FACTORS INFLUENCING MANAGEMENT OF HAZARDOUS SOLID WASTE IN OBUNGA AND MIGOSI RESIDENTIAL AREAS IN KISUMU COUNTY, KENYA

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A Research Thesis Submitted in Partial Fulfilment of the Requirements for the Award of the Degree of Master of Science in Environment and Natural Resource Management in the Department of Environment and Natural Resource Management, School of Science and Technology of Africa Nazarene University

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DECLARATION

I declare that this document and the research that it describes are my original work and that they have not been presented in any other University for academic work.

_____ _____

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17S03DMEV001

This research was conducted under our supervision and is submitted with our approval as University supervisors

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DEDICATION

This thesis is dedicated to my wife Cammelyne, daughters Tracy and Clare, and son Travis for their emotional support and spiritual, psychological, and other forms of support accorded to me that largely contributed to the successful conduct of this paper.

ACKNOWLEDGEMENT

First and foremost I want to appreciate my God, who made everything possible, it was by his grace, mercy and love that I come this far. Special thanks to my two supervisors: Dr. Mark Ndunda Mutinda and Dr. Stanley Maingi Makindi for their tireless effort towards achievement of this proposal. I also acknowledge my friend Muchoki for the personal assistance with the typing work during this proposal development.

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ABSTRACT

Hazardous-solid waste management, (HSWM) is the collection, treatment, and disposal of waste material that, when improperly handled, can cause substantial harm to human health and safety or to the environment. The main purpose of the study was to assess the selected factors influencing management of hazardous solid waste in Obunga and Migosi estates in Kisumu County, Kenya that was guided by the following specific objectives: (i) To find out the influence of knowledge on the HSWM (ii) To determine the influence of socioeconomic factors on the HSWM (iii) To establish the influence of social institutions on the HSWM and (iv) To examine the influence of infrastructure on the HSWM and (v) to determine the combined influence of the independent variables on the management of hazardous solid waste. The study used descriptive research design. The target populations of the study was the residents of Obunga and Migosi estates living in 1637 households. A stratified random sample of 326 households were surveyed using a structured questionnaire. Descriptive (means, standard deviation and frequency distribution) and inferential (regression) statistics were used to analyse the data. The results of the study indicate that the households' management of hazardous solid waste was low (Mean of 1.71 on a scale of 1 to 5). Household heads' knowledge of waste management was high (mean of 3.60 on a scale of 1 to 5). The management of hazardous solid waste in the study area was statistically significantly ($p< 0.05$) influenced by household heads' knowledge ($\beta=0.796$, $t(325)=14.45$, $p <0.001$), socio-economic factors ($\beta=0.718$, $t(325)=11.53$, $p <0.001$), social institutions dealing with solid waste management ($\beta=0.774$, $t(325)=13.45$, $p <0.001$), and infrastructure involved in solid waste management ($\beta=0.754$, $t(325)=16.35$, $p <0.001$). The combined model showed that infrastructure ($\beta=0.378$) was the most important variable followed by socio-economic factors ($\beta = 0.355$), knowledge ($\beta=0.288$, and finally social institutions ($\beta=0.224$). The social institutions dealing with waste management were found to be overcharging the residents and finally it was established that infrastructure was a major challenge to proper waste management in the region since the County did not a proper dump site and lacked equipment for handling wastes. The study therefore recommends the following: all the stakeholders (county government, the non-government agencies on environment and the local residents involved in the management of wastes) to try and create proper awareness of the dangers of hazardous solid wastes to the community and the environment, train households on proper handling of wastes (separation of wastes, storage, treatment and disposal), creation of public private partnerships that will deal with waste management at a lower cost. Finally, the study recommends for further studies on hazardous liquid waste such as sewer system, overflowing septic tanks and oil spills from the oil depots at the port area.

DEFINITION OF TERMS

Hazardous solid waste: a solid waste that has substantial or potential threats to public health or the environment

Infrastructure: this is the basic physical and organizational structures and facility for waste disposal

Landfills: it is a site for the disposal of waste materials by burial

Municipal solid waste: Solid waste generated within urban set ups

Rubbish: waste material collected from household usage of products

Septic tank: it is an underground chamber made of concrete, fiberglass or plastic through which domestic wastewater flows for basic treatment

Sludge: thick, soft, wet mud or a similar viscous mixture of liquid and solid components, especially the product of an industrial or refining process

Wastewater: is any water that has been affected by human use

ABBREVIATIONS / ACRONYMS

CBO **:** Community Based Organization

CGK **:** County Government of Kisumu

DOE : Department of Environment

EMCA **:** Environmental Management and Co-Ordination Act

HSWM Hazardous Solid Waste Management

IPA : Innovation for Poverty Action

IPCC : Intergovernmental Panel on Climate Change

KNBS **:** Kenya National Bureau of Statistics

MDG **:** Millennium Development Goals

MSWM : Municipal solid waste management

NEMA **:** National Environment management Authority

NGO **:** Non-Governmental Organization

SCOPE **:** Scientific Committee on Problems of the Environment

SWM : Solid waste management

UN ECOSOC : United Nations Economic and Social Council

UNEP : United Nations Environmental Program

UNESCO : United Nations Education Scientific and Cultural Organization

CHAPTER ONE

INTRODUCTION

1.1 Introduction

This study assessed factors that influence the management of hazardous solid waste in Obunga and Migosi residential areas in Kisumu County, Kenya. The research variables captured in the study were knowledge of waste management, socio-economic factors, existing institutions, established infrastructure and management of hazardous solid waste. This chapter captures the background of the study, statement of the problem, purpose of the study, objectives of the study, research questions, and significance of the study, scope of the study, delimitation of the study, limitation of the study, assumptions of the study, theoretical framework and conceptual framework of the study.

1.2 Background of the Study

All Kenyans are entitled to a clean and healthy environment and must safeguard and enhance the Environment (Ministry of Environment and Forestry 2016). The local authorities are expected to maintain cleanliness and prevent nuisances; it shall be the duty of every local police to take all lawful, necessary and reasonably practicable measures for keeping its county at all times in clean and sanitary condition, and for preventing the occurrence therein of, or for remedying or causing to be treated, any nuisance or condition liable to be injurious or dangerous to health, and to take proceedings at law against any person creating or responsible for the continuance of any such nuisance or condition (GoK, 2017).

The increase in solid waste generation has not been accompanied with similar capacity to handle the waste generated in the country. Solid waste generated includes plastics, glass, ceramics, metal, leather, wood, textiles, paper and domestic organic waste (food

waste). Collection systems are inefficient, and disposal systems are not environmentally friendly making solid waste management a real challenge in Kenya. About 30 to 40 percent of all solid waste generated in urban areas is uncollected and less than 50 percent of the population is served (Igweta, 2014); he further states that up to 80 percent of collection transport is out of service or in need of repair and argues that if the issue of sustainable solid waste management in Kenya is not considered urgently, all the towns in Kenya will be engulfed in waste.

In the early days, waste disposal was not a problem as habitations were sparse and the land was plentiful. Waste disposal became a problem with the rise of towns and cities where large numbers of people started to congregate in relatively small areas in pursuit of livelihoods (Khamala 2014). In 2014, the National Environment Management Authority, Kenya (NEMA) came up with the National Solid Waste Management Strategy. The purpose of this Strategy is to guide sustainable solid waste management in Kenya to ensure a healthy, safe and secure environment for all (UNEP, 2017). The domestic solid waste is any non-putrescible waste consisting of combustible materials which come from household, arising from human activities and has no value to people who possess it (Khamala 2014).

In Kisumu city, Solid waste management (SWM) is today tackled as a delegated responsibility of the County Government of Kisumu (CGK), one of the 47 devolved systems of governments in the western region of Kenya (Igweta, 2014). The Department of Environment (DOE) executes the services under sections of; Street Sweeping, Refuse Collection and the Dumpsite Management. Besides, there are Community Based Organizations (CBOs), Non-Governmental Organizations (NGOs)

and private companies (UNEP, 2017). Estimates in Kisumu City show that about 35 organizations are involved in sorting at the source, collection, transportation, recycling, and creating awareness on SWM. It is estimated that only about 10% of the SWs are disposed of compared to Nairobi at approximately 40% (UNEP, 2017). This activity with the advent of CGK has been expanded to cover wastes generated in other county townships (such as Ahero and Maseno among others) while the main disposal site remains the 2.73 ha at Kachok dumpsite from the 1970s. This expansion though significant in its extent and characteristics has not been adequately structured and determined (Kasima, 2014).

The government of Kenya outlines the environmental requirements for waste disposal in Kenya were not enacted then (GoK, 2017). In the present time, the planning and regulation of waste management in Kisumu City is limited and cannot be qualified and quantified appropriately. The unplanned dumping site at Kachok was formalized in the 1990's when then the Municipal Council posted employees to attempt some control but with lack of regulation. The Kachok dumping started in around 1975 due to increased business within the Kisumu town and that the locals rejected the present Kibuye Market as a dumping site. The enhanced business started with the advent of the railroad that reached Kisumu (then port Florence) in 1901 (Khamala *et al.* 2014).

In 1903 the township boundaries were gazetted, and in the 1930s and 1940s, the city became a leading East African Centre for the military, investment, and administration. Some 12,000 acres, including water, was thus set aside for its development (the Republic of Kenya, 2014). It was extended to 53 km2 that included the populated Peri-urban settlements of Manyatta and Nyalenda in 1976. The town is now the third largest

in Kenya after Nairobi and Mombasa. Evidence though shows that Kachok Dumpsite was reserved for a sisal factory in the 1960s but later for public use as Government Trust Land. Surprisingly, no prevailing thought for future has been devoted to a dumpsite for Kisumu town and the environs and even for Kisumu County to date. This is common in Kenya for the counties and county important cities today (UN ECOSOC, 2015).

The city's population, on the other hand, has grown over the years. At the present growth rate of 4.74%, Kisumu's population is now estimated at 560,000 people. Dependent young people characterize it; three-quarters of who are under 30 and 43.5 percent are under 15 years old (UN ECOSOC, 2017). Today, 50% Peri-urban area houses the highest population density at 10,000 people per km2, the urban areas at 1,500 to 3,000 people and the rural areas at 170 to 680 people per km2. It covers an area of 297 km2 of land and 120 km2 under the Lake Victoria. As noted by Khamala *et al.* (2014), Nairobi population density at approximately 2.2 million is way above Kisumu City. It is the nearest City for comparison of progress and challenges of SWs management, needless to mention the other African and world cities. No area of Kisumu City today is within the high-density range of Nairobi (>30,000 people per km2) (UN ECOSOC, 2017).

The urban areas are still within the low population density of Nairobi (<5,000 per km2). The question is; at what stage is solid waste management going to be enhanced within Kisumu City and to include Kisumu County. The Kisumu Peri-urban areas population density is only at 10,000 people per km2, which is within the lower range of the Medium density population of Nairobi (5,000 to 29,000 people per km2). A study was therefore

conducted at the dumpsite to determine; the state of the Kachok dumpsite, its material and suitability to minimum standards for Kisumu Town, County and the future which is of great concern to the volume characteristics of waste, water flow and water quality, surrounding dynamics and evaluation (UN ECOSOC, 2017).

1.3 Statement of the Problem

The county government of Kisumu has embarked on a rigorous plan to manage solid waste in the urban centre of Kisumu, but the management of wastes Kisumu like many urban areas of developing countries is becoming a big problem as the administration has to grapple with increase in waste generation and an overflowing dumpsite that causes pollution from uncontrolled disposal of waste. The excessive generation of solid waste is due to the establishment of the county government in the urban centre that has promoted rural urban migration due to increased job opportunities in the urban centers causing an increase in the urban population and an increase in the amount of solid waste generated. Currently Hazardous solid waste management has remained elusive in Kisumu city. This study therefore, identified and studied some of the factors that may have caused the inability of the county government to manage the problem of solid waste in the urban centre. The study looked at household head knowledge of solid waste management, socio-economic factors, social institutions involved in solid waste management, and infrastructure used in solid waste management.

1.4 Purpose of the Study

The main purpose of the study was to assess the selected factors influencing management of hazardous solid waste in Obunga and Migosi Estates, Kisumu County, Kenya.

1.5 Objectives of the Study

The following are the research objectives that were addressed by the study:

(i) To determine the influence of household heads' knowledge on solid waste management on the hazardous solid waste management in Obunga and Migosi Estates in Kisumu County, Kenya;

(ii) To determine the influence of socio-economic factors on the management of hazardous solid waste in Obunga and Migosi Estates in Kisumu County, Kenya;

(iii) To establish the influence of social institutions related to solid waste management on the management of hazardous solid waste in Obunga and Migosi Estates in Kisumu County, Kenya;

(iv) To examine the influence of infrastructure involved in solid waste management on the management of hazardous solid waste in Obunga and Migosi Estates in Kisumu County, Kenya.

(v) To determine the combined influence of all the independent (household head knowledge of solid waste management, socio-economic factors, social institutions, and infrastructure) variables on the dependent variable management of hazardous solid waste management in Obunga and Migosi Estates in Kisumu County, Kenya.

1.5 Research Questions

The following are the research questions that were addressed by the study:

(i) What is the influence of household head knowledge of solid waste management on the management of hazardous solid waste in Obunga and Migosi Estates in Kisumu County, Kenya?

(ii) How does the socio-economic factors influence the management of hazardous solid waste in Obunga and Migosi Estates in Kisumu County, Kenya?

(iii) What is the influence of social institutions involved in solid waste management on the management of hazardous solid waste in Obunga and Migosi Estates in Kisumu County, Kenya?

(iv) How does infrastructure related to solid waste management influence the management of hazardous solid waste in Obunga and Migosi Estates in Kisumu County, Kenya?

(v) What is the combined influence of the independent factors (household head knowledge of solid waste management, socio-economic factors, social institutions, and infrastructure) on the dependent factor management of hazardous solid waste management

1.6 Significance of the Study

The study will be beneficial to the local community as well as the county government on the management of solid hazardous waste. The county government of Kisumu can take the findings as an assessment on how effective they are in the waste management and any other county can adopt the study recommendations and findings to gauge their efficiency and role in solid waste management.

1.7 Scope of the Study

The research instruments only contained questions regarding hazardous solid waste management where the respondents were given chance to express their independent opinion on solid waste management. The study engaged the residents of Obunga and Migosi estate in Kisumu County as the target respondents since Migosi is a major formal settlement in Kisumu County while Obunga is a major informal settlement in Kisumu as well with a defined population structure and definite settlement pattern. The study shall focused on the methods of handling of hazardous solid waste by both the

county government staff and the residents; it also focused on the segregation, distribution and storage of hazardous solid waste by the residents as well as treatment of the collected hazardous solid waste by the county government staff.

1.8 Delimitation of the Study

The study was delimited by the liquid waste management in Kisumu County; this is because Kisumu County has got urban centers that are not affected by the liquid waste and are not directly involved in the pollution because of lack of sewer systems. The locals in those urban centers use septic tanks and pit latrines for waste disposal and following the fact that Kisumu is generally a dry place; there is no or very little cases of overflow except for some areas in Nyando Constituency around Ahero irrigation schemes that is prone to floods like once a year (every April to May rains). The flooding in those areas is not a major health concern since those rural areas do not generate much waste to promote infection.

1.9 Limitation of the Study

The limitation of the study was that of departmental officers that are usually very few where the study found out that only two or three officers were in the office at the time of data collection. Lack of availability of the respondents were countered through use of various methods of reaching respondents at the county offices such as emails and face to face visit where the officers away on duty had emails sent to them to give them chance to participate in the study irrespective of their location. The other limitation that was faced by the study is the hostility and insecurity problems associated with informal settlement where this was countered through engagement of the area leadership such as local chiefs and member of county assembly who helped the researcher in identifying

some peer educators in the area to who assisted the researcher through the data collection process.

1.10 Assumptions of the Study

The study assumed that all participants in the study are household heads and the household heads are available for the study. The study also assumed that the household heads are knowledgeable of the waste management system in their locality. The study also assumed that the response given by the household heads will be a true reflection of the waste management system without any biasness. Further, the study assumed that the response given by the residents in Migosi and Obunga residential areas were enough to generalize on the whole population of Kisumu and would be representative of the whole country as waste management system is considered by the researcher to be the same in the whole country.

1.11 Theoretical Framework

When his highly influential Rubbish Theory, first published in 1979, Michael Thompson launched the discipline of waste studies. It remains the most comprehensive analysis on the culture of waste to date. Thompson argues that there are two mutually exclusive cultural categories that are socially imposed on the world of objects: a transient category and a durable category. However, he identifies a region of flexibility, wherein a transient object that declines in value and life span can linger in a valueless and timeless limbo of rubbish, until it is discovered by a creative individual and transferred into something deemed durable. He links stability and change on one hand, with materiality on the other, providing a rich analysis of social and cultural dynamics. His instrumental theory of rubbish draws on case studies and anthropological fieldwork

to highlight the ever-changing subtleties of object value and our complex relationship to waste.

The rubbish theory by Thompson (1979) therefore provides a platform for debate on what happens to the collected garbage or solid waste where it deals with how the county government can turn what was once value less into a more valuable property. It looks at what the poor throws away that the rich men picks and put in their pocket. It discusses the recycling and bring into use waste that are supposed to be discarded into a more meaningful property that would be bought back by the same people who threw them away as waste. It encompasses the knowledge in waste management and infrastructure such as remediation of sludge ponds and incinerators where hazardous materials can be separated from non-hazardous before destruction.

The rubbish theory is relevant for the study since it discusses the re-use of waste that has to go through the proper method of waste management. It touches on the issues of infrastructure, knowledge and the culture of waste management that has to be properly utilized to realize the theory of rubbish that advocates for the reuse of the waste that had been thrown for destruction. The theory is relevant to the study ideology on the reuse part of the solid waste; the study advocates for the proper management of hazardous solid waste through proper collection methods and proper disposal methods where it looks at the culture of the population, it looks at the customs of the population, the existing social institutions and the available infrastructure for the waste management.

1.12 Conceptual Framework

The conceptual framework in figure 2.1 gives the relationship between the independent variables and the dependent variables of the study. The independent variable knowledge captures the usage experience of the respondents where the respondents explained their experience on hazardous solid waste and how it affects their environment. The respondents were given chance to explain how they participate in the disposal of hazardous solid waste. The self-assessment part gave chance to the respondents to explain the roles they play in the hazardous solid waste management within their environment. Finally, the free response measure of knowledge involved open response where the respondents were given chances to respond on hazardous solid waste management without guidelines.

The second variable of socio-economic factors entailed the roles played by the occupation of the respondents with regard to employment status on their ability to pay for the hazardous solid waste management. The other issue addressed by the variable was on the education levels of the respondents with regard to the role it played in the management of hazardous solid waste then finally, the income level of the respondents was used to measure their ability to pay for garbage collection.

The third variable of social institution involved the engagement of religious institutions that teach their members the benefits of living in a clean environment and also take part in community services such as community clean ups. The other group was peer groupings such as the existing women group who had part of their agenda of living in a clean environment. It also focused on the civil society such the NGOs that advocate for clean environments then finally the education institutions in the area that taught basic social sciences such as pollutions to the environment, their causes and mitigation

that makes the future generations aware of the benefits of living in a clean environment without pollution.

The last objective is the infrastructure that involved the existence of sanitary landfills for damping of hazardous solid waste; the remediation of sludge ponds and the existence of incinerators for containing electronic waste in the area. Finally, the erosion control of the steepened slopes since Kisumu County is characterized by hilly areas that promote mass movements of solid waste from one place to the other during rainy seasons.

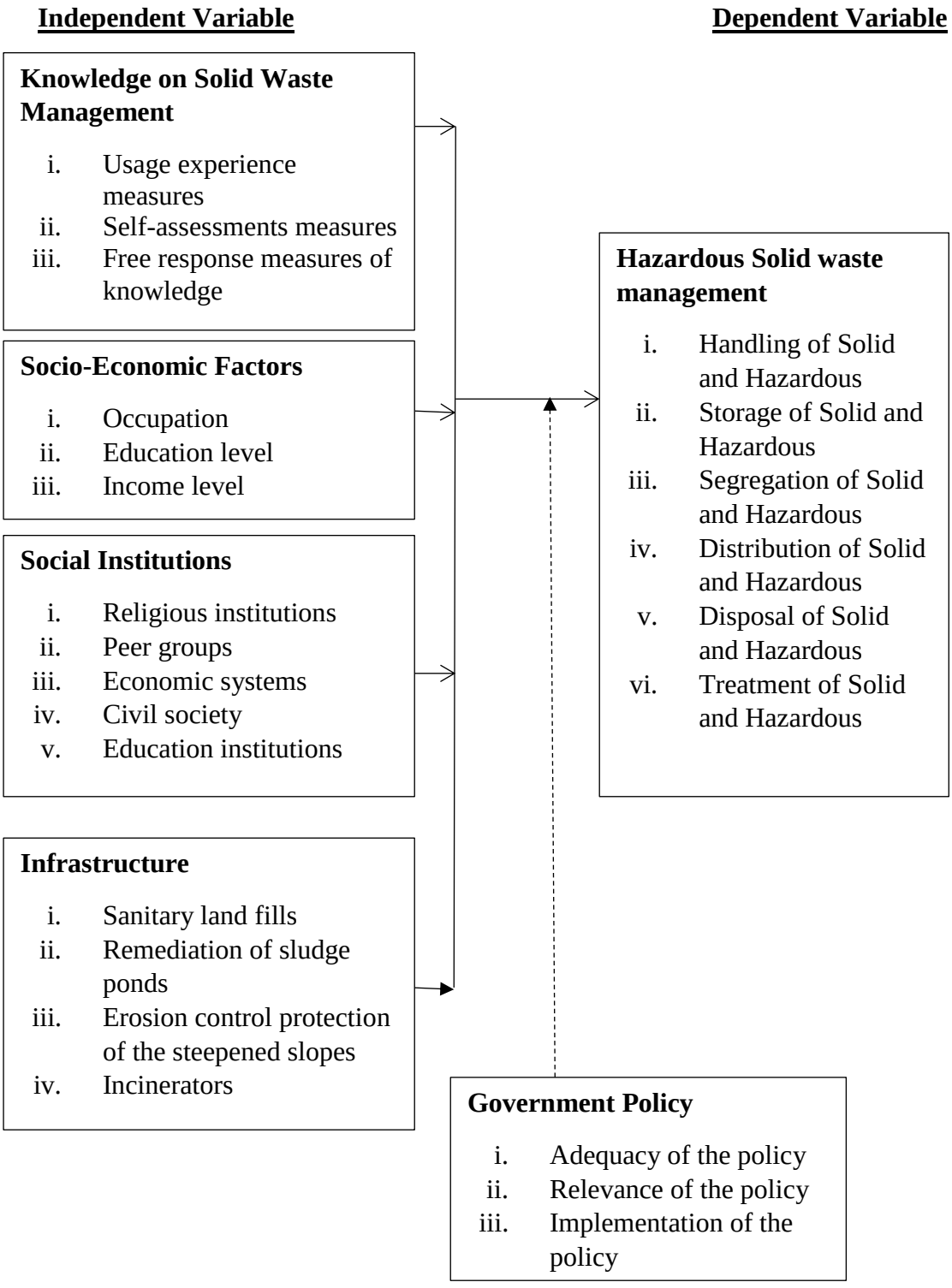


Figure 2.1: Conceptual Framework Showing the Relationship between Factors Influencing Solid Waste Management in Obunga and Migosi Residential Areas

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The purpose of the research was to assess the selected factors influencing management of hazardous solid waste in Obunga and Migosi estates in Kisumu County, Kenya. The following variables were reviewed by the study: knowledge of waste management; culture of the population; existing institutions in the region; established infrastructure in the region and existing government policy and management of hazardous solid waste.

2.2 Hazardous Solid Waste Management

Management has never been and shall never be avoided. In this way, some ancient scholars and the modern scholars in environmental management, IT and many more have dwelt in waste management with the ever-increasing industrialization activities and doubling population after every century (Greenberg, 2017).

Solid waste management is described as the control of generation, storage, collection, transfer and transport, processing, and disposal of solid wastes in manner that is in accord with the best principles of public health, economics, engineering, conservation, aesthetics and other environmental considerations, and that is also responsive to public attitudes (Gu *et al* 2015). Waste management incorporates "the collection, transport, storage, treatment, recovery and disposal of waste." Both definitions concur with Mexican scholars who view waste management as the body of actions related to waste characterization and classification, waste selection, storage and transportation, as well as its transfer, treatment and final disposal (Ravindra, Kaur & Mor, 2015).

Hazardous wastes is all wastes that have dangerous properties which include being radioactive, toxic, explosive, corrosive, flammable, and infectious or other

characteristics causing danger to human health or the environment, whether alone or together with other wastes. These wastes include drugs, wastes resulting from the manufacture of glues and adhesives, treatment of metals, waste residues arising from industrial waste disposal operations such as incineration and so on (Hou, 2017).

Solid waste is generated from a number of sources which include households (kitchen and yards), commercial areas such as hotels, shops, and eateries, industries (packaging and raw material), institutions such schools, offices, and schools, demolition sites and construction, animals that are domesticated and wild (manure, carcasses of dead animals), streets (sand, silt, clay, concrete, bricks, asphalt, residues from air deposition and dust), parks (leaves from trees, fallen branches) and unique (sewage sludge, health care, household hazardous wastes). The source and quality of waste produced influences the selection of a suitable SWM process (Hu, Li, Nguyen & Kavan, 2015).

Management of waste is intentioned to minimize the effect of waste on environment, aesthetics, or health. Waste management includes waste generation, removal of waste, and minimization of waste, transporting waste, treating waste, reusing and recycling, storing, collecting, landfill disposal, financial and marketing aspects, environmental considerations, policing and regulating, training and educating, implementation and planning. Still, management of waste practices is not identical amongst both developed and developing nations, urban and rural regions and residential and industrial sectors (Govindan, Rajendran, Sarkis & Murugesan, 2015).

Waste management in town centers in the East African region has been centralised for a long time. Municipal solid waste management (MSWM) system in East Africa that

had changed from the colonial days in the 40s, 50s and early 60s when it was efficient due to the lower urban population and the adequate resources to the current status that shows inefficiencies (Govindan *et al* 2015). The storage, collection, transportation and final treatment/disposal of wastes are reported to have become a significant problem in urban centers the composition of wastes generated by the East African urban centres is mainly decomposable organic materials based on the downtown community consumption that makes much kitchen wastes, compound wastes and floor sweepings (Burnley, Coleman & Peirce, 2015). This calls for an efficient collection system to avoid health, aesthetics and environmental impacts. The global trend of increased use of electrical and electronic goods is also evident in Kenya where E-waste is becoming a significant threat to the environment and human health in urban centers (United Nations Statistics Division 2016).

2.3 The Influence of Knowledge on the Management of Hazardous Solid Waste

Human causes the waste problem, and thus the solution is in changing that behavior, public knowledge about waste and waste management can have a positive effect on the process. Both formal and informal environmental education is vital to enhance people's experience and to change people's attitude to appreciate ecological concerns. Formal training is essential to increase awareness, improve extension services, and sensitizes people on environmental issues and to build institutional capacities. Non-official environmental education benefits people outside the formal education system. Public awareness empowers the public to develop a strong sense of responsibility for environmental issues (Burnley, Coleman & Peirce, 2015).

Technical training helps people get professional help, which also helps improve comprehensive planning in sustainable waste processes. This includes the collection

and analysis of waste data, which often lacks human resource personnel in developing countries (Gratton, 2013). As a result, there are very few waste systems experts to formulate and implement plans tailored specifically for the regions in these developing countries. The absence of human, technical resources at national and local levels with technical expertise necessary in engineering or management affects operations. Technical human resources in a host country determine the level of utility derived from expatriates and external help essential for sustainable solid waste processes Human resource capacity helps to ensure that the right plans are put in place in waste management, and priorities of funding for technology types carefully selected appropriately (Chen *et al*, 2017).

The United Nations recognizes the role played by the general population in the sustainability of the environment. It has supported the education of the masses in both informal and formal matters of the environment. It helps the development of a curriculum on environmental education worldwide. Environmental education gained recognition when the UN Conference on the Human Environment which was held in Stockholm, Sweden, in 1972, declared environmental education as must use tool to address global environmental problems. The United Nations Education Scientific and Cultural Organization (UNESCO) and the United Nations Environmental Program (UNEP) made three major declarations that have guided the course taken in environmental education (Baldé, *et al* 2015). Among the major issues addressed were the management of hazardous waste and how this information would be imparted around the world. This workshop was able to come up with a framework for education. This participation by the UN community in the production and use of scientific knowledge is considered the best approach to the management of waste. Many studies

have been conducted in the developed world to evaluate and apply strategies to reduce poor waste disposal using behavioral interventions while little has and is being done in developing countries (WHO, 2016).

The Kenya Government has committed itself to develop a National Strategy on Environmental Education and Public Awareness. It has pledged to create a National Environmental Education Curriculum examinable at the primary, secondary and tertiary levels. It documents disseminates and encourages the use of indigenous knowledge in environmental protection and conservation. It aspires to strengthen capacities for acquisition, developing and distribution of environmental information. It has established various environmental resource centers at all levels, and the government has also developed and implemented Education for Sustainable Development Policy (Ambeck, *et al* 2015).

The technical know-how continues to be a challenge in developing countries where experts on planning, operations, monitoring and evaluation of waste projects are not sufficient (Baldé, *et al* 2015). The county governments are unable to attract and pay for expertise; hence projects initiated by external consultants collapse due to lack of continuity due to knowledge gaps. A study noted that technical expertise required is lacking both at national and local regions, where training on technical background in engineering or management. Research in Kampala, Uganda depicted that execution on waste management suffered due to lack of appropriate personnel (Agrawal, Singh & Murtaza 2015). The study also discovered that managerial, technical staff and even laborers in were lacking due to inadequate training and poor conditions of service. Even laborers shun the sector due to poor perception and working conditions. The study will,

therefore, try to find out if the knowledge and technical know-how is a factor in the management of hazardous solid waste in Kenya.

2.4 The Influence of Socio-Economic Factors on the Management of Hazardous Solid Waste

Waste generation is determined by some factors such as socio-economic factors, knowledge and awareness among the citizens and many others. One of the prominent factors determining waste generation is the socio-economic status of the family. According to the American Psychological Association, socioeconomic status (SES) is often measured as a combination of education, income, and occupation. Some authors have shown that the amount of waste generated by a country is proportional to its population and the mean living standards of the people (Cózar, *et al* 2015). Household waste generation rates to income levels of people. However, it has been shown that these are not the only significant factors. Amongst other socioeconomic factors that have been said to influence household waste generation are persons per dwelling, cultural patterns, education, and personal attitudes (Andersson, 2016).

United Nations Population Division defines waste as any substance in solid, liquid or gaseous form which may be hazardous or non-hazardous, organic or inorganic, that has lost its primary value and is disposed of, or is intended to be disposed of or recycled is termed as waste. And household solid waste is said to be total waste generated by a single household unit. Many previous studies have examined household solid-waste generation and composition (Hickle, 2014). Environment problems associated with the generation of waste are part of societal changes where households play an important role. Household always had played an essential role in the waste generation, and which was affected by societal change leading to environmental problems. These societal

changes influence the characteristic of given households, including family size, social status and wealth, residential location and community status. Some studies describe the correlation between household solid-waste generation and composition and relevant socioeconomic parameters (Hu, Li, Nguyen & Kavan, 2015).

A relationship was established between waste generation and socioeconomic factors, using regression analysis. In another study, Income and population density were the variables that were said to be influencing waste handling and generation; in the research (ISWA, 2015). There is no relationship between the income of the family and waste generation. Various authors have shown that the amount of waste generated by a country is proportional to its population and the mean living standards of the people. In recognition of the importance of a reliable tool to predict the MSW characteristics, various researchers have attempted to construct models to predict these parameters. They found that relationships obtained between various parameters vary by country. This has been attributed to variations in consumer behavior and lifestyles. Although models are available to predict waste generation patterns in developed countries very little research has been done so far to develop models applicable in developing countries (Hu, Li, Nguyen & Kavan, 2015).

A study conducted was to analyses the factors that influence waste handling and generation using the variables income and population density, it was found out that income did not affect the total solid waste generated in a municipality. However, later researches were carried out and showed that there is a positive correlation between income and waste generation (OECD, 2014). It was later proved that when statistically analyzed the relationship between socioeconomic factors and waste generation and

composition: that a clear waste difference existed between the more prosperous section concerning the total and the individual components of the waste stream. In their research found that household waste generation and composition varies from one household to another. And in the same study, they found out that monthly income, average family size, number of rooms and employment status were the main influential factors in the reduction of both solid waste generation and composition (Quoden, 2014).

The positive relationship between family employment and the generation of household solid waste and a negative correlation with the education level of the family. On the contrary, there was a positive relationship between waste generated and the education level of the family member; it was argued that consumption pattern changes with a change in education level (OECD, 2014).

The analysis shows that despite many previous theories associating higher income and economic status with higher waste volume, these findings certainly did not apply in their particular study. The eating habits and family size of the residents of the study area, on the other hand, tend to influence the household weight significantly.

2.5 The Influence of Social Institutions on the Management of Hazardous Solid Waste

Local governments are usually authorized to have responsibility for providing solid waste management services, and most local government laws give them exclusive ownership over waste once it has been placed outside a home or establishment for collection. As cities grow economically, business activity and consumption patterns drive up solid waste quantities. At the same time, increased traffic congestion adversely affects the productivity of the solid waste fleet. Productivity loss is exacerbated by

longer hauls required of the fleet, as open lands for disposal are further and further away from urban centers (Cohen, IJgosse & Sturzenegger, 2013). This, therefore, brings about inefficiencies which may be corrected when the community and nearby social institutions come together and come up with a waste management system to keep their areas clean,

Globally, nations are doing all they can to solve the problem of waste management and come with a sustainable way of addressing the issue. Multiple plans of action, developed at all levels of government, are being conducted to match the growing burden. The development of citywide initiatives for waste management by social institutions is limited by the rapid pace of urban growth itself and the limited amount of financial resources available to the institutions. Filling the void, local initiatives to create urban solid waste management are playing a pivotal role in building better solid waste management systems (Aparcana & Salhofer, 2013).

German development cooperation projects now implement the outcomes of analyses and resulting recommendations for action in their day-to-day operations. In so doing, they benefit from the sectorial and cross-sectoral approach of the advisory project. In Kosovo, the government has collaborated with some social institutions to develop a training module to provide further training for employees in social institutions, local authorities and waste management companies. Similar measures are being planned for other countries. In Africa, many developing and emerging countries are faced with the significant challenge of improving their inadequate and unsustainable waste management systems, in the last twenty years, some solid waste management projects

have been carried out in collaboration with external social institutions (Cohen, IJgosse & Sturzenegger, 2013).

For example in Ghana, Some projects were successful in producing lasting impacts on the improvement of solid waste management in the country. However, many projects could not support themselves or expand further when these social institutions discontinued their support. Some technical, financial, institutional, economic, and social factors contribute to the failure to sustain the projects, and they vary from project to project (Ezeah, Fazakerley & Roberts, 2013).

In Kenya, solid waste collection systems are inefficient, and disposal systems are not environmentally friendly; a solid waste study done in Nairobi shows that about 30 to 40 per cent of all solid waste generated in urban areas is uncollected and less than 50 per cent of the population is served. Overburdened and ineffective solid waste management systems in congruence with rapidly changing consumption patterns plague the city and major towns within the country (Velis, *et al* 2012). The role of private individuals or social institutions also falls in this area. This could be either collection or supplying bins or cans. The option is limited by some local realities such as lack of proven local expertise and local entrepreneurs with the kind of capital required to manage a system effectively. There is also the question of accountability (Walker, 2018). Some private waste collectors have been known to collect waste in city estates only to dump it at the roadside away from the town. The study will, therefore, seek to find out how these social institutions affect the management of hazardous solid waste in Kenya.

2.6 The Influence of Infrastructure on the Management of Hazardous Solid Waste

Significant problems that come with urbanization in developing countries include inadequate physical infrastructure, crowding with high levels of waste, unsustainable resource consumption, and the settlement of environmentally vulnerable lands. Governmental resources to maintain and expand support in growing urban areas cannot keep pace with the rate at which urban settlements have been increasing. High levels of growth not only demand a greater degree of services but also work to depreciate infrastructure already in place (Ezeah, Fazakerley & Roberts, 2013).

Inadequate infrastructure and ineffective technologies has been a significant factor that has contributed to the inefficient and improper solid waste management system, In a study focusing on solid waste management in the developing world, it was discovered that many sources of waste might only be reached by roads and alleys which may be inaccessible to certain methods of transport because of their width congestion and elevation. This is experienced more in unplanned settlements such as slums or low-income areas, and thus they primarily affect the infrastructure selection (Finnveden *et al.,* 2012). In India, poor conditions of containers and inadequate maintenance and replacement of worn out collection vehicles contributed to behaviours such as littering and illegal dumping by citizens who felt they could not properly dispose of trash since trash bins and waste services were poorly maintained (Velis, *et al.,* 2012).

It can be argued that many African cities and Municipal councils lack the infrastructural capacity to handle both the hazardous solid waste generated daily by the ever increasing city dwellers. By extension, almost all counties in Kenya require the resources and infrastructure to manage solid waste as they struggle to fund social services in the entire

counties. In Uganda, Urban local government authorities in Uganda are responsible for solid waste management services. They, however, lack adequate infrastructure, operate in an inefficient institutional set-up, and have limited financial and technical resources (Finnveden, *et al.*, 2012). This has led to an inadequate level of provision of services. The rate of waste generation is increasing each day. According to the mayor of Kampala, about 1,580 tons of solid waste is generated per day. But only 40% of it is collected. A significant amount of solid waste is either burnt on the streets or ends up in drainage channels, marshy areas and empty plots (Chen, *et al.*, 2017).

The accumulation of solid waste also presents one of the most visible infrastructural problems in Africa, especially in South Africa. It has been shown that wear on infrastructure has rapidly depreciated capital, which has limited the ability that municipalities have to collect waste and properly dispose of it. The primary problem with urbanization in developing countries is the stress that it puts on old infrastructures operating over their designed capacities. This leads to issues with the provision of potable water, proper sanitation services, underdeveloped roadways, and the accumulation of solid waste. These stresses put pressure on environmental conditions in urban areas, which can have significant adverse impacts on fragile ecosystems (European Commission, 2016).

Like many developing country cities, Nairobi's solid waste sector, this could be taken to represent the country's situation generally, is mostly characterized by low coverage of solid waste management services, pollution from uncontrolled dumping of waste, inefficient public services, chaotic or unregulated private sector participation, and lack of key solid waste management infrastructure. In Nairobi, the capital city of Kenya of

about 3 million people, only about 25 per cent of the estimated 1,500 tons of solid waste generated daily gets collected. This is mainly due to the inadequate infrastructure available to the local government (European Commission, 2016).

2.7 Effect of Government Policy on the Management of Hazardous Solid Waste

In numerous countries, especially developed countries, measures have been instituted to reduce the number of waste products generated as well as to promote reuse of materials. In the United States, for example, a few states have mandatory statewide laws requiring industrialists to separate their wastes into recyclable and non-recyclable, and they are collected separately. Some countries need industrial waste to be sorted into various categories before collection (Cohen, IJgosse & Sturzenegger, 2013).

The French government regulates the use of certain materials, elements or energy sources to facilitate the recovery of constituent materials. Economic instruments have also been used to enhance better solid waste management. In some instances, governments have instituted solid waste pricing systems that provide continuous incentives for industries to reduce waste generation. Other incentives include tax credits to industries that use recycled materials as part of their raw materials, stabilization of markets for recyclables through price supports for the establishment of materials banks, soft loan that encourage private enterprises to implement resource recovery activities and so on. Deposit-refund system is also used in some countries to promote reuse of containers (Cohen, IJgosse & Sturzenegger, 2013).

Developing countries, especially in African and Asian continents, are still finding it difficult to manage their waste accordingly. This may be due to inadequate government policies and regulation to waste. In countries with rapid population, there is a need for

government policies to be very clear on the issue of solid waste management. There is an urgent need for competent bureaucracies for proper management of waste, especially in the growing urban centers. There is a need for services and programs that will cater to the management of hazardous chemical and biological waste (Aylor Pollard, 2012).

Since independence, the Kenyan government has come up with many policies to encourage industrialization thus promote growth in the country. All these policies have made Kenya one of the most industrialized countries in East Africa. The growth of industries in Kenya has therefore been very rapid from about 600 sectors in 1970 to 1,500 in 1990 and more than 3,000 in 2018. The manufacturing industry has been growing at an average of 9.1% per annum since independence (Cohen, IJgosse & Sturzenegger, 2013).

However, this high rate of growth implies that if the waste levels of these industries have not been subjected to adequate supervision, their impacts on the environment must be considered. It can be observed that despite the encouragement of industrial development, the government has failed to give enough emphasis to environmental protection especially hazardous solid waste. The local government act chapter 265 of the laws of Kenya 0provides the local authorities in Kenya the responsibilities of maintaining cleanliness in the areas of their jurisdiction and this include the collection of solid wastes from, among other areas, residential, industrial and commercial sectors. The act also empowers the local authorities to enact by-laws to the same effect. But the application of this act has been somewhat ineffective (Aylor & Pollard, 2012).

The Factories Act (Cap 514 of the Laws of Kenya) deals with the sectors that generate waste; compliance is mandatory for factory owners. Above all the Environmental

Management and Coordination (Waste management) regulations, 2006 prescribe the procedure for and criteria for handling waste. The Public Health Act, Cap 242 section 118 is responsible for nuisances which include accumulation of hazardous waste. This Act further specifies that appropriate handling, treatment and disposal of waste by type can help reduce costs and hence protect public health (Cavé, 2015).

2.8 Summary of Review of Literature and Research Gaps

This section summarizes the gaps identified previously as crystallized argument regarding the missing knowledge gap. Researches have failed to recognize that waste management is an environmental issue, which is significantly related to development, and that management structures must be pegged to town growth. Most studies about solid waste management have focused on big towns and disregarded the small upcoming urban centers and even estates, which are developing very fast. As a consequence, most of these towns are getting polluted with wastes due to inadequate and inappropriate methods of collection and disposal. The use of big cities could have been a significant bottleneck in seeing the whole issue in totality. The intended research was thus aimed at appraising the situation in Obunga and Migosi Estates, which are small estates.

Most studies on factors influencing waste management focused on characterization and quantification of household solid waste in a mid-level income country's city while focusing on recycling potential which is only a single waste management option out of the several existing options for sustainable solid waste management. Therefore, a study in an informal settlement in a developing country needed to be carried out, combining the characterization of household solid waste with the determinants of household's choice of waste management options. The resulting policy prescriptions in Obunga and

Migosi Estates were found to be relevant particularly after characterization of the waste and recommendation of adoptable management options.

The studies reviewed in this chapter showed that waste management is a critical environmental issue in developing countries that required to be addressed. Proper solid waste management needs a tri-sector model involving the households and industries, municipal authorities and private waste collectors and therefore with the incorporation of homes and industries in waste management a household waste reduction policy will be of great help to counter adverse effects related to poor waste management. Most studies reviewed only considered one or two sectors in the model and therefore created a gap. Table 2.2

Table 2.2: Summary of Knowledge Gaps

Year	Author	Title	Findings	Gap
2016	Ma & Hipel	Exploring social dimensions of municipal solid waste management around the globe	Global distribution of social dimensions reports on MSW management is inequitable and the research on the social dimensions of MSW management is insufficient, which may attract increased research interest and attention.	The study has not given a better understanding of the links between biodiversity/ecosystem change and human well-being
2017	Sellers	Fundamentals of hazardous waste site remediation	Availability of medical solid disposal equipment and facilities significantly affect sustainable management of medical solid waste.	The study did not properly capture developing ways to better communicate existing and newly gained scientific information so policy makers and the public are unable to understand it in order to implement the needed actions
2010	LaGrega, Buckingham & Evans	Hazardous waste management.	There are inadequacies in the implementation of regulations associated with hazardous waste management due to fragmented responsibilities among government departments and local authorities.	The study should have given more about the characteristics of households that lack access to water supply and sanitation services to better understand obstacles to expanding access
2011	Luthra, Kumar Kumar & Haleem	Barriers to implement green supply chain management in automobile industry using interpretive structural modeling	Eleven numbers of relevant barriers have been identified from literature and subsequent discussions with experts from academia and industry	Key science and technology institutions are not sufficiently mobilized to address the specific challenges of health that afflict the poorest countries. Recommend national science and technology plans including strengthening science advisory mechanisms for policy makers, promoting science education and focusing scientific investments in locally specific challenges in health, agriculture and the environment of waste.

		technique Meru Town.		
2010	Ekmekçioğlu, Kaya & Kahraman	Fuzzy multicriteria disposal method and site selection for municipal solid waste	RDF combustion is the best disposal method alternative for Istanbul. In the second stage, the same methodology is used to determine the optimum RDF combustion plant location using adjacent land use, climate, road access and cost as the criteria	The study revealed that the solid waste is still very much considered as a problem rather than a resource to be recycled or re-used, an area that requires more studies to authenticate
2015	Guerrero, Maas & Hogland	Solid waste management challenges for cities in developing countries	The outcomes of the research are a comprehensive list of stakeholders that are relevant in the waste management systems and a set of factors that reveal the most important causes for the systems' failure	This study generalized the developing world instead of focusing on a specific target area thus not so accurate results.
2014	Samuel Kerama	Determinants of useful solid waste management in Kakamega municipality	Technical factors, social factors and institutional factors influenced effective solid waste management	The researcher generalized the elements; thus no specific factors were studied.
2013	Nash	Influence of solid waste management practices on the socio-economic lives of Karai residents in	Solid Waste Management practices have a positive impact on socioeconomic lives of residents. It contributes a lot to their socioeconomic expenditure leading to improved standards of living.	The study focused on rural areas which have relatively less solid waste thus less accurate results in comparison.

		Naivasha municipality		
2014	Willy Kipkoech	Determinants of household solid waste management in Kenya.	Locations further away from the town centers were ignored in household solid waste management in the municipality compared with areas near the town center which were given more attention and infrastructure	The study only focused on the solid waste management by the households ignoring the contributions by the municipalities in the solid waste management
2014	Leme, Rocha, Lora, Venturini, Lopes & Ferreira	Techno-economic analysis and environmental impact assessment of energy recovery from Municipal Solid Waste (MSW) in Brazil	Power generation projects using landfill biogas in Brazil strongly depend on the existence of a market for emissions reduction credits.	The study is limited to comprehensive numerical data and values for measuring the environmental impact in relation to techno-economic analysis
2014	Strande & Brdjanovic	Faecal sludge management: systems approach for implementation and operation	Industries without due consideration to the proper administration of wastes is directly related to the level of pollution and environmental degradation. Poor coordination between the local authorities and industrialists led to unmonitored pollution in the town.	Information on FSM is generally not readily available, more so on integrated management of FS in urban and peri-urban areas of low- and middle-income countries.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

Chapter three covers the research design that was used in the study, it gives the research site of the study, the target population to participate in the study, the sampling procedure that was adopted and the data collection techniques to be implemented, the data processing and analysis techniques and finally the legal and ethical considerations of the study.

3.2 Research Design

The researcher adopted descriptive research design for the study. Descriptive research design was appropriate for the study based on the phenomenon of the study topic and the nature of the data collection instruments that were used in this case. Creswell (2003) defines descriptive research as the study that describes the characteristics of the phenomenon or the population being studied.

3.3 Research Site

The research site for the study was Obunga and Migosi estates in Kisumu urban centre in Kisumu County. Obunga estate was selected due to its informal settlement nature while, Migosi estate was selected for the study due its formal settlement. The two estates are also old in the town. Kisumu urban centre was purposively selected for study this study as a fast growing urban centre with a rapid expanding population due to fact that it is the headquarters of the County. The location of the research are in Kisumu urban centre is shown in Figure 3.1.

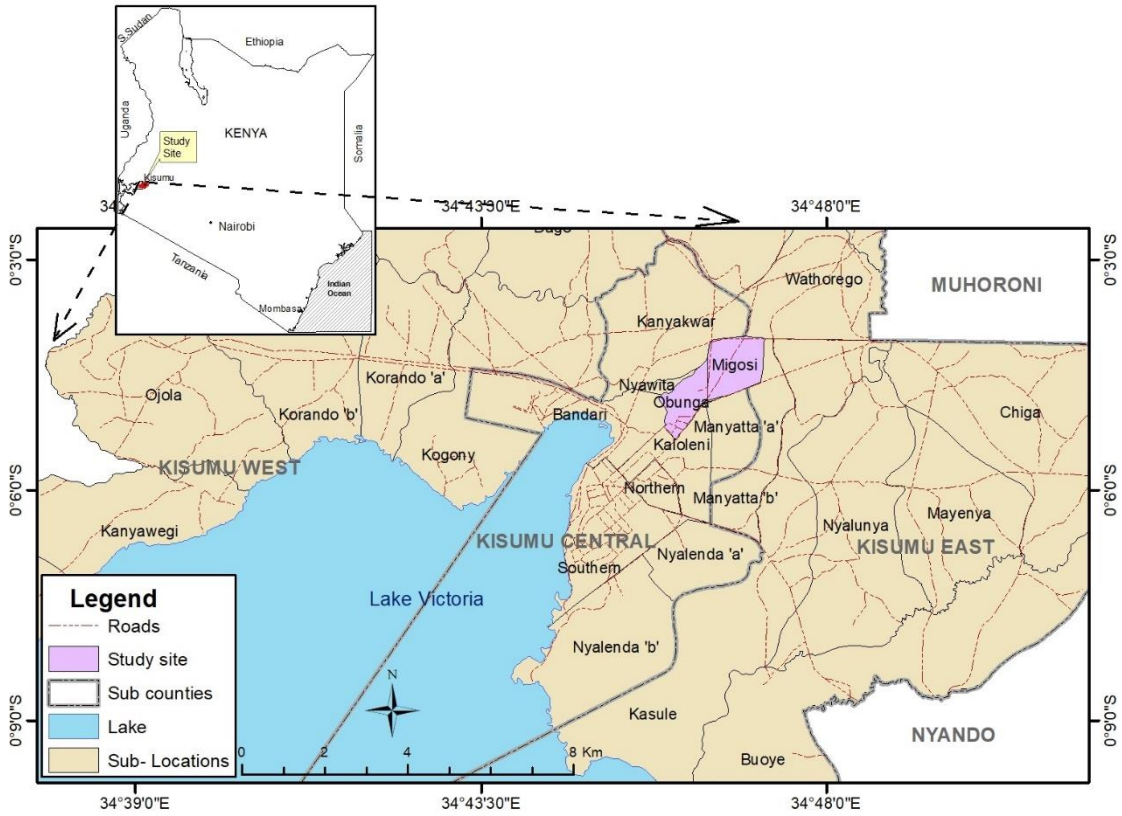


Figure 3.1: Map showing the location of the study area

3.4 Target Population

The target population for the study was the residents of Obunga and Migosi estates where heads of households were given a chance to participate in the study. The study also targeted county government officials, department of environment charged with the waste collection and disposal from the urban centers. The population of the area is shown in Table 3.1.

Table 3.1: Target Population

	Households	No. in the Department
County Government of Kisumu, Department of Environment		15
Households in Obunga	875	
Households in Migosi	762	
Totals	1637	15

KISIP Report (2017)

3.5 Study Sample

3.5.1 Sampling Procedure

The study employed stratified random sampling techniques for the study where the households to participate in the study was selected based on particular groups as defined by their geographical locations till the sample size was exhausted. Stratified random sampling was appropriate for this study since the target population has some defined geographical boundaries that allowed them to be placed in different groups according to residential estates of Obunga and Migosi. Kothari (2004) defines stratified random sampling as a method of sampling that involves the division of a population into smaller groups known as strata after which the selection of the respondents is done at random.

3.5.2 Study Sample Size

To get sample size determination from the total population, the recommended scientific Yamane (1967) formula was employed for convenience and accuracy purposes. The formula is as follows:

$$n = \frac{Z^2\ p\ q}{d^2}$$

$$n = \frac{(1.96)^2\ X\ (0.5)\ X\ (0.\ 5)}{(0.05)^2}$$

n = 384 households

Where: n = the desired sample size.

Z = the standard normal deviate at 1.96

P =proportion of population with the characteristic under study (in this case it's the default of 0.5 since the households are homogenous)

q = proportion of the population with no characteristics under study (1- 0.5)

d = degree of accuracy desired set at 0.05 (5% testing at 95% Confidence Interval)

The Yamane (1967) indicates that any population of less than 10,000 will have a smaller sample size and therefore finite correction (nf) must be applied as follows:

$$nf = \frac{n}{1 + n/N},$$

Where;

nf= finite correction/exact sample size

n= desired sample population

Therefore:

$$311 = \frac{384}{1 + 384/1637}$$

n = 311 is the estimate sample size for the households that participated in the study.

The sample population was then proportionally allocated as shown in Table 3.2.

Table 3.2: Sample Size

	Households	Proportion	Totals
County Government of Kisumu, Department of Environment	-	-	15
Households in Obunga	875	311/1637*875=166	167
Households in Migosi	762	311/1637*762=144	144
Totals			326

A total of 326 respondents participated in the study where 15 were from the department of environment while 167 household heads were from Obunga estate and 144 household heads were from Migosi estates.

3.6 Data Collection

Burns and Grove (2003) define data collection as the precise, systematic gathering of information relevant to the research sub-problems, using methods such as interviews, participant observations, focus group discussion, narratives and case histories. According to Kothari (2008), primary data refers to information that a researcher gathers from the field. Primary data was obtained from the original sources using self-administered questionnaire.

3.6.1 Data Collection Instruments

The data collection instruments that were used in the study were questionnaires to the heads of the households and the other set of questionnaires were administered to the county government staff, department of environment, Kisumu County (see appendix A and B).

3.6.2 Pilot Testing of Research Instruments

Before the final data collection, the researcher took 10% of the sample population which is about 30 respondents from a different location (Nyalenda Estate) in Kisumu

County other than Obunga and Migosi residential estates; administer the questionnaires then test for reliability and validity of the instruments.

3.6.3 Instrument Reliability

Reliability test was tested from the pilot questionnaires to determine the extent of internal consistency of the data collection instruments. It gave the status of the data collection instruments on if they have the required internal consistency that makes them fit and appropriate for data collection process. The administered questionnaires were then tested against Alpha test where the Cronbach Apha value of 0.7 and above established in the study indicates that the data collection instruments used for the study are reliable. Sekaran and Bougie (2013) describes the instrument reliability as the internal consistency of the data collection instruments where the same instruments can be used to obtain similar results from a different population.

3.6.4 Instrument Validity

Validity of the instruments was tested by the University Supervisors who later on gave a go ahead for data collection after reviewing data collection instruments indicating that the research instruments used for the study were valid and objective with respects to the study objectives and what needs to be captured by the instruments. Orodho and Kombo (2002) view instrument validity as the authenticity of the data collection instruments by a competent individual.

3.7 Data Collection Procedures

Before data collection, the researcher obtained a letter of authority to collect data from the Department of Environment and Natural Resource Management, School Science and Technology after which a letter was obtained from the Ministry of Education

National Council for Science Technology and Innovation (NACOSTI) in Nairobi and the County Administration Offices to enable the researcher to conduct the study.

The first set of 311 questionnaires was administered to households in both Obunga and Migosi estates while the second set of 15 questionnaires was administered to the Kisumu County Government, department of environment. The questionnaires were either self-administered or researcher administered depending on the literacy level of the respondents.

3.8 Data Processing and Analysis

Collected data was checked for completeness then coded into SPSS version 22 for the purposes of analysis. Descriptive data was then analyzed using frequency of responses, percentages, mean and median as deemed appropriate by the researcher. Inferential statistics was then used for the purposes of analysis where regression analysis was used to test for the liner relationship of the variables between dependent and independent as given in Table 3.3.

Regression Analysis

$Y = \beta + X_1 \beta_1 + X_2 \beta_2 + X_3 \beta_3 + X_4 \beta_4 + €$

Where: β = constant

$X_1 + X_2 + X_3 + X_4$ = knowledge, socio-economic factors, social institutions and infrastructure respectively

$\beta_1 + \beta_2 + \beta_3 + \beta_4$ = coefficient of knowledge, socio-economic factors, social institutions and infrastructure respectively

€ = standard error

Table 3.3: Summary of Data Analysis

Research Question	Independent Variable	Dependent Variable	Statistical Analysis
What is the influence of knowledge on the management of hazardous solid waste in Obunga and Migosi Estates, Kisumu County-Kenya?	Knowledge i. Usage experience measures ii. Self-assessments measures iii. Free response measures of knowledge	hazardous solid waste	i) Descriptive statistics = mean, standard deviation, percentages and frequencies ii) Inferential analysis = regression analysis
What is the influence of socio-economic factors on the management of hazardous solid waste in Obunga and Migosi Estates, Kisumu County-Kenya?	Socio-economic i. Occupation ii. Income level iii. Education level	hazardous solid waste	i) Descriptive statistics = mean, standard deviation, percentages and frequencies ii) Inferential analysis = regression analysis and cross tabulations
What is the influence of social institutions on the management of hazardous solid waste in Obunga and Migosi Estates, Kisumu County-Kenya?	Social Institutions i. Religious institution ii. Peer groups iii. Economic systems iv. Civil society v. Education institution	hazardous solid waste	i) Descriptive statistics = mean, standard deviation, percentages and frequencies ii) Inferential analysis = regression analysis and cross tabulations
What is the influence of infrastructure on the management of hazardous solid waste in Obunga and Migosi Estates, Kisumu County-Kenya?	Infrastructure i. Sanitary land fills ii. Remediation of sludge ponds iii. Erosion control protection of the steepened slopes iv. Incinerators	hazardous solid waste	i) Descriptive statistics = mean, standard deviation, percentages and frequencies ii) Inferential analysis = regression analysis and cross tabulations

3.8 Legal and Ethical Considerations

The researcher obtained all the relevant research approvals and permits from the relevant institutions such as the Ministry of Education National Council for Science Technology and Innovation (NACOSTI) in Nairobi; the School department and the County Administration Offices to enable the researcher to conduct the study. All the responses given to the study are treated with uttermost confidentiality where the respondent's identity are hidden and no respondent shall be targeted for victimization based on the response given to the study and the study findings are only to be used purposely for the study purposes. Before participating in the study, the respondents were reminded of their rights to deny participating in the study and that the response given shall be used purposely for the research work where the results of the response shall be availed to any interested party upon request.

CHAPTER FOUR

DATA ANALYSIS AND FINDINGS

4.1 Introduction

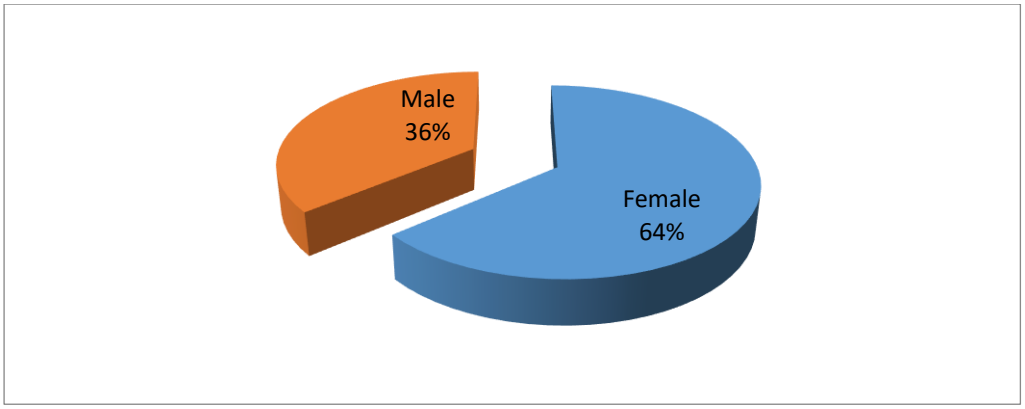
This chapter presents data analysis, presentation, and interpretation of the findings. The study was designed to assess the selected factors influencing management of hazardous solid waste in Obunga and Migosi Estates, Kisumu County, Kenya. The chapter presents the characteristics of the respondents, the analysis of solid waste management, the analysis on the influence of household knowledge on the management of hazardous solid waste management, the influence of on the management of hazardous solid waste management, the influence on social institutions on the management of hazardous solid waste management and the influence of infrastructure on the management of hazardous solid waste management.

4.2 Characteristics of the Respondents

Section 4.2 gives the presentation of the characteristics of the respondents by either male or female.

4.2.1 Response Rate

The participants' sex was observed and recorded during the administration of the questionnaires and the information was summarized as shown in Figure 4.1.



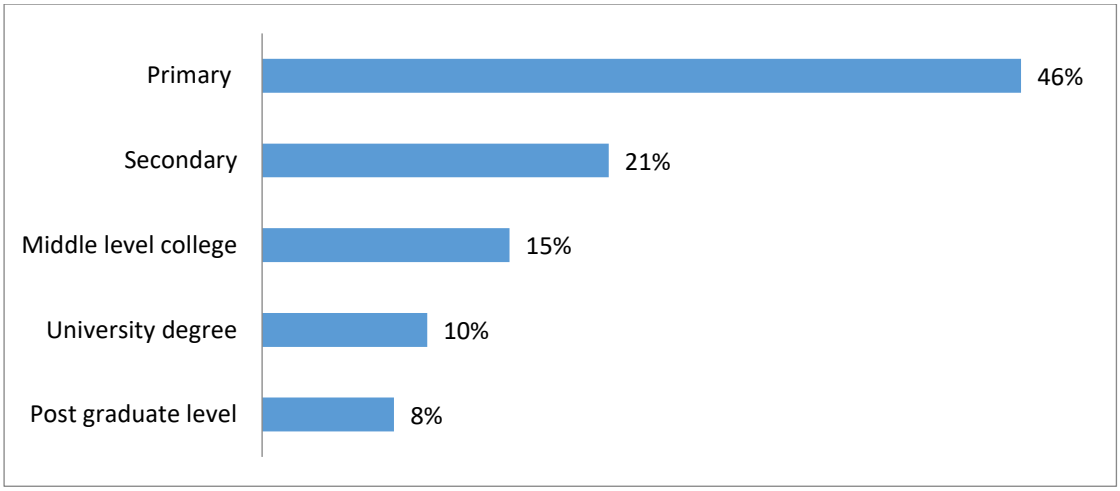
(n=311)

Figure 4.1: Response Rate

The study findings in Figure 4.1 indicate that the response rate was 95% where majority (64% n=199) of the respondents were female followed by the male respondents (36% n=112). The higher number of female respondents than the male respondents was informed by the fact that the study was conducted during the day where most men are engaged during the day as compared to women where some were housewives left to take care of the children. However, the skewed gender response did not interfere with the study findings since the researcher needed any household head to participate in the study.

4.2.2 Highest Level of Education of the Household Head

The study findings in this section give the level of education of the respondents from primary level as the lowest to post-graduate level as the highest. The results are summarized in Figure 4.2.



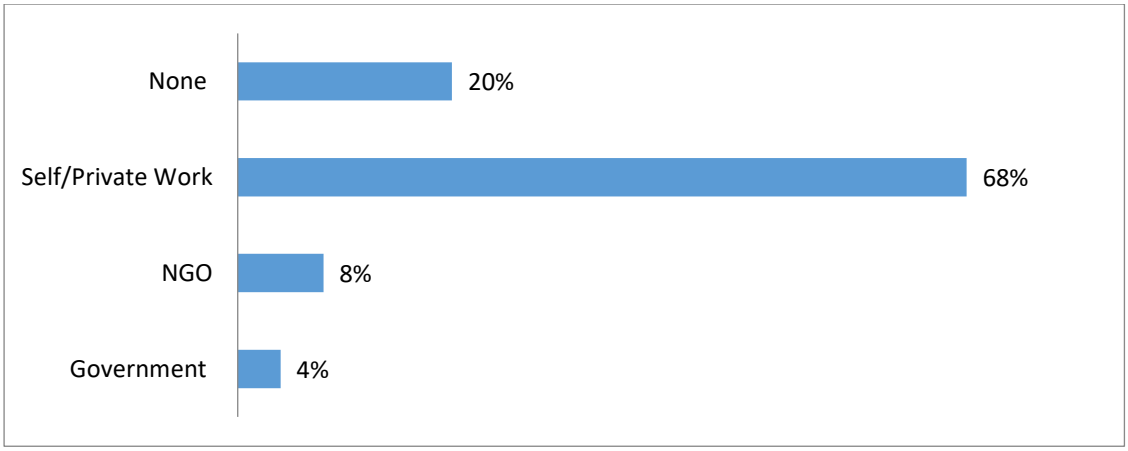
(n=311)

Figure 4.2 Highest Education Level

The study findings in Figure 4.2 indicate that majority (46% n=143) of the respondents have primary school level of education followed by secondary at 21% (n=65) response rate. The least response from the figure is post graduate (8% n=25) indicating that most of the respondents in the study do not have formal level of education; however, this did not affect the response since the questionnaires were self-administered by the researcher where the researcher was able to make the respondents understand the content of the questions through translations into the local language or Swahili language for ease of understanding the questionnaires by the respondents.

4.2.3 The Occupation of the Respondents

The study findings in this section give the occupation of the respondents where they are given the options of self-employment, NGOs, Governments and No employments.



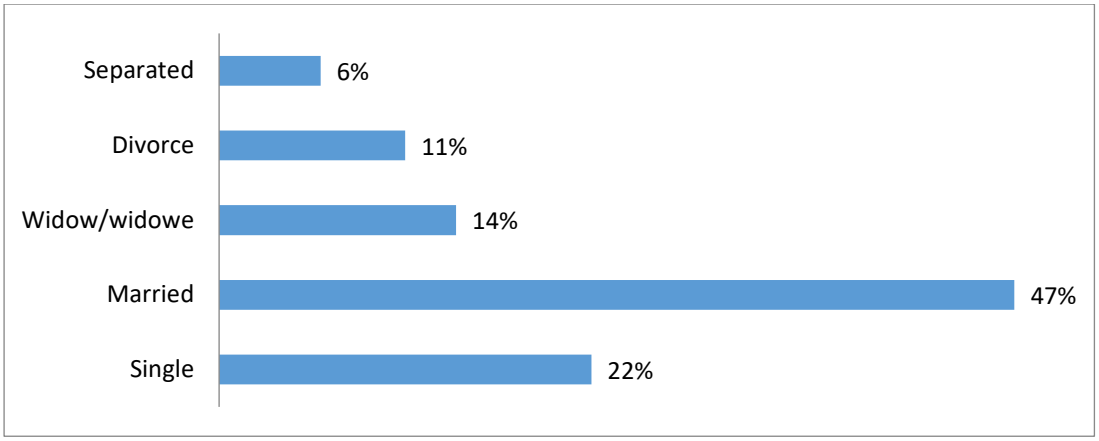
(n=311)

Figure 4.3 Occupation of the Participants

The study findings in Figure 4.3 indicate that majority of the respondents (68% n=211) are self-employed and are doing their private work. This is followed by the number that is jobless (20% n=62) while the least population works for the government as given by 4% (n=12). The indication of self or private work as the highest gave an economic problem associated with the lack of financial commitment in paying for waste collection. However, some of the self-employed household heads had good financial position to support the payment for waste management.

4.2.4 Marital Status of the Respondents

The study findings in this section gives the marital status of the respondents where they are given the options of separated, divorced, widowed, married or single.



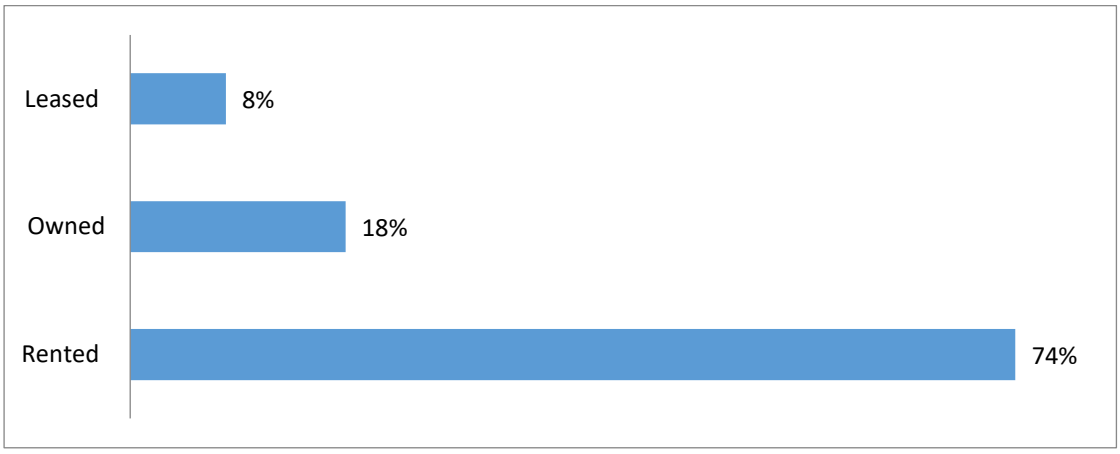
(n=311)

Figure 4.4 Marital Status

The study findings in Figure 4.4 indicate that majority of the respondents (47% n=146) are married followed by (22% n=68) the population of respondents who are single while the least response was (6% n=18) the respondents who are separated. Since majority of the households were married, this is an indication that the households in the area generate enough waste that require proper management.

4.2.5 Ownership of the House

The finding in this section gives the ownership of the house where the respondents are given the options of leased, owned or rented.



(n=311)

Figure 4.5 Ownership of the House

The study findings in Figure 4.5 indicate that majority (74% n=230) of the respondents live in rented houses followed by the respondents (18% n=55) who live in the owned houses while the least group (8% n=25) were those respondents who live in leased houses. Since majority of the respondents rented the houses, they are not likely to give their full commitment in waste management in their area of stay since such duties are left to the landlords but they are responsible for the proper disposal of waste from their households.

4.3 Hazardous Solid Waste Management in Obunga and Migosi Estates

This section explains the dependent variable of this study and shows how it was created and tested for use in answering the research questions of this study.

4.3.1 Hazardous Solid Waste Management Obunga and Migosi Estates

The dependent variable for this study, hazardous waste management in Obunga and Migosi estates was operationalized as an index involving 11 indicators statements listed in Table 4.1. The household heads were asked to state the extent of agreement with the management of hazardous solid waste in a scale of 1-5 where 5-Strongly Agree, 4-Agree, 3- Neither Agree nor Disagree, 2- Disagree and 1 - Strongly Disagree. The responses of the household heads were then scored and the scores were summed together to create and index of household head hazardous solid waste management for Obunga and Migosi estates. The frequency distribution and the descriptive statistics are shown in Table 4.1.

Table 4.1: Frequency Distribution and Descriptive Statistics for Hazardous Solid Waste Management in Obunga and Migosi Estates

Statement	5 (%)	4 (%)	3 (%)	2 (%)	1 (%)	Mean	Std. Dev
There is proper handling and disposal of hazardous solid waste	11	13	9	38	29	1.65	0.11
There is proper storage of hazardous solid waste	16	20	7	32	25	1.13	0.26
There is proper segregation of hazardous solid waste	12	18	7	35	28	1.89	0.47
There is proper distribution of hazardous solid waste	13	19	6	33	29	1.75	0.89
There is proper disposal of hazardous solid waste	16	22	5	31	26	1.69	0.79
There is proper treatment of hazardous solid waste	13	15	6	39	29	1.94	0.54
There is proper waste separation at the time of disposal	7	12	6	44	31	1.98	0.61
There is effort by my household to reduce the waste generated on a daily basis	6	16	5	43	30	1.63	0.87
I have waste collection bins strategically placed for my household use	11	14	6	38	33	1.75	0.82
I always ensure my waste are disposed of correctly and collected by the collecting agents who do come regularly like weekly basis	4	14	5	42	35	1.88	0.68
Before disposing any waste, I always ensure that hazardous waste are properly disposed off	17	24	8	25	26	1.56	0.64
Grand Mean						**1.71**	

The study finding in Table 4.1 indicate that there is no proper handling and disposal of hazardous solid waste as given by 38% for disagree and 29% for strongly disagree. The study findings also indicated that there is no proper storage of hazardous solid waste as indicated by 32% of the respondents for disagree and 25% for strongly disagree. The study also indicated that there is no proper segregation of hazardous solid waste as indicated by 35% for disagree and 28% for strongly disagree. The overall mean response for hazardous solid waste management in Obunga and Migosi estates is 1.71 indicating disagreement in the manner in which hazardous solid waste is managed.

4.3.2 Reliability Analysis for Hazardous Solid Waste Management Index

The reliability of the index of hazardous solid waste management was evaluated through Cronbach Alpha which measures the internal consistency. Cronbach Alpha value is widely used to verify the reliability of the construct. The results are shown in Table 4.2.

Table 4.2: Cronbach's Alpha for Index of Hazardous Waste Management

	Cronbach's Alpha	No. of Items
Hazardous Solid Waste Management	0.811	30

The study findings in Table 4.2 on the pilot test indicate that 'Hazardous Solid Waste Management' factor had a Cronbach's reliability alpha of 0.811, indicating that the scales measuring the objectives had a very high reliability and therefore no amendment on the objectives was necessary. This implied that the research instruments were adequate, objective and had reasonable internal consistency to give very reliable results since their Alpha value was greater than 0.7. Zinbarg (2005) states that an alpha coefficient of 0.7 or higher indicates that the gathered data are reliable as they have a relatively high internal consistency and can be generalized to reflect opinions of all respondents in the target population about the study problem.

4.3.3 Assumptions for Regression Analysis for Hazardous Solid Waste Management

The normality was tested using the Shapiro-Wilk test, which also has power to detect departure from normality due to either skewness or kurtosis or both. The results of the normality test are shown in Table 4.3.

Table 4.3: Shapiro-Wilk Test for Hazardous Solid Waste Management

	Statistics	Df	p
Hazardous Solid Waste Management	0.859	308	0.001

The findings in Table 4.3 indicate that the significance value is less than the alpha value (0.05 testing at 5% one tail test), thus one concludes that all the results of the Shapiro-Wilk test are normally distributed ($p < 0.001$). Normality tests are done to determine whether the sample data has been drawn from a normally distributed population. Normality assessment can be done by using a graphical or numerical procedure. According to Razali and Wah (2011), Shapiro-Wilk test assesses whether data is normally distributed against hypothesis whereby if statistic ranges from 0 to 1 and figures higher than 0.05 indicate the data is normally distributed. He further observed that Kolmogorov-Smirnov test is considered appropriate for samples larger than 2000 while Shapiro-Wilk test is deemed appropriate for samples ranging from 50 to 2000. In this study, the usable response rate was 310 and hence Shapiro-Wilk test was used.

To confirm the absence of multicollinearity among the independent in the model, all the independent variables were tested for multicollinearity using tolerance and Variable inflection factor (VIF), the results of the multicollinearity tests are shown in Table 4.4.

Table 4.4: Multicollinearity for Hazardous Solid Waste Management

	Tolerance	VIF
Hazardous Solid Waste Management	0.722	1.843

To conform non-multicollinearity the results in Table 4.4. show that the tolerances of values 0f above 0.2 and VIFs of below 5.0, this is supported by the findings of Ringle *et al*., (2015) who observed that the maximum level for the VIF range is 5 while Hair *et al*., 2010 observed that the tolerance value for multicollinearity should be below 0.2.

Multicollinearity is exhibited if one or more independent variables can be expressed in terms of the other independent variables. That would imply that the independent variables are not truly independent of each other as assumed by fitting the OLS model. The fitted OLS model assumed that the independent variables do not exhibit multicollinearity.

Mugenda and Mugenda (2012), posit that multicollinearity can occur in multiple regression models in which some of the independent variables are significantly correlated among themselves. Multicollinearity is a situation that occurs when the independent variables are highly correlated (Martz, 2013). If an independent variable has a tolerance of less than 0.2, it implies that the independent variable shares more than 80% of its variance with another independent variable in the model.

4.4 The Influence of Household Knowledge on the Management of Hazardous Solid Waste

This section gives the influence of household knowledge on the management of hazardous solid waste. It gives the descriptive response in frequency, percentages and mean. It also gives the regression results of the study indicating the relationship between the variables.

4.4.1 Household Knowledge on the Management of Hazardous Solid Waste

The independent variable household knowledge on the management of hazardous waste was operationalized as an index composed of nine indicator statements listed in Table 4.5. The respondents were asked to state the extent of agreement with the influence of household knowledge on the management of hazardous solid waste in a scale of 1-5 where 1-strongly disagree, 2- disagree, 3-neutral, 4-agree and 5-strongly agree. The results are summarized in Table 4.5.

Table 4.5: Frequency Distribution on the Influence of Household Knowledge on the Management of Hazardous Solid Waste

Statement	1	2	3	4	5	Mean	Std. Dev
	%	%	%	%	%		
We are aware of the dangers of solid waste and we know how to carefully handle and dispose them	17	12	10	36	25	3.35	0.25
Our household is very much aware of health effect of solid waste from our daily usage	6	23	8	39	24	3.48	0.47
We usually ensure that all the solid waste are carefully disposed in the right places	7	15	7	45	26	3.69	0.36
I participate in the sorting of waste before their disposal	3	14	8	48	27	3.54	0.47
I know how my garbage collected disposes my waste	3	14	5	42	36	3.68	0.14
I usually caution my garbage collector on proper waste disposals	10	14	6	38	32	3.98	0.47
Whenever I generate any solid waste, I do consider the impact it has to my family	10	17	5	41	27	3.47	0.69
I believe that having a proper solid waste disposal provides healthy environment for my family	6	12	6	44	32	3.64	0.57
I know the environmental degradation effect of solid waste if not properly disposed	7	16	5	43	29	3.57	0.64
Grand mean						**3.60**	

The study findings in table 4.6 indicate that majority of the respondents are aware of the dangers of solid waste and they know how to carefully handle and dispose them as given by 39% of the respondents for agree and 28% of the respondents for strongly agree. Majority of the respondents also agreed that their household is very much aware of health effect of solid waste from their daily usage as given by 40% of the respondents for agree and 36% of the respondents for strongly agree. They respondents also indicated that they know the environmental degradation effect of solid waste if not properly disposed as given by 38% of the respondents for agrees and 29% of the respondents for strongly agree. The grand mean was 3.60 indicating agree for the responses in the influence of household knowledge on the management of hazardous

solid waste. The standard deviation for the responses is less than one indicating that the responses were not deviated from the actual mean as given in Table 4.5.

4.4.2 Reliability Test for the Index of Household Head Knowledge on Waste Management

Reliability of this index of household head knowledge of waste management was evaluated through Cronbach Alpha which measures the internal consistency. Cronbach Alpha value is widely used to verify the reliability of the construct. The results are shown on Table 4.6.

Table 4.6: Cronbach's Alpha for Household Knowledge on Waste Management

	Cronbach's Alpha	No. of Items
Household knowledge	0.718	30

The study findings in Table 4.6 on the pilot test indicate that 'Hazardous Solid Waste Management' factor had a Cronbach's reliability alpha of 0.718, indicating that the scales measuring the objectives had a very high reliability and therefore no amendment on the objectives was necessary. This implied that the research instruments were adequate, objective and had reasonable internal consistency to give very reliable results since their Alpha value was greater than 0.7. Zinbarg (2005) states that an alpha coefficient of 0.7 or higher indicates that the gathered data are reliable as they have a relatively high internal consistency and can be generalized to reflect opinions of all respondents in the target population about the study problem.

4.4.3 Assumption for Regression Analysis for Household Knowledge

Tests were conducted on the variable household head knowledge for normality and linearity before using it in the regression model.

Normality Test for Household Knowledge

The study checked the normality of the data set by looking at descriptive values of skewness and kurtosis. The skewness values obtained in the study indicate that the scores are skewed as many are negatively skewed and not that much closer to zero. The values range from -2 to +1 hence no skewness problems in the study. The kurtosis values also fall within the range of -2 to +3, and therefore do not display excessive kurtosis as well. These results suggest that the normality assumption is not violated in the study. Table 4.7 gives the results from the study.

Table 4.7 Normality Test for Household Knowledge

	N	Skewness		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Std. Error
Household Knowledge	311	-.303	.221	-.886	.438

Linearity Test for Household Knowledge of waste Management

The study conducted linearity test to determine whether the relationship between household knowledge and the management of hazardous solid waste was linear or not. According to the results shown in Table 4.8, the significant deviation from linearity is 0.445 which is greater than 0.05 implying than there is a linear relationship between household knowledge and management of hazardous solid waste.

Table 4.8 Linearity Test for Household Knowledge on the Management of Hazardous Solid Waste

		Sum of Squares	df	Mean Square	F	p.
Between Groups	(Combined)	38.165	27	1.414	4.778	.001
	Linearity	30.282	1	30.282	102.369	.001
	Deviation from Linearity	7.883	26	.303	1.025	.445
Within Groups		27.511	93	.296		
Total		65.676	120			

Heteroscedasticity Test for Household Knowledge on the Management of Hazardous Solid Waste

The study findings had the homoscedasticity test evaluated for pairs of variables using the Levene statistic for the test of homogeneity of variances. The results are then given as shown in Table 4.9. From the study findings of test for homogeneity, the probability associated with the Levene Statistic (<0.071) is more than the level of significance (0.05) testing at 1-tail test 5% significance level, the researcher concludes that the variance is homogeneous for organizational culture.

Table 4.9 Homoscedasticity Test for Household Knowledge

Levene Statistic	df1	df2	p.
2.031	93	311	.071

4.4.4 Research Question One

The researcher tested for research question one: what is the influence of household knowledge on the management of hazardous solid waste in Obunga and Migosi Estates in Kisumu County?.

The question was answered using linear regression analysis. The model summary for the regression model is given in Table 10.

Table 4.10 Regression Model Summary for Household Knowledge and Management of Hazardous Solid Waste

R	R Square	Adjusted R Square	Std. Error of the Estimate
.796[a]	.633	.630	.44879

The study found that household knowledge explained a significant proportion of variance in the management of hazardous solid waste, R^2= .633. This implies that 63.3% of the proportion in the management of hazardous solid waste can be explained by household knowledge. Other factors not covered by this study therefore contribute to 36.7%. The F-test was conducted to test the fit of the model and the results are shown in Table 4.11.

Table 4.11 ANOVA Table for the Regression Testing the Fit of the Model

Model		Sum of Squares	df	Mean Square	F	p.
1	Regression	42.080	1	42.080	208.929	.001[b]
	Residual	24.370	121	.201		
	Total	66.450	122			

a. Dependent Variable: management of hazardous solid waste
b. Predictors: (Constant), household knowledge

The findings indicate that the significance value in testing the reliability of the model for the relationship between household knowledge on the management of hazardous solid waste was $F(1, 122) = 208.929$, $p < 0.001$. Therefore, the model is statistically significant in predicting the relationship between the study variables. The regression coefficient of the model showing the *beta*, *t* statistics and the collinearity statistics is shown in Table 4.12.

Table 4.12 Regression Coefficients for Household Head Knowledge and Management of Hazardous Solid Waste

Model		Unstandardized Coefficients		Standardized Coefficients	t	p
		B	Std. Error	Beta		
1	(Constant)	.344	.245		1.403	.163
	Knowledge	.867	.060	.796	14.454	.001

a. Dependent Variable: management of hazardous solid waste

The regression analysis (Table 4.12) shows that household head knowledge on solid waste management has positive significant influence (β=0.796, t=14.45, p<.0.001) on the management of hazardous waste in the Obunga and Migosi estates. This indicates that as the higher the knowledge of waste management the better is the management of hazardous waste management.

4.4.5 Implications

The study established that the households are aware of the general effects of solid waste to the environment but not aware of the specific effect of solid waste to the environment. The study has indicated that the households do not involved in the sorting of solid waste before disposal thus making waste management difficult. It has also revealed that the households have no regard for proper waste management as most of them are less concerned with what happens to the solid waste after they have given them out to the collectors. The results thus indicate that there is likelihood of continuous environmental pollution that will eventually make the whole environment unfit for habitation unless proper waste management methods are adopted by the households.

4.5 The Influence of Socio-Economic Factors on the Management of Hazardous Solid Waste

This section gives the influence of socio-economic factors on the management of hazardous solid waste. It gives the descriptive response in frequency, percentages and mean. It also gives the regression results of the study indicating the relationship between the variables.

4.5.1 Socio-economic Factors

The independent variable socio-economic factors of the respondents was operationalized as an index involving six (6) indicators listed in Table 4.13. The respondents were asked the extent of agreement with the influence of household knowledge on the management of hazardous solid waste in a scale of 1-5 where 1-strongly disagree, 2- disagree, 3-neutral, 4-agree and 5-strongly agree. The responses were scored and summed up to form the index of socio-economic factors as shown in Table 4.13.

Table 4.13: Descriptive Statistics and Frequency Distribution for the Socio-Economic Factors

Statement	1	2	3	4	5	M	SD
	%	%	%	%	%		
My family in unable to raise money for the garbage collection	39	28	6	12	15		
My area of residence have no organized forms of garbage collection	40	36	6	8	10		
My neighbors refused to pay for the waste collection due to lack of money	11	13	9	38	29		
I have a large family that generate a lot of waste and my house is small so we constantly throw the waste away without collecting them at one pint	16	20	7	32	25		
Since I am living a single lady/man's life, I do not see the need of waste management	12	18	7	35	28		
I do not have proper education/training on solid waste management	13	19	6	33	29		

The study findings in Table 4.13 indicate that most of the residents have disagreed that they are unable to raise the money for garbage collection as given by 39% for strongly disagree and 28% for agree. The study also indicates that the residents have organized forms of garbage collection in their area though they indicated that it's not very effective as given by 40% for strongly disagree and 36% for disagree that they have no form of organized garbage collection.

4.5.2 Reliability of the Index of Socioeconomic Factors

Reliability of the socioeconomic factors index was evaluated through Cronbach Alpha which measures the internal consistency. Cronbach Alpha value is widely used to verify the reliability of the construct. The results are shown in Table 4.14

Table 4.14: Cronbach's Alpha for Socio-economic factors

	Cronbach's Alpha	No. of Items
Socio-economic factors	0.792	6

The study findings in Table 4.14 show that index of socio-economic factors had a Cronbach's reliability alpha of 0.792 which is above 0.7 hence the factors were reliable and had good internal consistency for the study.

4.5.3 Assumption for Regression Analysis for Socio-economic Factors

Test for normality and linearity was conducted on the index of socio-economic factors to check if any assumptions on regression analysis were violated.

Test for Normality for Socio-Economic Factors

The study checked the normality of the data set by looking at descriptive values of skewness and kurtosis. Table 4.15 gives the results from the study.

Table 4.15 Normality Test for Socio-Economic Factors

	N	Skewness		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Std. Error
Socio-economic	311	-.766	.217	.999	.431

The skewness values obtained in the study indicate that the scores are skewed as all are negatively skewed and not that much closer to zero. The kurtosis values also fall within the range of -1 to +1, and therefore do not display excessive kurtosis as well. These results suggest that the normality assumption is not violated in the study.

Test for Linearity for Socio-Economic Factors

The study conducted linearity test (Table 16) to determine whether the relationship between socio-economic factors on the management of hazardous solid waste was linear or not.

Table 4.16 Linearity Test for Socio-Economic Factors on the Management of Hazardous Solid Waste

		Sum of Squares	df	Mean Square	F	Sig.
Between Groups	(Combined)	48.030	40	1.201	5.345	.000
	Linearity	34.225	1	34.225	152.356	.000
	Deviation from Linearity	13.805	69	.354	1.576	.143
Within Groups		18.420	200	.225		
Total		66.450	308			

The linearity test (Table 4.16) shows the significant deviation from linearity is 0.143 which is greater than 0.05 implying that there is a linear relationship between socio-economic factors and hazardous solid waste management.

Test for Heteroscedasticity for Socio-Economic Factors

The heteroscedasticity test, evaluated for pairs of variables using the Levene statistic for the test of homogeneity of variances. The results are then given as shown in Table 4.17.

Table 4.17: Homoscedasticity Test for Socio-Economic Factors

Levene Statistic	df1	df2	Sig.
2.342	22	82	.099

From the study findings of test for heteroscedasticity, the probability associated with the Levene Statistic (<0.099) is more than the level of significance (0.05) testing at 1-tail test 5% significance level, the researcher concludes that the variance is homogeneous for loan accessibility.

4.5.4 Answering Research Question Two

The researcher tested for research question two:

What is the influence of socio-economic factors on the management of hazardous solid waste in Obunga and Migosi Estates in Kisumu County, Kenya?

The researcher used regression analysis where regression assumptions such as normality test and multicollinearity test were conducted after which ANOVA and Coefficient Tables were generated. The model summary for regression analysis is shown in Table 4.18.

Table 4.18 Model Summary for Socio-Economic Factors and the Management of Hazardous Solid Waste

R	R Square	Adjusted R Square	Std. Error of the Estimate
.818[a]	.669	.511	.51607

The study found that household socio-economic factors explained a significant proportion of variance in the management of hazardous solid waste, R^2= .669. This implies that 63.3% of the proportion in the management of hazardous solid waste can be explained by household socio-economic factors. Other factors not covered by this study therefore contribute to 33.1%. The F-test was conducted to test the fit of the model and the results are shown in Table 4.19.

Table 4.19 ANOVA Table for the Regression Analysis Testing the Fit of the Model

	Sum of Squares	df	Mean Square	F	p.
Regression	34.225	1	34.225	128.509	.001[b]
Residual	32.225	121	.266		
Total	66.450	122			

a. Dependent Variable: Management of Hazardous Solid Waste
b. Predictors: (Constant), Socio-Economic Factors

The findings indicate that the significance value in testing the reliability of the model for the relationship between socio-economic factors and the management of hazardous solid waste was $F(1, 122) = 128.509$, $p < 0.001$. Therefore, the model is statistically significant in predicting the relationship between the study variables. The regression coefficient of the model showing the *beta, t* statistics and the collinearity statistics is shown in Table 4.20.

Table 4.20: Regression Coefficients for Socio-Economic Factors and Management of Hazardous Solid Waste

	Unstandardized Coefficients		Standardized Coefficients	t	p.
	B	Std. Error	Beta		
(Constant)	1.124	.244		4.611	.001
Socioeconomic	.755	.067	.718	11.336	.001

a. Dependent Variable: Management of Hazardous Solid Waste

The regression analysis coefficients (Table 4.20) shows that household socio-economic factors have positive significant influence (β=0.718, t=11.33, p<.001) on the management of hazardous solid waste management by households in Obunga and Migosi estates. The study therefore concluded that socio-economic factors significantly influence management of hazardous solid waste.

4.5.5 Implications of the Finding

The fee charged by the waste collectors has discouraged many households from waste collection thus making them disengage from organized waste collection programs. The occupation of households has influenced the management of solid waste as indicated by the study that household heads that are employed are able to pay for the waste collection from their residents. The income level of the household heads has played a major role in waste collection as those household heads with higher income levels tend to engage other waste collectors to manage their waste other than the ones assigned to them by the county government. Finally, the study has established that education level of the household heads has contributed positively in the proper management of hazardous solid waste from the households.

4.6 The Influence of Social Institutions on the Household Management of Hazardous Solid Waste

This section gives the influence of infrastructure on the management of hazardous solid waste. It gives the descriptive response in frequency, percentages and mean. It also gives the regression results of the study indicating the relationship between the variables.

4.6.1 Social Institutions Involved in Solid Waste Management

The independent variable, social institutions was operationalized as an index that combined eleven (13) indicators as shown in Table 4.21. The respondents were asked the extent of agreement with the influence of social institutions on the management of hazardous solid waste in a scale of 1-5 where 1-strongly disagree, 2- disagree, 3-neutral, 4-agree and 5-strongly agree. The responses were scored using the 1-5 scale and them summed up to form the index of social institutions involved in solid waste management in Obunga and Migosi estates. The descriptive statistics and the frequency distributions are shown in Table 4.21.

Table 4.21: Descriptive Statistics for the Social Institutions Involved in Hazardous Solid Waste Management

Statement	1	2	3	4	5	M	SD
	%	%	%	%	%		
We have organized groups that do collect our garbage regularly at a fee	14	21	8	28	29	3.42	0.25
The youth groups in our area have been advocating for proper waste disposal in our area	26	32	5	21	16	2.91	.75
Different families with different households have organized systems of waste disposal in our area	13	15	6	39	29	3.81	0.36
If I had money I would form a group for waste management and then collect money from the residents	7	12	6	44	31	2.98	0.57
Waste disposal is of economic benefit and some groups of people have taken it upon as their main business in my area	6	16	5	43	30	3.97	0.47
There are non-governmental organizations in my area that give free teachings on the benefits of proper waste disposal	4	14	5	42	35	3.14	0.65
We get the services of waste disposal from the county government	11	14	6	38	33	3.87	0.75
There is a participatory approach on solid waste management in my area	27	25	6	22	20	3.21	0.14
Whenever there is conflict on waste disposal in my area, all the stakeholders are involved in conflict resolution	21	38	8	15	18	2.74	0.19
We have no problem with the county government management of solid waste in my area	25	36	9	17	13	2.93	0.17

The existing schools in the area give proper education to our children concerning proper waste management in their society as seen on school children behavior towards waste management	25	45	7	15	8	2.80	0.78
The existing religious institutions have good teachings on the benefits of proper solid waste management	28	46	7	13	6	2.86	0.47
Grand Mean						3.22	

The study findings in Table 4.21 indicate that most of the residents have organized groups that do collect their garbage regularly at a fee as given by 28% of the respondents for strongly agree and 29% for strongly agree. The study also indicated that the youth groups in our area have not been advocating for proper waste disposal in their area as given by 26% of the respondents for disagree and 32% for strongly disagree. The study also indicated that the existing schools in the area do not give proper education to their children concerning proper waste management in their society as seen on school children behavior towards waste management as given by 25% of the respondents for disagree and 45% for strongly disagree. All the standard deviations were below one indicating that the study response was not much deviated from the actual mean. The response gave a mean of 3.22 which is for ‘agreed’ indicating that social institutions influences the management of hazardous solid waste.

4.6.2 Reliability Test for Social Institutions Involved in Hazardous Waste Management

Reliability of the index of social institutions involved in solid waste management was evaluated through Cronbach Alpha which measures the internal consistency. Cronbach Alpha value is widely used to verify the reliability of the construct. The results of the test are sown in Table 4.22.

Table 4.22: Cronbach's Alpha for Social Institutions

	Cronbach's Alpha	No. of Items
Social Institutions	.814	13

The study findings in Table 4.22 show that the index of social institutions had a Cronbach's reliability alpha of 0.814, indicating that the scales measuring the objectives had a very high reliability and therefore no amendment on the statement was necessary. This implied that the research instruments were adequate, objective and had reasonable internal consistency to give very reliable results since their Alpha value was greater than 0.7.

4.6.3 Testing for Assumptions of Linear Regression Model

The data for use in modeling linear regression has to be tested for assumptions of normality, linearity and homoscedascity. This section deal with these three tests.

Normality Test for Social Institutions

The normality of the data set was checked by looking at the descriptive values of skewness and kurtosis. The skewness values obtained in the study indicate that the scores are skewed as all are negatively skewed and not that much closer to zero. The kurtosis values also fall within the range of 0 to +3, and therefore do not display excessive kurtosis as well. These results suggest that the normality assumption is not violated in the study. Table 4.23 gives the results from the study.

Table 4.23: Normality Test for Social Institutions

	N	Skewness		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Std. Error
Social Institutions	311	-.887	.220	.633	.437

Linearity Test for Social Institutions

The study conducted linearity test to determine whether the relationship between social institutions and management of hazardous solid waste was linear or not. According to the results shown in Table 4.24, the significant deviation from linearity is 0.091 which is greater than 0.05 implying than there is a linear relationship between social institutions and management of hazardous solid waste.

Table 4.24: Linearity Test for Social Institutions Involved in Hazardous Solid Waste management

		Sum of Squares	df	Mean Square	F	Sig.
Between Groups	(Combined)	54.611	45	1.214	7.893	.000
	Linearity	39.823	1	39.823	259.007	.000
	Deviation from Linearity	14.788	44	.336	2.186	.091
Within Groups		11.839	77	.154		
Total		66.450	122			

Homoscedascity Test for Social Institutions

The study findings had the homoscedasticity test evaluated for pairs of variables using the Levene statistic for the test of homogeneity of variances. From the study findings of test for homogeneity, the probability associated with the Levene Statistic (<0.110) is more than the level of significance (0.05) testing at 5% significance level, the researcher concludes that the variance is homogeneous for social institutions. The results are then given as shown in Table 4.25.

Table 4.25 Homoscedasticity Test for Social Institutions

Levene Statistic	df1	df2	Sig.
2.718	31	77	.110

4.6.4 Influence of Social Institutions on the Management of Hazardous Solid Waste Management

The researcher tested for research question three of this study, which was stated as :

What is the influence of social institutions on the management of hazardous solid waste in Obunga and Migosi Estates in Kisumu County, Kenya?

The bivariate linear regression analysis was used to test the influence of the independent variable of the dependent variable. The summary for the regression model shwing the R square is shown in Table 4.26

Table 4.26: Model Summary for Social Institutions and Hazardous Solid Waste Management

R	R Square	Adjusted R Square	Std. Error of the Estimate
.774[a]	.599	.596	.46911

The study found that social institutions explained a significant proportion of variance in management of hazardous solid waste, R^2= 0.599. This implies that 59.9% of the proportion in management of hazardous solid waste can be explained by social institutions. Other factors not covered by this study therefore contribute to 40.1%. The F-test was used to test the fit of the regression model, the results of the test are shown in Table 4.27.

Table 4.27: ANOVA for Social Institutions

	Sum of Squares	df	Mean Square	F	Sig.
Regression	39.823	1	39.823	180.965	.001[b]
Residual	26.627	121	.220		
Total	66.450	122			

a. Dependent Variable: management of hazardous solid waste
b. Predictors: (Constant), Social Institutions

The findings indicate that the significance value in testing the reliability of the model for the relationship between social institutions and management of hazardous solid waste was $F(1, 121) = 180.965$, $p < 0.001$. Therefore, the model is statistically significant in predicting the relationship between social institutions and management of hazardous solid waste. The regression coefficient of the model showing the *beta, t* statistics and the collinearity statistics is shown in Table 4.28.

Table 4.28: Regression Coefficients for Social Institutions

Model		Unstandardized Coefficients		Standardized Coefficients	t	p
		B	Std. Error	Beta		
1	(Constant)	1.038	.212		4.891	.001
	Social Institutions	.786	.058	.774	13.452	.001

a. Dependent Variable: management of hazardous solid waste

The study found that social institutions significantly predicted management of hazardous solid waste, $\beta = .774$, $t(122) = 13.452$, $p < 0.001$. It was therefore concluded that social institutions significantly influence management of hazardous solid waste in Obunga and Migosi estates in Kisumu urban centre.

4.6.5 Implications of the findings

The engagement of the youth in waste collection as an income generating activity has promoted waste management and collection in the residential areas. The youths are motivated by the money they collect from the households thus making them penetrate the hidden places for waste collections. The waste collections by the existing social institutions such as women groups and youth groups are a success and should be encouraged by all the county governments. The county governments should do a lot of campaigns in sensitizing the general populations about the waste benefits of proper waste management in the area. The fees charged by the social groups are high thus making some households not to participate and if that fee is left b the county

government to increase without proper regulations, then it will make many households to drop the organized waste management in their areas.

The social institutions involved in the waste management have not done enough training to the households on proper waste management strategies such as sorting and removal of waste from the houses on time for collections. The social institutions should be facilitated by the county governments in training of the households on proper waste management strategies that are aimed at improving the environment.

4.7 The Influence of Infrastructure on the Management of Hazardous Solid Waste in Obunga and Migosi Estates

This section of the study dealt with objective number four, which was determining the influence of infrastructure on the management of hazardous solid wastes in Obunga and Migosi estates in Kisumu urban centre.

4.7.1 Infrastructure Related to Solid Waste Management

The independent variable, infrastructure involved in solid waste management was operationalized as an index that combined eleven (11) indicators shown in Table 4.29. The respondents were asked the extent of agreement with the influence of household knowledge on the management of hazardous solid waste in a scale of 1-5 where 1-strongly disagree, 2- disagree, 3-neutral, 4-agree and 5-strongly agree. Their responses were scored and the scores were then summed up to form the index of the infrastructure used in hazardous solid waste management in Obunga and Migosi estates in Kisumu urban centre. The descriptive statistics and the frequency distribution of the index of infrastructure are shown in Table 4.29.

Table 4.29: descriptive statistics and Frequency Distribution of the Index of Infrastructure used in Hazardous Solid Waste Management

Statement	1	2	3	4	5	M	SD
	%	%	%	%	%		
There is proper handling and disposal of hazardous solid waste	22	39	8	14	17		
There is proper storage of hazardous solid waste	28	26	6	21	19		
There is proper segregation of hazardous solid waste	32	27	8	16	17		
There is proper distribution of hazardous solid waste	30	28	9	21	14		
There is proper disposal of hazardous solid waste	26	37	9	16	12		
There is proper treatment of hazardous solid waste	19	26	8	23	24		
There is proper waste separation at the time of disposal	34	19	7	13	27		
There is effort by my household to reduce the waste generated on a daily basis	33	20	7	12	28		
I have waste collection bins strategically placed for my household use	19	27	25	20	9		
I always ensure my waste are disposed of correctly and collected by the collecting agents who do come regularly like weekly basis	14	20	19	32	15		
Before disposing any waste, I always ensure that hazardous waste are properly disposed off	11	44	22	15	8		

The study findings in table 4.29 indicate that there is no proper handling and disposal of hazardous solid waste as given by 39% for disagree and 22% for strongly disagree. The study also indicate that there is no proper storage of hazardous solid waste as given by 28% of strongly disagree and 26% for disagree. The study findings indicate that there is no proper segregation of hazardous solid waste as given by 32% of the respondents for strongly disagree and 27% of the respondents for disagree.

4.7.2 Reliability Test for the Index of Infrastructure Used in Waste Management

The reliability of this index was evaluated through Cronbach Alpha which measures the internal consistency of a multi-indicator variable. Cronbach Alpha value is widely used to verify the reliability of the construct. The results of the test are shown in Table 4.30.

Table 4.30: Cronbach's Alpha for Social Institutions

	Cronbach's Alpha	No. of Items
Infrastructure	.814	11

The study findings in Table 4.30 on the index indicate that infrastructure had a Cronbach's reliability alpha of 0.814, indicating that the scales measuring the objects had a very high reliability and therefore no amendment on the statement was necessary. This implied that the research instruments were adequate, objective and had reasonable internal consistency to give very reliable results since their Alpha value was greater than 0.7.

4.7.3 Tests for Linear Regression Model Assumptions

The data used for this analysis was tested for the assumption that underlie linear regression models, these included test for normality, test for linearity, and test for collinearity of the variables forming the index.

Normality Test for Infrastructure

The data related to infrastructure was checked for normality of the data set by looking at descriptive values of skewness and kurtosis. The skewness values obtained in the study indicate that the scores are skewed as all are negatively skewed and not that much closer to zero. The kurtosis values also fall within the range of 0 to +3, and therefore do not display excessive kurtosis as well. These results suggest that the normality assumption is not violated in the study. Table 4.31 gives the results of the test.

Table 4.31 Normality Test for Infrastructure

	n	Skewness		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Std. Error
Infrastructure	311	.987	.320	.533	.537

Linearity Test for Infrastructure

The linearity test to determine whether the relationship between social institutions and management of hazardous solid waste was linear or not. According to the results shown in Table 4.32, the significant deviation from linearity is 0.987 which is greater than 0.05 implying than there is a linear relationship between infrastructure and management of hazardous solid waste.

Table 4.32: Linearity Test for Infrastructure and Management of Hazardous Solid Waste

		Sum of Squares	df	Mean Square	F	Sig.
Between Groups	(Combined)	64.611	49	1.214	8.893	.000
	Linearity	49.823	1	38.823	259.007	.000
	Deviation from Linearity	24.788	50	.436	2.286	.091
Within Groups		31.839	78	.154		
Total		56.627	128			

Homoscedascity Test for Infrastructure

The study findings had the homoscedasticity test evaluated for pairs of variables using the Levene statistic for the test of homogeneity of variances. From the study findings of test for homogeneity, the probability associated with the Levene Statistic (<0.110) is more than the level of significance (0.05) testing at 5% significance level, the researcher concludes that the variance is homogeneous for social institutions. The results are then given as shown in Table 4.33.

Table 4.33: Homoscedasticity Test for Infrastructure

Levene Statistic	df1	df2	Sig.
3.318	31	309	.210

4.7.4 Influence of Infrastructure on the Management of Hazardous Solid Waste

The researcher tested for research question four, which was stated as:

What is the influence of infrastructure on the management of hazardous solid waste in Obunga and Migosi Estates in Kisumu County, Kenya?

The simple liner regression analysis to assess the influence of infrastructure on the hazardous solid waste management in Obunga and Migosi estates. The independent variable was the index of infrastructure, while the dependent variable was index of hazardous solid waste management in Obunga and Migosi estates. The regression model summary is shown in Table 4.34.

Table 4.34: Model Summary for Infrastructure

R	R Square	Adjusted R Square	Std. Error of the Estimate
.974[a]	.769	.596	.32911

The study found that infrastructure explained a significant proportion of variance in management of hazardous solid waste, R^2= 0.769. This implies that 76.9% of the proportion in management of hazardous solid waste can be explained by infrastructure. Other factors not covered by this study therefore contribute to 23.1%. The F-test for the fit of the regression model and the results are shown in Table 4.35.

Table 4.35: F-test for the Fit of the Regression Model

	Sum of Squares	df	Mean Square	F	p
Regression	37.723	1	37.723	171.468	.001[b]
Residual	28.627	310	.220		
Total	66.350	311			

The F-test results (Table 4.35) show $F(1,121) = 171.468$, $p= 0.001$. Therefore, the model is statistically significant in predicting the relationship between infrastructure and management of hazardous solid waste. The regression coefficients, *t*-value and level of significance for the relationship between infrastructure and hazardous solid waste management are shown in Table 4.36.

Table 4.36 Regression Coefficients for Infrastructure

	Unstandardized Coefficients		Standardized Coefficients	t	p
	B	Std. Error	Beta		
(Constant)	2.138	.212		3.891	.001
Infrastructure	.696	.158	.754	15.352	.001

a. Dependent Variable: management of hazardous solid waste

The study found that infrastructure significantly predicted management of hazardous solid waste, $\beta = .754$, $t(122) = 15.352$, $p < .001$. The study therefore concluded that social institutions significantly influence management of hazardous solid waste.

The findings obtained in the study imply that for every one-unit change in social institutions, management of hazardous solid waste increases by 0.754, hence implying a positive impact of social institutions on management of hazardous solid waste

4.7.5 Implications of the Findings

The study has revealed that the county government has failed in the provision of the sanitary landfills that can be used by the waste collectors. Waste from the households do find its way back to the streets since the existing sanitary landfills are either dilapidated or are very far away and are out of reach to those disposing waste using handcarts. The disposal of solid waste has also been a challenge since the county government of Kisumu does not have incinerators for managing and destroying solid

wastes. The remediation of sludge ponds has faced challenges in its implementation in the country due to lack of equipment's and trained personnel.

4.8 Combined Influence of the Independent Variables on the Dependent Variable

The influence of the four independent variables used in this study (household head knowledge of solid waste management, socio-economic factors of the households, social institutions used in waste management and infrastructure used in waste management) on the dependent variable hazardous solid waste management in Obunga and Migosi was determined using multiple linear regression. The regression model summary is shown in Table 4.37.

Table 4.37: Model Summary for All the Variables

R	R Square	Adjusted R Square	Std. Error of the Estimate
.783[a]	.613	.657	1.743

The study found out that the independent variables in the study explained a significant proportion of variance in the dependent variable R^2= 0.657, which implies that 65.7 % of the proportion in hazardous solid waste can be explained by the independent four independent variables while other variables not covered by this study contributes to 21.7% . The F-test was used to test the fit of the regression model and the results are shown in Table 4.38.

Table 4.38: F-test showing the Fit of the Regression Model

Model		Sum of Squares	df	Mean Square	F	p.
1	Regression	8.654	4	8.654	71.175	.001[b]
	Residual	4.978	9	.365		
	Total	13.632	13			

a. Dependent Variable: Hazardous solid waste

The findings in Table 4.38, indicate that the significance value in testing the fit of the regression model for the relationship between the independent variables and the dependent variable, the hazardous solid waste management was $F(1, 13) = 71.175$, $p < 0.001$ therefore, the model is statistically significant in predicting the relationship between the study variables. The regression coefficients, t-values and the significance level are given in Table 4.39.

Table 4.39: Regression Coefficients for the Overall Model

	Unstandardized Coefficients		Standardized Coefficients	t	p
	B	Std. Error	Beta		
(Constant)	.952	.290	.332	1.356	.001
Knowledge	.102	.498	.224	1.543	.001
Socio-economic factor	.346	.373	.355	1.497	.001
Social institutions	.248	.665	.288	1.647	.001
Infrastructure	.425	.336	.378	1.124	.001

Based on the linear regression model, $Y = \alpha + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + u$, the model therefore becomes; $Y = 0.332 + 0.224\ X_1 + 0.355X_2 + 0.288X_3 + 0.378X_4 + u$

Where Y = dependent variable (hazardous solid waste)

α = constant

$\beta_1, \beta_2, \beta_3$ and β_4 are coefficients of independent variable variables

X_1, X_2, X_3 and X_4= are independent variables (knowledge, socio-economic factors, social institutions and infrastructure)

Testing at 5% significant level, the regression analysis in Table 4.39 is significant since all the p-values (Sig. $p<0.025$) testing at 2 tail test. The findings indicate that that every unit increase of knowledge by 22.4%, a unit increase of socio-economic factor by 35.5%, a unit increase of social institutions by 28.8% and a unit increase of

infrastructure by 37.8% would increase hazardous solid waste by one unit taking into considerations the other variables to be constant value and the value for the standard error.

This implies that infrastructure has the highest influence compared to the other independent variables on the hazardous solid waste management (β=0.378), this could be a key factor to recommend to the County government in terms of improving the situation of waste management.

CHAPTER FIVE

DISCUSSIONS, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Introduction

This chapter presents discussions, summary, conclusions, and recommendations. The main purpose of the study was to assess the selected factors influencing management of hazardous solid waste in Obunga and Migosi Estates, Kisumu County, Kenya.

5.2 Discussions

This section provides a discussion of the findings in the following manner: (i) the influence of household knowledge on the management of hazardous solid waste, (ii) the influence of socio-economic factors on the management of hazardous solid waste, (iii) the influence of social institutions on the management of hazardous solid waste, and (iv) the influence of infrastructure on the management of hazardous solid waste

5.2.1 The Influence of Household Knowledge on the Management of Hazardous Solid Waste

The study findings indicate that the respondents are aware of the dangers of solid waste and they know how to carefully handle and dispose them. The households being aware of the dangers of the solid waste are also very much aware of health effect of solid waste from daily usage and they usually ensure that all the solid waste is carefully disposed in the right places where most of them indicated that they are often taught by the waste collectors on the proper usage of the household waste. This finding is directly related to the findings by Gratton, (2013) who indicated that technical training helps people get professional help, which also helps improve comprehensive planning in sustainable waste processes. He further indicated that this includes the collection and analysis of waste data, which often lacks human resource personnel in developing countries.

The study has also indicated that the households do not participate in the sorting of the solid waste before disposal. This was illustrated by the respondents' response that they usually have like one basket where they put in all the waste as they await their collection. This finding is in line with study by Agrawal and Murtaza (2015) who indicated that the county governments are unable to attract and pay for expertise; hence projects initiated by external consultants collapse due to lack of continuity due to knowledge gaps. The study further noted that technical expertise required is lacking both at national and local regions, where training on technical background in engineering or management. Research in Kampala, Uganda depicted that execution on waste management suffered due to lack of appropriate personnel.

The residents do not follow up what happens to the waste collected from them after they have been taken up by the garbage collectors as indicated by the study that the respondents do not follow up on what happens to the waste after they have left their hands. The study has indicated that some of the residents do not know the environmental impact of poor waste management. This finding is supported by a study that was conducted by Li and Kavan, (2015) that indicated that the quality of waste collected is directly influenced by the source of that waste which could either be sorted or not sorted. The findings also indicated that the rise in poor waste management is mostly attributed to poor waste handling by the source of the waste producer.

5.2.2 The Influence of Socio-Economic Factors on the Management of Hazardous Solid Waste

The study has indicated that although most of the residents are able to raise the fee charged for waste collection by the organized groups in the areas, there are some households that are not able to raise the fee charged for garbage collection on time thus

making their waste not to be collected. when their waste is not collected, that brings a pile up of waste in the area thus posing environmental hazard to the neighbors thus the fee charged by the waste management agents is high and requires a review. This finding is supported by a study that was conducted to analyses the factors that influence waste handling and generation using the variables income and population density where it was found out that income did not affect the total solid waste generated in a municipality. The finding is also supported by another research by OECD, (2014) that showed that there is a positive correlation between income and waste generation.

The findings later proved that the relationship between socioeconomic factors and waste generation and composition is a clear waste difference existed between the more prosperous section concerning the total and the individual components of the waste stream. The research found out that household waste generation and composition varies from one household to another as reported in a similar study by Quoden, (2014), that found out that monthly income, average family size, number of rooms and employment status were the main influential factors in the reduction of both solid waste generation and composition where household income contributes positively towards proper waste management.

Finally, the study established that environment problems associated with the generation of waste are part of societal changes where households play an important role in relation to their income levels. This finding is supported by Hickle, (2014) who established that households always play an essential role in the waste generation, and which is affected by societal change leading to environmental problems. These societal changes influence the characteristic of given households, including family size, social status and wealth,

residential location and community status. Some studies describe the correlation between household solid-waste generation and composition and relevant socioeconomic parameters

5.2.3 The Influence of Social Institutions on the Management of Hazardous Solid Waste

The study has indicated that the residents have organized groups that participate in waste collection at a fee charged that is usually regulated by the county government. The groups that do collect waste are usually composed of youth groups, women groups and local community sometimes form welfare association of the residents in the area to look into such issues like garbage collection and security of the members. This finding is similar to the study findings by Cohen and Sturzenegger, (2013) who indicated that local governments are usually authorized to have responsibility for providing solid waste management services, and most local government laws give them exclusive ownership over waste once it has been placed outside a home or establishment for collection. As cities grow economically, business activity and consumption patterns drive up solid waste quantities and the local government are no longer in a position to control waste management by themselves without involving the residents thus the rise of youth groups, women groups and resident associations that participate in the waste management in the area. The study further indicated that increased traffic congestion adversely affects the productivity of the solid waste fleet. Productivity loss is exacerbated by longer hauls required of the fleet, as open lands for disposal are further and further away from urban centers.

The study has also indicated that waste disposal is of great economic benefit to the waste management team to the extent that some residents have taken upon themselves

to collect waste such as plastic bottles without charging any fee to the residents. The individuals who walk round the residential areas collecting used bottles often do it by themselves without involving the local authority or the residents for permission. This finding support the rubbish theory as used in the study on what the poor throws away that the rich find value in it and put in the pocket. The rubbish theory was advanced by Thompson (1979) that discussed extensively on the value of waste disposal and the hidden economic value of the dirty waste.

5.2.4 The Influence of Infrastructure on the Management of Hazardous Solid Waste

The study has revealed that there is there is poor handling and disposal of hazardous solid waste as there is no proper storage and segregation. The study has indicated that the disposal of hazardous solid waste is very poor from the source of the waste generation to the final point of damping site. This finding is supported by the report by European Commission, (2016) that indicated that the accumulation of solid waste presents one of the most visible infrastructural problems in Africa. It has been shown that wear on infrastructure has rapidly depreciated capital, which has limited the ability that municipalities have to collect waste and properly dispose of it. The study further indicated that the primary problem with urbanization in developing countries is the stress that it puts on old infrastructures operating over their designed capacities. This leads to issues with the provision of potable water, proper sanitation services, underdeveloped roadways, and the accumulation of solid waste. These stresses put pressure on environmental conditions in urban areas, which can have significant adverse impacts on fragile ecosystems.

Finally, the study indicates that there is poor infrastructure for waste management in the county due to lack of commitment by the county government in acquiring the infrastructure for waste management. This is supported by a study by Finnveden, *et al* (2012) who indicated that many African cities and municipal councils lack the infrastructural capacity to handle both the hazardous solid waste generated daily by the ever increasing city dwellers. By extension, almost all counties in Kenya require the resources and infrastructure to manage solid waste as they struggle to fund social services in the entire counties. The finding is also supported by Chen, et al., (2017), who observed that the urban local government authorities in Uganda are responsible for poor solid waste management services. They lack adequate infrastructure, operate in an inefficient institutional set-up, and have limited financial and technical resources. This has led to an inadequate level of provision of services. The rate of waste generation is increasing each day. According to the mayor of Kampala, about 1,580 tons of solid waste is generated per day. But only 40% of it is collected. A significant amount of solid waste is either burnt on the streets or ends up in drainage channels, marshy areas and empty plots because of lack of proper infrastructure for waste disposal.

5.3 Conclusions

Based on the study findings, the following conclusions were made:

(i) There is lack of proper knowledge among residents in the area regarding hazardous solid waste management in the area. The residents are not aware of the harmful effect of their household wastes.

(ii) The fee charged by the agents on waste management is very high to the locals thus making some of the residents opt out of the arranged waste management plan for the area.

(iii) The areas of study have proper organized social institutions such as the youth groups, women groups and individual waste collectors that participate in waste management in the area. The study has however established that the county government does not have proper record of the waste management agents in the county.

(iv) The major hindrance to proper waste management in the count is infrastructure with respect to the landfills to be used for deposition of collected garbage. The geographical distance of the existing landfills and the lack on incinerators has contributed to the poor management of solid waste in Kisumu County.

5.4 Recommendations

The study recommends that the county government, the non-government agencies on environment and the local residents involved in waste management should create proper awareness on hazardous solid waste management by the households where they should be trained in waste handling, waste segregation, waste storage, waste treatment and waste disposal methods.

The study recommends that the youth groups, women groups and other stakeholders involved in waste collection from the households should review their fees so that it becomes affordable for the households to easily afford without struggling to pay waste collection fees.

The study recommends that the county government and the non-governmental organizations involved in waste management should train waste collectors on the environmental effect of waste to the households so that they can train the households on waste handling and treatments.

The study also recommends for priority by the county government on funding for the infrastructure involved in waste management in the county such as the landfills and the motor vehicles that will be used in waste collections.

Finally, the study recommends for further studies on hazardous liquid waste such as sewer system, overflowing septic tanks and oil spills from the oil depots at the port area.

5.5 Recommendations for Further Studies

The study covered four factors influencing the management of hazardous solid wastes in two estates in Kisumu urban centre. There is need therefore to understand the following aspects related to waste management in Kisumu urban centre, they include:

(i) The assessment of the factors affecting liquid wastes in Kisumu urban centre.

(ii) Disposal of hospital wastes in Kisumu urban centres.

(iii) Disposal of electronic wastes in Kisumu urban centre

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APPENDICES

Appendix (A): Questionnaire for the Households

My name is Simon Ouko, as part of my course work at African Nazarene University; I am conducting a study on the "factors influencing management of hazardous solid waste in Obunga and Migosi residential areas in Kisumu County, Kenya". Please fill in the questionnaires as requested and any response given by you shall be treated with uttermost confidentiality and used purposely for research work where results of the study shall be availed to you upon request.

Section A: Demographic Details

Please tick (√) your perceived relevant response to each of the questions below

1. **In which year were you borne?.....**
2. **Sex**
   - Male ☐
   - Female ☐
3. **Highest Level of Education**
   - Primary ☐
   - Secondary ☐
   - Middle level College ☐
   - University Degree ☐
   - Post-graduate level ☐
4. **Employer**
   - Government ☐
   - NGO ☐
   - Self/Private Work ☐
   - None ☐
5. **For how many years have you lived in this estate? .....**
6. **Ownership of the House**
   - Rented ☐
   - Owned ☐
   - Leased ☐

7. **Marital Status**
   - Single ☐
   - Married ☐
   - Widow/widower ☐
   - Separated ☐
   - Divorced ☐

8. **What is the number of people living in your house?**

   .....

9. **How many rooms is your house?**

   .....

10. **What is your family income per month?**

    ……...

11. **Education Level**
    - Primary education ☐
    - Secondary ☐
    - No Formal education ☐

Section B: The Influence of Knowledge on the Management of Hazardous Solid Waste in Obunga and Migosi Estates

Use the rating-scale where strongly agree [5], Agree [4], **Neither Agree nor Disagree** ***[3],*** **Disagree [2], Strongly Disagree** ***[1], and kindly tick (√) the degree of agreement with the statements provided below:***

	Statement	**1**	**2**	**3**	**4**	**5**
12	We are aware of the dangers of solid waste and we know how to carefully handle and dispose them					
13	Our household is very much aware of health effect of solid waste from our daily usage					
14	We usually ensure that all the solid waste are carefully disposed in the right places					
15	I participate in the sorting of waste before their disposal					

16	I know how my garbage collected disposes my waste					
17	I usually caution my garbage collector on proper waste disposals					
18	Whenever I generate any solid waste, I do consider the impact it has to my family					
19	I believe that having a proper solid waste disposal provides healthy environment for my family					
20	I know the environmental degradation effect of solid waste if not properly disposed					

Section C: The Influence of Socio-Economic Factors on the Management Of Hazardous Solid Waste Obunga and Migosi Estates

Use the rating-scale where Strongly Agree [5], Agree [4], **Neither Agree nor Disagree** ***[3],*** **Disagree [2], Strongly Disagree** ***[1], and kindly tick (√) the degree of agreement with the statements provided below:***

	Statement	**1**	**2**	**3**	**4**	**5**
21	My family in unable to raise money for the garbage collection					
22	My area of residence have no organized forms of garbage collection					
23	My neighbors refused to pay for the waste collection due to lack of money					
24	I have a large family that generate a lot of waste and my house is small so we constantly throw the waste away without collecting them at one pint					
25	Since I am living a single lady/man's life, I do not see the need of waste management					
26	I do not have proper education/training on solid waste management					

Section D: The Influence of Social Institutions on the Management of Hazardous Solid Waste in Obunga and Migosi Estates

Use the rating-scale where Strongly Agree [5], Agree [4], **Neither Agree nor Disagree** ***[3],*** **Disagree [2], Strongly Disagree** ***[1], and kindly tick (√) the degree of agreement with the statements provided below:***

	Statement	**1**	**2**	**3**	**4**	**5**
27	We have organized groups that do collect our garbage regularly at a fee					
28	The youth groups in our area have been advocating for proper waste disposal in our area					
29	Different families with different households have organized systems of waste disposal in our area					
30	If I had money I would form a group for waste management and then collect money from the residents					
31	Waste disposal is of economic benefit and some groups of people have taken it upon as their main business in my area					
32	There are non-governmental organizations in my area that give free teachings on the benefits of proper waste disposal					
33	We get the services of waste disposal from the county government					
34	There is a participatory approach on solid waste management in my area					
35	Whenever there is conflict on waste disposal in my area, all the stakeholders are involved in conflict resolution					
36	We have no problem with the county government management of solid waste in my area					
37	The existing schools in the area give proper education to our children concerning proper waste management in their society as seen on school children behavior towards waste management					
38	The existing religious institutions have good teachings on the benefits of proper solid waste management					

39. Do you find environmental change in your area due to county government waste disposal management?

- Yes ☐
- No ☐

Explain

……

40. Are you willing to pay for the solid waste disposal in the area?

- Yes ☐
- No ☐

If yes, how much are you willing to pay?

- Ksh 0 – 200 ☐
- 201 – 400 ☐
- Above 400 ☐

If no, why are you not willing to pay for the disposal of solid waste management in your area?..

……

41. What is your opinion on the best way to manage solid waste in your area?.....

……

Section E: Hazardous Solid Waste Management in Obunga and Migosi Estates

Use the rating-scale where Strongly Agree [5], Agree [4],* Neither Agree nor Disagree *[3],* Disagree [2], Strongly Disagree *[1], and kindly tick (√) the degree of agreement with the statements provided below:

	Statement	**1**	**2**	**3**	**4**	**5**
42	There is proper handling and disposal of hazardous solid waste					
43	There is proper storage of hazardous solid waste					
44	There is proper segregation of hazardous solid waste					
45	There is proper distribution of hazardous solid waste					
46	There is proper disposal of hazardous solid waste					
47	There is proper treatment of hazardous solid waste					

48	There is proper waste separation at the time of disposal					
49	There is effort by my household to reduce the waste generated on a daily basis					
50	I have waste collection bins strategically placed for my household use					
51	I always ensure my waste are disposed of correctly and collected by the collecting agents who do come regularly like weekly basis					
52	Before disposing any waste, I always ensure that hazardous waste are properly disposed off					

Appendix B: Photos From the Field



Two soilid waste containers (black and large with a smallone blue)



A plastic waste collection bin in Obunga Estate





Open dump site in Migosi Estate



A streest in Obunga



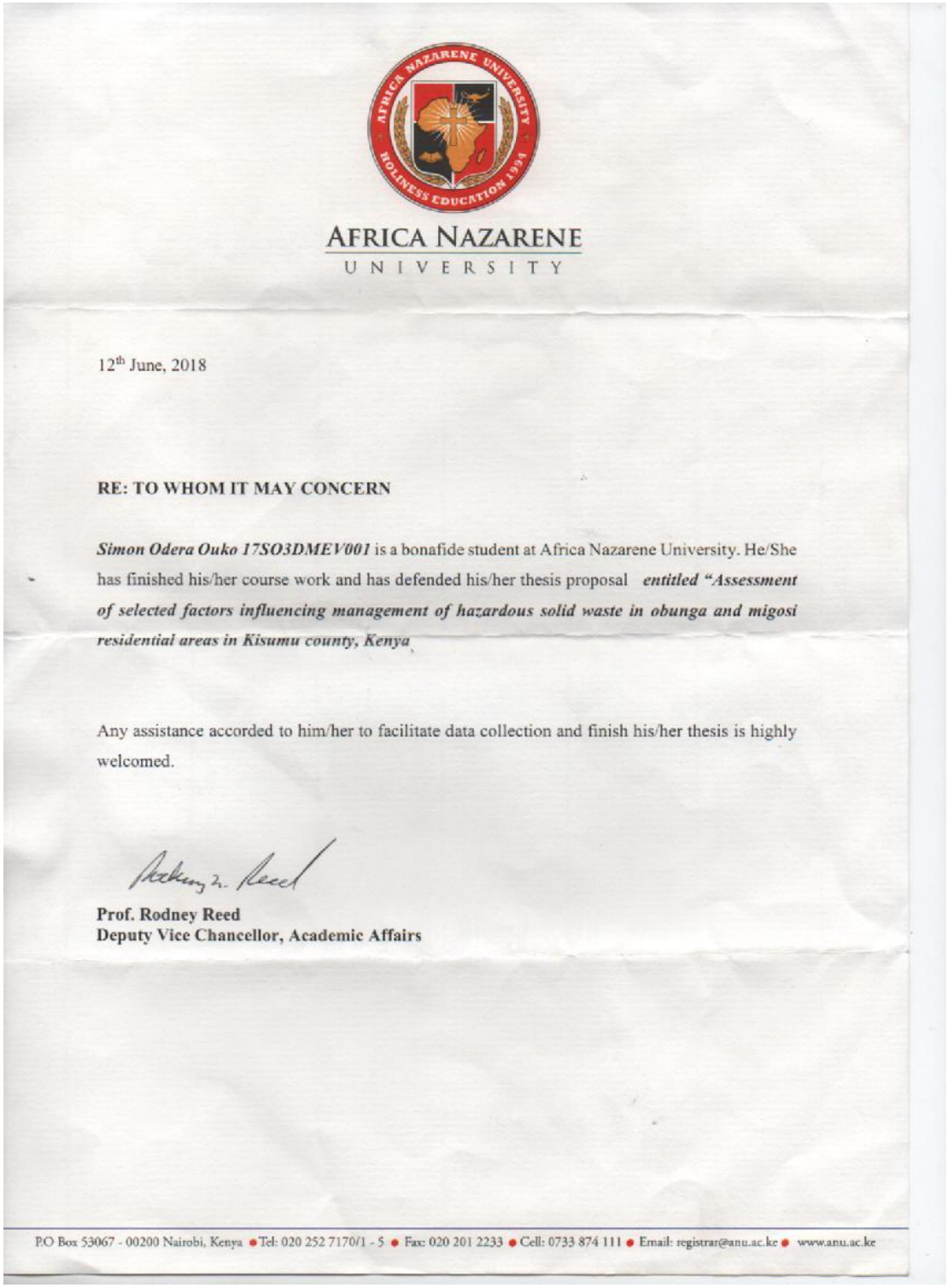
Waste dumped in plastsic cantainers





The researcher standing next to an open dump site in Migosi estate

Appendix C: Letter of Authority to Collect Data



AFRICA NAZARENE
UNIVERSITY

12th June, 2018

RE: TO WHOM IT MAY CONCERN

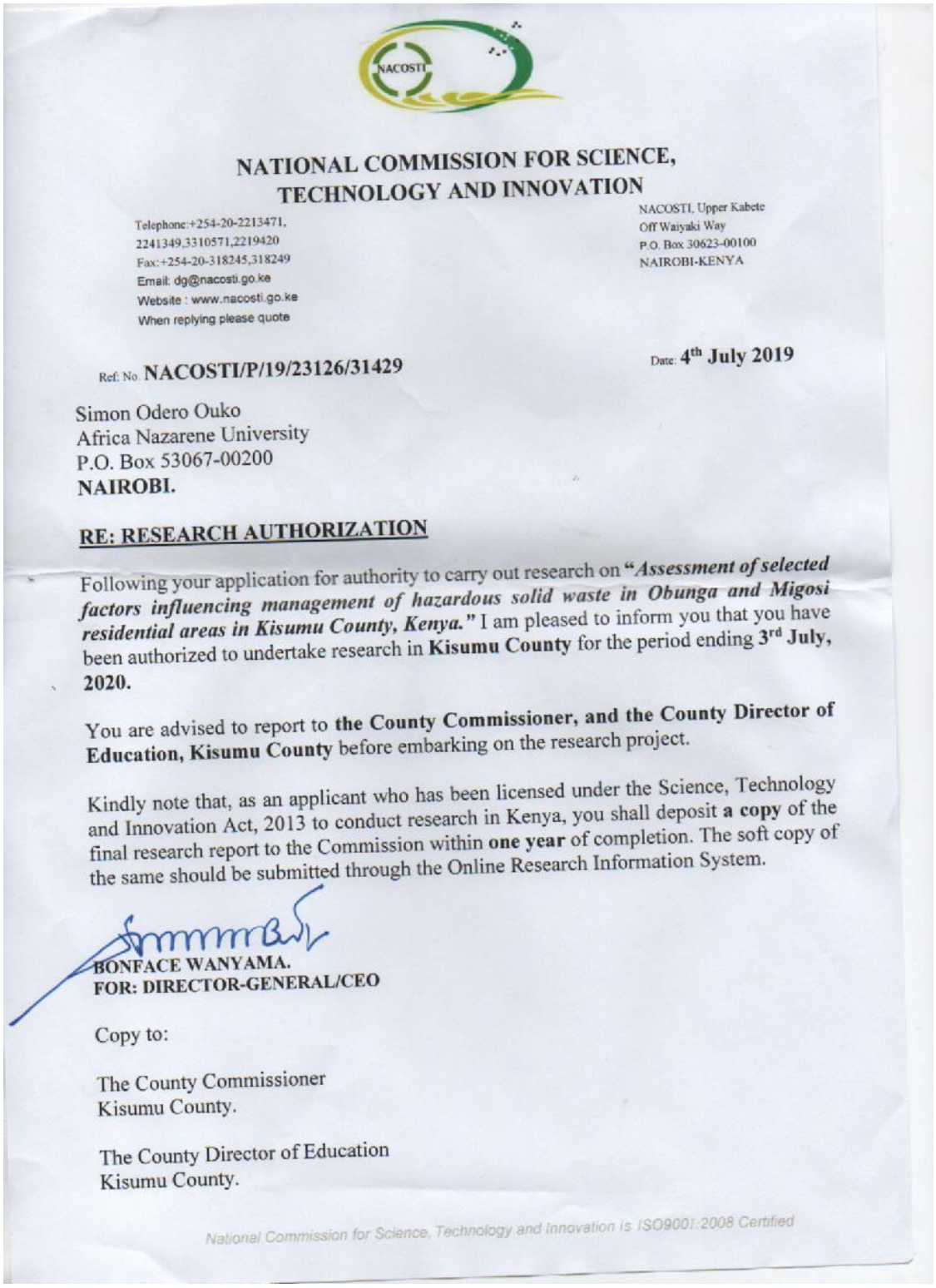
Simon Odera Ouko 17SO3DMEV001 is a bonafide student at Africa Nazarene University. He/She has finished his/her course work and has defended his/her thesis proposal ***entitled "Assessment of selected factors influencing management of hazardous solid waste in obunga and migosi residential areas in Kisumu county, Kenya***

Any assistance accorded to him/her to facilitate data collection and finish his/her thesis is highly welcomed.

Prof. Rodney Reed
Deputy Vice Chancellor, Academic Affairs

P.O Box 53067 - 00200 Nairobi, Kenya • Tel: 020 252 7170/1 - 5 • Fax: 020 201 2233 • Cell: 0733 874 111 • Email: registrar@anu.ac.ke • www.anu.ac.ke

Appendix D: NACOSTI Letter



NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone:+254-20-2213471, 2241349,3310571,2219420
Fax:+254-20-318245,318249
Email: dg@nacosti.go.ke
Website : www.nacosti.go.ke
When replying please quote

NACOSTI, Upper Kabete
Off Waiyaki Way
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/19/23126/31429**

Date: **4th July 2019**

Simon Odero Ouko
Africa Nazarene University
P.O. Box 53067-00200
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Assessment of selected factors influencing management of hazardous solid waste in Obunga and Migosi residential areas in Kisumu County, Kenya."*** I am pleased to inform you that you have been authorized to undertake research in **Kisumu County** for the period ending **3rd July, 2020.**

You are advised to report to **the County Commissioner, and the County Director of Education, Kisumu County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

BONFACE WANYAMA.
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Kisumu County.

The County Director of Education
Kisumu County.

National Commission for Science, Technology and Innovation is ISO9001:2008 Certified

Appendix E: NACOSTI Permit



THIS IS TO CERTIFY THAT:
MR. SIMON ODERO OUKO
of AFRICA NAZARENE UNIVERSITY,
24505-100 Nairobi,has been permitted
to conduct research in *Kisumu County*
on the topic: *ASSESSMENT OF SELECTED FACTORS INFLUENCING MANAGEMENT OF HARZADOUS SOLID WASTE IN OBUNGA AND MIGOSI RESIDENTIAL AREAS IN KISUMU COUNTY, KENYA*
for the period ending:
3rd July,2020

Permit No : NACOSTI/P/19/23126/31429
Date Of Issue : 4th July,2019
Fee Recieved :Ksh 1000

Applicant's Signature

Director General
National Commission for Science, Technology & Innovation