, and technical aspects as a form of solution to integrated urban management. This study was however important in so far as understanding and analysis of current waste management would lead to better plans and budgets for waste generation in the coming years.

2.3 Solid Waste management in Developing countries

In a study conducted by Pfammatter *et al*, (1996) on non-governmental refuse collection in a few selected developing countries, he argued that the importance of waste collection and disposal, is mostly beyond the means to handle the growing amount of waste generated by rapidly expanding cities. thereby suggesting a realistic approach to improve the deplorable situation would be for the inhabitants of unreached areas to assume their own responsibilities with regards to waste handling. And that the inhabitants should set up a collection system that is appropriate to their economic standing and adopted to the conditions of the area. However, this, can take different forms i.e. the community either pays private collectors from within or outside the neighborhood to carry the waste communal collection points, or the households assume responsibility for part of the work. In other words, the study observed that such types of non-governmental primary refuse collection schemes have been initiated and operated in different cities of Asia, Africa, and Latin America over the past few years. Therefore, the study suggested on the improved solid waste collection, and to assess the potentials and limitations of such non-governmental approaches are based on practical experience. The reviewed cases thereby ranged from community-based schemes in Indonesia, China and some parts of Africa i.e. Burkina Faso, Ivory Coast and Cameroon, to schemes operated and management by small private enterprises in Peru and Columbia.

The study further argued that the problem or cause of inadequacy in waste management coverage to be; limited awareness among the populace, poor allocation of resources, and use of appropriate technology, low political priority, rapid urbanization and operational deficiencies in waste management schemes. These were the independent or causal variables of the study. The effects of these variables were; resultant health issues, indiscriminate solid waste dumping and the environmental impacts. These effects were the study's dependent variables. In the long run these effects impair the quality of life, mostly, the vulnerable populations and possess negative impacts on the national economies.

In addition to, according to Pfammatter *et al*, (1996) non-governmental primary refuse collection is basically a suitable approach to increase service coverage in low-income urban areas. And that small private enterprises and community organizations have an enormous potential in reducing part of the burden of the responsible Authority. However, most schemes are still not self-sustainable and that they face problems which can and do

lead to breakdown of operations. Therefore the study recommends that, collaboration between Public Authorities and Non-Governmental actors should be present and establish a service oriented partnership.

Secondly, selection of an affordable and sustainable technology. Low cost technical solutions are thus an important factor for successful collection system.

Thirdly, orientation of the users and their involvement in decision-making, thus the willing to contribute to decision making is strongly dependent on the felt need of the population for solid waste collection and disposal. Enhancing people's awareness regarding the consequences of inappropriate solid waste handling, and providing information on possible improvements are thus crucial elements.

Lastly, Assessment and Transparent Recovery of incurred costs, lack of costs Assessment and Insufficient cost recovery are the major causes for a dependency on the external financial assistance. A more communal Approach in managing Non-Governmental schemes may lead to the required accountability and improved motivation of its actors.

Therefore the study focused on refuse collection that is basically a suitable approach to increase service coverage in low-income urban areas.

As far as collection and disposal of solid waste is done in the study area, Kitengela, the private service providers and the youth undertaking the process of solid waste management are overwhelmed by the growing population and an increased generation of waste since due to availability; items are discarded with no real attachment or need for repair. Collection is only done to those entity that can pay for the services. Those residents who cannot afford, always end up dumping on the streets or behind their houses which is normally done at night. And with only 11 private service providers and the youths working together, are supplementing the local Authority's role in the process of solid waste management, which is still not comparable to the growing population in Kitengela. Besides waste being dumped at the streets in Kitengela, and very few times collected; waste from Slaughterhouse effluents are discharged to the environment e.g. open drains and water, thereby causing pollution. The effluents also emit objectionable odour to the surrounding. Furthermore, the effluents of the slaughter houses being discharged; collection, transportation process rarely happens.

Consequently, another study on (Harir *et al* 2015), Exploring the Resources Recovery Potentials of Municipal Solid Waste; A Review of Solid Waste Composting In developing Countries; identified that there is high potentials of composting in the solid waste stream from cities in developing countries. However the study, recommended that the recovery of organic waste material and papers for composting and the recycling of plastic, metals, textiles and others to explore their resource recovery potentials. This will largely reduce the ultimate quantities of solid waste for disposal and lower the operating costs. This strategy will achieve sustainable waste management in developing countries. The study further noted, that Composting is sustainability in developing countries and considering the numerous benefits such as production of organic compost, reduction of waste quantity for final disposal, reduced air pollution and ground water leachate and also creates employment and income. The study further acknowledged that Composting, is the most suitable for developing countries due to the low costing; low technology; low pollution effect and it has more benefits to the environment and the economy when compared to the disposal of organic waste into open dumps as is widely practiced in developing countries. However, while composting is the most appropriate for the organic waste materials the other waste like plastics, metals, leather, textiles are best to be recycled. The huge organic materials and other recyclables in the total wastes stream compositions in addition to the numerous multiplier benefits of composting and recycling reviewed in the study were evidence that high resource recovery potentials are inherent in the municipal solid waste stream from cities in the developing countries. However, to actualize the potentials, will require the compliment of appropriate government policy on composting and recycling in addition to an adequate public education on the need to mitigate poor waste management. Therefore, the study recommended composting and recycling as a policy for sustainable waste management in developing countries.; Example, Refuse Defined Fuel**;** Most research have been done on composting as a solution for organic solid waste however, toxic organic waste that cannot be used as organic fertilizer but instead can be used to make excellent raw material for charcoal briquettes.

Another study that was also inspiring as well, was produced by the World Bank's Global Urban and Disaster Risk Management (DRM) Unit, Since 2012 the World Bank has been exploring the application of results-based financing (RBF) in the solid waste sector as an instrument to improve MSW services and outcomes (2014). Results-based

financing for MSW is a financial mechanism through which the payment for solid waste services is conditioned to the achievement and verification of pre-agreed targets. A basic feature of RBF is that financial payments or in-kind rewards are provided to a service provider conditional on the recipient undertaking a set of pre-determined actions or achieving a pre-determined performance goal. RBF offers opportunities to innovate in the use of development finance in the solid waste sector and to achieve results.

However, The Global Partnership on Output-Based Aid (GPOBA) is a global partnership program administered by the same World Bank Group. Established in 2003, GPOBA funds, designs, demonstrates and documents innovative Output-Based Aid (OBA) approaches in developing countries and is at the forefront of this effort. Drawing on more than a decade of global experience using results-based financing (RBF)—particularly output-based (OBA)—to improve access to energy, water and sanitation, health, and education, GPOBA is applying the same innovative thinking to solid waste management projects.

The study presents case studies of cities in Nepal, the West Bank, China, Malaysia, Indonesia, Tanzania, Jamaica, and Mali that adapted RBF principles to fit local contexts and meet individual obstacles. It aims to help practitioners apply RBF principles in solid waste management and highlights the role outcome-based incentives could play in improving services and outcomes.

Until recently, RBF principles and designs had not been widely applied in the solid waste sector, apart from the use of some performance-based contracting with private providers of solid waste services and carbon finance for methane mitigation. Given existing weaknesses and the obstacles that cities face regarding solid waste management and service delivery, RBF can benefit the sector by ensuring that public funds are used efficiently and transparently. The study provides eight examples of RBF designs, each tailored to the specific context and needs of the solid waste sector in the specific city or country. These projects are currently in various stages of preparation or implementation; hence, lessons can be inferred only in terms of how solid waste projects can be developed using RBF principles. The eight examples can be classified into three main categories: firstly, RBF to improve solid waste service delivery and fee collection: in Nepal and the West Bank, the projects use RBF subsidies to improve the financial sustainability of MSW services by increasing user fee collection while simultaneously

improving waste collection services; Secondly RBF to promote recycling and source separation: in the cases of China, Indonesia, and Malaysia, an "incentive payment" model is used to improve source separation and collection of waste through changes in behavior at the household level; and Thirdly RBF to strengthen waste collection and transport in under-served communities: in Mali and Tanzania, projects were designed to strengthen secondary waste collection and transport for under-served communities. In the case of Jamaica, the project was designed to improve waste collection in inner city communities and to encourage waste separation as well as general neighborhood cleanliness.

2.5 Solid waste management in Africa.

Most countries in Africa have generally experienced poor waste disposal mechanisms. This has raised the concern to look into how effective stakeholders can best handle the problem of proper waste disposal. Achankeng (2003) in his study, attempts to examine how globalization and increasing urbanization have impacted on the management of municipal solid waste sector in Africa and more particularly in Cameroon using the cases of Bamenda and Yaoundé cities. After defining globalization and situating Africa in the global scene, the urbanization process is reviewed as the theatre of globalization. The globalized African cities and waste management are then examined, trailing the stages of waste management.

The study further argues that, Globalization has raised some troubling concerns for the developing world, including Africa. One such concern is its effect on urbanization and the ramifications that go with it. Cities are traditionally engines of social modernization and economic growth and at the same time the theatres in which globalization stages its actions. For Africa this has meant fueling the already unprecedented urban growth phenomenon and increasing the effects that go with it. One key obstacle is the management of municipal solid waste. Globalization has been identified as playing a negative role in solid waste management in African cities. Impacts include the transfer of globalized or internationalized waste management methods and ideologies together with an increased volume and variety of waste, resulting from increased flows of goods and services, and changed life style and consumption patterns; conflicting involvement of multi-national companies with local initiative groups, city and national government in

waste management matters and other issues which directly or indirectly affect the waste sector.

The study further observes that solid waste generation, as one would expect, varies between countries, cities, and parts of cities in Africa. Nevertheless waste generation rates for the continent's major cities are estimated to range from 0.3-1.4 kg per capita per day. This gives an average of 0.78 compared to an average of 1.22 kg per capita for developed countries. In addition, the study believes even though many factors/sources influence municipal solid waste management, population size is an important one. There is a positive correlation between city population size and both the percentage of waste moved and rate of households enjoying regular waste collection. This suggests that increasing city size poses a greater problem to the solid waste management in Africa.

However, the study claims that waste stream is mostly made up of garbage, which constitutes 50-80 percent of all the waste. Garbage includes wastes from household preparation, cooking and serving of food; market refuses, handling, storage and sales of produce and meals. Nonbiodegradable solid waste or rubbish (paper, carton, cardboard, plastics, clothes, rubber, leather bottles, glass, ceramics, tin cans, etc.) is also generated. Other sources include: ashes, bulky waste, street sweeping, abandoned vehicles, non-hazardous industrial waste, construction and demolition waste etc. In addition to the sources already mentioned, the study demonstrates that waste is also derived from private and public institutions and sewage treatment centres. One other source of solid waste in African cities is imported second hand goods from the developed world. These old goods are near the end of their life cycle and spend little time with their final owners before being put aside as waste. Cases of accepting imported foreign waste in exchange for 'hot' currencies have been reported in Africa. Current studies indicate that new and increasing element in waste composition are those of non-biodegradable waste. Electronic waste or E-waste, and waste from white goods are increasing. In regular household waste generation, plastics, paper and cartons, tin cans, glass, bottles and fibre are on the increase. Their rates of generation have a relationship with the different socio-economic parts of the city- a trend that suggests the increasing influence of globalization and changing consumption habits.

According to the study, the author further observes the process of solid waste management in Africa starting with collection and transportation method and says even

though more than half of the entire waste management budget is dedicated to waste transportation alone, only a very limited percentage of waste is moved to the waste treatment centre or disposal. One of the big problem is the pre-collection of large amounts of waste trapped in inaccessible residential quarters, prior to its transport to the nearest official regular waste management facility. Such areas constitute more than 60 percent of the city area and are inhabited mostly by low-income members of the African urban communities. There is no house-to-house collection, so pre-collection from homes to the public or communal skips placed at strategic spots in the city, has to be organized by households or some informal private groups. Such groups and individuals are doing a complementary service even though on their own initiative. They do the service for a negotiated payment from the households concerned.

Furthermore in terms of waste reduction and recovery the study shows that there are a few formal systems of material recovery in Africa. However, there is a wide reuse of plastics, bottles, paper, cardboard, cans for domestic purposes. The practice is highly common among the poor. And that the greatest problem is the lack of local or national markets for the recyclables. Most manufactured goods are imported. Nevertheless, few items are converted into new products for local use e.g. smelting of aluminum cans and scraps metals into household utensils, transforming old car tyres into shoes, ropes, flower pots; and paper and plastic waste articles into tourists' products thereby creating employment in the process. Paper and carton is transformed into newspapers.

In terms of composting, the study argues out that the organic content of solid waste in African cities to be as high as 70 percent, suggesting that composting could be a very viable recovery alternative in Africa. However this has been tried in various countries at different scales with very poor results. Composting at industrial scale was tried in Dakar, (Senegal), and Abidjan (Cote d'Ivoire) but they soon failed because of no demand for the final product. International NGOs have sponsored small scale composting in Benin, Cameroon, Egypt, Kenya, Nigeria, South Africa, and Zambia; but the practice has not had significant impact on the cities MSW reduction. Moreover, poor quality of the manure resulting from inadequate segregation of waste appears to have increased the low demand. In a recent study of composting in Bamako, Mali and Cameroon the study demonstrates how increasing quantities of strange global products such as plastics and packaging have invaded compost manure, rendering it unacceptable by farmers. Many

projects have ended due to many problems, but one key reason being poor quality as a consequence of plastic materials and importation of artificial fertilizers.

And with reference to landfills in Africa, the study points out that, majority of landfills are dumps on open plots, wetlands, and lands with water near the surface. They are usually not provided with liners, fences, compactors or soil cover. Waste pickers use this advantage to visit the site and sort valuables for themselves. The study claims that, South Africa, Uganda, Ghana and Egypt are upgrading their landfills to sanitary ones. One great concern is that in Africa, the landfills are owned and operated by the very body that is supposed to enforce standards. The philosophy of getting waste out of sight and consequently out of mind seems to be the overriding consideration of the authorities. Hence removing the waste is considered paramount giving their limited resources. This neglect starts from the way aid donor see waste matters. According to the study 'Of all the regions, Africa has the lowest level of investment of World Bank funds in solid waste sector'. The study notes that even though, African governments spend much on solid waste management, the investment on this waste sector, as a fraction of the total project costs is very low compared to other regions. In 15 projects in the African region the study explains, six percent was the average with the lowest being one percent and the highest 27.6 percent.

According to the study, most African countries do not have a firm grip on any sustainable method of municipal solid waste management. It is all a history of trials and abandonment with many issues seemingly unresolved. Africa's national and urban governments are copying ill-adapted global strategies and technologies not suitable to the local realities. They are not adequately exploring and using local initiatives and strategies, which could go a long way to improve solid waste management. Imported waste management technologies have not adequately solved the problem. Local and adapted techniques involving collaboration with the stakeholders and coordinated by the government would be important. Decentralized participatory management with mutual respect and close collaboration is indispensable. Therefore the study did not provide future estimates of solid waste management in Africa and how the situation of solid waste generation will look like for better planning of budgets and strategies in many African cities so as to cope with increasing consumer habits and rapid population growth in Africa. (Achankeng, 2003)

Future Directions of Municipal Solid Waste Management in Africa (2012) is another study on solid waste in Africa by T. Simelane and R. Mohee, (2012)**.** The study acknowledged that the attractiveness of many cities in Africa are marred by the inefficient collection, management, disposal and reuse of municipal solid waste (MSW). Rectifying this requires a change in attitude towards how MSW is viewed. MSW needs to be viewed as a resource that should be incorporated into human development agenda and urban development. The study points out that this, has the potential for generating income for cities in Africa through the re-use of waste for purposes such as energy generation. However, this requires the adoption of appropriate technologies, most of which are not readily available in Africa. The inability of African countries to make efficient use of their waste through re-use suggests that as a future direction, African countries need to adopt a set of appropriate technologies that will assist them to convert waste into re-usable assets.

In addition to (Simelane and Mohee, 2012) the study observed that rates and quantities of solid-waste generation, composition and disposition vary across Africa, these being linked to local economies, levels of industrial development, waste management systems and lifestyles of the country concerned. The quality and availability of data on solid-waste generation and management in Africa is, however, scanty, and this impedes the development of programmes that will promote efficient use of solid waste in Africa. Developing a broader understanding of the types of solid waste that are generated by African cities, and researching how these can be used to advance development is now more than desirable, as solid waste is increasingly seen as an alternative source of renewable energy.

However, in regards to Collection and disposal of solid waste in Africa, the study further explains that in the urban centres throughout Africa, less than half of the solid waste generated is collected, and 95 per cent of that is neither contained nor recycled. It is indiscriminately thrown away at dumping sites on the periphery of urban centres, or at temporary sites. These inefficient forms of solid-waste disposal have serious health and environmental impacts, which extend beyond their boundaries, polluting nearby water sources and serving as breeding grounds for disease. Among the low-income countries this is worse. For instance, in Lesotho only 7 per cent of urban households have garbage

collection facilities, while in Gaborone (Botswana) and Maputo (Mozambique), nearly all solid waste is disposed of in an open dump rather than a sanitary landfill. Whereas, Solid waste generation in selected cities of Ogo State, observed that in 2005 in Lagos (Nigeria) heaps of garbage piled up at street corners and were often dumped indiscriminately. In other words in spite of all these obstacles, it can be mentioned that some African countries have set themselves ambitious goals and targets that seek to implement effective waste management techniques and strategies in order to promote proper management and disposal of waste. These include recycling, composting and anaerobic digestion. Progress made so far on these areas and technologies and the methods adopted are encouraging. (Simelane and Mohee, 2012)

Therefore the study suggested that future directions of solid-waste management in Africa, were that of alternative uses, such as composting, separation and recycling, which are capable of converting waste into assets and also assist in generating employment and income, are desirable if the continent is to catch up with the international trends and standards of managing MSW. For Africa to attain this, the study claimed there are a number of hurdles/barriers that still need to be overcome. These include improving methods that are currently used to collect and dispose of waste, the most popular of which, in many African countries, is, the use of unsanitary landfills or open dumping. This has promoted scavenging, which renders low social status to those who promote recycling by re-using waste for various purposes. The lack of advanced methods that are supported by appropriate technologies means that in Africa there are very few alternative uses of solid waste. To change this situation, the study believed that investment in solid waste management and technologies needs to be promoted. This should be supported by extensive research on MSW management that should put emphasis on: natural environmental analysis; social norms and concerns analysis; analysis of economic factors that promote waste production; historical influences on waste disposal and management in Africa; political contexts of waste management in Africa; local, regional and national legislation on waste management in various countries of Africa; institutional factors, including educational factors, that would promote innovative uses of waste in Africa; and lastly technological developments for waste re-use and management that are suitable for African economies and the environment. (Simelane and Mohee, 2012)

2.6 Solid waste in East Africa

A study by James Okot-Okumu, analyzes solid waste management trends in East African cities (2012) from the colonial time to the present, where the cities have moved from the purely centrally controlled systems monopolized by the urban authorities to the current mixture of both public and private systems in varying combinations, that involve many actors (service providers) serving the different urban communities. The main obstacle associated with this transition in solid waste management systems are described and compared among the major cities in EAC.

Furthermore, the study reports that waste management in urban centres of East Africa has for a long time been centralized, with the use of imported refuse truck that collect wastes from sources or transfer point and delivers to designated waste dumps. Municipal solid waste management (MSWM) system in East Africa has changed from the colonial days in the 40s, 50s and early 60s when it was efficient because of the lower urban population and adequate resources, to the current status that displays inefficiencies. The centralized waste management system has evolved into the current management mixtures that include decentralized as well as the involvement of the private sector. The storage, collection, transportation and final treatment/disposal of wastes are reported to have become a major problem in urban centres of EAC. The composition of wastes generated by the East African urban centres is mainly decomposable organic materials based on the urban community consumption that generates much kitchen wastes, compound wastes and floor sweepings. This calls for efficient collection system to avoid health, aesthetics and environmental related effects. The global trend of increased use of electrical and electronic goods is also evident in EAC where E-waste is becoming a significant threat to the environment and human health in EAC urban centres.

In addition, the densely populated urban zones (e.g. slums) have low income households with waste generation estimated between 0.22 and 0.3 kg/cap/day. Solid waste generation by the higher income households is estimated between 0.66 and 0.9 kg/cap/day on average. However, Overall waste generation rate for EAC urban centres vary on average between 0.26 (low income) and 0.78 (high income) kg/cap/day (Okot-okumu, 2012).

Composting is being practiced in more than 11 urban councils of Uganda under the Clean Development Mechanism (CDM) pilot project, promoted by the World Bank and

also in Dar es Salaam composting was initiated by the women's CBO (KIWODET) operating in Kinondoni but unfortunately the KIWODET composting project was suspended because of land use pressure and negative consumer attitude. In other words, the study suggests that EAC countries should consider composting as an option for the implementation of an integrated approach to solid waste management. On the contrary, Refuse Defined Fuel**;** Most research have been done on composting as a solution for organic solid waste, however, toxic organic waste that cannot be used as organic fertilizer but instead can be used to make excellent raw material for charcoal briquettes.

However in regards to solid waste management processes such as waste transfer stations, the generated wastes are transported to transfer points (Skips, bunkers, standby trailers, mostly by the waste generators (e.g. households, commercial premises, market traders) themselves or hired (informal) labour, before collection by urban council workers or private operators. Industries, large institutions (e.g. educational, hospitals), shopping malls, large markets have their own transfer stations served by skips , bunkers, trailers and other waste containment facilities. Moreover, in terms of waste collection and transportation, three main methods of wastes collection can be identified as the informal primary or pre-collection phase mainly from households to community collection points (e.g. skips, bunkers or open roadside) mostly by households, hired labour. The secondary phase collection is from community transfer points to final disposal sites or landfills and is mostly by formal institutions like urban councils and private operators. Private operators mostly collect wastes directly from generating sources (door to door) and collect waste at negotiated fees with the individual clients. Industries and shopping malls in most cases contract private waste collectors to pick wastes from their premises, while community markets and hospitals still rely mainly on urban council collection. Other collection modes take the form of a "summon to bring" system, where a truck is parked at a location and a horn (hooting) summons people to deliver wastes to the truck. The frequencies of household waste collection vary between low-income and high income groups. The high-income groups dispose waste often 3 times a week that is determined by the frequency of collection by most contractors of 2-3 times a week (Okot-okumu, 2012).

And lastly final disposal of waste, almost all waste disposal sites in EAC urban councils are in what are considered wasteland like old quarry sites or valleys close to wetlands that are not prioritized for other uses as is often the case in developing countries. The

disposal sites are therefore in most cases located in environmentally sensitive areas in lowlands areas such as wetlands, forest edge or adjacent to water bodies. They often do not have liners, fences, soil covers and compactors as is in most developing countries. In Uganda for instance, Kampala city has upgraded its waste dump at Kitezi to a sanitary landfill. The landfill was funded by the World Bank and has been managed since 1999 by private companies. Though built to standard with a leachate treatment plant, there is some leachate leakage before the treatment plant and this is polluting the surrounding environment with heavy metal.

According to the study, the demand for solid waste collection has steadily increased in the East African urban councils as urban population increase with the accompanying expansion of settlements mostly occupied by the peri-urban poor (in informal settlements) that receive little or no waste services at all. The waste collection and disposal levels are low in all urban councils in East Africa resulting in waste piles that cause environmental degradation and health hazard. Waste management is a decentralized function of urban councils but its funding is predominantly external and the urban councils do not prioritized waste management in their annual plans. These have combined to cause poor allocation of resources and ineffective solid waste management by urban councils.

Therefore, the study recommends that the need for urban councils to explore opportunities for innovative integrated approach for sustainable waste management such as the 3Rs, composting, anaerobic biogas production that involve all stakeholders including the community and the informal sector. And that conventional waste management methods have failed because they do not effectively address local conditions such as culture, financing system, institutional framework, technical and human capacities, socio- political situation and waste characteristics. The study insists that the process from planning to implementation should also be all inclusive to ensure consensus building for success. The role of the private sector, NGOs, CBOs and the informal sector should be strengthened to minimize waste in the environment while at the same time providing social and economic benefits to communities especially the urban poor. This requires long-term planning by the urban councils that involve all the stakeholders (Okot-okumu, 2012).

2.7 Solid Waste in Nairobi, Kenya

A study on Solid Waste Management in Nairobi, Kenya. A case for emerging economies by Muniafu, M. and Otiato, E. (2010), gives an overview of the solid waste technology status in the capital city of a slowly industrializing country in Africa, Kenya, and suggests a way forward in improving waste technology. In other words currently the city, Nairobi, lacks an effective waste management system leading to high possibilities of negative short and long-term impacts on human health and the environment in general. To overcome these, there are wide ranges of requirements and suggested solutions, which include creation and enforcement of waste management policies as well as procedures, incentives, community participation, education and awareness, proper waste collection procedures and disposal sites among others.

Therefore the study (Muniafu and Otiato, 2010) suggests way forward, firstly by putting in place an ideal waste management system that embraces a technical approach including collection and transportation plans, waste reduction, recycling and disposal plans. And that it should have improved management and regulatory systems that embrace an institutional and financial approach including legal, private sector and public education and awareness plans. Secondly the study claimed that there should be greater public involvement through intolerance to waste mismanagement which will exert pressure on the authorities and waste management agencies who will otherwise remain relaxed. Thirdly the study suggested that the costing of waste management systems should be allowed for their incorporation into budgets that is now a must. Many local authorities do not have it as an annual expenditure.

Fourthly, is that waste collection efficiency by both private and public operators should be improved. Fifthly, Development of waste management policies that will address all types of wastes ranging from medical to industrial. This calls for a speeding up of the process of developing and finalizing regulations, guidelines and standards on solid waste management as set out by the environmental legislature. Another suggested way forward of the study was to establish appropriate economic policies to encourage the development of the comprehensive technologies for utilizing solid waste e.g. Brick-making and cement making. Furthermore, establishment of waste transfer stations where intense settlements do not allow for landfills that are close. These reduce overall community truck traffic, offer flexibility in waste handling and disposal options, reduce air pollution, fuel consumption and road wear, allow for screening of waste, reduce

traffic at the disposal facility and offer citizens facilities for convenient drop-off of waste and recyclables. And Involving corporate companies through their corporate social responsibility (CSR) plans. Many companies already know that for the long-term survival of businesses, they must nurture their markets and that creating social and environmental values is as important for their long-term survival as generating economic capital. Lastly is by putting in place certain monitoring processes and empower NEMA and the relevant institutions, improve access to information and auditing processes, systems and records to be developed. Penalties and incentives should also be put in place.

However, assessing the benefits and costs of various solid waste management policies and projects, is simply complex because it involves numerous, interconnected, economic, social, and biological components. The barriers to effective municipal solid waste (MSW) management is not simply lack of policy but lack of infrastructure, education, social awareness of problems and solutions, and lack of institutions promoting sustainable actions (Barret & Sue, 2001). Urban solid waste and sanitation management is a matter of grave concern to most Municipal Authorities. The problem in waste management emanates from the various levels of handling waste from the individual, household and community levels (Puopiel, 2010; Otchere et al., 2014; Puopiel & Owusu-Ansah, 2014). Among the reasons that are attributable to this menace are passive attitude towards waste disposal, low level of enforcement of bye-laws that exist, lack of financial resources(sufficient budget) and the absence of the technical capacity(lack of skills and expertise) to manage waste (Mariwah, 2012; Asamaa, 2007).

Factors contributing to poor solid waste management in small scale Businesses in Nairobi; A case study of Huruma, (Nambisia, 2013), is another study that showed that solid waste in Huruma is disposed in a number of ways such as on the roads and on open grounds. Results of the study demonstrated that due to financial constraints most people in Huruma cannot afford private garbage collection services which was reported by the study to have a negative impact on the environmental status of Huruma. The study concluded that solid waste management in the study area was a major problem and this was the case due to lack of appropriate planning in solid waste management; inadequate political will and governance; poor technology and weak enforcement of existing legislations among others. The study therefore recommended that there is need to

encourage recycling of solid waste that are not degradable for instance metals, plastics and so on.

Another study on Institutional Factors Affecting Municipal Solid Waste Management Compliance; a case study of waste transporters in Nairobi City (2011) set out to establish how the institutional factors affect the municipal waste transportation within Nairobi City. However, the study's specific objectives were; to investigate whether waste transporters were aware of the waste management regulations of 2006 in the city; to find out whether transporters comply with the waste management regulations of 2006; and, to determine whether institutional factors affect compliance of waste management regulations of 2006 by waste transporters operating within Nairobi City.

The findings revealed that majority of fifty nine point six percent of the companies used open or half- covered vehicles and eighty point nine percent of the waste transporters vehicles were inspected and eighty three percent were licensed to transport waste. Therefore the study observed that waste transporters' awareness was positively and significantly correlated to inspection; licensing and vehicle. And that lack of compliance was largely attributable to both regulative and normative institutional factors, and that there were no enforcement whatsoever on the part of NEMA the body that is mandated to ensure compliance of environmental laws countrywide.

Mapping Pollution in the Mathare River; An Analysis of Waste Disposal Patterns and River Pollution in an Informal Settlement (Mwaniki, 2012), Is also another study sought to evaluate if there exists a relationship between waste generation and disposal patterns among Mathare slum dwellers and pollution of Mathare River. The study's objectives were; to compile and compare existing literature on water quality in the Mathare River; to examine the types of waste generated at both households and business levels, their method and points of disposal and whether these contribute to river pollution; and, to identify and map out on-site pollution spots within the Mathare River.

Therefore the study found out that there exists a relationship between waste disposal patterns among Mathare slum dwellers and pollution of the Mathare River (Muthee, 2014) Recommendations from the study were among other things, the development of a waste management plan for the Mathare slums, with a bias on on-site recycling. The study further says that the achievements of such will not only help shape the river rehabilitation, but will also promote a clean environment and create economic, social,

environmental and recreational opportunities for those living in the Mathare Slums, the larger Nairobi city and those further downstream.

Sharing the Burden of Solid Waste on Society; an assessment of the Environmental Equity at Dandora Dumpsite, Nairobi, Kenya (2014), the study was trying to assess environmental equity among urban population. Objectives of the study were to; Identify common diseases attributable to the Dandora dumpsite prevalent among communities living in its neighborhood; Establish whether these Diseases were suffered equally among these communities; Examine if there are factors that could have made part of these communities more vulnerable to health risks; and, Determine if there is a relationship between the socioeconomic status and exposure to health hazards.

Therefore the study's findings revealed that the socially and economically deprived persons suffer more from the consequences of mismanaged waste even when they are in the same neighborhood with those better off. And that they are also more vulnerable to health risks, which the study further showed a relationship drawn between socioeconomic status and environmental equity issues.

Recommendations for the study were that the low socioeconomic persons be empowered to become the solution to the problem, and that there is also need to formulate environmental policies geared towards alleviating the Burden borne by such category of persons.

2.8 Solid waste in Kitengela

Kitengela comprises an area of approximately 390 km2 (GOK, 2001) within Kajiado County and is part of a larger rangeland ecosystem called the Athi-Kaputiei Plains (a 2,456 km2 ecosystem). It was one of the first areas in Maasai land where group ranches were subdivided into private land holdings. In the mid-1970s, the Kitengela group ranch was created, covering 18,292 ha, with 215 registered members (all Maasai). It was subdivided in 1988, giving roughly 250 acres each to 215 landowning households (Kristjanson *et al*., 2002). This trend toward privatization was followed throughout Kajiado County. According to official records, in 2006, out of a total of 52 group ranches, subdivision is complete on 32, and in the progress on 15 of which seven are in dispute and under court injunction (Burnsilver and Mwangi, 2006). Only five group ranches have not started to subdivide.

Furthermore, land sales in Kitengela started occurring in the 1990s, with owners selling parts of their plots, as well as passing on plots to several inheritors (Reid *et al*., 1990). Many of the sales were to non-Maasai and farmers, a trend echoed throughout Kajiado County, where 75% of all farmers involved in cultivation were non-Maasai only a few years after subdivision (Rutten 1992). Scenic plots overlooking the park have been purchased by ex-urban dwellers.

Population growth and urbanization have occurred in parallel with land tenure changes in Kitengela. During the 1980's and throughout the 1990's, the towns of Athi River and Kitengela grew rapidly, with industries and an export processing zone established in the area. The 1999 population census counted 17,347 residents of Kitengela, up from 6,548 in 1989 (GOK, 2001) and population doubled from 17347 to 58,208 by August 2009 (KNBS). More than two-thirds of the population is concentrated in the Kitengela trading centre and other smaller trading centres (Nkedianye, 2004). This rapid population increase has led to more settlement patterns which have been influenced by proximity to Nairobi City. Furthermore, high agricultural potential areas such as the horticultural farming in the area between Kitengela and Isinya is becoming prominent and a major source of income and employment. The horticultural crops grown include onions, tomatoes and Asian vegetables and mining areas.

However, the study demonstrates the effects of poor solid waste management in Kitengela Ward. In particular the process of solid waste management in kitengela, the rate of generation of solid waste has increased so much that the local agencies responsible for the collection and disposal of wastes are unable to deal with the total quantity produced every day. As a result, a major part of the waste remains uncollected and accumulates in the form of heaps at various locations within the inhabited study areas that soon begins to rot and becomes an environmental hazard.

Therefore the study examine the effects of solid waste in Kitengela with the aim of establishing a better means of solid waste management process which will benefit Kitengela Ward.

2.10 Theoretical Framework

This research was based on cause and effect theory modelled by Pfammatter *et al*, (1996) in figure 2.1. The theory's origin were from a study on the Non-Governmental Refuse Collection in a few selected developing countries, acknowledging that the importance of waste collection and disposal, is mostly beyond the means to handle the growing amount of waste generated by rapidly expanding cities. Thereby suggesting a realistic approach to improve the deplorable situation would be for the inhabitants of unreached areas to assume their own responsibilities with regards to waste handling. And that the inhabitants should set up a collection system that is appropriate to their economic standing and adopted to the conditions of the area. However, this, can take different forms i.e. the community either pays private collectors from within or outside the neighborhood to carry the waste to communal collection points, or the households assume responsibility for part of the work. In other words, the study observed that such types of non-governmental primary refuse collection schemes have been initiated and operated in different cities of Asia, Africa, and Latin America over the past few years. Therefore, the study suggested on the improved solid waste collection, and to assess the potentials and limitations of such non-governmental approaches are based on practical experience. The reviewed cases thereby ranged from community-based schemes in Indonesia, China and some parts of Africa i.e. Burkina Faso Ivory Coast and Cameroon, to schemes operated and management by small private enterprises in Peru and Columbia.

Furthermore, the study theorized the problem or cause of inadequacy in waste management coverage to be; limited awareness among the populace, poor allocation of resources, and use of appropriate technology, low political priority, rapid urbanization and operational deficiencies in waste management schemes. These were the independent or causal variables of the study. The effects of these variables were; resultant health issues, indiscriminate solid waste dumping and the environmental impacts. These effects were the study's dependent variables. In the long run these effects impair the quality of life, mostly, the vulnerable populations and possess negative impacts on the national economies.

2.11 Conceptual Framework

The conceptual framework in figure 2.2, tries to weave together relationships that the study believes are crucial for the improvement of solid waste management in Kitengela

Ward. In developing it, the objectives guiding the study area are put into consideration. It is hinged on the fact that for any solid waste management program to be successful; it has to put into consideration the following variables: solid waste management (dependent variable); sources of solid waste e.g. households and commercial institutions i.e. markets, slaughter houses and barriers of solid waste in Kitengela (independent variable). This will ultimately result in improved waste management strategy. It presupposes that effective strategy towards solid waste management will bring about; improved livelihoods that are likely to change in terms of improvement in the environment. With this form of improvement in waste management the livelihoods, the attitudes and practices of the community members in Kitengela Ward is likely to shift from negative environmental attitudes to positive environment attitudes hence resulting to an improved environmental status of solid waste management. However the conceptual framework borrows a lot from the cause and effect model by **Pfammatter *et al*, (1996)** on Non-Governmental Refuse Collection and proposed the cause of inadequate service delivery to be; limited awareness, poor allocation of resources, inappropriate technology, low political priority, rapid urbanization and operational deficiencies. These shortcoming led to inadequate service delivery which in turn culminated in halth risk, indiscriminate dumping and environmental impacts, as illustrated below in **Figure 2.1**: Causes and effects of inadequate service delivery in low-income urban areas

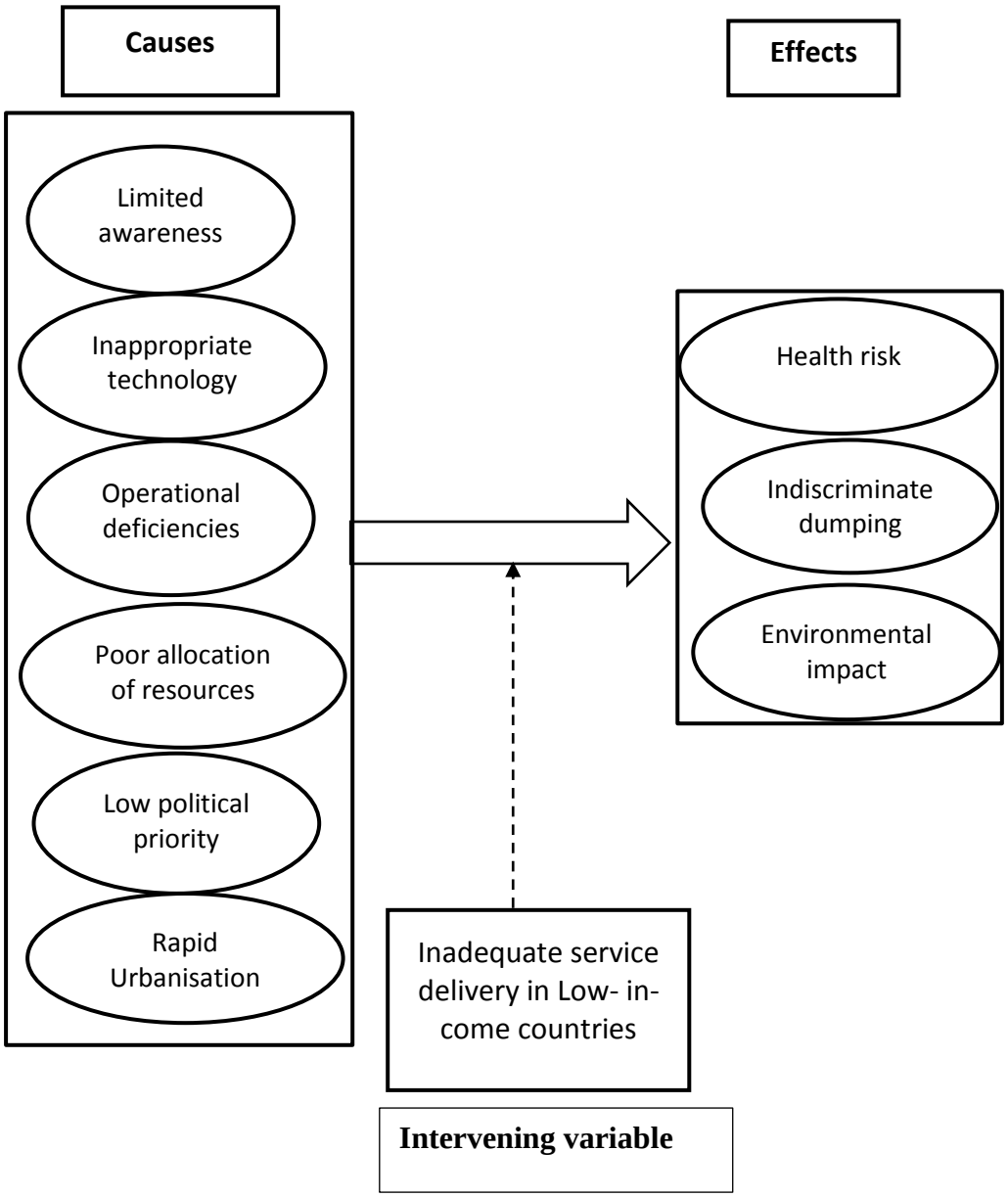

Figure 2.1: Causes and effects Model
Source; Pfammatter *et al*.,(1996)

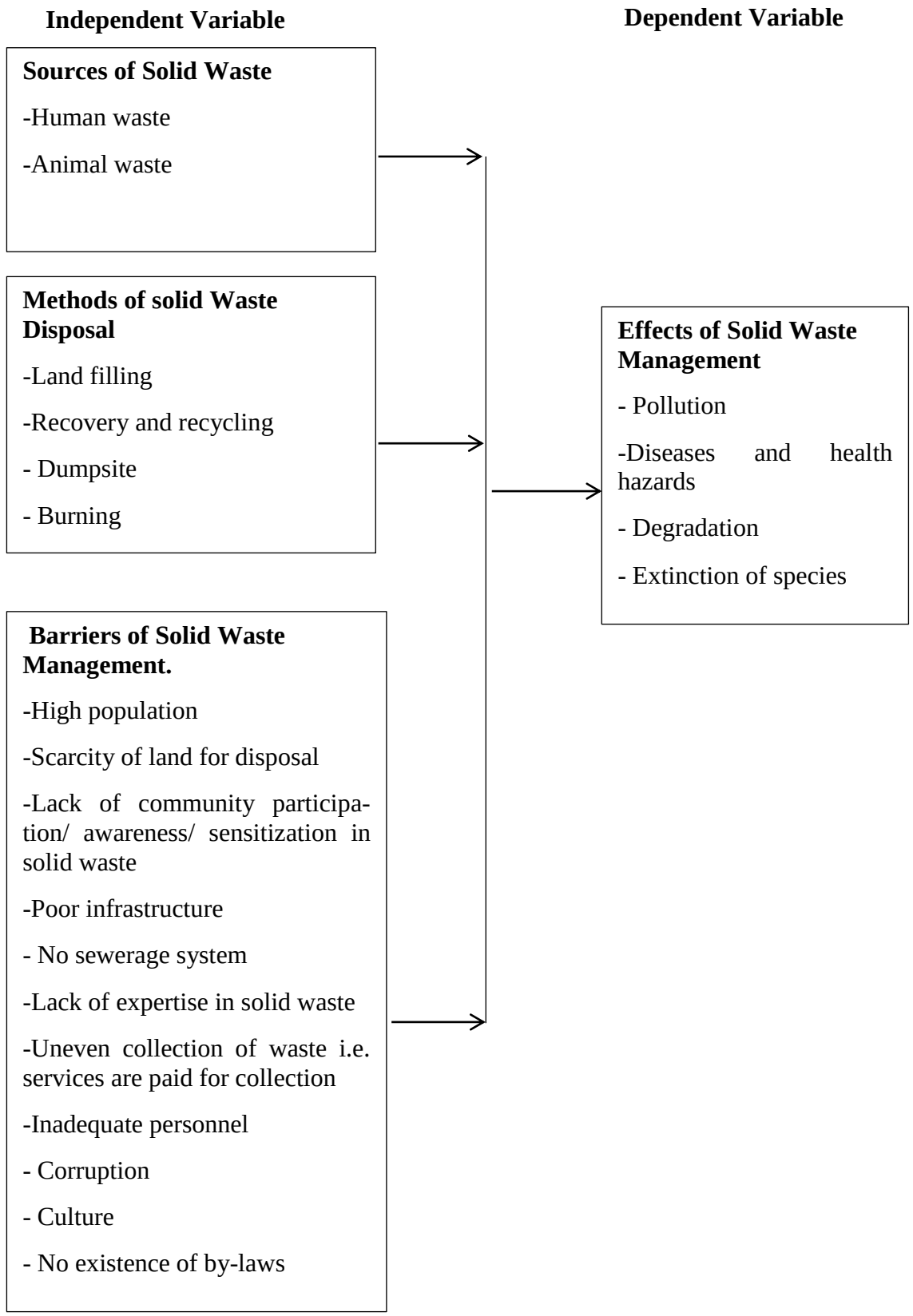

Figure 2.2: Conceptual Framework
Source; researcher (2017)

2.12 Research Gaps of the study

Global production of waste has practically doubled over the past ten years and is expected to reach 2.5 billion tons per year in 2025 as a result of the combined effect of urban development and changes in consumption patterns (Périou, 2012). Communities in developing countries often turn to waste disposal methods that have proven to be destructive to human health and the environment, such as open dumping and burning (or unregulated landfills) because they feel they have no other options to manage their solid waste (Mwanthi and Nyabola, 1997; Goett, 1998; Alavi Moghadam *et al*., 2009; Narayana, 2009; Al-Khatib *et al*., 2015; Hilburn, 2015). With industrial progress, growing urban areas and rapid growth, solid-waste management has become a major concern in many developing countries. However, as the urban population in Nairobi and elsewhere in East Africa grows, so does the solid-waste management burden, a situation worsened by poor funding for urban sanitation departments and a lack of enforcement of sanitation regulations. At least 100 million people in East Africa lack access to improved sanitation (Troschinetz and Mihelcic, 2009). In addition to, the disposal sites are, in most cases, located in environmentally sensitive, low-laying areas such as wetlands, forest edge or adjacent to bodies of water. They often do not have liners, fences, soil covers and compactors as is in most developing countries (Troschinetz and Mihelcic, 2009). More often than not, the urban poor have to make do with living amid waste despite the health risks. With this exponential growth of waste, new practices of SWM must be undertaken and these systems need to be sustainable and adapted to the needs and challenges prevalent throughout the developing world. With the world becoming more urbanized and developed, and with populations rapidly increasing each year, consumption levels are reaching historic levels (IPA, 2014). However, the rate of generation of household solid waste in the developing countries is increasing with an increase of population, technological development, and the changes in the life styles of the people which is posing a great environmental and public health problem.

In the empirical studies analyzed above, it is imperative to note that little emphasis was put on regional solid waste generation and composition. Further, they estimated current global waste generation and composition, with respect to future predicted estimates that of 2025 and how the situation will look like. However, the authors did not fully utilize the micro level analysis of solid waste management in reference to households units as major contributors. Their concentration on global aspects obscures the methodological

approaches that are also essential in looking at waste management in general. Therefore the goal of my thesis is to focus on the forgotten current effects of solid waste management in kitengela, and to gain greater insights on what are the sources that contribute to solid waste management and even more importantly, what are the methods of solid waste disposal in kitengela; what are the effects of solid waste management on commercial institutions and households in kitengela and lastly what are the barriers of solid waste management in kitengela.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This section describes the research design and methodology that was adopted in this study. It entails the nature and sources of data, population and sample description, methods of data collection and analysis.

3.2 Site Location / Study Area

Kitengela ward is located in Kajiado County just 30 kilometres south of Nairobi, Its coordinates are 1°27'0" S and 36°58'0" E) or -1.45 and 36.9 and its Joint Operation Graphics reference is SA37-05.

Kitengela has an urban population of 8378 people i.e., human population which later doubled from 17,347 to 58,208 as of August 2009 (KNBS).

Furthermore, Kitengela comprises an area of approximately 390 km2 (GOK, 2001) within Kajiado County and is part of a larger rangeland ecosystem called the Athi-Kaputiei Plains (2,456 km^2 ecosystem Kitengela is close to Athi River town in Machakos County in the former Eastern Province, whereas Kitengela belongs to Kajiado County in the former Rift Valley Province). Kitengela is growing quickly and is expanding with residential houses. Moreover, Kajiado County had an annual population growth rate of 5.5 percent with population in 2012 estimated at 807,069 of which 401,784 were females and 405,285 males (KNBS, 2013). However, the main urban areas in the county are Kitengela, Ongata Rongai, Kiserian, Ngong, Loitokitok, Namanga, Isinya and Kajiado. The 2012 projected urban population in the county stands at 191,827 which is 23.8 percent of the total population. (County, L. (2013).

3.3 Choice of the study Area

In relation to the choice of the study area, Kitengela was choosen as an ideal study for various reasons, firstly, changes in land tenure system in Kitengela, that started occurring in the 1990s encouraged land owners to selling parts of their plots to several inheritors (Reid *et al.,* 1990). And mostly land was sold to non-Maasai. Little by little, industries and export processing zones in towns such as Athi River and Kitengela experienced

rapid population growth and urbanization that was occurring parallel to land tenure changes.

Proximity then became a relief for people working in the city of Nairobi and its environs thereby providing relatively cheap residency as well. As more people started realizing about Kitengela, and its affordable land, many people started buying land for either retirement or built houses for settlement. This brought with it rapid increase in population, migration from rural areas to urban towns, explained by the growth of Ngong and Ongata Rongai Wards in Kajiado North as well as Kitengela Ward in Kajiado East that have attracted high numbers of migrants from rural areas.

With proximity and land tenure system becoming a factor of rapid population and urbanization, this has led to an increased generation of waste since due to availability; items are discarded with no real attachment or need for repair.

The choice of the study area shown in figure 3.1 and figure 3.2, was illustrated by the need to show the effects of poor solid waste management in Kitengela Ward. In particular the process of solid waste management in Kitengela, the rate of generation of solid waste has increased so much that the local agencies responsible for the collection and disposal of wastes are unable to deal with the total quantity produced every day. As a result, a major part of the waste remains uncollected and accumulates in the form of heaps at various locations within the inhabited study areas that soon begins to rot and becomes an environmental hazard. Effect of environmental pollution from Noonkopir dumpsite and a medical incinerator in the middle of the town are also a big health hazard. The garbage dumpsite that serves Kitengela Ward is about 5 acres; it's already full. The main problem in adopting sanitary landfills for solid waste disposal is of land acquisition. The requirement of land to accommodate increasing solid waste has been increasing day by day.

Sanitary land filling are diverted to other uses and these results to unplanned dumping on any available government land. Moreover, as the time passes by and the existing sites get exhausted i.e., Noonkopir dumpsite; new sites can be found only at increasing distance from the area which generate most of the solid waste. The value of land goes up due to the fast development, sometimes uncontrolled and has continued to put much pressure on land and substantially enhanced financial resources that have to be raised for land acquisition. Not only that, increasing distances means lesser number of trips per vehicle,

and to cater to the same area, a larger fleet of vehicles and bigger manpower .i.e. more private service providers and more youths for the entire process to be successful and dealing with the public demands becomes an intractable problem by itself. Currently there are 11 companies and as many youths being involved as compared from 9 private service providers and less youth that were there in 2009. The garbage composition at the dumpsite is inorganic (mainly composed of plastics use by shoppers) and organic materials generated from kitchen wastes. The decomposed organic portions emits a foul smell, the liquid oozing from the garbage dumpsite is potentially toxic and has burnt all vegetation on contact. During the rains, this effluent eventually pollutes Athi River which provides water downstream for millions. Furthermore, waste from Slaughterhouse effluents are discharged to the environment e.g. open drains and water, thereby causing pollution. The effluents also emit objectionable odour to the surrounding. Besides the effluents of the slaughter houses being discharged collection, transportation process rarely happens. Consequently, Kitengela town does not have a sewerage system, and this situation becomes worst in rainy seasons where most buildings in Kitengela have septic tanks merely for sewage tanks and not cesspit or soakpits tanks; that are not properly constructed, and the sewage waste comes out and mixes with waste dumped just outside resulting in serious health implications. The only two new public toilets are yet to be commissioned that have proper sewage lines.

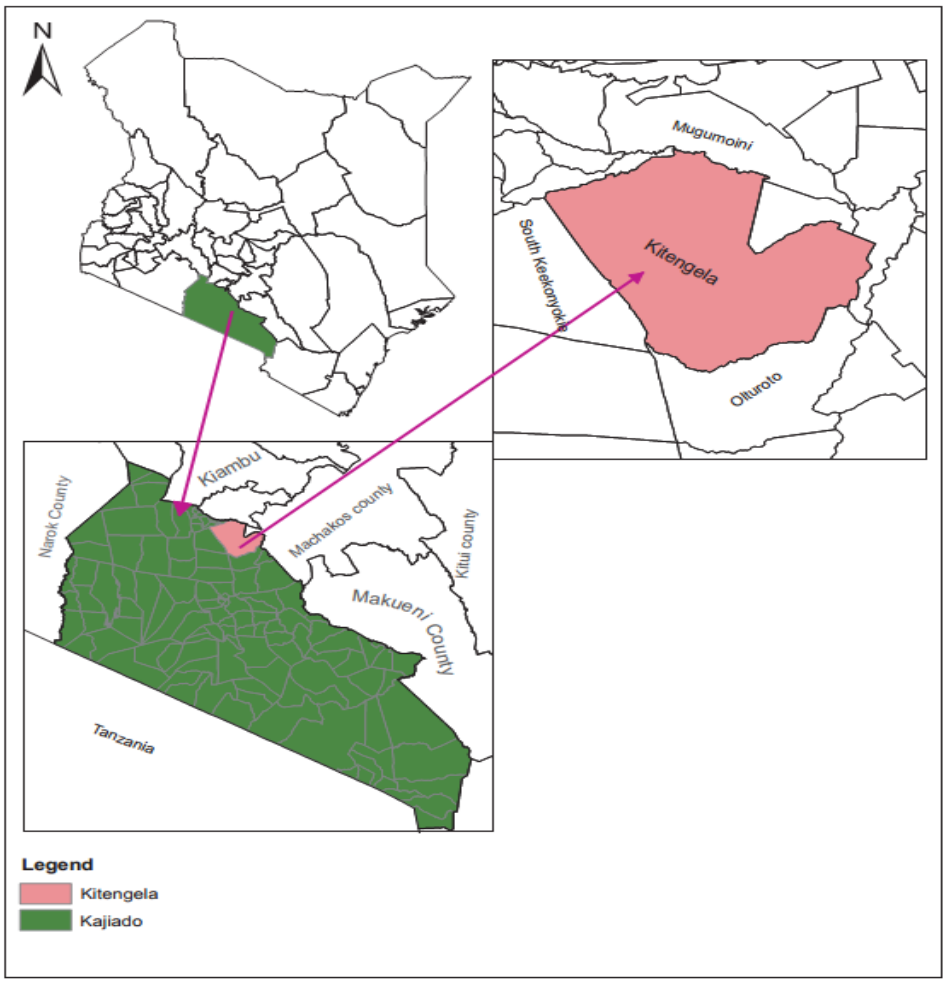

Figure 3.1 Map of Kenya in relation to the study area (Kitengela)

Source; researcher (2017)

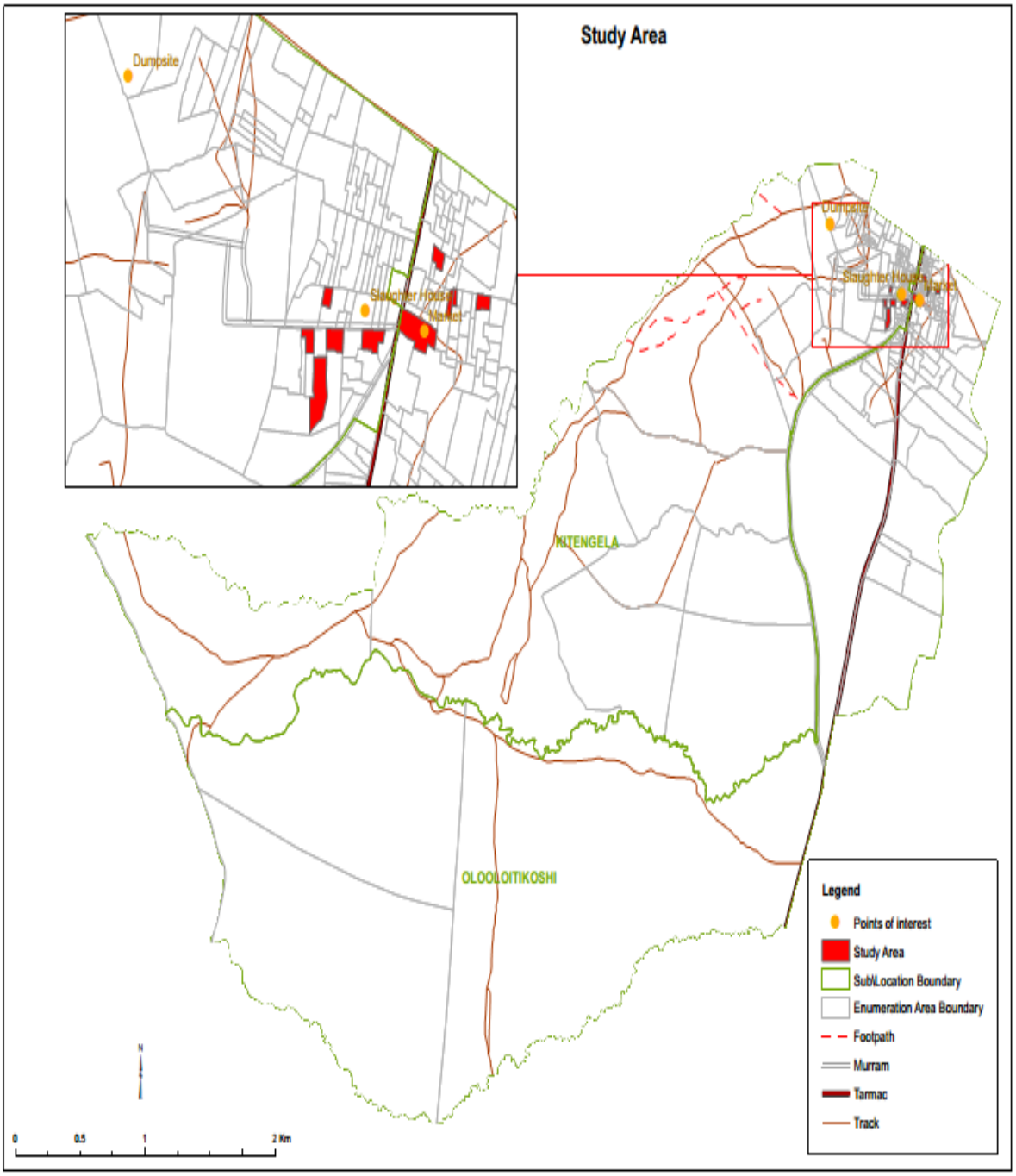

Figure 3.2 Map of Kitengela, subdivided into two sub locations i.e. kitengela sub location and Olooloitikoshi sub location

Source; researcher (2017)

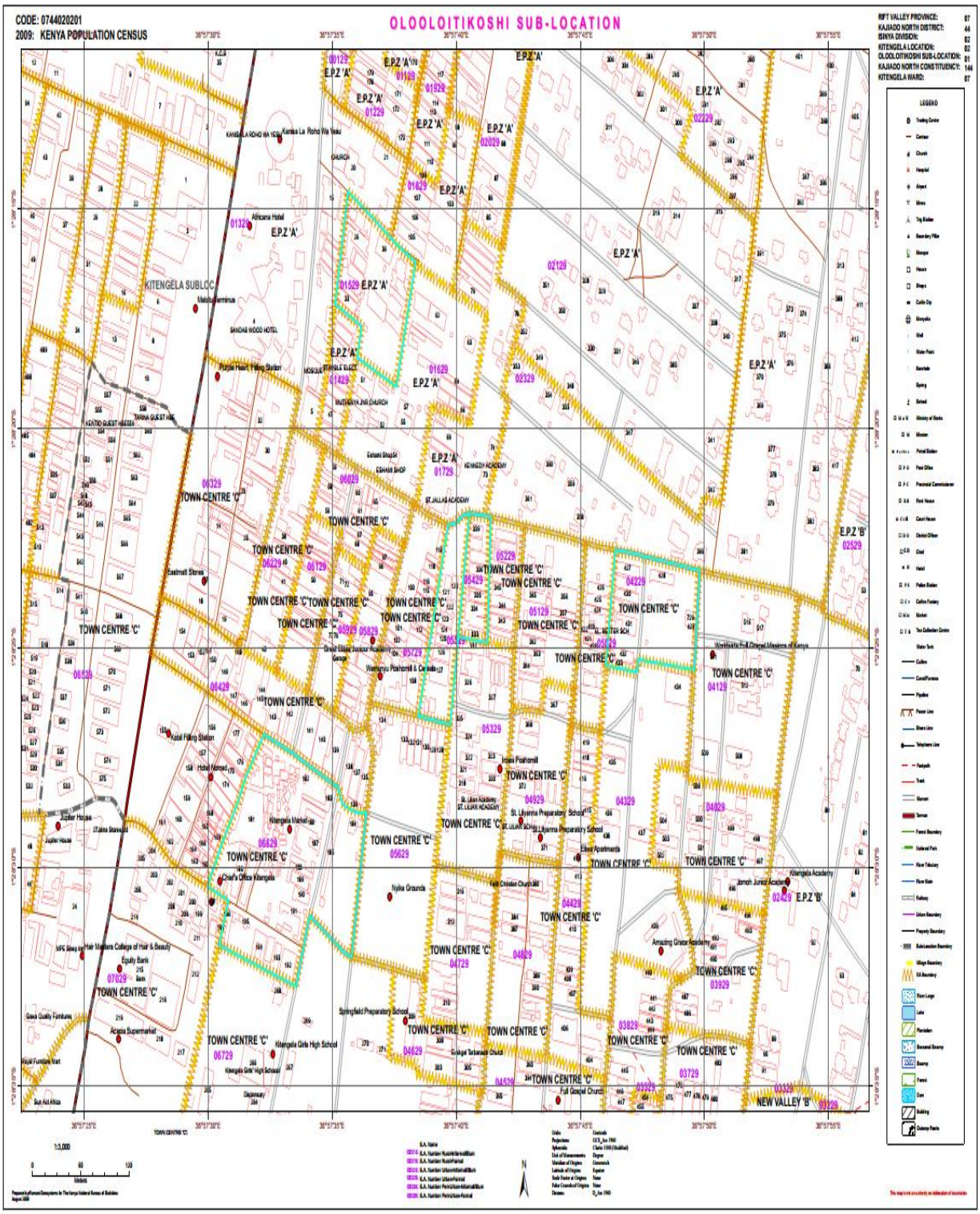

Figure 3.3; Map of Respective Five EA's in Olooloitikoshi Sub Location Marked in Green. Source; KNBS

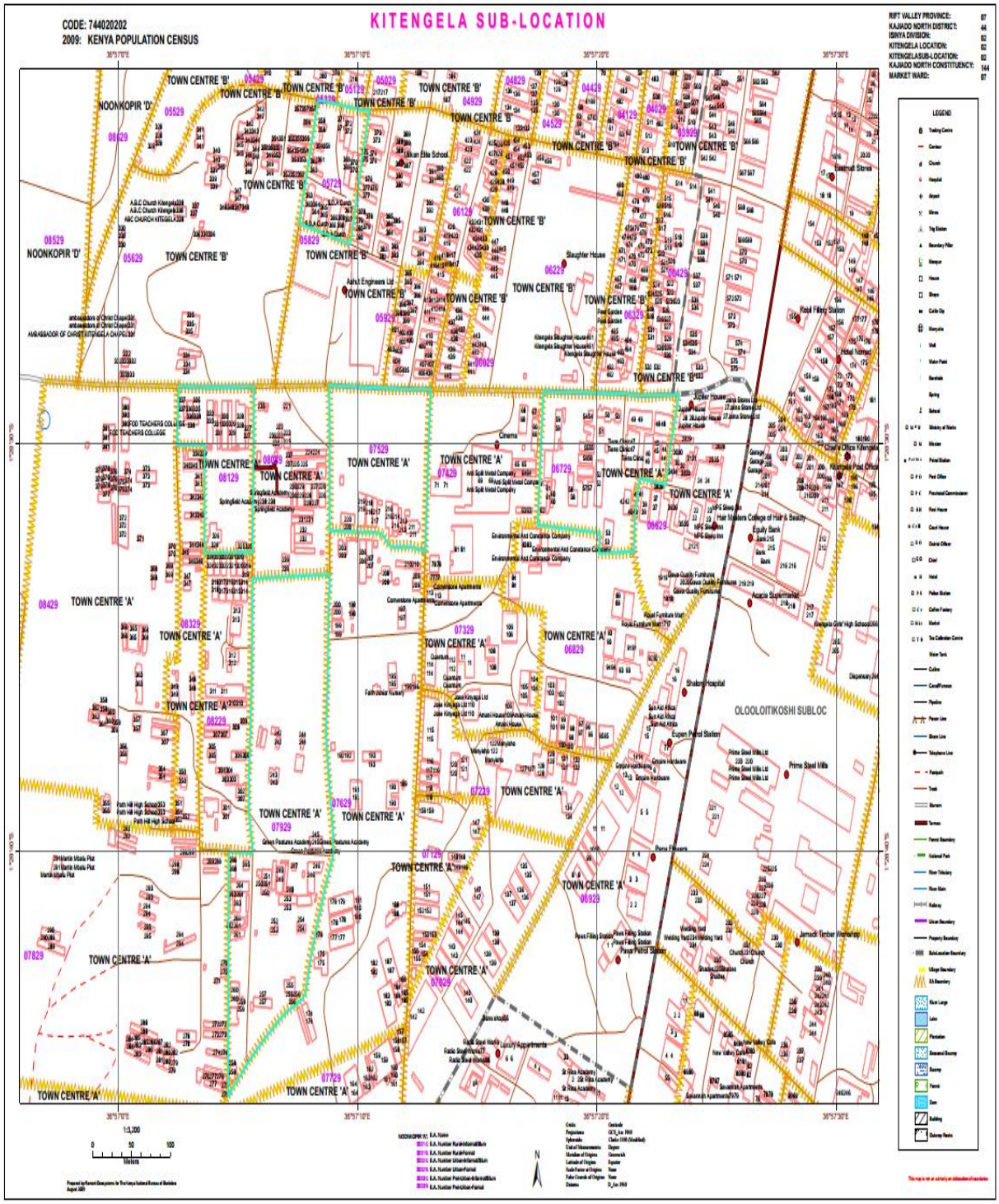

Figure 3.4: Map of five Respective EA's in Kitengela Sub Location marked in green

Source; KNBS

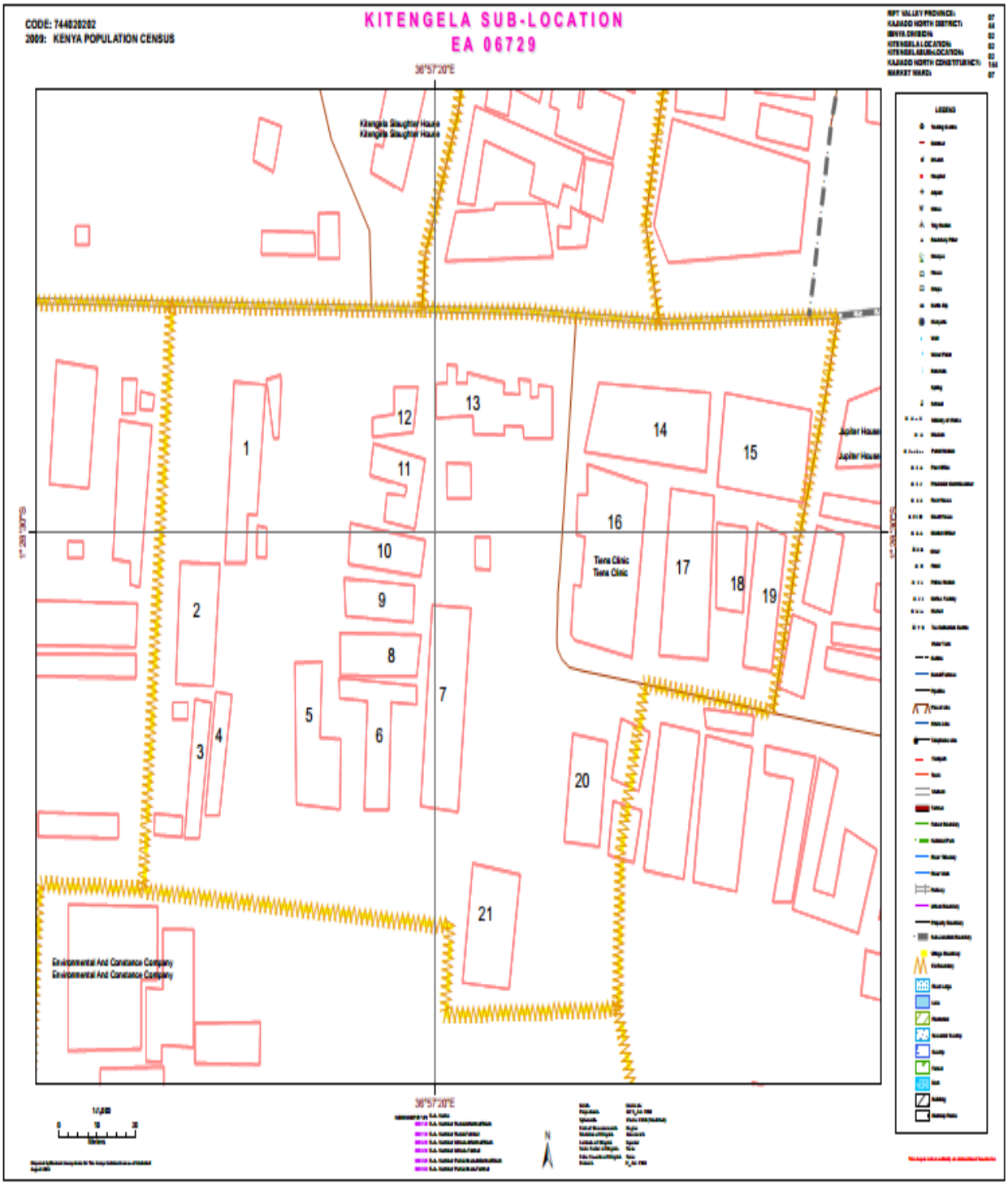

Figure 3.5: Showing Numbered Household in EA 06729 in Kitengela Sub Location.
Source; KNBS

3.4 Research Design

The research was a case study and adopted both qualitative and quantitative research methods. The quantitative methods was used to obtain data in frequencies and percentages whereas the qualitative techniques was also used to collect detailed data that contributed to in-depth understanding of the context of solid waste management.

3.5 Target Population, Sample Size and Sampling Procedure

Saunders et al (2009), define sampling frame as the complete list of all the cases in the population from which a probability sample is drawn. The sample frame of the study was drawn from the National census list; Kenya National Bureau of Statistics (KNBS 2009), where Kitengela's population was at 58208 and subjected it to the following formula to determine the sample size; the Nasuirma Model was used;

$$n = \{NCv^2\ \}/\{Cv^2\ + (N-1)\epsilon^2\}$$

Where; n- is the sample size

N- Target population (58208)

Cv – is the coefficient of variation (0.5)

ϵ- is the tolerance of desired level of confidence, at 95% level (0.05)

Nasuirma (2000) formula which is expressed as follows;

The Nasuirma model determined by:

Therefore $n=58208(0.5)^2 / 0.5 + (58208-1)0.05^2$

$n= 14552/ 145.518125$

$n= 100$

The study comprised of Solid waste managers, sources of solid waste e.g. households and commercial institutions such as markets and slaughter houses within the area of study and barriers of solid waste. Other actors and stakeholders in the study area like government bodies and non-governmental organizations were also included. The respondents were systematically chosen from selected locations within the area of study. Systematic random sampling technique was used to sample respondents in the study area.

The researcher only identified what type of waste were being generated from markets, slaughter houses, and industries with respect to household types of waste.

Due to financial constraints and time to the project, it was unlikely that the researcher would have embarked on measuring the volumes of various types of waste which would have been available for the subjection of hypothesis testing. Therefore the researcher only concentrated on households as the Unit of Analysis.

Furthermore, in the study area, Kitengela as from the census of the 2009, had two sub locations namely; Olooloitikoshi and Kitengela sub locations as shown in figure 3.3 and figure 3.4 respectively. Currently the two sub-locations are referred to one single ward. In addition, the two sub locations representing the study area, were again subdivided into 213 Enumeration areas {Small area composed of one or more neighbouring blocks, used by Stastistics for distributing questionnaires to households and dwellings (census collection)}of which most of the EA's were within the town centre. From these 213 EA's, the researcher applied probability proportional to size whereby the EA's that had the highest/largest number of Households in the study area had the highest probability of being selected. Such that, from these 213 EA's, only ten EA's which were randomly selected were enough to represent the spread using Geo-code from the KNBS. Consequently from this ten EA's the researcher did household listing and structure numbering whereby the process is demonstrated in figure 3.5 EA06729. Such that, the researcher had to visit all the household in the ten EA's and identify which Households had the head of the household most of the time and this was being done randomly by the researcher. The benefit of having EA's in the study, was that it provided the boundary of the area the researcher wanted to distribute his questionnaire. Moreover, besides coming up with 10 households per EA's, the researcher attained a sampling frame through the process whereby after randomly identifying which households to start with, the total

number of households within the EA's, come up with the interval between the starting household up to the tenth household, and this was made easier as explained in figure 3.5, before embarking on the distribution of the questionnaires, the researcher identified which households heads were in most of the time. However, the same process as explained was done throughout the ten EA's. And lastly, the researcher applied systematic random sampling from the sampling frame/ of the households listed/visited throughout the EA's.

3.6 Nature and sources of data

3.6.1 Primary data

This refers to first hand data obtained from the field. These entailed data on: Solid waste Management, sources of solid waste, methods of solid waste disposal, effects of solid waste management on commercial institutions and households in Kitengela. Primary data was collected through household and commercial institution surveys by administration of questionnaire (Appendix A), conducting interviews (Appendix D) and by observation (Appendix C).

3.6.2 Secondary data

Secondary data was acquired from the central government agencies (KNBS) and from the relevant literature review such as related documents, books, published and unpublished written materials, thesis, dissertations, journals, articles, and reports. Data on solid waste management was obtained from the State of Environment report for the district in NEMA office in Kitengela. Data on the demographic characteristics of the area was obtained from the Kenya Bureau of Statistics whereas relevant reports on solid waste management were also obtained from Kajiado County.

3.7 Data Collection Techniques.

The study involved administering questionnaire, interviews and observation to obtain information deemed to be relevant to this study.

3.7.1 Questionnaire

A series of pilot questionnaires were used with a small representative sample to ensure the effectiveness of the questionnaires carried out, which was followed with the finished

and well-designed questionnaire to derive data from the solid waste management, actors, and sources of waste management. The survey was conducted through a sample of households and commercial institutions in the area. The data focused on determining the sources contributing to solid waste in Kitengela, examining methods of solid waste disposal in Kitengela, examining again effects of solid waste management on commercial institutions and households in Kitengela, and investigate barriers facing solid waste management in Kitengela and any other relevant information regarding waste management in Kitengela Ward was derived from the respondents in a professional manner.

3.7.2 Interviews

This technique involved predetermined questions that was a guide to the interview process. It was used to obtain relevant data from various areas that were involved in solid waste management in the area of study. It looked into the sources contributing to solid waste management, Methods of solid waste disposal in Kitengela, effects of solid waste management on commercial institutions and households in Kitengela, and barriers of solid waste management in Kitengela.

Semi-structured interviews was used to solicit for both quantitative and qualitative responses in order to complement one another. This enabled the study to have rich data that was important in answering the study questions.

Key informant interviews was conducted with different individuals. They provided in-depth data on various aspects of solid waste management in kitengela. They included: leaders in local service providers (community groups, local authority, private service providers, and estate agents). These individuals were believed to possess vital knowledge about the study area.

3.7.3 Observation

Non- participant observation method was adopted where the researcher took a descriptive account of events thus management of solid waste in Kitengela. The researcher had a pre written set of events to check off as the process of data collection continued. This was complemented with visual photographs as evidence of the phenomena.

3.8 Data Processing and Analysis

3.8.1 Data Processing

Preliminary data operations entailed processing of data, cleaning, and data reduction. Field data was first assembled in to a single sample data in the form of a data code book. For the open ended questions, all the responses per question were first to be compiled, then assigned meaning in the context of solid waste management before including them in the code book. The code book and associated data was then used to design a data entry interface in SPSS and excel. Data entry were approached from the basis of quality assurance protocol where each case was being entered twice by different data entry assistants and at the end of data entry exercise, was a comparative analysis of the two data files that was done to limit data entry errors. A frequency distribution analysis on all variables was used as a tool for identifying outliers and missing responses of which they were to be confirmed with the results in the questionnaires, observation sheets and GPS records. The clean data files was then used to create the study database files from which all the variables required to address the stated questions were available.

3.8.2 Data Analyses

3.8.2.1. Statistical Data Analysis

This study used descriptive statistical techniques to accurately describe the sample data in terms of what was typical about them and dispersion about the typical characteristics. The descriptive results formed the basis for further inferential analysis to measure differences and association between the Systematic random sampling techniques used in the study area. Furthermore, Chi-Square was used establish associations between the dependent variable(effects of solid waste management) and independent variable (sources of solid waste , methods of solid waste, barriers of solid waste)of the study.

3.9 Reliability of Research Instruments

Reliability is the degree to which an assessment tool produces stable and consistent results (Phelan & Wren, 2006). The researcher employed the test-retest method to establish reliability. This involved administering the same instruments twice to the same group of subjects. A time lapse of two weeks was given between the first and second test in establishing reliability of the research. The scores from Time 1 and Time 2 were then

correlated in order to evaluate the test for stability over time. The scores in time 1 and time 2 in this research were similar.

3.10 Validity of Research Instruments

Validity refers to how well a test measures what it is purported to measure (Phelan & Wren 2006) For this to exist, the techniques to be used are meant to yield information that is not only relevant to the study hypothesis but also in terms of "relevance" and "corrections". Creswell and Miller (2000) noted that an instrument that yields valid data will necessary yield reliable data but an instrument that yields reliable data will necessarily yield valid information. Validity was established by consulting lecturers/supervisor/colleagues. Errors were corrected.

3.10.1 Ethical Consideration

The research was genuinely concerned about other people's quality of life hence the researcher undertook the study while exercising utmost integrity to prohibit unethical behaviours. Being in the punitive measures that go with research plagiarism and Fraud, the researcher was very ethical by maintaining personal, original and first hand data collection, data analysis and in making honest and original presentation of research methodology and results. The researcher maintained objectivity in all phases of the study in order to get accurate and reliable data. Permission to carry out the research was sought from the relevant institutions namely the NACOSTI. Participation by respondents was voluntary and with informed consent in all the information which was obtained and kept in strict confidence. And lastly respondents were assured through there voluntary participation that whatever they disclose will not be shared through any other means and whatever solutions that come from this study, then they will be known as anonymous and residents of Kitengela. This was to ensure that the respondents be comfortable of their security and disclose the core issues that relate to this study.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the findings of the study based on the collection of data from the field. Issues that the study looked at as discussed in chapter one are;

- Determine sources contributing to solid waste in Kitengela.
- Examine methods of solid waste disposal in Kitengela.
- Examine the effects of solid waste management on commercial institutions and households in Kitengela
- And lastly investigate barriers of solid waste management in Kitengela.

Demographic information of the respondents is presented first. Data collected is drawn from the research questions as listed in chapter one and reorganized into thematic questions as used in the questionnaires.

4.2 Demographic Information

This section presents information on demographic data that was collected from the field. This includes gender, age and educational level.

4.2.1 Gender

Data regarding information on gender is as presented in figure 4.1

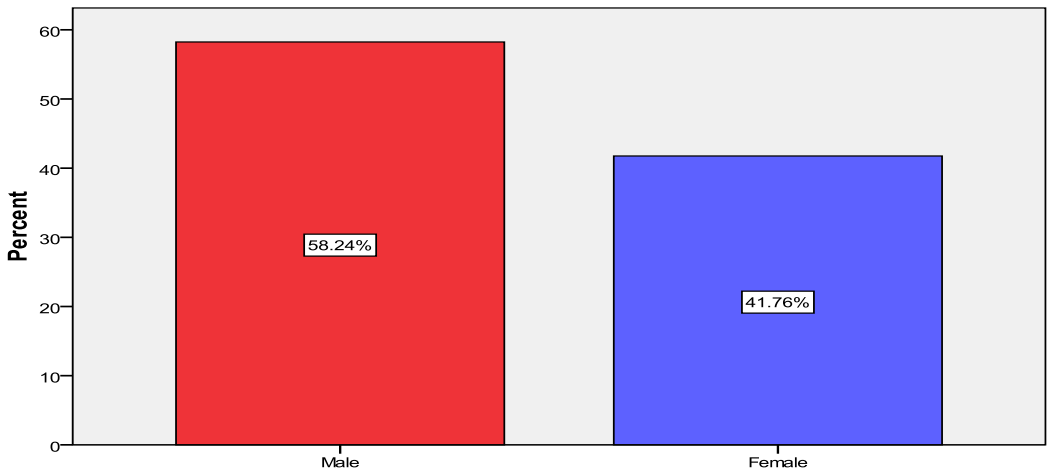

Figure 4.1: Gender

Source; researcher (2017)

Data on the graph above shows gender representation respectively with 58.24% of the majority representing male where as 41.76% representing females.

4.2.2 Age

The researcher was also interested in the collection of data regarding age of the respondents so as to ascertain the response given with relation to the topic of study. Here the results illustrated how conscious the older people were in regards to waste management as compared to respondents who were in the ages of between 21 and 40 years of age. The older respondents cared more about their environment as compared to the age bracket of 21 to 40 years of age. Further the younger respondents consumed twice as much as the older respondents mainly because of different lifestyles. However data on Age is represented table 4.1 with relations to waste management.

Table 4.1: Age

Age	**Frequency**	**Percent**
Between 21 and 30 years	55	56.1
Between 31 and 40 years	33	33.7
41 and 50 years	7	7.1
Above 50 years	3	4
TOTAL	**98**	**100**

Source; researcher (2017)

4.2.3 Educational Level

Equally important to the researcher was to find demographic information concerning the level of Education of the respondents. Such information was useful in terms of waste awareness in the study area. The result below explains it all in table 4.2.

Table 4.2 Educational Level

Level of Education	**Frequency**	**Percent**
Secondary	39	39.8
Post- secondary	30	30.6
Graduates	29	29.6
TOTAL	**98**	**100**

Source; researcher (2017)

4.3 Sources of Solid Waste in Kitengela Ward

This section presents data collected from the field covering the first research objective that attempted to determine the sources of solid waste management in Kitengela Ward. The study focused on identifying what types of waste was generated from households and commercial institutions such as markets, slaughter houses and industries. With respect to generation of waste from households, the data collected from the field is shown in figure 4.2.

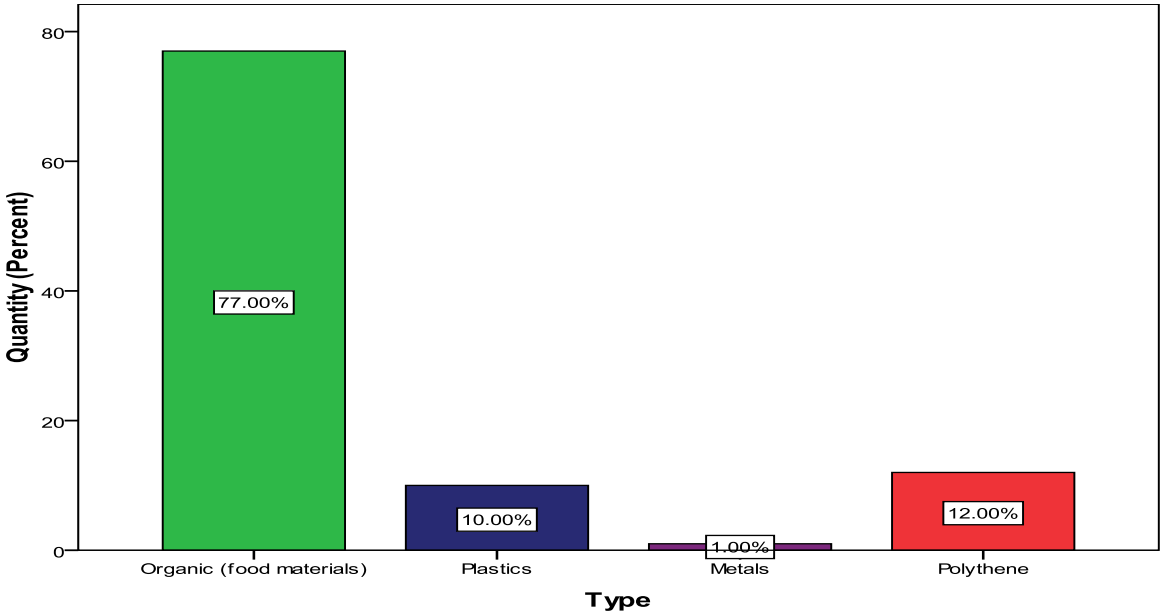

Figure 4.2: Types of solid waste in Households
Source; researcher (2017)

Various types of solid waste generated from the households were organic waste i.e. food material representing the most share of waste, followed by polythene that of 12% and plastics 10% and metals at 1% respectively.

On the other hand, commercial institutions such as, slaughter houses and industries generated different types of waste with the exception of markets that generated similar type of waste than that of households, which were mostly organic waste representing the most, followed by polythene, plastics and metals respectively.

Table 4.3: Sources of Solid Waste

Type of Waste	Slaughter house	Industry	Markets	Household
Organic	4	3	7	30
Metal	2	7	2	2
Polythene	4	2	5	14
Plastics	1	2	6	7
TOTAL	**11**	**14**	**20**	**53**

Source; researcher (2017)

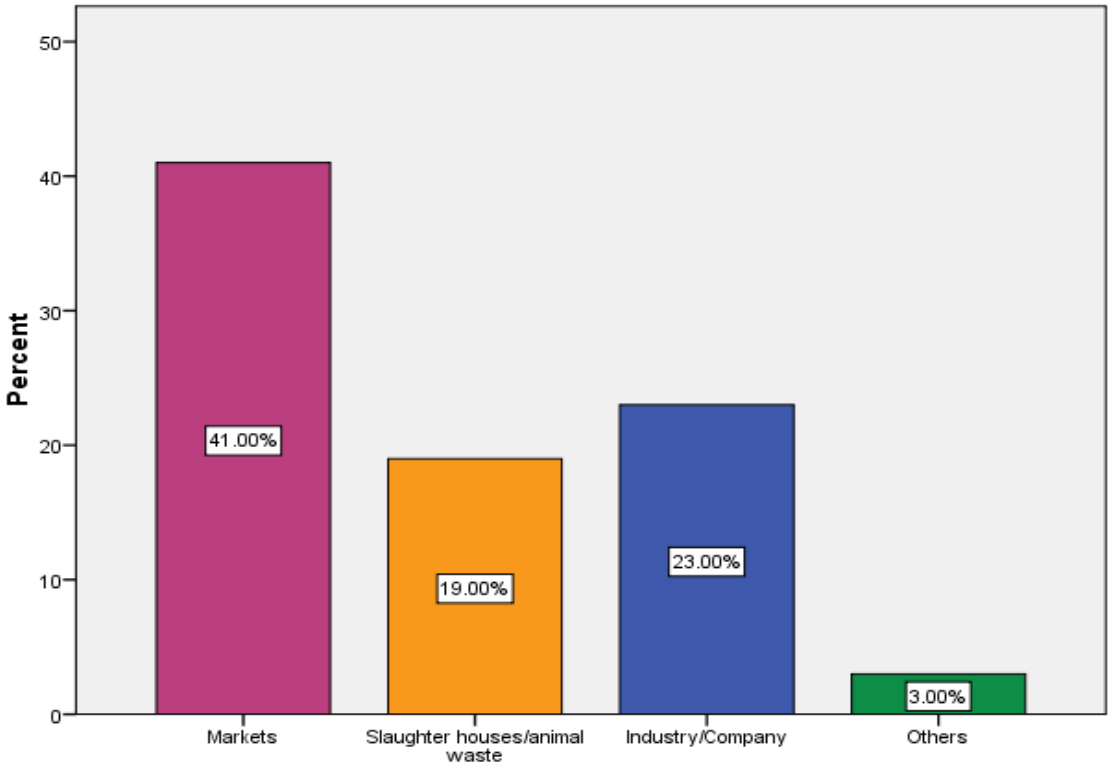

Figure 4.3: Other Solid Waste sources
Source; researcher (2017)

In addition, the data collected from the field demonstrated that Households and Markets are the Major Sources of Solid Waste in Kitengela.

4.4 Methods of solid waste disposal in Kitengela.

In order to gain a deeper understanding on the methods of solid waste disposal, the researcher found it necessary to identify which types of collection and disposal methods were available in the study area. And data showed that the preferred method of solid

waste disposal method was Dumpsite (Noonkopir) representing 68% then followed by burning, others and then incineration.

Table 4.4: Method of Solid Waste Disposal

Method of SW Disposal	Frequency	Percent
Burning	26	26.7
Incineration	1	1.0
Dumpsite	68	69.3
Others	3	3.0
Total	**98**	**100**

Source; researcher (2017)

On the other hand, at the household level the data collected demonstrated that the household method of solid waste disposal was mostly done through plastic bags. And the reasons for such household preference on the method of household waste is demonstrated in figure 4.4. Most of the household disposal preferences were; it is easy using the polythene bags , followed by it is convenient then cheap mode of waste disposal at the household level , effective mode of waste disposal , and it is the only available means , cleanliness and no other alternative as the reasons preferred most in household level.

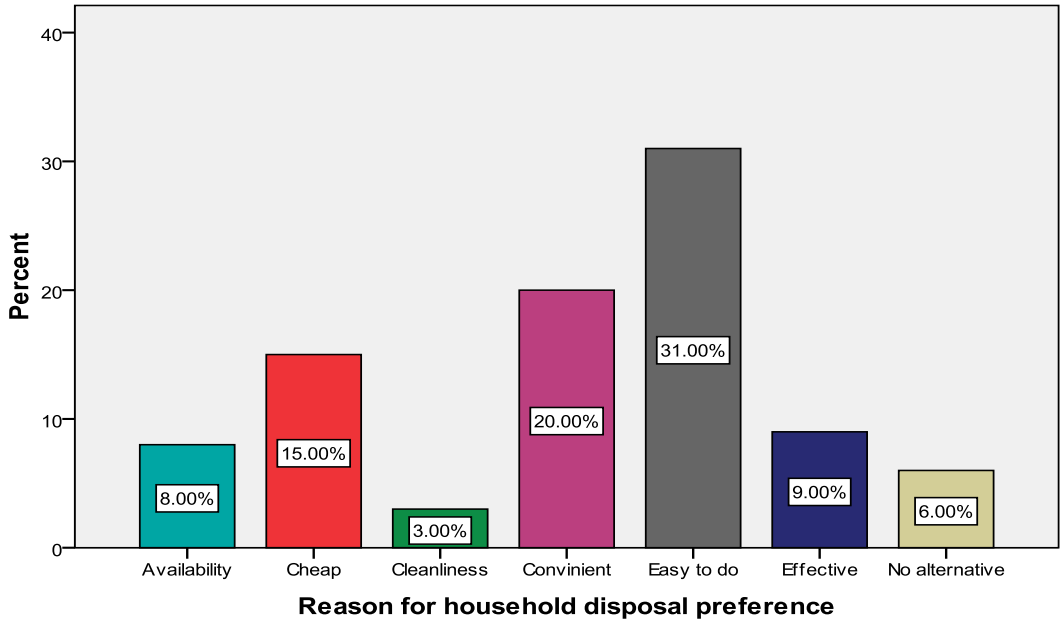

Figure 4.4: Reason for household disposal preference
Source; researcher (2017)

Furthermore, besides the reasons for household disposal preferences, the study also looked at the organizations or firms that were engaged in the process of solid waste disposal and collection in Kitengla. And the data clearly showed that majority of the organizations that engaged in solid waste were mostly the private firms (around 11 of them in Kitengela) representing 92%, then followed by household/estates associations representing 3% and then youth groups representing 2%. The county council of Kitengela is only concentrated on collecting waste from public county government entities and the private firms collects from various private firms and households and various institutions within Kitengela Ward.

However, on the contrary for an effective solid waste management system, the collection capacities have to be greater than or equal to the solid waste generation rates. Which is not the case as represented by the data collected from the study area. Only a third of the waste is collected.

In relation to the frequency of the how solid waste is collected in the household, payment for the collection of waste per month is as shown below in table 4.5.

Table 4.5: Collection cost

Collection Cost (Kshs)	**Frequency**	**Percent**
Free	5	5.1
Between 1 and 100	34	34.8
Between 101 and 200	46	46.9
Between 201 and 300	6	6.1
Above 300	7	7.1
TOTAL	**98**	**100**

Source; researcher (2017)

Majority of the respondents paid between kshs 1-200/=, whereas only six and seven respondents paid in the range of between Kshs 200/= and above Kshs 300/=. On the other hand only five out of the ninety eight respondents in the study area did their own collection and disposal of their respective waste.

In addition to the payment of collection cost of solid waste per month, the table 4.6 provides the frequency of the collection cost in the study area.

Table 4.6: Frequency of Collection

Frequency of Collection	Frequency	Percent
Once a week	69	70.4
Twice a week	23	23.5
Not at all	4	4.1
Once a month	2	2.0
TOTAL	**98**	**100**

Source; researcher (2017)

And from table 4.6, the data provided clearly shows that majority of the collection frequency was undertaken in between once a week and twice a week, whereas compared to not paying anything at all representing four percent of the total and once a month representing the least. Therefore, besides data on the schedule of waste collection from the study area suggests that waste is collected and disposed once or twice a week. This was not the case on the ground as many of the households answered other times ranging from several weeks to months. The situation compels residence and sometimes human scavengers to burn the over flowing waste in-situ generating smoke and making such places uncomfortable to live. This phenomenon is attested by Evan (1994), thus "Garbage is often burned in residential areas and in landfills to reduce volume and uncover metals". Burning creates thick smoke that contains carbon monoxide, soot and nitrogen oxides, all of which are hazardous to human health and degrade urban air quality.

In addition to, the method of solid waste disposal in, low-income countries, Africa included, collection services make up the bulk of SWM budget (as high as 80 to 90% in many cases), yet collection rates tend to be much lower, leading to lower collection frequency ,mostly Sporadic and inefficient. The Service offered are limited to high visibility areas, the wealthy, and businesses willing to pay. Therefore high fractions of inerts and compostables impact collection—overall collection is normally below 50%, **(**Hoornweg et al, (2012). This scenario is similar to collection done in the study area. Even in the study area, the collection cost and the frequency of collection of waste are limited to respondents who can afford an average of one hundred and fifty Kenya shillings and more. Furthermore, collection is normally done with an average radius of four hundred to five hundred meters away from the Kajiado/Namanga road from both ends of the road.

Consequently another aspect, concerning methods of solid waste disposal in Kitengela, that come out clearly from the study area, was that most of the respondents residing in the study area understood proper solid waste management as shown in figure 4.5.

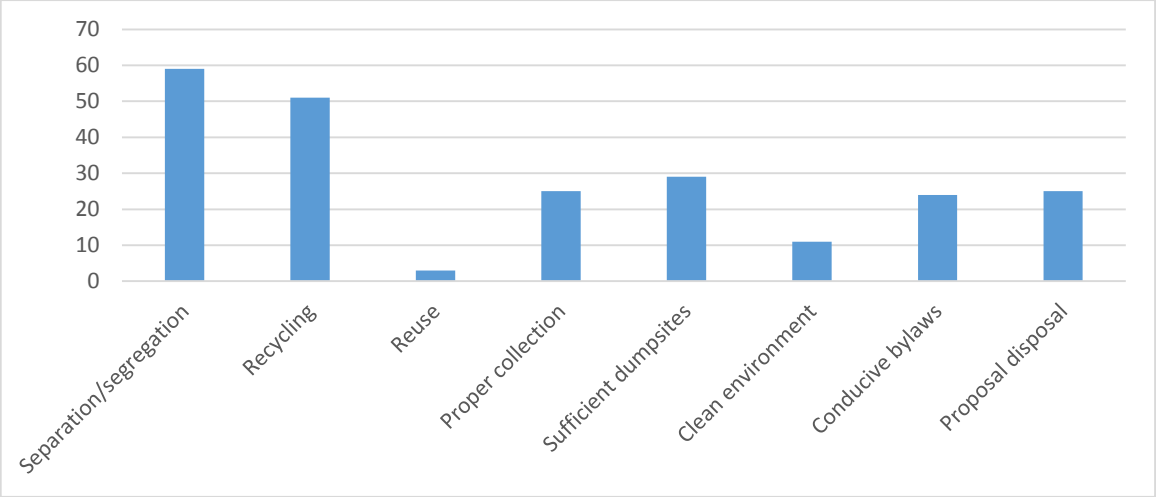

Figure 4.5: Understanding of Solid waste management

Source; researcher (2017)

What was worrying was that majority of the respondents had no waste educational background which gave the researcher a difficult time in the field. In addition, poor understanding of waste in the study area encouraged the problems of solid waste management as shown in the figure 4.6.

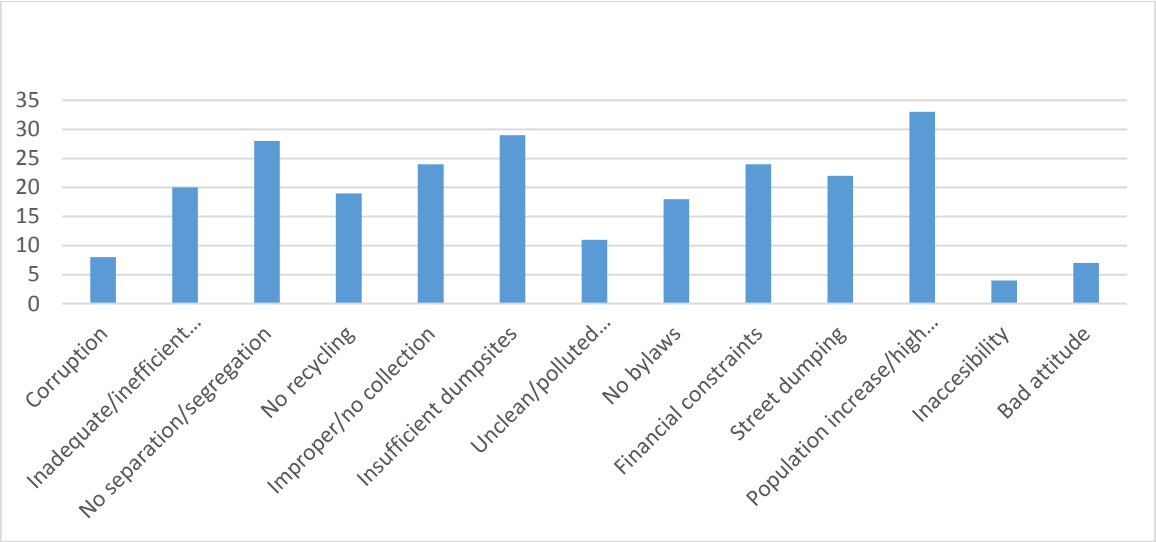

Figure 4.6: Problems in Solid waste management

Source; researcher (2017)

The rapid population growth and rapid changes in lifestyles drives rapid increase in the quantity and changes in the composition of urban solid waste as is the case in Kitengela and in most African cities. However, the absolute growth of population and income implies that the absolute volume of waste is unlikely to decline UNEP, (2011**).** Furthermore, in the study area, the driving aspect in the problem of solid waste was shown by the data from the field demonstrating that increase in population is directly correlated with the per capita level of income and the amount of waste per capita that is generated. (UNEP, 2001). Besides population increase being the major problem, another problem that come out as well was insufficient dumpsite i.e. Noonkopir, which is already full. Other problems are shown in figure 4.7.

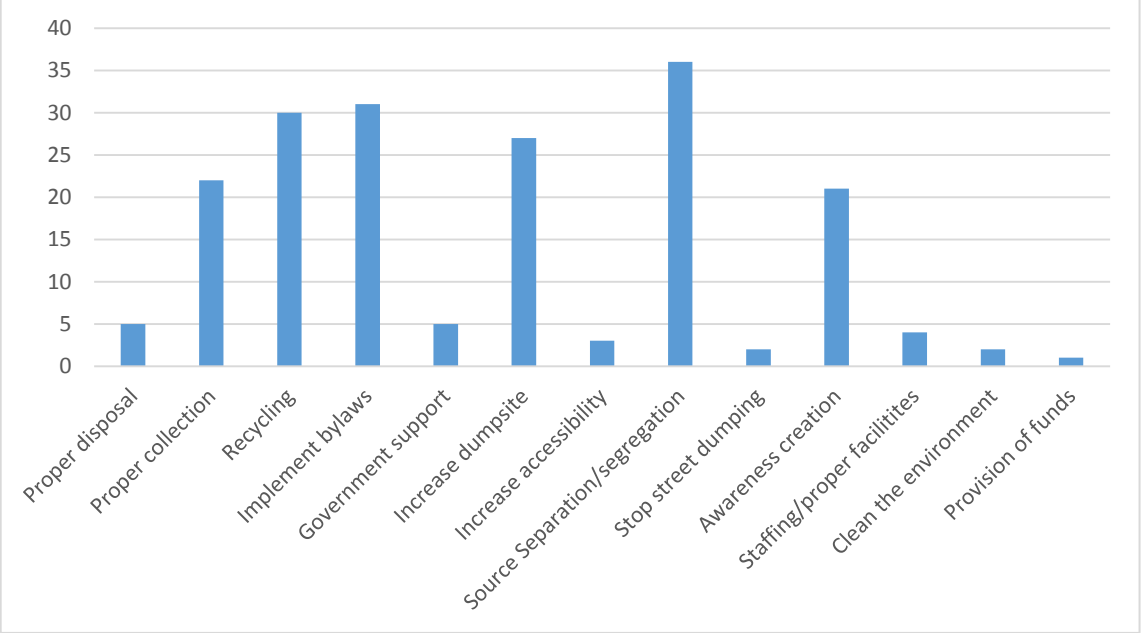

Figure 4.7: Solutions to Solid waste management

Source; researcher (2017)

On the other hand solutions of solid waste that respondents were articulating to, is represented in the figure 4.7. Among the leading solutions that came out were; source separation/segregation, implementation of bylaws purely on solid waste management which at the moment is missing in the study area, recycling was another solution put forth, increase dumpsites and should not be near residential areas as with the case of Noonkopir dumpsite, proper collection and awareness creation as solutions to solid waste management in kitengela. In addition to the methods of solid waste disposal in the study area,

sewage connectivity/systems to households was inadequate and the basic reason for this was due to no sewage planning connections in the study area.

4.5 The effects of solid waste management on institutions and households in Kitengela

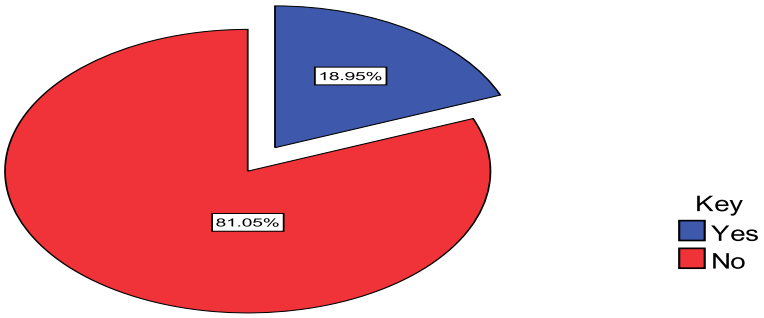

Figure 4.8: Institutional efficiency to handle solid waste

Source; researcher (2017)

Since the majority of waste from households and commercial institutions were organic and that the easiest mode of disposal was from both households and commercial institutions were through plastic paper bags, the researcher wanted to understand how these effects were ultimately affecting the environment. Is it that the institutions were incapable of handling waste and what challenges were these institutions facing that they cannot handle solid waste in the study area. In table 4.6, the frequency of collection is at its most at once a week. This demonstrates that waste is collected in areas where residents pay only. And what about the areas where waste is not collected, it manifests and decays there, resulting in pollution, diseases and health hazards, degradation especially with plastic bags everywhere and ultimately extinction of species a good is the manifestation of cranes(birds) that feed on waste and thereby resulting in disappearance of other birds.

Furthermore figure 4.8, examine the effects of solid waste management on institution and households in the study area, and the response was strongly a NO with 81.05% of the respondents disagreeing and only 18.95% agreed they were capable to handle. However, besides the institutional efficiency to handle waste, another concern the study

looked into was the challenges facing these institutions that handle solid waste in Kitengela. And the results demonstrated is provided in the figure 4.9.

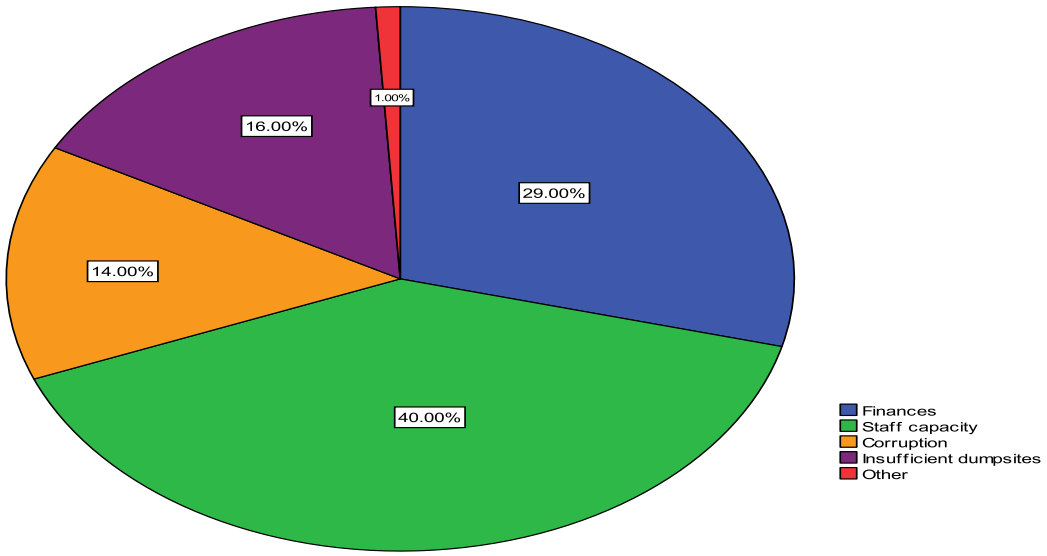

Figure 4.9: Challenges facing institutions that handle solid waste in Kitengela

Source; researcher (2017)

On the other hand, the researcher also looked at the challenges facing institutions that handle waste and shortage of staff capacity was the main challenge facing institutions, this refers to 40% that are engaged from collection to transportation up to disposal are few as compared the large population that is growing fast. Finances was another challenge that the researcher also looked at, representing 29%. Finances combined with corruption equaled the shortage of staff capacity, the three demonstrated to be the major challenges the study area was facing. Corruption in itself representing 14%. In addition to the challenges facing institutions, insufficient dumpsite in the study area came out at 16%. Only one dumpsite is serving the entire study area and it's already full. And lastly others were representing 1% of the challenges facing institutions that handle waste in Kitengela.

Furthermore, the researcher also sought to evaluate about the respondents opinion on the effects of waste status of the environment. And this is shown in figure 4.10

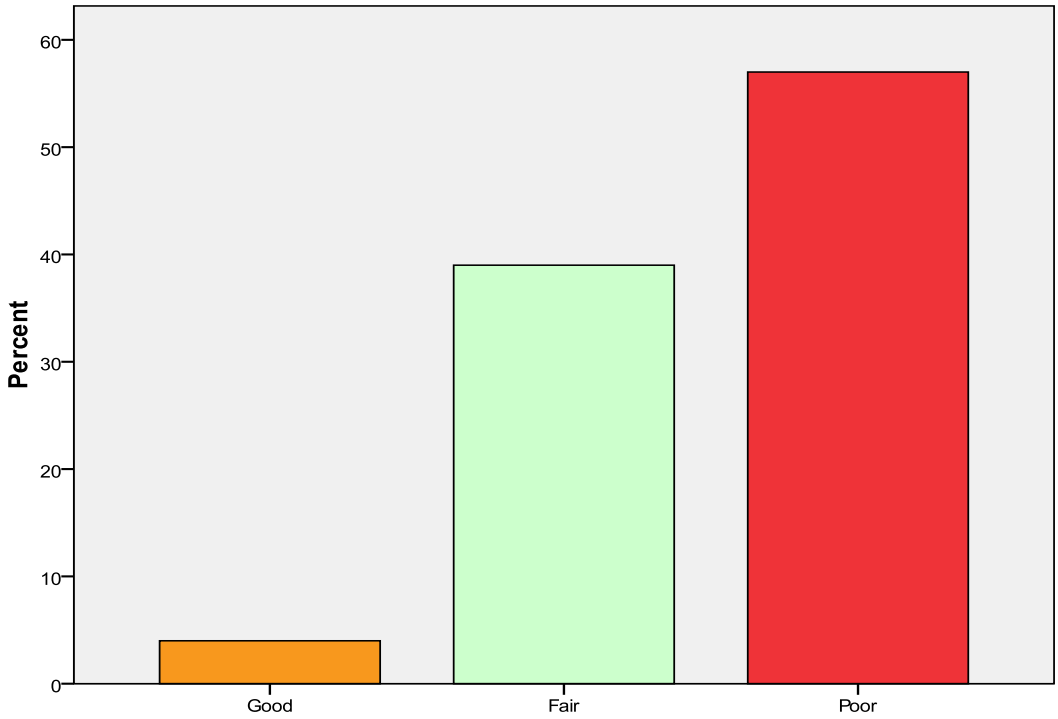

Figure 4.10: Effects of waste status

Source; researcher (2017)

Figure 4.10 explains respondent's opinion on the effects of waste status of the environment in the study area. And majority of respondents of 58% said the waste status of the environment in the study area was poor. A considerable 38% said it was fair and only 4% said they were comfortable with the environment and it was good.

In addition to, figure 4.10, showed the respondents opinion on the effects of waste status of the environment, again the researcher wanted to clarify what were the negative effects of solid waste disposal methods used in the study area? Figure 4.11, clearly provides the effects of solid waste disposal method. In Figure 4.11, demonstrates pollution was higher compared to diseases, degradation, injuries and others. However, the use of plastic bags for household waste disposal was worrying in itself, since it raised the stakes for pollution of non-biodegradable paper bags that is evident in the dumpsite in the study area. Furthermore, the presence of a medical incinerator in the middle of the study area raised the pollution in Kitengela a notch higher. *''They release those black smokes early hours in the morning and in the evening, sometimes we cannot breathe properly''……. Attested one of the respondents.*

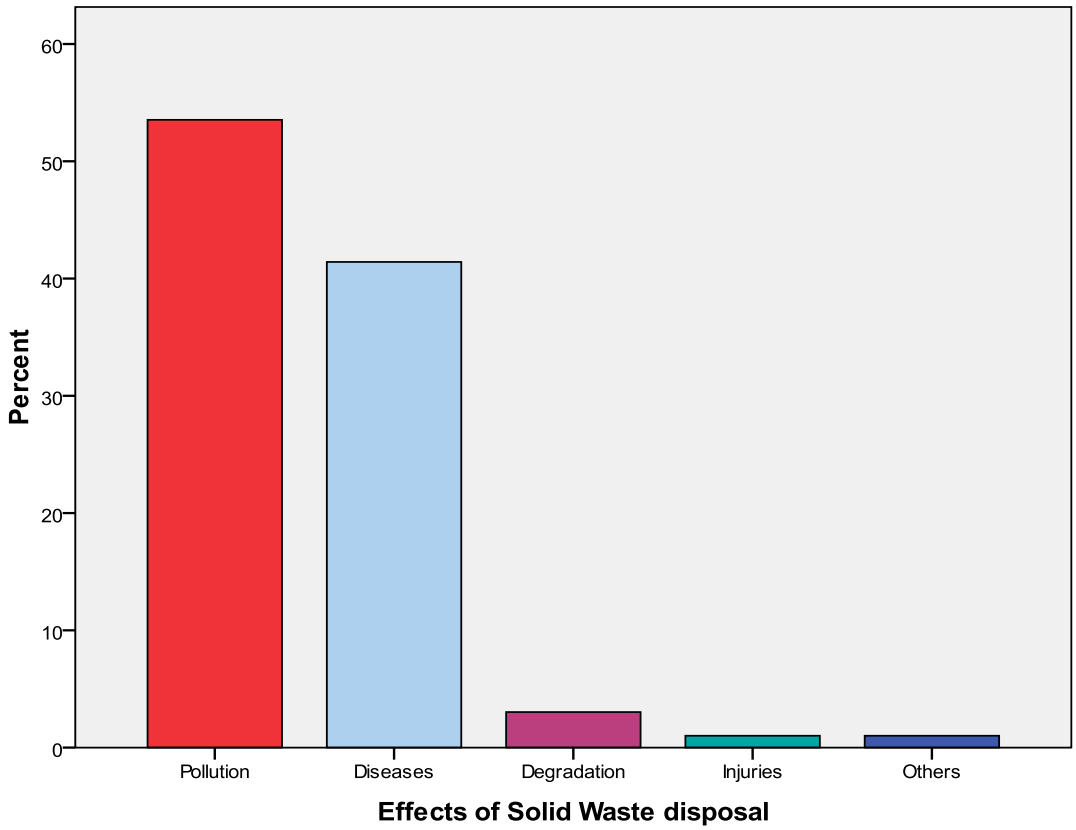

Figure 4.11: Effects of solid waste disposal

Source; researcher (2017)

4.6 Barriers of solid waste management in Kitengela.

This section provides information of the data collected from the field concerning barriers of solid waste management in the study area. The question the researcher sort to understand was concerned about the personnel for waste management which were the organizations engaged in the collection/disposal of waste in the study area, and a number of issues came out from the data. Issues were; lack of equipment's, little knowledge concerning waste, poor transportation of waste, youth who were collecting waste were being used for convenience purposes and were used to collect waste that might harm them in one way or another, no training of waste collection procedures, haphazard collection and littering of the collected waste on the road. However, Rapid growth of population has created a number of extreme land use planning and infrastructural challenges that have crippled the capability of national and municipal governments in developing countries in increasing SWM service levels at the rate that they are demanded (Périou, 2012). In the

municipal solid-waste management system (SWMS) of developing countries typical problem areas can be identified. These can be described as: 1) budgetary constraints, 2) inadequate service coverage and operational inefficiencies of services including unskilled manpower, 3) ineffective technologies and equipment, 4) inadequate landfill disposal, and 5) limited utilization of waste reduction activities such as recycling. (Périou, 2012).

However, poor infrastructure tied up with poor personnel encouraged poor solid waste disposal in the study area. In that, infrastructure includes both the physical and organizational capabilities, in terms of the physical infrastructure; there is no planning of infrastructure currently at the study area, i.e. roads, no planning for construction of residential houses, no planning for sewage connectivity, insufficient dumpsite; only one in the study area which is already full. On the contrary organizational infrastructure, what came out from the data was mostly lack of equipment, poor transportation of waste, lack of experience to handle waste. Figure 4.12, provides clear picture on the question, of, does infrastructure in the study area encourage poor solid waste disposal. Majority of the respondents agreed that poor infrastructure is a barrier that encourages poor solid waste disposal.

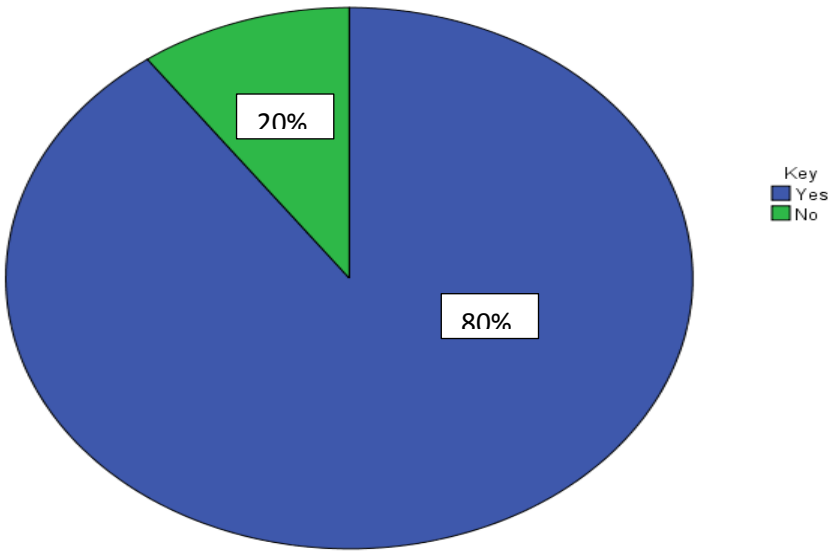

Figure 4.12: Poor Infrastructure
Source; researcher (2017)

In addition to the third objective of the study, uneven collection of waste which was the services paid for collection of waste were not accommodative to everyone, not only that, even the facilities which were the household solid waste collection facilities were not

adequately distributed equally in all municipality. Residents who could not afford that amount used other modes of waste disposal which most of the time were mischievous and at night just disposed of waste within the neighborhood or burning of the waste. Such methods encourage indiscriminate dumping as people turn to evaluate price, distance of travel and weight of the load. Further, narrow streets may not have space for locating storage containers and may be so narrow, treacherous or irregular that motorized collection vehicles cannot be used. Houses that are considerable distant from the nearest accessible road also pose particular problems in receiving adequate waste services (Henry *et al*., 2006). However, quite a significant proportion of households had inadequate proper storage receptacles. This attracted flies and also served as breeding place for many insects and vermin which transmit diseases. The stench emanating from these open receptacles become a nuisance to people. A study conducted by Benneh *et al*. (1993) showed that the problem of solid waste in Accra begins at the home where open storage of solid waste was practiced by about 42% of households in Accra as against 44%. Consequently infrastructure again demonstrated that due to poor roads network within the households in the study area and tied with poor planning of construction of households, accessibility for collection of waste was a big issue, one of the respondents said; *''They hardly reach this neighborhood for collection of waste due to access roads are not in good condition and they are very narrow, so we call local youths who use porters and collect the waste, and hardly do we know where they dispose the waste''*. Figure 4.13, demonstrates distribution of waste collection facilities in the study area;

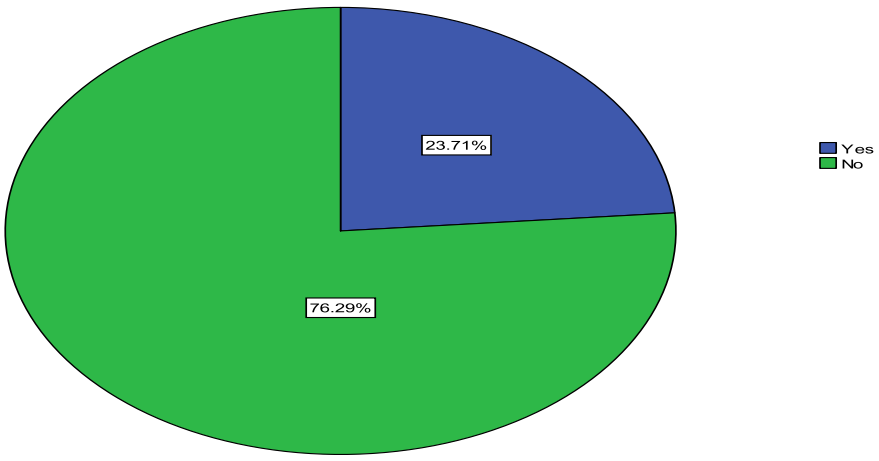

Figure 4.13: Uneven distribution solid waste collection facility
Source; researcher (2017)

Plate 4.1: Noonkopir dumpsite.
Source; researcher, Noonkopir dumpsite.

However, in respect to county council that is concerned with the whole process of solid waste in the study area, the overall perception of residents are that they are adequately equipped as compared to the other organizations engaged in solid waste collection and disposal i.e. the private services providers, youth groups, household/estates associations; the response was, they hardly even engage in the process besides providing jurisdiction(zoning as referred in the study area) on the collection of solid waste. In addition to the inadequate service coverage and operational inefficiencies of services including an unskilled workforce is another major set of challenges faced by municipalities in providing sufficient waste services to citizens. Municipal solid waste collection schemes of cities in the developing world generally serve only a limited part of the urban population. The people remaining without waste collection services are usually the low income population living in urban and rural areas (Zhu *et al.*, 2008). One of the main reasons is the lack of financial resources to cope with the increasing amount of generated waste produced by the growing cities. Furthermore, poor administration is the order of the day, with no educational background on environment; majority of the workers are of different academic disciplines, which makes the whole picture of solid waste management in the study area a catastrophe waiting to happen. Even the dumpsite is already full and is surrounded by residents as shown in the plate 4.1.

On the other hand, another barrier concerning solid waste in the study area was with how culture relates to the issue concerning solid waste management.

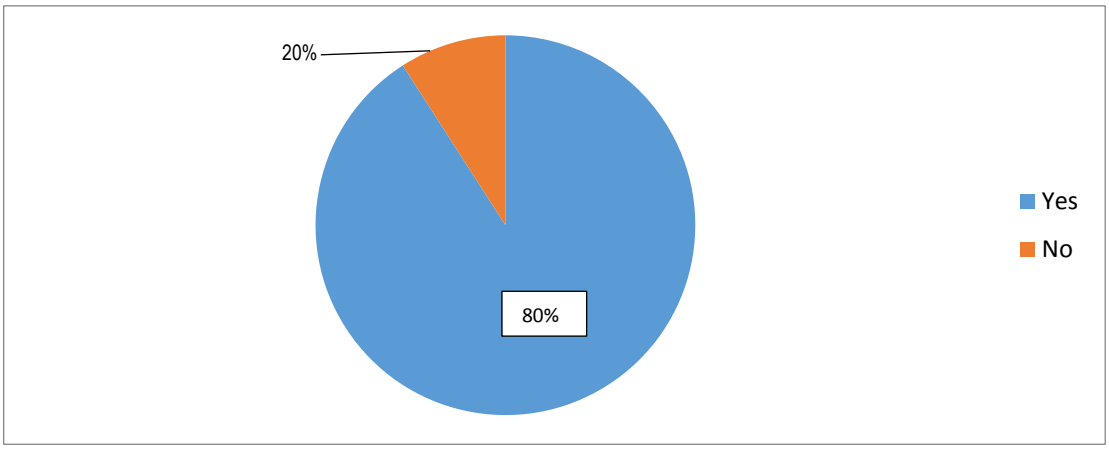

Figure 4.14: Culture affects solid waste management

Source; researcher (2017)

Figure 4.14, demonstrates that culture in the study area affects solid waste management system. And a strong response supporting the claim, is shown from the graph whereas a slight margin were not convinced that culture is a problem in waste generation.

However, often times when systems are breaking down and problems are escalating, people look to societal factors to fix the issue. This has often been the case when dealing with the mismanagement of solid waste in the developing world. Many researchers have argued that the waste problem is caused by human behavior and therefore the solution lies in changing that behavior (Milea, 2009). Public awareness and attitudes about waste can affect the whole SWMS (Zhu *et al*., 2008). Furthermore, attitude-behavior gap often emerges and can be further affected by a variety of reasons including convenience, social norms, lack of public participation, and lack of education and awareness of effective waste management techniques (Milea, 2009; O'Connell, 2011).

However, recognizing trash as a problem does not prevent littering or other negative behaviors concerning waste management (Moore, 2012). And within this attitude/behavior gap, exists an inconsistency between one's values and actions. This specifically refers to the discrepancy between people's concern over the environmental harm posed by household waste and the limited action by those same people to reduce their waste or engage in other pro-environmental behaviors (O'Connell, 2011). Many researchers observed this gap first hand when conducting observations in communities of the developing world. I

personally observed this behavior in study area, where individuals I had just interviewed, who claimed they were concerned about the trash problem in their community, then proceeded to litter in the street later that day, not connecting their values with this action. A negative behavior often associated with the mismanagement of solid waste in developing countries is the occurrence of littering. There are a multitude of causes that can contribute to an increase in public littering rates, such as a lack of social pressure to prevent littering, absence of realistic penalties or consistent enforcement, and lack of knowledge of the environmental effects of littering (Al-Khatib *et al*., 2009). Other causes also include the amount of litter already present at a particular site, presence of signs referring to litter, and the number and/or placement and appearance (if any) of waste collection bins at the site. Convenience of garbage bins has been cited many times in research as a priority when disposing of trash, and when these are not present or lacking in areas this has been reason enough to litter (Henry *et al*., 2006).

Other times people become accustomed to throwing their waste in streets and other inappropriate places, as there had been no formal system for sorting and disposal in their community, so when changes are implemented people are not changing their disposal behavior out of pure habit and custom (Yousif and Scott, 2007). Similarly, a range of socio-economic factors can affect public attitudes toward littering, frequency of littering, and the effective approaches to impede the littering tendency within an individual (Al-Khatib *et al*., 2009). These factors are region and culture dependent, and it is very important to study them if an effective littering prevention program is to be designed. For example, in a study conducted in Cuba looking at the relationship between social norms and pro-environmental behaviors, researchers found that a majority of citizens participated in recycling buybacks and non-littering initiatives, not only because the government supports these efforts for economic reasons, but also because of the social pressure created by the community. Citizens also possess internalized social norms and believe that if they do not adapt their behaviors accordingly, they become outsiders and are looked down on (Mosler *et al*., 2008). To get a clearer understanding of the complexity of street litter problems, integration between socio-economic and environmental studies is essential (Al-Khatib *et al.,* 2009).

The participation of the community in the production and use of scientific knowledge is considered the best approach to environmental management of waste. Many studies have been conducted in the developed world to evaluate and apply strategies to reduce littering by means of behavioral interventions (Al-Khatib *et al*., 2009), but in developing countries little has been done. And lastly, young people have been found to litter more than older ones and males more than females and people who are alone litter more than those in groups (Bell *et al.*, 1990). People from the rural areas are more likely to litter than the urban residents, but the latter are less likely to comply with litter regulations than visitors (Viljoen *et al.*, 1987). The lack of interest in the environment creates a culture of non-participation of communities in decision making processes. That stance enhances lack of responsibility for pollution and waste issues.

Ultimately this produces communities that have little knowledge of or concern for their impact on the environment and older people are more willing to participate in recycling of waste as compared to the younger generation (DEAT, 1996).

Moving on, the study also tried to understand whether there is any support from the community in terms of participation in solid waste management. However this was not the case as shown in the figure 4.15.

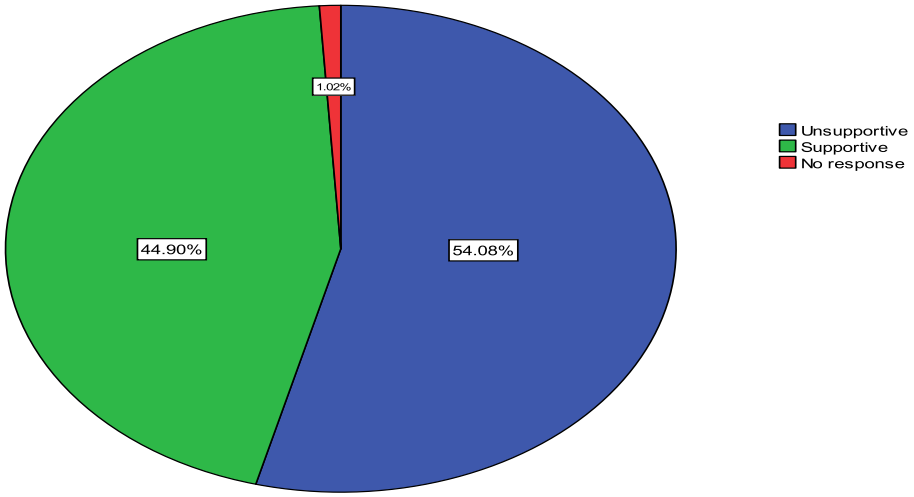

Figure 4.15: Community support of SWM

Source; researcher (2017)

As shown in the figure 4.15, community support in terms of any participation whatsoever was not the case representing majority of the respondents as not supportive of a margin of 54.08% whereas 44.9% representing and only 1% representing no response in solid

waste management in the study area. In addition to participation, some of the major constraint seen throughout the developing world is the lack of education and awareness of effective waste-management practices in relation to participation. One study in Gaborone, Botswana, found that even though citizens were aware of recycling and other sustainable waste-management techniques, this does not necessarily translate into participation in pro-environmental activities such as recycling initiatives. They appear to have not embraced waste management reforms amid their limited knowledge of such activities (Bolaane, 2006). The lack of interest in the environment creates a culture of non-participation of communities in decision-making processes. That stance enhances lack of responsibility for pollution and waste issues. Ultimately this produces communities that have little knowledge of, or concern for, their impact on the environment (Poswa, 2001). What it may come down to is the difference between information and knowledge. Being presented with the information without prior knowledge may be ineffective in creating change. However, if prior knowledge of waste management was met with new information, these communities may be more willing to accept it and implement these changes.

Furthermore, for a 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.

On the flip side, the study also wanted to bring out if there was need for community sensitization and awareness on solid waste management, and the results are presented figure 4.16.

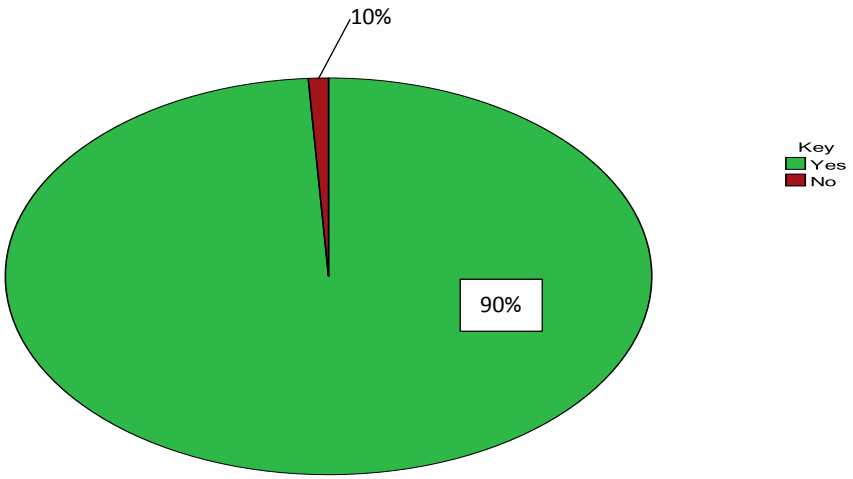

Figure 4.16: Community awareness and sensitization

Source; researcher (2017)

However most of the respondents agreed to the need for community awareness and sensitization, whereas a small portion disagreed to community awareness and sensitization. Besides agreeing respondents in supportive of community awareness and sensitization put forth mechanisms/methods they felt should be used; use of Barraza's/ forums , use of advertisement concerning solid waste management in local radio stations, use of religious institutions and schools to educate residents in the study area on solid waste management.

The need to improve public awareness of, and community participation in, waste management has been widely recognized by researchers as necessary to create sustainable waste systems and to promote environmental citizenship amongst community members (Lumbreras Martín and Fernández García, 2014). Typically, people are more likely to participate in waste management activities, for example recycling, when they observe others in their vicinity recycling. In developing countries recycling programs are rare, so wealthier members of the country rely on informal recyclers as the behavior norm (O'Connell, 2011). The results of a study done in Malaysia by Aini and colleagues (2002) indicated that, in order to overcome the solid waste crisis, the "conscience of the individual needs to be raised through environmental awareness and concern, inculcation of sustainable consumption practices and education on waste management." Environmental awareness and knowledge about environmental conservation were found to affect

recycling attitude positively but positive attitude may not have resulted in recycling if knowledge about it was poor (Aini *et al*., 2002), so waste managers need to take steps to help align the information presented to the public with the knowledge these individuals already have.

Moreover, 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: 1) reinforce environmental sustainability, public health, family and child safety; and 2) 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 result (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 motiva-

tion (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 (Aini *et 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).

Consequently, on the other hand, the study looked at the service provision offered by those charged with the responsibility on solid waste management and whether there were overlaps among the service providers in terms of jurisdiction on collection of solid waste. Figure 4.17, presents overlaps among service providers.

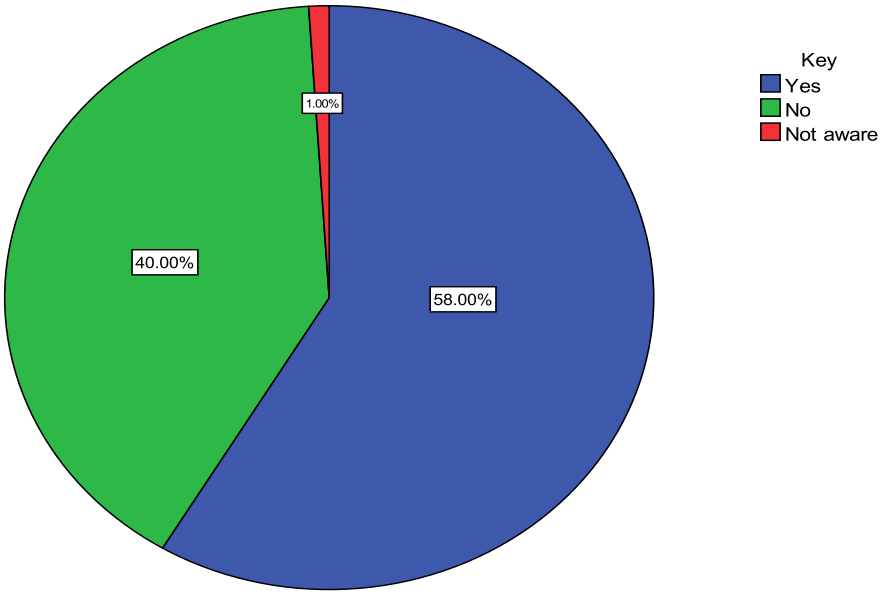

Figure 4.17: Overlap among service providers

Source; researcher (2017)

Most of the respondents tied the notion of overlaps with the service provision offered in terms of corrupt practices among the service providers in the study area. In that, collection most of the time is not done properly in the study or done in hastily, or access to collection purposes is another problem by itself altogether, and what comes after is that households end up paying more for only waste to be collected. On the other hand, zoning/jurisdiction is done only by the county council to the private service providers and the youth who are engaged in the collection of waste through a contracted agreement, but this is mostly on paper and not actually the real scenario. Figure 4.17, clearly demonstrates what the response was from the data collected from the field, and majority of 58% agreed on overlaps among service providers and only 40% disagreed.

Furthermore, respondents were provided with a table as shown in appendix II of the observational schedule for the study area. Figure 4.18, Illustrate the results from the field.

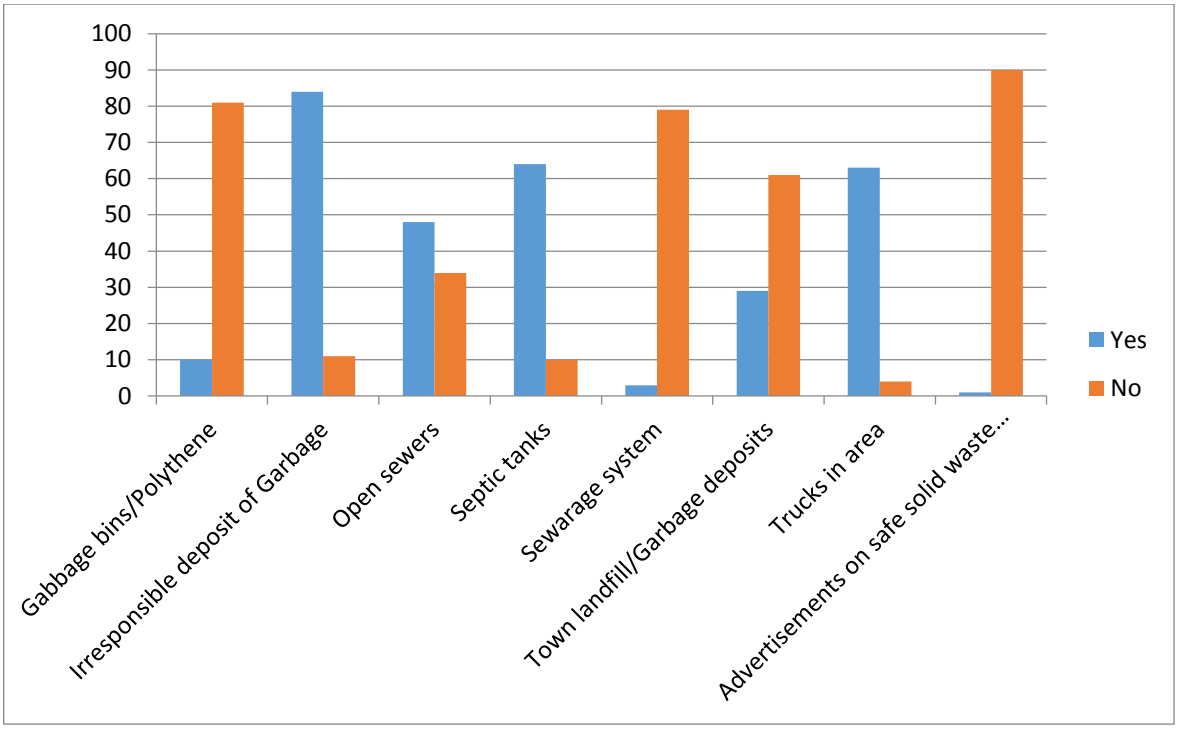

Figure 4.18: Observational schedule

Source; researcher (2017)

The responses were summarized into "YES'' and ''NO''. However, starting with whether garbage bins were available in the study area, and most of the response was a NO of 81% whereas a YES of 10%.

Irresponsible deposits of Garbage was another question put forth to the respondents and a ÝES of 84% meaning that in the study area irresponsible deposits of garbage was prevalent in most areas and a NO of 10%.

Open sewers was another question and a 48% of YES there are open sewers in the study area, conversely a 36% of NO disagreed. Availability of septic tanks in households/buildings in the study area was also asked and a 64% of YES agreed but said they are very poor and this becomes evident when it rains in the study area, whereas a slight percentage of 10% said there are no septic tanks.

Moreover, availability of sewage system was also asked and sharp percentage of NO i.e. 79% said there was no sewage system/connectivity in the study area, whereas only less than 10% said there was a sewage system in the study area.

Town landfills/Garbage deposits (where waste is dumped and later on the collectors come and collect) in the study area showed a NO of 61% and a YES of 28%. Trucks in

the collection of waste in the study area showed a YES of 62% and a NO of less than 10%. But in poor condition.

And lastly availability of Advertisements on safe solid waste management in the study area showed the highest with a NO of 90% meaning there are no safe advertisements on solid waste management in the study area whereas a YES of less than 5% in terms of safe Advertisements in the study area.

Hypothesis Testing

Hypothesis testing one

In this section, the study tested its hypothesis using Chi-Square test and the following results are demonstrated below;

H_0; Household Waste Types does not affects Solid Waste Management.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	108.617[a]	12	.000
Likelihood Ratio	18.404	12	.104
Linear-by-Linear Association	.226	1	.634
N of Valid Cases	97		

Source; researcher (2017)

The results from the test statistics used from the chi-square test indicated that there is a significant relationship between Household Waste Types and Solid Waste Management. However, the P-Value of the study was less than 0.05 (95% confidence level). In other words, $X^2$of 108.617 (P<0.05) i.e. (P-Value= 0.01). This supports the assumption (alternative hypothesis) that Household Waste types such as organic (food materials), plastics, metals, and polythene affects Solid Waste Management in the study area

Hypothesis testing two

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	61.225[a]	42	.028
Likelihood Ratio	47.488	42	.259
N of Valid Cases	98		

Source; researcher (2017)

H_0: there is no relationship between household waste types and the reason for household disposal preference method.

The results from the test statistics used from the chi-square test indicated that there is a significant relationship between Household waste types and the reasons for household disposal preference method. However, the P-Value of the study was less than 0.05 (95% confidence level) i.e. (P-Value= 0.028). In other words, $X^2$of 61.225 (P<0.05). This supports the assumption (alternative hypothesis) that there is a relationship between Household Waste types and the reason for Household disposal preference method.

Hypothesis testing three

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	23.690[a]	12	.022
Likelihood Ratio	14.917	12	.246
Linear-by-Linear Association	1.004	1	.316
N of Valid Cases	96		

Source; researcher (2017)

H_0: there is no relationship between age and household waste types

The results from the test statistics used from the chi-square test indicated that there is a significant relationship between Age and Household Waste Types. However, the P-Value of the study was less than 0.05 (95% confidence level) i.e. (P-Value= 0.022). In other words, $X^2$of 23.690 (P<0.05). This supports the assumption (alternative hypothesis) that there is a relationship between Age and Household Waste Type.

4.7 Discussions of the Findings

Hypothesis One;

H_0; Household Waste Types does not affects Solid Waste Management.

H_1; Household Waste Types affects Solid Waste Management.

Global production of waste has practically doubled over the past ten years and is expected to reach 2.5 billion tons per year in 2025 as a result of the combined effect of urban development and changes in consumption patterns (Périou, 2012). Communities in developing countries often turn to waste disposal methods that have proven to be destructive to human health and the environment, such as open dumping and burning (or unregulated landfills) because they feel they have no other options to manage their solid waste (Mwanthi and Nyabola, 1997; Goett, 1998; Alavi Moghadam *et al*., 2009; Narayana, 2009; Al-Khatib *et al*., 2015; Hilburn, 2015). With industrial progress, growing urban areas and rapid growth, solid-waste management has become a major concern in many developing countries. However, as the urban population in Nairobi and elsewhere in East Africa grows, so does the solid-waste management burden, a situation worsened by poor funding for urban sanitation departments and a lack of enforcement of sanitation regulations. At least 100 million people in East Africa lack access to improved sanitation (Troschinetz and Mihelcic, 2009). In addition to, the disposal sites are, in most cases, located in environmentally sensitive, low-laying areas such as wetlands, forest edge or adjacent to bodies of water. They often do not have liners, fences, soil covers and compactors as is in most developing countries (Troschinetz and Mihelcic, 2009). More often than not, the urban poor have to make do with living amid waste despite the health risks. With this exponential growth of waste, new practices of SWM must be undertaken and these systems need to be sustainable and adapted to the needs and challenges prevalent throughout the developing world. With the world becoming more urbanized and devel-

oped, and with populations rapidly increasing each year, consumption levels are reaching historic levels (IPA, 2014). However, the rate of generation of household solid waste in the developing countries is increasing with an increase of population, technological development, and the changes in the life styles of the people which is posing a great environmental and public health problem.

The study's findings resonates with the hypothesis on Household waste type affects Solid Waste Management. This supports the assumption (alternative hypothesis) that Household Waste types such as organic (food materials), plastics, metals, and polythene affects Solid Waste Management in the study area. In the results, Household waste types such as organic waste i.e. food material represented the most share of waste and since most of it is not collected properly, it decomposes very quickly which provides a favorable habitat for insects, vermin, and scavenging animals, which proliferate and spread air- and waterborne diseases such as plague, dengue fever and diarrhoea among local populations in the study area. Furthermore, volumes of solid waste runs in millions of tons and would accumulate if no proper management schemes are put in place to collect them (Songsore & McGranahan, 1993). However, assessing the benefits and costs of various solid waste management policies and projects is complex because it involves numerous, interconnected, economic, social, and biological components. The barriers to effective Municipal Solid Waste (MSW) management is not simply lack of policy but lack of infrastructure, education, social awareness of problems and solutions, and lack of institutions promoting sustainable actions (Barret & Sue, 2001). Urban solid waste and sanitation management is a matter of grave concern to most Metropolitan, Municipal and District Assemblies in Africa. The challenge in waste management emanates from the various levels of handling waste from the individual, household and community levels (Puopiel, 2010; Otchere *et al*., 2014; Puopiel & Owusu-Ansah, 2014). Among the plethora of reasons that are attributable to this menace are passive attitude towards waste disposal, low level of enforcement of bye-laws, lack of financial resources and the absence of the technical capacity to manage waste (Mariwah, 2012; Asamaa, 2007). In addition to, the shortfall in the unaccounted waste represents solid waste which does not end up at landfill sites and clogs communities as heaps burnt day and night. The other component that is accounted for also represents the challenge of efficient transportation and disposal with almost no-existent well engineered disposal site (World Bank, 2013). Buttressing the above point is the fact that, this raises an alarm as to what happens to the large vol-

umes of unrecovered solid waste and how it is handled at the household level. This problem necessitates a study for immediate solution. Poor waste management particularly with regards to waste disposal creates serious issues of environmental contamination of water and soil, air pollution from waste burning, sanitation and hygiene challenges which goes a long way to pose serious environmental health risk and aesthetic burdens (Attipoe, 1996). There are no proper solid domestic waste management practices in some urban areas of the study area and the municipality is no exception. People deliberately ignore and throw solid waste into the open spaces and gutters. Some people regrettably defecate into polyethylene bags and leave them as litter in the environment, this is mostly because there are no public toilets constructed. Flies are attracted to them and may spread pathogens. Health and social side effects are equally as important as environmental impacts when considering Municipal Solid Waste Management (Gladding, 2002).

Hypothesis Two

H_0: there is no relationship between household waste types and the reason for household disposal preference method.
H_1: there is a relationship between household waste types and the reason for household disposal preference method

The results from the test statistics used from the chi-square test indicated that there is a significant relationship between Household waste types and the reasons for household disposal preference method. However, this supports the assumption (alternative hypothesis) that there is a relationship between Household Waste types and the reason for Household disposal preference method

However, at the household level, the data collected demonstrated that the household method of solid waste disposal was mostly done through plastic bags. And the reasons for such preference method of household waste disposal were mostly; it is easy using the polythene bags, followed by it is convenient then cheap mode of waste disposal at the household level, effective mode of waste disposal, and it is the only available means, cleanliness and no other alternative as the reasons preferred most in household level. The use of plastic bags for household waste disposal was worrying in itself, since it raised the stakes for pollution of non-biodegradable paper bags that is evident in the dumpsite in the study area. However, quite a significant proportion of households had inadequate proper storage receptacles. This attracted flies and also served as breeding place for many insects and vermin which transmit diseases. The stench emanating from these open

receptacles become a nuisance to people. A study conducted by Benneh *et al.* (1993) showed that the problem of solid waste in Accra begins at the home where open storage of solid waste was practiced by about 42% of households in Accra as against 44%.

Furthermore, due to absence of household collection facilities in all areas of the municipality, about two thirds of the households in the study area collect and transport their waste close to passable areas due to inaccessibility, or pay the youths for such forms of job for final disposal. Such methods encourage indiscriminate dumping as people turn to evaluate distance of travel and weight of the load. Poor waste management particularly with regards to waste disposal creates serious issues of environmental contamination of water and soil, air pollution from waste burning, sanitation and hygiene challenges which goes a long way to pose serious environmental health risk and aesthetic burdens (Attipoe, 1996). Consequently, even garbage deposits/town dumping zones are not present, whereby waste would be collected, data showed from the study area, illustrated that most of the response was a NO of 81% whereas a YES of 10%. Sanitary sites are generally open spaces in communities which are used as dumping sites. They are sometimes provided with large metallic containers (communal skips) as receptacles for waste collection and transportation periodically, while sometimes they are just open dumping areas. Sanitary sites are usually the sites where public toilets are located in communities where there are no toilet facilities in the houses. They are useful points in assessing the efficiency of waste management in the municipality as it indicates the frequency of waste disposal, level of waste disposal by households, rates of collection by municipal authorities. It is also useful in the determination of the efficiency of management system in place as it relates to the number of sites available and the population of a community and waste generated (Ampofo, *et al* 2015).

In addition to, the relationship between Household Waste types and the reason for Household disposal preference method, Household Waste types such as organic (food materials), plastics, metals, and polythene affects household disposal preference method in the study area. In the results, organic waste i.e. food material represented the most share of waste and since most of it is not collected properly, it decomposes very quickly which provides a favorable habitat for insects, vermin, and scavenging animals, which proliferate and spread air- and waterborne diseases such as plague, dengue fever and diarrhoea among local populations in the study area. When not disposed of with sound sanitary practices, leachate is produced by accumulated MSW which leaks into the

environment and contaminates ground water and surface water. MSW also contributes to some global environmental challenges, such as the increase of greenhouse gas (GHG) emissions in the atmosphere – contributing almost 5% of total human-based GHG emissions (Hoornweg, D., Bhada-Tata, P., 2012). Open burning in dumpsites releases particulates as black carbon and persistent organic pollutants, which bioaccumulate in the food chain. Many cities engaged in flood management programs recognize that uncollected solid waste – which blocks drains – is a major factor causing flooding.

Therefore, besides data on the schedule of waste collection from the study area suggests that waste is collected and disposed once or twice a week. This was not the case on the ground as many of the households answered other times ranging from several weeks to months. The situation compels residence and sometimes human scavengers to burn the over flowing waste in-situ generating smoke and making such places uncomfortable to live. This phenomenon is attested by Evan (1994), thus "Garbage is often burned in residential areas and in landfills to reduce volume and uncover metals". Burning creates thick smoke that contains carbon monoxide, soot and nitrogen oxides, all of which are hazardous to human health and degrade urban air quality.

And with the urban population projected to increase by 2017, the population in each of urban areas in Kajiado County will increase but would still be less than the required number to qualify as a municipality which requires a minimum population of 250,000 (*Source*: *Cities and Urban Areas Act, 2011*). Ngong town holds more of the urban population than any other town in the county with 41 percent of the total population. The other towns with rising projections are; Kitengela with 23 percent, Ongata Rongai with 16 percent and Kajiado with 6 percent. This translates that the collection of waste will reduce drastically from only a third to a considerable proportion, according to future projections that is (Nema, 2013). With only eleven private service and quite a number of youths doing the collection/disposal, the fact speaks for itself that future solid waste in the study area will be a ticking time bomb. As from 2009, there only existed only nine and compared to the current number translates to an addition of three private service firms. This depicts a worrisome catastrophe waiting to happen. Further, even zoning/ jurisdictional coverage for collection will only serve residents willing to pay and what about the informal residents? This is a problem that necessitates a study for immediate solution. Corrupt practices in the collection/disposal also showed from the results of the field that some residents paid tokens for waste to the private service/collectors and the

youths when the collection process started, this was due to few equipment's like lorries for collection gets full quickly and since it's only a couple of them, i.e. at most four, they end up going and coming back after a week. This form of behavior has transformed the residents to pay the services twice and brought in a culture of pay to survive or collection to be done and not wait until next week for the second collection to be done which again has no guarantee that the uncollected waste from the left residency will be collected. Moreover, even the private service providers and the youth have already categorized which zones in the study area pays for the tokens and which zones refuse to pay. This forces the residents other options.

Hypothesis Three

H_0: there is no relationship between age and household waste types

H_1: there is a relationship between age and household waste types

The results from the test statistics used from the chi-square test indicated that there is a significant relationship between Age and Household Waste Types. This supports the assumption (alternative hypothesis) that there is a relationship between Age and Household Waste Type.

Kajiado County had an annual population growth rate of 5.5 percent with population in 2012 estimated at 807,069 of which 401,784 were females and 405,285 males (KNBS, 2013). However, the main urban areas in the county are Kitengela, Ongata Rongai, Kiserian, Ngong, Loitokitok, Namanga, Isinya and Kajiado. The 2012 projected urban population in the county stands at 191,827 which is 23.8 percent of the total population. (Nema, 2013).

There are a number of reasons that cause urban population growth and these vary from country to country according to the socio-economic development. Population growth trends have shown a higher degree of urbanization (percentage of population living in an urban area) in developing countries than in developed countries. To this effect, Miller (1998) stated that the number of people living in the world's urban areas has increased almost 13-fold from 200 million to 2.5 billion between 1950 and 1996. It is projected that by 2025 the population growth will reach 5.5 billion and about 90% of this urban growth is expected to occur in developing countries. Miller estimated that every day, roughly 150 000 people are added to the urban population of developing countries. The complicating factor to the urban population growth is the fact that the growth occurs in

cities which already have trouble in supplying their residents with water, food, housing, jobs, sanitation and basic services. Urban population growth is generally caused by the migration of people from rural to urban areas with the aim of enjoying better employment opportunities, improved food supplies, better sanitation, higher incomes, access to health care and emergency services and educational opportunities. As a result, towns and cities find difficulties in creating infrastructure and services that can keep pace with the fast growing urban population. Consequently, living and environmental conditions deteriorate as unplanned informal settlements without basic services are mushrooming (Tannerfeldt, 1995; Miller, 1998). This has put a strain on the conventional municipal service systems, in particular solid waste collection. Miller (1998) has stressed, that urban growth is fueled by government policies that distribute most income and social services to urban residents, especially in capital cities. Miller's argument is true in most parts of the developing countries. However, in contrast to above remarks, in the study area, proximity to the city Centre and affordable means of living conditions were the main reasons for fast growing population which have added to the already increasing population.

Furthermore, the youthful population was at 215,707 in 2009 making 31.4 percent of the total county population. Females were at 52.7 percent compared to males at 47.3 percent. Population was projected to reach 281,929 in 2015 and 313,854 in 2017. Also, the child bearing age group which was at 178,547 females in the year 2009 in this age group and is projected to reach 259,786 in the year 2017. The females of reproductive age are 52.2 percent of the total female population in the county. Moreover, the county's productive population stood at 385,514 in 2009 and is projected to reach 560,923 in the year 2017. The group constitutes 56.1 percent of the total population. Male are more (50.06 percent) compared to females (49.94 percent), (Nema, 2013).

The aged population group was at 15,347 in the year 2009 and is projected to reach 22,329 in the year 2017. The group constitutes 2.2 percent of the total population. Most of the aged are females constituting 53 percent of the total. This large increase of aged population may increase the dependency ratio. And majority of them reside away from the Ward (Nema, 2013).

Buttressing the above point is the fact that, the youthful population, the child bearing age group, the county's productive populations consequently increases with the projections. This resonates with the county's waste generations rates. The absence of such data is a

big problem that necessitates a study for immediate solution, not only in Kajiado County but also the entire nation at large. Interestingly the above age groups populations are directly related to the generation of waste in the county. More so for the child bearing age group, and the productive populations at the household level and partly as well for youth population group.

However, in the study area, majority of the respondents were between Ages 21-50, depicting a blend of all the three age groups i.e. 15-60. And from this groups, nearly half of the respondents had an average of five household members, thus translating to more waste being generated at the household level, whereas, more than half of the respondents were either living alone or in pairs and working in Nairobi. This was mainly within the town Centre of the study area.

Consequently, young people have been found to litter more than older ones and males more than females and people who are alone litter more than those in groups (Bell *et al.*, 1990). People from the rural areas are more likely to litter than the urban residents, but the latter are less likely to comply with litter regulations than visitors (Viljoen *et al.*, 1987). The lack of interest in the environment creates a culture of non-participation of communities in decision making processes. That stance enhances lack of responsibility for pollution and waste issues. Ultimately this produces communities that have little knowledge of or concern for their impact on the environment (DEAT, 1996).

In addition, quite a number of studies exists, one in particular was by (Grover, *et al* 2014), on the rate of generation of household solid waste in the developing countries is increasing with an increase of population, technological development, and the changes in the life styles of the people which is posing a great environmental and public health problem. Therefore, the study was conducted in Dehradun city, India; to find out the correlation among residential solid waste generation, family size and income. The study covered 100 houses with different socioeconomic levels such as income level and family size.

There were six components of solid waste; food waste, paper, polyethylene, plastic, glass and metal which were evaluated in the study. Based on monthly income, generation of food, paper, plastic and glass waste showed nonsignificant positive correlation while non-significant negative correlation was found with polyethylene waste. Further, residential waste generation such as food, paper, plastic and metal showed significant positive

correlation with family size whereas generation of glass and polyethylene waste showed non-significant positive correlation with family size. Conversely, Age of the residents was not included in the socio-economic bracket. However, in contrast to (Grover, *et al* 2014) another study by (Poswa, T.T (2001), demonstrated that the purpose of his study were twofold. Firstly, the effect of the social dimensions of households on solid waste practice was investigated in order to examine relationships between socio-economic status and current solid waste practices. Secondly, a waste stream assessment was carried out to examine waste generation and composition trends among different social status residential urban areas. However, the study's finding were that, the understanding of the relations within households is vital for planning appropriate, effective and sustainable solid waste service programmes /systems. Gender relations, age, educational status and income are significant factors to be considered in planning and effectively operating solid waste management plans.

Further, the study observed, that the age of respondents appeared to be related to a number of waste management issues such as street cleaning and litter. That the no concern for street cleaning and litter increased disproportional with age. To this end, the study has noted that youth were less concerned about clean streets and litter. Contrary to this, there was a marginally difference between those who expressed concerned for the clean environment and those who showed no concerned as the age increases. On the basis of these findings, it was concluded that the younger persons in the study area had less regard for the environment while the elderly people were split in two with the majority in favor of clean streets and litter free environment.

The lack of interest among the young age groups was attributed to the fact that young people in most societies often have little sense of responsibility, as they assume that someone else will take care of problems such as environmental issues. The older people who showed no interest might be due to their generally inactivity and thus lose interest in community issues (National Progressive Primary Health Care Network (NPPHCN), 1999). Moreover, the study conceded, that it has been suggested that past experiences of older people living in developing communities where local governments failed to provide adequate waste collection and street cleansing services had forced people to accept the fact that they live in degraded environments. The resultant effect of such experiences is a negative interaction between people and the environment (Byrne, 1996; DEAT, 1997).

Poverty, unemployment, overcrowding and lack of resources (Sapsford and Jupp, 1996) exacerbate this. Further, the lack of participation in community development is likely to result in the loss of esteem with the resultant feeling that an individual can play a limited or no role in changing the external environment (DEAT, 1997). This sense of frustration and alienation is worsened by the neglect shown by modern society towards older and more inactive citizens, and which often focuses its attentions and resources on the young (NPPHCN, 1999). In addition to, the study also conceded that the analysis of the study has brought to light the importance of gender attitudes in the planning of waste management systems in particular domestic solid waste services. The issue of gender is often seen as an aspect that is only addressed for political reasons. It has received little or no serious attention in waste management planning. In spite of the proportionally high numbers of women workers in most municipal cleansing services and community-based collection services, decision-makers, planners and waste managers have ignored the effect of gender in the rendering of waste management services.

The effect of different perceptions of men and women in the family settings needs to be understood in order to design effective and sustainable domestic waste management service programmes. The significance of such understanding is that men and women, including boys and girls, are engaged in different waste related activities such as managing resources within the household/family; formal municipal collection services; recycling or private enterprise for different reasons. Lastly, he concluded that, older people are more willing to participate in recycling of waste as compared to the younger generation.

Therefore with all evidence portrayed in the explanations above there is strong relationship between age and household waste types in the study area. However, data collected from the field supports the effects with the test statistics applied.

The challenge in waste management emanates from the various levels of handling waste from the individual, household and community levels (Puopiel, 2010; Otchere *et al*., 2014; Puopiel & Owusu-Ansah, 2014). Issues of collection/disposal becomes again a whole scenario with projection of the three Age groups expected to rise and with the situation not changing i.e. one dumpsite which is already full begs the question, who will be mostly affected? How we are better custodians of the concept of sustainable development, if we do not think or foresee a better environment for the next generation?

The results from the study area have clearly demonstrated the dire condition Kitengela Ward is facing, Kajiado County and the entire nation at large concerning the effects of solid waste. If the issues of solid waste in Kitengela is not treated with the seriousness it deserves as seen in Nairobi then, its increase curbed, opportunities that would have otherwise been avoided for its effect will become foreclosed due to environmental complications.

CHAPTER FIVE
SUMMARY OF THE FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

The findings of the study were mostly centered on Households in the study area as the unit of analysis. However, due to financial constraints and time of the research project, it was unlikely that the study would have solved all the problems associated with the study area. Furthermore, the study only identified in reference to the first objective in chapter one, determined sources contributing to solid waste in Kitengela i.e. types of waste generated in commercial establishments e.g. Markets, Slaughterhouse and industries in the study area.

Among the summary of the research findings upon which the conclusions and recommendations of the study were made are; firstly, starting with household waste types affects solid waste management. The results from the test statistics used from the chi-square test indicated that there is a significant relationship between Household Waste Types and Solid Waste Management. This supports the assumption that Household Waste types such as organic (food materials), plastics, metals, and polythene affects Solid Waste Management in the study area. In that, household waste type such organic (food materials), plastics, metals, and polythene affects Solid Waste Management in terms of pollution to the environment, diseases and health hazards brought about by pollution and uncollected waste in the study area, degredation of the environment with plastic paper bags and lastly extinction of species especially birds e.g. cranes(birds) feeding on waste.

Secondly, again results from the test statistics used from the chi-square test indicated that there is a significant relationship between household waste types and the reasons for household disposal preference method. This supports the assumption that there is a relationship between Household Waste types and the reason for Household disposal preference method. This is better understood by the easiest mode of disposal in the study area is by the use of plastic paper bags which is evident in the study area. This makes waste degrade the environment.

Lastly, the results from the test statistics used from the chi-square test indicated that there is a significant relationship between age and household Waste Types. This supports the assumption that there is a relationship between age and household Waste Type.

The population of in the study area is composed of the youth population, the child bearing population and the county's productive population are on the majority as compared to older population. This means that generation of waste is increasing with the population and that household waste type such organic (food materials), plastics, metals, and polythene are generated more in the study area.

In addition to, the summary of the findings, the study also sort to answer the questions of the research project that are in chapter one. Moving on, the first question, what were the sources that contribute to solid waste in Kitengela? In reference to chapter 5 of the research project, results from the field indicated/illustrated that among the sources that contributed to waste in the study area were from Households and commercial establishments in the study area. Further, most of the waste were organic representing most of the share.

Furthermore, among the methods of solid waste disposal in Kitengela, results from the field supports the assumption of poor method of disposal/collection. However, methods of collection/disposal from the households was mainly through plastic bags and then transported to the dumpsite of which majority of the residents use dumpsite as compared to incineration and burning. Moreover, the dumpsite that is supplementing the entire study area is already full and its only one.

And lastly, barriers of solid waste management in Kitengela, was supported by results as indicated/illustrated in chapter 5. Among the results from chapter five of the study, in relation to barriers of solid waste in this research project, were, personnel for waste management(private service providers and the youth), poor infrastructure, uneven collection of waste, culture in relation to generation of waste, the county council if they are adequately equipped and in terms of their expertise, support from the community in terms of participation, community awareness and sensitization, service provision by those charged with responsibility on solid waste management in Kitengela .i.e. Corrupt practices and are there cases of overlaps among service providers in terms of jurisdiction on collection of solid waste in Kitengela.

5.1 Conclusions

From testing the study's hypothesis and the findings of the results from the field in chapter five, the study however, concludes that the assumption of effects of solid waste in Kitengela Ward has held up and it's true. Furthermore, Solid Waste Management is in dire situation in the study area.

On the other hand, besides infrastructure being both the physical and organizational capabilities in relation to waste management; they are very poor, such that the illustration of the study concerning sewage situation in Kitengela Ward is nonexistence and other means supplementing the sewerage connectivity/system is no close to bringing a solution. Furthermore, communal method of disposal is the most predominant method of solid waste management system in the study area and collection is poor, but the system is gradually paving way for the door-to-door service which runs second in the Ward through the private services providers and the youth. Moreover, these forms of problems are compounded by inadequate proper storage receptacles, unavailability of community storage receptacles and long distance discourages dumping at site. Issues of none re-use of waste in most households contributes significantly to massive waste generation of which less is collected by private service providers and the youth i.e. only a third of waste is collected.

Consequently, the non-availability of land properly selected and demarcated for use as dump site resulted in all manner of improper disposal , inhabitants still practice improper disposal from nearby bush to open dumps due to lack of enforcement of regulatory policies and programmes irrespective of income levels. And lastly, the need to improve public awareness of, and community participation in, waste management has been widely recognized by researchers as necessary to create sustainable waste systems and to promote environmental citizenship amongst community members (Lumbreras Martín and Fernández García, 2014). Typically, people are more likely to participate in waste management activities, for example recycling, when they observe others in their vicinity recycling. In developing countries recycling programs are rare, so wealthier members of the country rely on informal recyclers as the behavior norm (O'Connell, 2011). The results of a study done in Malaysia by Aini and colleagues (2002) indicated that, in order to overcome the solid waste crisis, the "conscience of the individual needs to be raised through environmental awareness and concern, inculcation of sustainable consumption practices and education on waste management." Environmental awareness and

knowledge about environmental conservation were found to affect recycling attitude positively but positive attitude may not have resulted in recycling if knowledge about it was poor (Aini *et al.,* 2002), so waste managers need to take steps to help align the information presented to the public with the knowledge these individuals already have.

5.2 Recommendations

Notwithstanding the general problem with waste management at the household and community level and its impact for the entire Ward, solutions to these problems are very real and achievable. To this end, the study makes the following recommendations;

5.2.1 Recommendations for policy;

No existing bylaws on solid waste management in the study which is a worrisome. Clear bylaws should be enacted and stiffer penalties to regulate the dire situation that is present in Kitengela Ward. A good example that happened recently was; In the Gazette notice No. 2356, of 28th February, 2017, The Cabinet Secretary, Ministry of Environment and Natural Resources while exercising powers conferred under section 3 and 86 of the Environmental Management and Co-ordination Act (EMCA Cap 387), notified the public that with effect from six months from the date of the notice, banned the use, manufacture and importation of all plastic bags used for commercial and household packaging. Such a law clearly demonstrates that there is still some hope for being optimistic of our environment and doing something that is right in our conscious which will benefit everyone now and in future generations to emulate the same and rise the hope of protecting our environment and its importance.

No Public Health Officer in the study area, the nearest public health office is in the Kajiado which is far. There needs to be a public health officer within the study area.

The need to improve public awareness of, and community participation in, waste management has been widely recognized by researchers as necessary to create sustainable waste systems and to promote environmental citizenship amongst community members.

5.2.2 Recommendation for Future Research;

The Case for Motivation; Poverty levels in Kenya are 44-48% (living below a dollar a day). 60% of population in urban/peri-urban areas live in Informal settlements. With one in five youth below 25 unemployed, an efficient waste management value chain would

be the miracle cure for waste management at the Micro level - create jobs, manage waste. This resonates within the study area, quite a number of youths will get employed through this process.

Waste Management Value Chains; speaking of value chains, 50-60% of solid waste is organic in the study area. We haven't seriously looked into recycling as a value chain - only 3-5% of plastic is recycled, despite 80% of all plastics in Kenya being recyclable. Dried organic manure retails for Kshs1200 to Kshs 3000/- a ton - half of Nairobi's output of 2000 tons (theoretically) is worth 1.2 million Kenya Shillings. PER DAY.

Refuse Defined Fuel**;** Most research have been done on composting as a solution for organic solid waste however, toxic organic waste that cannot be used as organic fertilizer but instead can be used to make excellent raw material for charcoal briquettes.

Going Micro; With the Kampala example in chapter two of the study. Dumping in the study area is on a micro level on illegal dumpsites. Why fight the prevailing mentality? Why not process and manage at the micro level? Push un-recyclables higher up to the landfills (reduced tonnage, reduced transport costs, reduced landfills).

Going Tech**;** Transport accounts for a large portion of garbage disposal costs. Nairobi County has tested route optimization using geolocation and big data to reduce garbage runs and transport costs. How about using the geo-location and big data to optimize the entire garbage value chain? A view of the bigger picture always presents better opportunities.

At the moment in reference to county integrated development plan 2013-2017 (GOK,2013), there are well elaborated plans that up to date no progress has been done so far, some of the plans are in relation to the construction of sewage system, better dumpsites of which no further actions have taken forth. The residents of the county especially Kitengela Ward are waiting to see if anything will be done. Therefore this study recommends that such plans need not to be on paper but rather evidence of actions done for the betterment of the county at large.

The development of a properly engineered landfill site at a suitable location as the current location encourages indiscriminate waste disposal as a result of distance and cost.

The allocation of skips should be based on the populace and not the size of an area as most researchers prove a strong positive correlation between waste generated and population particularly within the area. This is in reference to both Households and in the central business department whereby it will control the culture of littering and create a positive consciousness concerning waste.

Lastly, waste segregation would encourage reuse and facilitate recycling and more importantly reduce the volume of waste that is transported to final disposal site.

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APPENDICES

APPENDIX 1: TRANSMITTAL LETTER

ABDIRIZAQ EDDLE IBRAHIM

UNIVERSITY OF NAIROBI

NAIROBI.

Dear Respondent,

RE: DATA COLLECTION

LETTER TO RESPONDENT

My name is Abdirizaq Eddle Ibrahim, an M.A student at the University of Nairobi in the Department of Geography and Environmental Studies. I am carrying out a research on ‘‘EFFECTS OF SOLID WASTE MANAGEMENT IN KAJIADO COUNTY. A CASE STUDY OF KITENGELA WARD’’

I will be very grateful to you if you can spare and sacrifice your time to provide information relating to the questions below. Kindly note that the information you give will be treated with utmost confidentiality and will be used for the purpose of this research only.

Thank you in advance for your time and effort.

Yours Faithfully,

ABDIRIZAQ EDDLE IBRAHIM (STUDENT)

APPENDIX II: QUESTIONNAIRE FOR HOUSEHOLDS

Questionnaire No…….

Date ……..

"EFFECTS OF SOLID WASTE MANAGEMENT IN KAJIADO COUNTY. A CASE STUDY OF KITENGELA WARD''

1. **Background Information**
   Put across (x) or a tick (√) against the appropriate option

A. Gender Male( ) Female ( )

B. Age

1. Below 20 years ( )
2. 21-30 years ( )
3. 31-40 years ( )
4. 41-50 years ( )
5. Above 51 years ( )

C. Level of education

1. Education Attainment

1. Primary ( )
2. Secondary ( )
3. Post-secondary ( )
4. Graduates ( )

D. Occupation

1. Unemployed ( )
2. Employed ( )
3. Self-employed ( )
4. Other specify……

E. Ethnic Group

1. Maasai ( )
2. Luo ( )
3. Kikuyu ( )
4. Kenyan Somali ( )
5. Other (specify) ……..…..

Section One; Sources of Solid Waste in Kitengela

F. What is your main type of waste material you generate?

a) Organic(food materials) ( )
b) Plastics ( )
c) Metals ( )
d) Polythene ( )

g) Which are other waste materials you generate at household level
---

h) Are there other sources of solid waste in the area other than the household?
1 Yes ( ) 2 No ( )

(i) If Yes above, which one?
1 River ( )
2 Industry/company ( )
3 slaughter houses/Animals waste ( )
4 markets
5 Other (Specify)…….

If YES in above options, please tick the types for other sources of waste generated in the table below?

Type of Waste	Slaughter house	Industry	Markets
Organic			
Metal			
Polythene			
Plastics			

Section Two; Methods of solid waste disposal in Kitengela?

G. Which types of solid waste collection/disposal methods are available in this area? (*Tick multiple if more than one)*

a) Burning ( )
b) Incineration ( )
c) Dumpsites ( )
d) Other (Specify) ……

H. At household level which is your method of solid waste disposal……

I. Why do you prefer the above solid waste disposal method at household level?
……
……
……

J. Are there organizations/ firms that engage in solid waste disposal/ collection in the area?

Yes ( ) No ( )

i). If Yes, which ones are they? (*Name)*

a. Private firms ( )
b. Youth groups ( )
c. Household/estate associations ( )
d. Other (Specify).....

ii). If No explain.....

J. In case organisations/firms exist, how much do you pay for solid waste disposal per month?

a) Free ( )
b) 1-100 ( )
c) 101-200 ( )
d) 201 ( )
e) > 301 ( )

K. Are there periods when you are required to pay more than above.
1. Yes ( ) and 2. No ( )
If yes please explain…….

L. Please indicate how often solid waste is collected in your household

a. Once in a week { }
b. Twice in a week { }
c. Not at all { }

M. What do you understand by proper solid waste management? Kindly give examples.....
.....
.....

N. What are the problems of solid waste management in this area?
.....
.....
.....
.....
.....

O. How can the problems of solid waste management be solved?

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

How many dumpsite(s) are there in Kitengela Town?

……..……

P. Suggest on how the dumpsite(s) can be improved?

……..……
……
……

Q. Rate sewerage connectivity to households in Kitengela Town

1. Adequate { } 2 .Inadequate { }

R. Please explain your answer in above……
……
……

S. Do you think the facilities (household solid waste collection facilities) are distributed equally (adequate) in all areas of the municipality?

1 Yes { } 2 No { }

T. If No in above question, please explain……
……
……

U. How is solid waste transported from your estate to the dumpsites/landfills?

1 Lorries/Motor vehicle { } 2 Porters { }

3Wheelbarrows { } 4 Other (Specify).....

Section three

Effects of solid waste management on institutions and households in Kitengela

V. Are institutions adequately equipped to handle solid waste in kitengela…….

W. How effective are institutions engaged in solid waste management in kitengela

1. Effective ( )
2. Very effective ( )
3. Not effective ( )

w. If 1 or 2 above explain …….

X. What are the challenges facing these institutions that handle solid waste in Kitengela……..

1. Finances ( )
2. Staff capacity( )
3. Corruption ( )
4. Insufficient dumpsites ( )
5. Other (specify)…….

Y. What is your opinion on the effects of waste status of the environment?

I. Good ( )
II. Fair ( )
III. Poor ( )

Z. What are the negative effects of solid waste disposal methods you use? (*probe for pollution, diseases, degradation, extinction etc*)……
……
……

Section C; Barriers of solid waste management in Kitengela?

1. What can you say about the personnel for waste management (i.e. private service providers and the youth), given the large population that results in the generation of waste?

……
……
……

2. Does poor infrastructure in Kitengela encourage poor solid waste?

1Yes 2 No

Please explain your answer above……
……

3. Do you think that uneven collection of waste i.e. services paid for collection of waste are accommodative to everyone? Explain

……
……

4. What is your opinion concerning culture in relation to the generation of solid waste?

.....

.....

.....

5. In respect to the local authority that is concerned with solid waste in Kitengela, do you think they are adequately equipped in terms of expertise in solid waste management?

Yes ( ) No ( )

6. Explain your answer above

……

……

……

……

7. According to you, is there support from the community in terms solid waste management (*probe for participation?*)

.....

.....

8. Do you think there is need for community sensitization and awareness on solid waste management in Kitengela?

If NO, above what are the mechanisms or methods to do this?

……

……

……

9. What can you say about service provision by those charged with responsibility on solid waste management in Kitengela? (*Probe for corrupt practices among service providers*).

10. Are there cases of overlaps among service providers in terms of jurisdiction on collection of solid waste in Kitengela?

APPENDIX III: OBSERVATIONS SCHEDULE FOR KITENGELA TOWN

Availability	YES	NO	Very good	Good	Fair	Poor	Very Poor
Garbage bins/ poly-thene							
Irresponsible deposits of garbage/solid waste							
Open sewers							
Septic tanks							
Sewerage system							
Town landfill/garbage deposits							
Tracks in the area							
Adverts on safe solid waste disposal							

APPENDIX IV: KEY INFORMANT INTERVIEW SCHEDULE (Community groups, Local Authority, Private Service Providers, and Estate Agents)

A. **Sources of Solid Waste in Kitengela.**

1. What are the main types of waste material generated in this area
2. Which are waste materials household generate in this area
3. Are there other sources of solid waste in the area other than the household (*probe for environmental sources-animals and rivers)*

B. **Methods of solid waste disposal in Kitengela?**

1. Which types of solid waste collection/disposal methods are available in this area
2. At household level which is your method of solid waste disposal
3. Are there organizations/ firms that engage in solid waste disposal/ collection in the area? Which ones are they? (*Name*
4. In case organisations/firms exist, how much does each household pay for solid waste disposal services per month? Are there periods when you are required to pay more than above.
5. What are the problems of solid waste management in this area? How can the problems of solid waste management be solved?
6. Approximately how many dumpsite(s) are there in Kitengela Town?
7. How do you define the distribution facilities of solid waste collection at household level?
8. How do you transport solid waste from this estate to the dumpsites/landfills?

C. Effects of solid waste management on institutions and households in Kitengela ?

1. In your assessment what can you say about institutions that handle solid waste in Kitengela (probe for effectiveness and challenges)

2. What is your opinion on the status of the environment as far as solid waste management is concerned?

3. What are the effects of solid waste disposal methods that are used in this area?

D. Barriers of solid waste management in Kitengela?

1. What can you say about the local service providers (probe for personnel emoluments, capacity) as compared to the large population in the area?
2. In terms of infrastructure in Kitengela, what is your opinion in relation to solid waste management?
3. What is your take on payment for services of solid waste collection by households in Kitengela?
4. What is your opinion concerning different cultural groups/communities in relation to the generation of solid waste?
5. In respect to the local authority that is concerned with solid waste in Kitengela, explain whether they are adequately equipped in terms of expertise in solid waste management?
6. According to you, what can you say about this community in terms of support to solid waste management (*probe for participation, sensitization and awareness?*). What methods do you suggest will be appropriate to achieve this?
7. What can you say about service provision by those charged with responsibility on solid waste management in Kitengela? (*Probe for corrupt practices among service providers*).
8. In terms of cases of overlaps/ conflicts/duplications among service providers concerning jurisdictions on collection of solid waste in Kitengela, how do you handle them?

APPENDIX V: TABLE OF FINDING A BASE SAMPEL SIZE WITH +/- 5% MARGIN ERROR

Table for finding a base sample size with +/-5% Margin Error

	Variability				
Population	50%	40%	30%	20%	10%
100	81	79	63	50	37
125	96	93	72	56	40
150	110	107	80	60	42
175	122	119	87	64	44
200	134	130	93	67	45
225	144	140	98	70	46
250	154	149	102	72	47
275	163	158	106	74	48
300	172	165	109	76	49
325	180	173	113	77	50
350	187	180	115	79	50
375	194	186	118	80	51
400	201	192	120	81	51
425	207	197	122	82	51
450	212	203	124	83	52
500	222	212	128	84	52
600	240	228	134	87	53
700	255	242	138	88	54
800	267	252	142	90	54
900	277	262	144	91	55
1000	286	269	147	92	55
2000	333	311	158	96	57
3000	353	328	163	98	57
4000	364	338	165	99	58
5000	370	343	166	99	58
6000	375	347	167	100	58
7000	378	350	168	100	58
8000	381	353	168	100	58
9000	383	354	169	100	58
10000	385	356	169	100	58
15000	390	360	170	101	58
20000	392	362	171	101	58
25000	394	363	171	101	58
50000	397	366	172	101	58
100000	398	367	172	101	58

Source: Watson, 2001 http://www.extension.psu.edu/evaluation/pdf/TS60.pdf (accessed last 20/06/2013).