

**Nairobi Household Solid Waste Management Practices: Need for Re-
Strategizing**

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**A Thesis submitted in partial fulfillment for the Degree of Master
of Science in Environmental Legislation and Management in the
Jomo Kenyatta University of Agriculture and Technology**

2011

DECLARATION

This Thesis is my original work and has not been presented for a Degree in any other university.

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DEDICATION

This Thesis is dedicated to my niece, Angel Mumbi for her innocent embrace of life and her passion for learning new things every day. She gives me hope that the future will be as bright as she is.

ACKNOWLEDGEMENT

I wish to thank my supervisors, Prof. Joseph Keriko and Mr. Paul Njogu for their knowledge, guidance and advice through the course of writing this thesis. I would like to appreciate Prof. Joseph Keriko for mentoring me and painstakingly revising this draft from start to end. Secondly, I would like to appreciate Mr. Paul Njogu for his passion, dedication and valuable insight during this study. My gratitude goes to both supervisors for encouraging and believing in me during tough times in the course of this study.

My appreciation goes to UNICEF KCO-WASH Section more so to my colleague Judy Raburu and the entire JKUAT ELM class of 2008 for their support and encouragement throughout this period.

I also wish to thank my parents; Jonah Fred Mulatya and mum Florence Mumbi for supporting me emotionally during the course of this study. I wish to acknowledge my dear brother, Ernest and wife Eunice for their unconditional support. I cannot forget my pastor Mr. Musilu for his spiritual guidance throughout my research work. Finally, I wish to thank my best friend Jolly Kathambi for being there for me and supporting me when I most needed her. Above all, I thank the almighty GOD for giving me good health and sufficient grace overtime.

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LIST OF ABBREVIATIONS AND ACRONYMS

°C	Degrees Celcius
Cap	Chapter
CBD	Central Business District
CBOs	Community Based Organizations
Co.	Company
CP	Cleaner Production
EA	Environmental Audits
EMCA	Environmental Management and Coordination Act
EIA	Environmental Impact Assessments
FAO	Food and Agriculture Organization
FW	Food Waste
<i>et al</i>	and others
GoK	Government of Kenya
GL	Glass
KAM	Kenya Association of Manufacturers
Kgs	Kilogrammes
KShs	Kenya Shillings
Ltd	Limited
MEAs	Multi- lateral Environmental Agreements
MDGs	Millennium Development Goals
NEMA	National Environment Management Authority
NCC	Nairobi City Council
NGOs	Non-Governmental Organizations

PP	Paper
4Rs	Reduce, Recycle, Re-use and Repair
SWM	Solid Waste Management
UN	United Nations
UNEP	United Nations Environmental Programme
WB	World Bank

ABSTRACT

Evidence from research data considers the total waste generated in the city of Nairobi to be approximately 3,000 tons/day. The rate of solid waste generation is far greater than the capacity of the City authorities to collect/dispose it and these uncollected wastes are evidenced in garbage heaps, and litter everywhere. The problem of the mixed waste, uncollected waste, unsafe waste disposal methods and failure to enforce environmental legislations remains a serious problem. The current waste management practices have failed to deliver; hence there is need for multi-sector and integrated approach that includes public engagement and political prioritization of the waste recovery and recycling efforts. This could be a step in the right direction for the benefit of our society and protection of environmental heritage. For this study, primary data was collected using semi-structured questionnaires and personal interviews with respondents. Secondary data collection entailed a comprehensive review and analysis of up to date literature on solid waste management strategies and existing Acts that relate to SWM. The sample population for questionnaires was 60 respondents per income stratum. Analysis of the household perceptions, attitudes and behaviour in relation to waste management practices was done and comparisons made between waste generated from high income, middle income and low income areas. Kenya's policy/legal framework was reviewed and public awareness at community level ranked.

This study has identified a workable solution to improve the legal, institutional and strategy arrangements for Solid Waste Management (SWM) at both national and local levels.

CHAPTER ONE

1.0 INTRODUCTION

1.0 General Introduction

Environment and management is becoming an important issue in the World politics, global economy as well as in the life of mankind. According to our common tragedy, anthropogenic activities are changing the environment in ways that have never been anticipated before by mankind. Poor solid waste management practices contribute to loss of resources, global warming (climate change) and adverse impacts on the public health systems. Reduction of Environmental degradation is an effort towards natural resources sustainability. This is part of the Millennium Development Goals (MDG's) (Thomaes *et al.*, 1995).

Human activities have dramatically altered this planet and its inhabitants where there effects have been exaggerated by increased population growth rates. The need to sustain the ever increasing population through industrialization has become an essential part of modern society and waste production is an inevitable outcome of these developmental activities. A material becomes a waste when it is discarded without compensation for its inherent value. These waste may pose a potential hazard to the human health or the environment when improperly treated, stored, transported or disposed. (Pepper *et al.*, 1994).

Solid waste management (SWM) encompasses the functions of collection, transfer, resource recovery, recycling and treatment. The primary target of SWM is to protect the health of the population, promote environmental quality, develop sustainability and provide support to economic productivity. To meet these goals, sustainable solid

waste management systems must be embraced fully by local authorities in collaboration with both the public and private sectors. Although in developing countries the quantity of solid waste generated in urban areas is low compared to industrialized countries, the SWM still remains inadequate (Kibwage, 2002). The science of waste management refers to the knowledge, management and related practices to safeguard the effects of waste pollution from human, ecological systems and the environment. Collection could mean gathering of waste from places such as residences, commercial centres, institution and industrial establishments and public places (UNEP, 2007). Processing refers to activity applied to waste to prepare it for subsequent operation. Disposal refers to the placing of waste in its ultimate resting place (Wamukoya and Situma, 2000).

Environmental problems occur as a result of the interaction between two complex systems, the human-society system and the ecological system. Best environmental management practices result to improved public health systems. The improved public health systems could save money from medical treatments and provide opportunities to develop education, investment, infrastructure and other economies. Waste management strategy can be a poverty eradication tool if properly guided through policy and legislations but most of the African countries have not achieved clean and health environment for its citizen due to the poor governance and lack of basic and applied sciences and technologies (World Resource Institute, 2000).

1.2 Environmental Legislations on Solid Waste Management

Widespread concern about the need for global action for the protection of the natural environment is a relatively recent phenomenon. General public awareness of the

problems relating to the global environment and the need for co-ordinated multilateral action to address these problems was not evident even a few decades ago. With the wider dissemination of information relating to the ever increasing environmental challenges, international concern has grown steadily over the years (UNEP, 2007). Modern international environmental law received a major boost with the 1972 United Nations Conference on the Human Environment held in Stockholm, Sweden, which brought much broader attention to the issues.

During the Stockholm conference, over 300 Multilateral Environmental Agreements (MEAs) were negotiated and the United Nations Environment Programme (UNEP) was established as the global watchdog for the management of environmental issues (NEMA, 2005). Twenty years later, the United Nations Conference on Environment and Development (UNCED) was held in Rio de Janeiro Brazil in 1992 with Agenda 21 as the main output of the conference. Since Rio, a host of other conventions, treaties and agreements have since been formulated to safeguard against various environmental issues. Kenya is party to several MEAs that address different aspects of the environment. Most of these MEAs have been domesticated whereas various others are at different levels of domestication into the existing laws (NEMA, 2005).

Some conventions that are relevant to waste management include:

- The Basel Convention on control of trans-boundary movement of hazardous waste and their disposal. This is an international treaty that was designed to reduce the movements of hazardous waste between nations, and specifically to prevent transfer of hazardous waste from developed to Less Developed Countries (LDCs).

It is also intended to minimize the amount and toxicity of wastes generated, to ensure their environmentally sound management as closely as possible to the source of generation, and to assist LDCs in environmentally sound management of the hazardous and other wastes they generate (http://en.wikipedia.org/wiki/Basel_Convention).

- Vienna Convention on substances that deplete the stratospheric ozone layer, 1987.
- Montreal Protocol, 1989.
- Bamako Convention on the ban of the import into Africa and the control of trans-boundary movement and management of hazardous waste within Africa.
- Cartagena Protocol on Biosafety, 1993.
- Stockholm Convention on persistent organic pollutants (POPs)
- Rotterdam Convention on the prior informed consent (PIC) procedure for certain hazardous chemicals and pesticides in international trade, 1998.

National legislations that touch on solid waste management include the environmental management and coordination act (EMCA) 1999. EMCA, 1999 is an Act of parliament that provides for the establishment of an appropriate legal and institutional framework for the management of the environment. Legal interventions provided in EMCA, 1999 dealing with solid waste include Part viii section 87(2)(a) and (b), 88(1), 91(4-5) for waste transporters (ROK, 1999a).

Waste Management Regulations, 2006 streamline the handling, transportation and disposal of various types of waste. These regulations have classified the different

types of waste and identified the most appropriate disposal methods. The regulations mostly focus on pollution on land and water, environmental management and compliance to the law (<http://www.nema.go.ke>).

1.3 Waste

Waste, rubbish, trash, garbage, or junk is any unwanted or undesired material (Wamukoya and Situma, 2000). It can also be anything rejected and cannot be stolen. "Waste" is the general term though the other terms are used loosely as synonyms, they have more specific meanings such as rubbish or trash is mixed household waste including paper, packaging and forms combustible portion of rubbish.

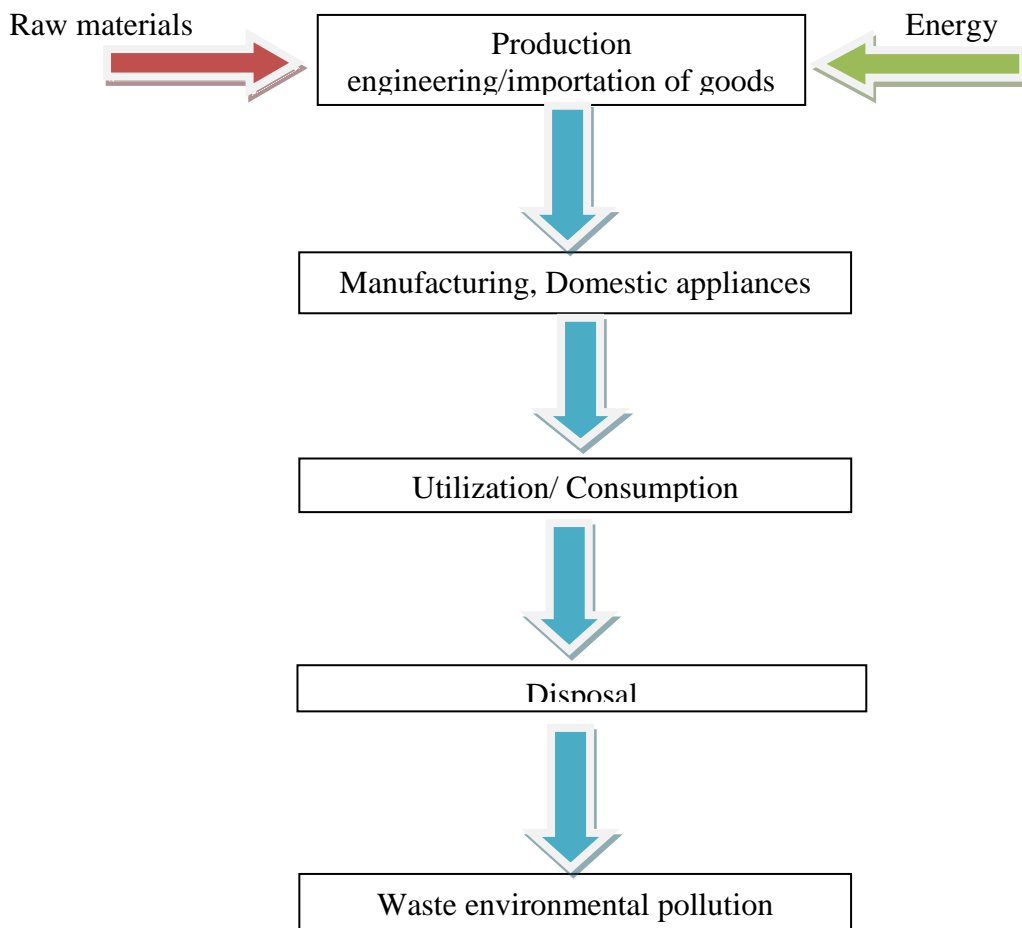
1.3.1 EMCA definition of waste

"Waste include any matter prescribed to waste and any matter whether liquid, solid, gaseous or radioactive, which is discharged, emitted or deposited in the environment in such volume, composition or manner likely to cause an alteration of the environment" (ROK, 1999a). Solid wastes include solid substances comprising of industrial waste, agricultural wastes, institutional wastes, domestic/household wastes as well as debris from construction and mining operations. Household solid wastes comprise of food waste, paper and paper products, old clothes and shoes, vegetable/fruit peelings, plastics etc (NEMA, 2005).

1.3.2 Government's desire

It is the government's desire to have pollution prevention through waste minimization and resource recovery. If this cannot happen, then there is a possibility

to compromise on the environmental and people's health quality. Poor environmental health quality will then mean poor economies and degraded resources with poor utilization strategies.



Sources: Own design, 2008

Figure 1: Conceptualized model of the city production and utilization systems

During manufacturing process, a lot of energy and materials are used and waste is produced. The producers are not prepared to accept product stewardship and the related environmental responsibility. As a result, cleaner production and green trading practices are not very common practices among the Kenyan business communities save for few multinational companies.

The research focuses on the current production strategies/technologies and explores available options that can be promoted in order to ensure efficient use of raw materials and energy resources. The recommendations will subsequently minimize waste generation; enhance profitability of enterprises and positively contribute to economic benefits (Theodore, 2000).

1.4 Rationale and Justification

This study aimed at bridging the gap that exists in solid waste management practises in Nairobi city. It has generated and increased knowledge on how to improve enforcement of the existing environmental legislations. It came up with plausible solutions and recommendations on how best to manage current waste management barriers and use of available technologies.

The study will help the local scholars, researchers, scientists and other stakeholders understand and relate to the concept of waste management strategies and also increased the economic growth. It will help project developers, NGOs and investors understand the Kenyan solid waste management framework better in light of its barriers, risks and high potentials. In the long run, this study will help Kenya position itself better to attain the Millennium Development Goals (MDGs) by the year 2015 and thus plays a more prominent role in creating awareness to households on the importance and need for improved environmental sanitation and hygiene for better health.

By implementing proper solid waste management strategies and technologies, Kenya is bound to benefit tremendously from alternative waste energy sources, improved

environmental conservation, reduced soil and water pollution and increased foreign direct investment. It is now time for Kenya to tap enormously the benefits of efficient waste management strategies as a tool for promoting sustainable development.

1.5 Statement of the Problem

The current trend of increased waste generation being witnessed in Nairobi city, calls for proper waste management practices. By the year 2030, Nairobi could be generating 35% more waste than it does today. This study aimed at identifying waste prevention and management strategies in Nairobi residential areas.

Without adequate enforcement of the existing environmental legislations and increased public involvement, important components of the integrated waste management systems including waste source separation, recycling, improved storage and collection systems will never see the light of the day. However, with elucidation of key barriers and gaps impeding solid waste management in Kenya, environmental degradation due to waste will be a thing of the past. As such, there was need to identify legal/policy barriers impending integrated SWM in Kenya and in the process come up with mitigating solutions for this problem.

1.6 Hypothesis

1.6.1 Null Hypothesis

Nairobi households waste management systems does not suffer from poor source separation, collection, transportation and disposal practices

1.6.2 Alternate hypothesis

Nairobi households waste management systems suffer from poor source separation, collection, transportation and disposal practices

1.7 Scope and Site of Study

Nairobi is the capital city of Kenya and has an estimated population size of 3.7 million people; a population that the Government estimates to be growing at the rate of 7 % per annum (Ochieng, 2005). This study covered Nairobi residential areas characterized by six estates as shown in Appendix 1. This included;

High income, e.g Muthaiga and Runda zone

Middle income e.g Buruburu and South B zone

Low income generation e.g Eastleigh and Kariobangi North zone

Key institutions that are involved in solid waste management were be included in the interview;

- Nairobi City Council (NCC)
- National Environmental Management Authority (NEMA)

1.8 Objectives

1.8.1 Main Objective

To outline the broad aspects of solid waste management problems in Nairobi households and propose a road-map towards strategic improvements for sustainable solid waste management.

1.8.2 Specific Objectives

The specific objectives were to;

- 1) Identify existing institutional and legislative barriers impeding solid waste management and investigate on the enforcements in place
- 2) Identify the difference in waste generated from high income areas to low income areas.
- 3) Analyze the household perceptions, attitudes and behavior in relation to household waste management practices in estates.
- 4) Determine the effects and gaps in the present practices of the city household waste management strategies and propose plausible solutions to the problems.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 General Overview

Urban centers in Africa support about 30% of human population (Kenya International Labour Organization, 2001). This is largely attributed to rural-urban migration of people in search for better livelihoods and has resulted into the problem of solid waste generation and management in Africa (Stren and White, 1989). The increased waste quantity is a threat to the public health systems, diminishes quality of land and environment, local economies, water resources, biodiversity, food production and tourism sector (Kibwage, 2002a). Evidence has shown that poor waste handling can create a potentially hazardous situation and pose significant risks of concern to society.

Some of the cases of contamination due to poor waste disposal which received attention in the past are the Love Canal Incident in New York (Misra and Pandey, 2005). Disposal of waste at Love Canal dump site was stopped but the area left unprotected over time. Subsequent exposure of the site to scavengers resulted in residents in a township in the area suffering serious health impairments, including several children in the neighborhood apparently born with serious birth defects. Similar incidents are recorded in other US locations, Europe, Japan and other locations in Asia (Pierzynski *et al.*, 1994).

Over the years Kenya has experienced an upsurge in the generation of waste, solid, liquid or gaseous form largely due to urbanization occasioned by rural urban

migration (Ikiara *et al.*, 2004). Kenyan urban population has been growing at a rate of 8% per annum and is now more than 35% of the country's total population. Generation of solid, liquid and gaseous wastes has been increasing at the same level as industrial development and the diversification of consumption patterns. About 21% of solid wastes generated emanate from industrial activities and 61% is from residential sources. Only 40% of it is collected and disposed of at designated disposal sites. The remaining 60% of the waste is either dumped in undesignated areas or disposed off in rivers that transverse the urban centre and this has often led to physical accumulation of garbage and occasional sewage flowing into water systems (Kibwage, 2002b). For instance, Nairobi River has lost its healthy ecological character due to the solid waste polluting its water. Results of a survey reveal that the environmental health status in the country has been deteriorating over time, hence the need for multi-sectoral approach to address the threat by diseases, majority of which are as a result of domestic waste (NEMA, 2005).

Nairobi solid waste management problem has over spilled to social and economic sectors. According to recent studies, the main concern is the large volume of waste generation, low collection capacity, uncoordinated disposal and weak enforcements practices. Solid waste management is currently a major environmental hazard in the country (Ochieng, 2005). The per capita waste generated ranges between 0.42 - 1.39 Kg/day. The average per capita rate for the city is 0.85 Kg/day/person and is projected to rise to 1 Kg/day/person by 2015 (JICA, 1998; Keriko, 2006). About 61% of the city waste generated is residential with components of the non-hazardous

and hazardous due to some industrial and hospital/pharmaceutical products becoming a waste at the household level (UNEP, 2002).

Nairobi currently produces about 2400 tons of garbage every day, amounting to almost one million tons of waste every year. On average, each Nairobi household generates over 253 Kgs a year. If the population trends remain uncontrolled with constant waste generation for the next 10 years, there will be 1,390,434 tonnes as much of waste to handle by 2015 (JICA, 2005). Table 1.0 and 2.0 below explain the trends in quantities and compositions of waste generated in Nairobi.

Table 1.0 Solid waste composition in Nairobi

	1997 (JICA)		2004 (ITDG)		2015 (Projection)
	Total (t/day)	Rate (%)	Total (t/day)	Rate (%)	Total (t/day)
Combustibles	1,317	92	2,231	95	3,672
Incombustibles	109	8	116	5	127
Total/day	1,426	100	2,347	100	3,799
Total/year	521,916		859,002		1,390,434

(Source: NEMA, 2005)

Table 2. Types of solid waste in Nairobi

Type	Percentage (%)
Metal	0.62
Rubber	0.18
Other	3.57
Leather	0.37
Plastics	20.60
Organic/food wastes	61.39

Textiles	0.64
Paper	11.84
Glass	0.74

(Source: ITDG, 2004)

With the increasing per capita waste generation in the country, the risks of waste on human health seems real and calls for the designing of appropriate waste management systems, especially in urban centres to cater for the rapidly growing population. High poverty and low awareness levels are some of the factors for the disparities between urban and rural population (Ikiara *et.al*, 2004).

2.2 National Context of Solid Waste Management

2.2.1 Policy Framework

The draft Environment and development policy of 1999 has never been endorsed by parliament, which was later overtaken by the enactment of EMCA of 1999. As such the country lacks a comprehensive policy that embraces the various environmental challenges. This lack of policy is reflected in the operations of many sectors especially the local authorities and has created a weakness in the integration of environmental concerns into development (RoK, 1999b). Lack of waste management policy has resulted into serious challenges on solid waste management. Prior to the enactment of EMCA of 1999, local authorities had monopoly over sanitation and solid waste management services in the country under the Local Government Act (Cap 265) and Public Health Act,1986 (Cap 242).

2.2.2 Legal Framework

Domestic solid waste management benefits from the legal instruments inherent in the relevant MEAs as well as the draft Waste Management Regulations of 2006. MEAs play a significant role in managing global environmental issues. They ensure that concerted actions are undertaken across various countries. Some of the relevant MEAs to issues relating to domestic waste include; Basel Convention on the Control of Trans-boundary Movements of Hazardous Waste and their Disposal, United Nations Convention on the Law of the Sea (UNCLOS), Tripartite Environmental Management Programme for Lake Victoria, Rotterdam Convention, Montreal Protocol among others. About 77 statutes exist addressing various aspects of the environment through specific sectors (NEMA, 2005). However, the sectoral statutes were independently inadequate to manage the environment and especially waste thus requiring harmonization. This led to formulation and enactment of EMCA of 1999 thus creating synergies and strengthening legal instruments for managing the environment. The harmonization of the environmental legislation under EMCA of 1999 improved environmental management. This has enabled environmental issues to be resolved in the event of any conflict with existing laws (NEMA, 2005). Some of the sectoral statutes related to waste management are listed in Table 3.0 below.

Table 3.0. Legal and Institutional Framework. (Source: NEMA, 2005)

S. No	Parliamentary Statutes	Institutions	Management Principles
1	Environmental Management and Coordination Act, 1999	NEMA	Environmental Impact Assessment and Audit (EIA/EA). Effluents discharge system

					Water pollution Disposal of wastes Hazardous wastes Licensing waste disposal sites
2	Physical Planning Act Cap 286,1996		Ministry of Lands Physical Planning Department		Land Development approvals Siting waste disposal sites Environmental Impact Assesment
3	Public Health Act 242, 1986		Ministry of Health Public Health Dept-		Environment, sanitation, health and hygiene
4	Local Government Act Cap 265, 1981		Local Govt. and Municipal Councils		Land Development approvals Environment and sanitation
5	Land Control Act Cap 302, 1981 and Land Adjudication Act Cap185		Ministry of Lands-Land Adjudication and settlement		Set apart land for infrastructure, social, amenities development
6	Government Lands Act Cap 280, 1984		Ministry of Lands-Lands Dept-		Compulsory Land Acquisition Register of Easement Rights of Way on private properties
7	Water Act, 2002		Ministry of Water/WRMA, Water		Water protection, conservation, pollution, water supply and sewerage regulation

2.2.3 Institutional Framework

The sectoral legislation is implemented through specific institutions, agencies and organizations. These institutions administer, enforce, coordinate and monitor various Acts of parliament including those related to the environment. Case example of these institution would be the National Environment Management Authority (NEMA) created under Part III – Administration – 7:1 of EMCA No.8 of 1999. The Act establishes NEMA as the principal instrument of Government for the implementation of all policies relating to environment.

Nairobi city is administered by the Nairobi City Council whose mandate over the city is derived from the Local Government Act, 1998. The council provides or regulates the delivery of services in education, public health physical planning, social services and sanitation including solid waste management. The services are regulated by the environment department through the city's by-laws on solid waste management as well as other administrative procedures and policies adopted by the Council.

However, despite these elaborate institutional frameworks, environmental degradation has continued to occur unabated thus demonstrating lack of coordination and enforcement of the various sectoral laws. The provision of environmental services, which includes drainage and all other forms of wastewater and garbage collection, are the responsibility of the NCC. In July 2007, the NCC published vide Kenya Gazette No. 6297 several by-laws including Solid Waste Management and

Waste Water Conservancy By-laws of 2007. The By-laws seek to criminalize garbage collection and disposal without authority of the NCC.

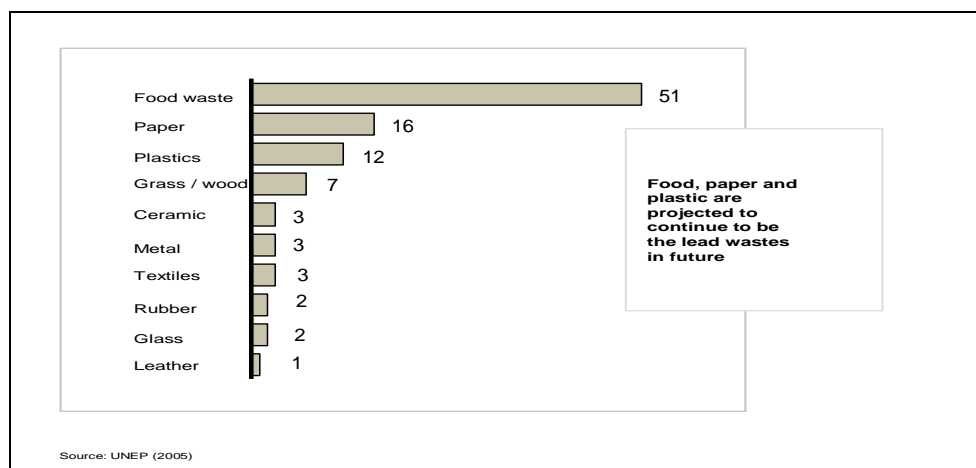
Although the responsibility of waste management is vested in local authorities, most of them lack the necessary capacity to deal with the amount of waste generated (GOK, 2005). In the 174 local authorities in Kenya, only 32 have some form of sewage treatment and disposal facilities, only two have conventional treatment plants while 30 have oxidation lagoons which can only handle organic waste. The management of waste in Nairobi is under the Nairobi City Council (NCC), the Ministry of Local Government and the Provincial Administration. To address these challenges, National Environmental Management Authority (NEMA) has established partnerships between local authorities, the private sector, civil society organizations and local communities in handling waste. Research reveals that Nairobi, Central and Western Provinces are among the regions with improved sanitary facilities in the country while North Eastern Province has the least access to such facilities (NEMA, 2005). In rural areas, 50% of households dispose domestic waste in farms. Much of the hazardous wastes end up in water and on land (JICA, 1998).

2.2.4 Waste Management System

In order to design a sustainable and environmental friendly waste management system, it is vital to know the overall waste generation and composition data of waste for the entire community. Generation rates of residential as well as industrial, institutional establishments, and public places and generation rates of the individual solid waste component are crucial for engineering designs of waste management facilities (RoK, 2005). The quantities of solid waste generated by all the above

categories need to be monitored frequently for effective services delivery and for improved management practices. Figure 2.0 below shows that, food, paper and plastic waste make up the bulk of the country's solid waste. They are also projected to continue to be the leading solid waste in the future. Chemical and hazardous waste in the country is mainly attributed to the new lifestyles adapted by the city's resident. ,

However, waste from hospitals and materials resulting from imports of cheap counterfeit goods (especially electronics) are the main sources of hazardous waste reaching the households. These types of waste are projected to pose a great danger to the population as the economy develops. Creating public awareness and building capacity of institutions handling these issues, should be given the first priority (Cardno Agrisystems Africa Ltd, 1999).



(Source: UNEP, 2005)

Figure 2.0. Percentage Composition of solid waste in Kenya

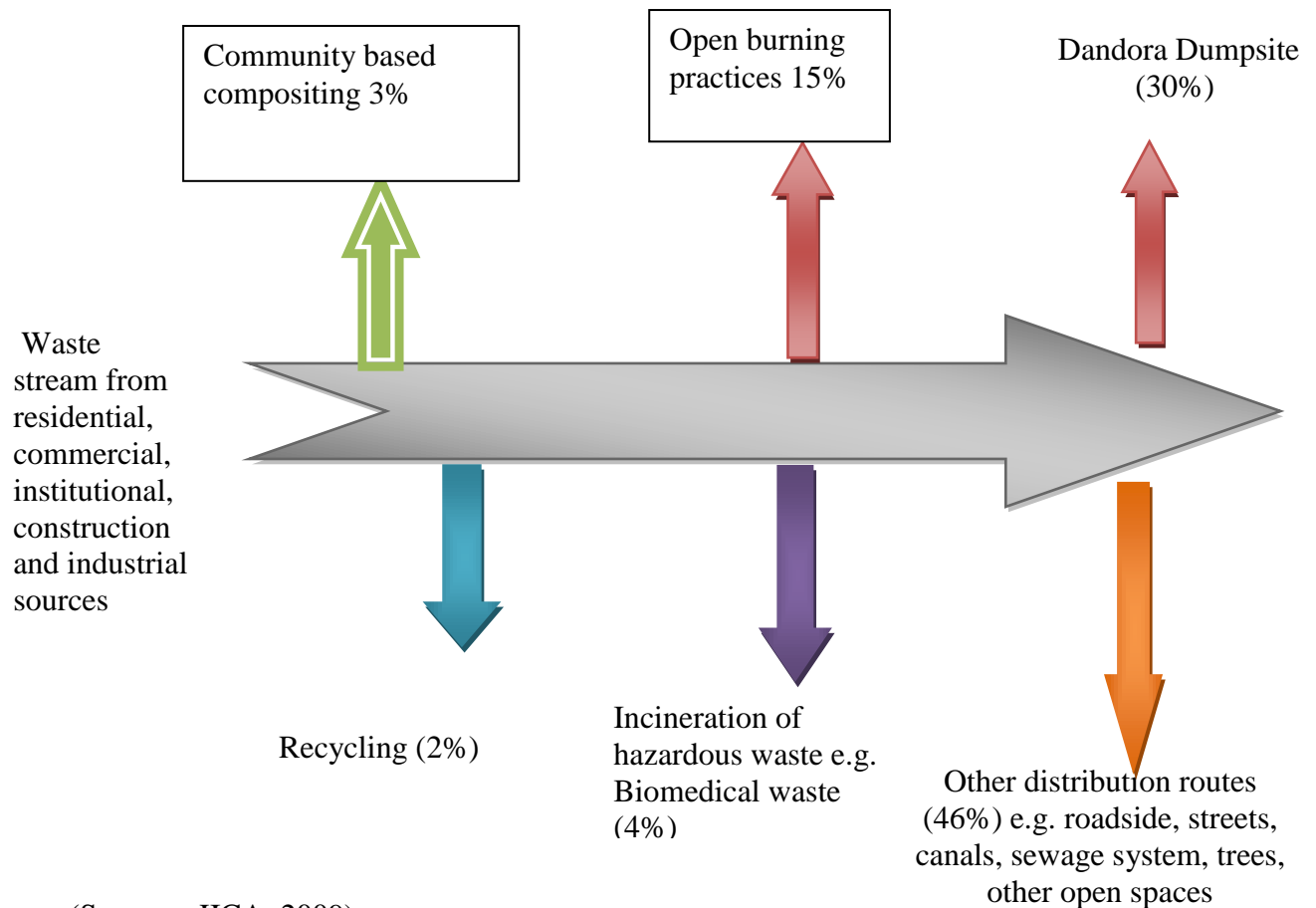
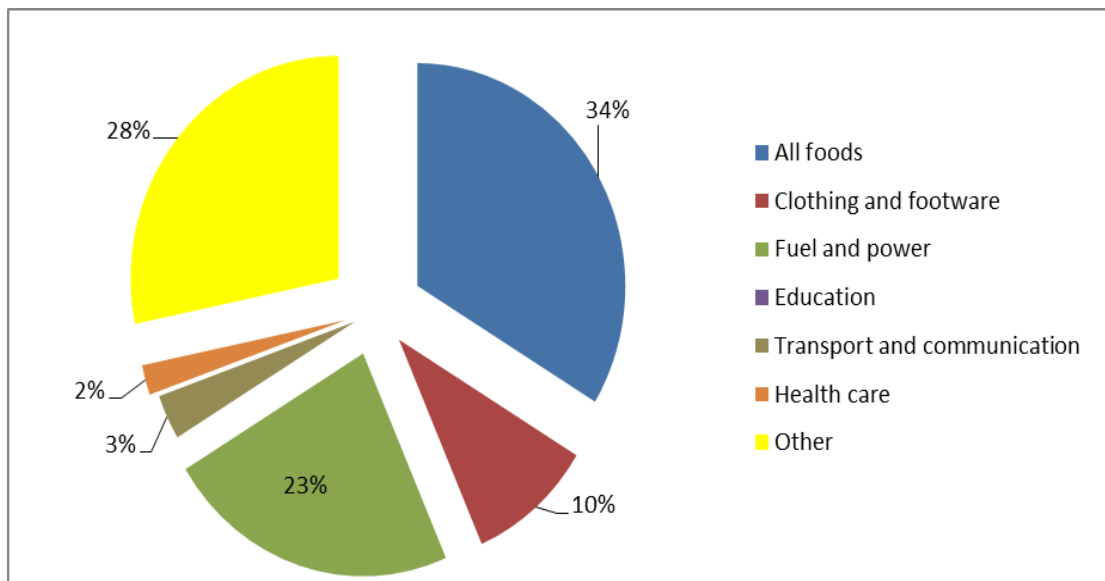


Figure 3.0 Current practices of waste management in the city of Nairobi

From Fig. 3.0, it is quite clear that our practices based on the production and importation is characterized by the use of products and dumping them on the dumpsites, resulting into increased environmental degradation. Economic growth and affluent lifestyles among the population has led to increased consumption which in turn has put pressure on natural resources both as raw material sources and as recipients of waste and pollution. Fig 4.0 shows consumption patterns in the country, whereby food consumption contributes 34% of overall domestic goods.



(Source: World Bank, 2000)

Figure 4.0 Household consumption by category in Kenya in 1999

The problem of the mixed waste, uncollected waste, unsafe waste disposal methods and failure to enforce environmental legislations remains a serious problem. The current waste management practices has failed to deliver, hence resulting in the need for multi-sector and integrated approach that includes; public engagement, political prioritization of the waste recovery and recycling efforts while relying on the engineering principles (UNEP, 2001).

Poor waste management practices and negative environmental health impacts could have been avoided through the application of proper planning and engineering practices of recycling technologies. It is necessary to utilize science and engineering principles in sitting and operating solid waste disposal facilities. This could be a step in the right direction for the benefit of our society and protection of environmental heritage.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Research Design

Three specific tasks were carried out in tandem with the objectives of this study. The first task was to make an integrative review and analysis of Nairobi's household waste management activities. The second task was to identify key barriers relating to the current waste management performance. The third task was to check and propose policy recommendations that can create synergies between institutions and facilitate proper implementation of effective waste management strategies.

3.2 Data Sources

A series of methods were used in this research work. Statistical data came from authoritative publications and existing Kenyan laws dealing with SWM. Secondary data collection entailed reviewing and content analysis of both theoretical and empirical literature. For primary data, formal interviews were undertaken after the problem questions had been formulated. Interviews were done through questionnaires and face to face conversation. The questionnaires were well structured to facilitate easy and short answering of questions by the respondent. Face to face interviews were recorded on a note book so as to retrieve their verbatim later for analysis. Personal presentations in class and seminars prior to the final project presentation helped give valuable feedback and suggestions for the research study.

3.3 Sample Size and Sampling Design

This was a descriptive study with both quantitative and qualitative aspects. The qualitative aspect was used to compliment the quantitative data to help ensure that all gaps had been addressed. Stratified random sampling was done; the samples were derived from three different stratum within Nairobi city (refer to appendix 2). The stratum included population drawn from three different residential areas as follows; low income zone, middle income group and high income zones. Due to time and financial constraints, the study was conducted in only three estates (Runda, Buruburu and Kariobangi North) which were characteristic of high income, middle income and low income zones respectively. A systematic random sampling of households within the estates was done to minimize biasness of data and the study units were either male or female household heads.

Data was collected on the mass of the total waste generated from these households. The wastes were then sorted manually into different categories i.e. plastic waste, organic waste, paper waste, glass waste, metal waste, composite waste and white goods. The mass of this waste were recorded for seven days and averaged to obtain the mass of waste generated for a single day. The descriptive statistics for the pilot survey were as shown in table 4.0 below.

Table 4.0. Mass of waste generated in the different income categories

Class	Number of house holds	Average mass (Kg) of waste generated per/HH/day	Standard deviation of waste generated per day. (S)
High class	40	6.500	1.223
Middle class	40	4.207	1.072
Low class	40	1.992	1.152

The formula for sample size calculation is shown below

$$\text{Eqn 1.0} \dots \dots \dots n \geq \frac{s^2 z^2}{d^2} = 15 \text{ (Gerry and Michael ,2002)}$$

$$d^2$$

Where:

z = the critical value of the standard normal distribution at 95% confidence.

s = the standard deviation of the mass of waste obtained from the pilot survey.

d = the maximum allowable absolute difference between the estimated mean and the true population mean (usually estimated by taking half of the standard deviation of the sample values).

The study used $n = 60$ for all income categories; this because a large sample size increases accuracy of the estimates.

3.4 Data Collection and Analysis

A total of 16 enumerators were used in this study. The enumerators were organized into three teams; each team consisted of 3 members with an environmentally related background and a supervisor. The supervisor's main activity was to ensure that correct sampling procedures were used and there was consistency in interviewing and data collection collected in the households.

Three Focused Group Discussions (FGD) and 3 key informant interviews with key staff in waste management institutions were carried out. Data was collected as follows; Document reviews of policies and laws provided secondary data for researchers. Questionnaires were administered to female or male adult heads of households; this

was complimented with direct observations by researchers. Two sets of questionnaires and one interview guide were developed and administered.

The general questionnaire (see appendix 3) had specific sections relating to each stakeholder: waste generators, collectors, recyclers and final disposers. The second questionnaire was used on private waste collectors involved with SWM in the sample zones. The second tool was an interview guide that targeted policy-makers and regulatory agencies. A sample of 18 interviewees was selected for face-to-face interviews with representation from all the identified sectors in waste management. A total of 2 FGD consisting of 2 groups (one with officials from NCC and the second with NEMA staff) were conducted. The sampling was purposive to address the non-homogenous nature of the population. Researchers within the respective zones used direct observation which was conducted to qualitatively map activities in the area, type of waste generated and the living standards of the residents. Key sources for secondary data included government documents and similar researches conducted in other countries.

The data was presented using tables, figures and pie charts. Data collected was checked for completeness before being analysed using SPSS Statistics software. This was supplemented by using MS Excel for analysis and illustration. For the primary and secondary data, analysis categories, themes and patterns were identified based on the objective of the study. The analysis of secondary data involved the generation of themes and categories. This was recorded on numbered note cards. The process entailed initially reading through the text. Specific segments of the information were identified which were then labeled to create categories and establish patterns.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1. Barriers in Legal and Institutional Frameworks Relevant to SWM

In Kenya there is no statute or national policy or organization established to regulate the management of solid waste. The policies, laws and organizations relevant to solid waste exist under different statutes including the Environmental Management and Co-ordination Act 1999, the Local Authorities Act, 1998 and the Water Act, 2002 and the Physical planning Act among others. These instruments have often led to overlapping duties and conflicting responsibilities within the organizations creating unnecessary conflicts in SWM. In September 2006, the National Environmental Management Authority issued regulations on solid waste management to be observed by all parties handling all kinds of waste in Kenya

For purposes of this study, only two key legislations and institutions were considered;

- EMCA, 1999 and Waste Management Regulations, 2006
- NEMA and NCC

Based on the research findings shown in table 5.0 below, only 24%, 63% and 13% of survey participants in high, middle and low income zones respectively acknowledged the existence of the various governments polices and institutions including EMCA Act 1999, NEMA mandated to deal with environmental issues, while the rest have no idea whatsoever.

Table 5.0 Ratings on degree of awareness on Environmental law and institutions in Kenya

	High income		Middle income		Low income	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Yes	15	24	38	63	9	13
No	45	76	22	37	51	87
Total	60	100	60	100	60	100

4.2 Policy Barriers/Gaps in Solid Waste Management

According to Fig. 5.0 below, majority of the respondents from both institutions NEMA (30%) and NCC (33%) cited lack of awareness of existing legislations and by-laws as the major policy barrier impeding SWM in Nairobi. Lack of awareness is still persistent in many aspects and the need to improve on these issues both at the national and local levels is crucial. Grassroots-level campaigns on available options and technologies recommended by Kenyan laws should be emphasized.

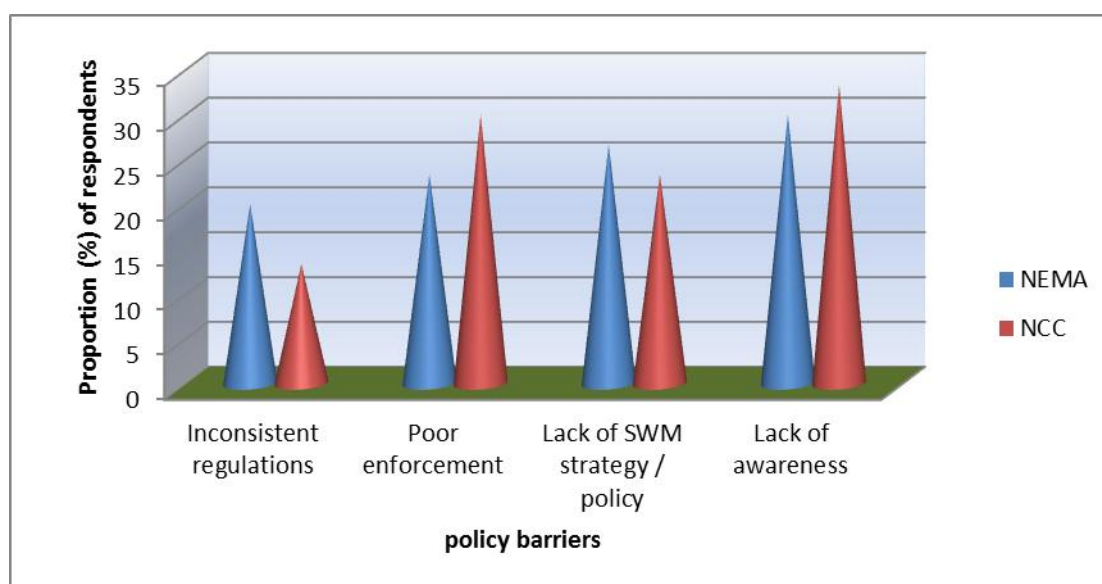


Figure 5.0. Policy barriers in solid waste management

From the study statistics displayed in Table 6.0 below, it is worth noting that the response from NEMA officials majorly indicated gaps on legal instruments while NCC respondents attributed gaps to the implementation process; this draws a conclusion on the exclusive mandates of each institution and more probably indicates the uncoordinated nature in SWM from these institution.

Table 6.0 Statistics on Policy barriers in Solid Waste Management

	NEMA		NCC	
	Frequency	Percentage	Frequency	Percentage
Inconsistent regulations	6	20	4	13.33
Poor enforcement	7	23.33	9	30
Lack of SWM strategy / policy	8	26.67	7	23.33
Lack of awareness	9	30	10	33.33
Total	30	100	30	100

From NEMA and NCC, 23% and 30% of interviewees respectively cited poor enforcement of existing legislations as the major cause of poor SWM. As such, clear directives and policies must be enacted to enforce good waste management practices and these calls for more concerted efforts with all relevant institutions. Law enforcement agents like the Kenya Police, city council officers and judges poorly understand environmental laws and enforcement procedures due to weak governance and corruption practices. Lack of proper strategies to enforce the environmental laws

and the city By-laws was cited as the second highest contributor to policy barriers in NEMA. This has created confusion and corruption phenomenon, with the city council officers often demanding bribes from Kenyans.

4.3 Institutional Barriers/Gaps for Solid Waste Management

Fig. 6.0 below shows bureaucracy and corruption noted as the leading institutional barriers impeding proper SWM in Nairobi. Private and international investors spend a lot of time and resources running up and down in a bid to secure a plethora of authorizations, permits and/or assessments that would otherwise be made in one central national office. While some investors wish to bribe their way into business others opt to avoid the high risk of investing in non-conducive business environments.

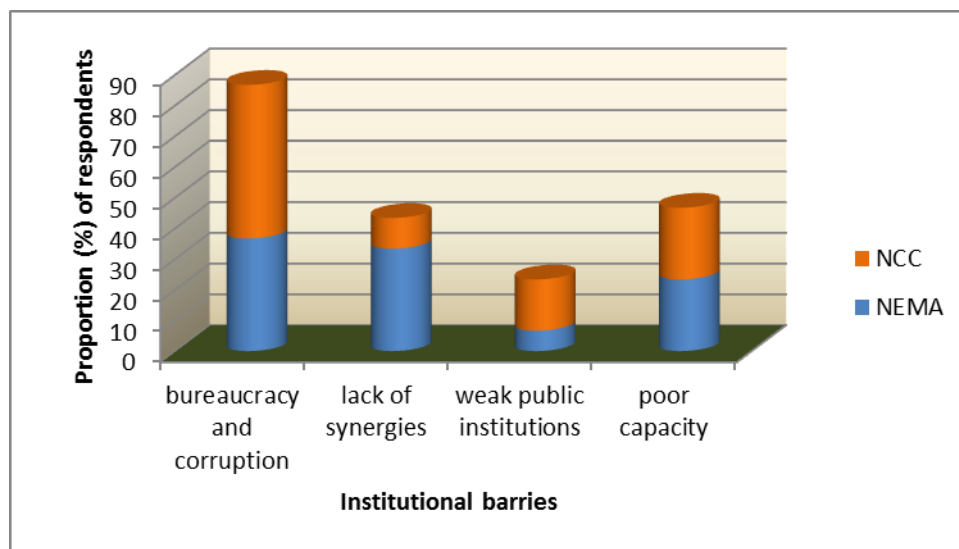


Figure 6.0 Institutional barriers in Solid Waste Management

Table 7.0 Statistics on Institutional barriers in SWM

	NEMA		NCC		NCC/NEMA
	Frequency	Percentage	Frequency	Percentage	Total Percentage
Bureaucracy / corruption	11	36.67	15	50	43.33
Lack of synergies	10	33.33	3	10	13.33
Weak public institutions	2	6.67	5	16.67	20
Poor capacity	7	23.33	7	23.33	23.33
Total	30	100	30	100	100

Data from Table7.0 above shows that 23% of respondents cited poor capacities of implementing public/private institutions while 13% referred to lack of policy/strategy synergies as a barrier within government departments. 20% of respondents acknowledged existence of weak public institutions with poor governance and poorly structured management as inhibiting factors for proper SWM.

Private waste collectors procured by NCC to boost capacity lack adequate finance, management and equipment and often fail to execute in a satisfactory manner. Typically winners of contracts for waste transportation are small operators with old equipment and unmotivated workers lacking technical knowledge on solid waste management. In order to send a consistent message to potential investors, it is important that within a particular country, there is a clear and consistent policy/strategy towards addressing sustainable solid waste management. Developing a consistent policy/strategy will require good communication between the relevant

actors mandated by the various acts. Sustainable solid waste management plans in Kenya has been left to foreign financiers e.g the SWM master plan developed by JICA (2006) has not been implemented to date. NEMA though highly known by majority of respondents has been accused of being unable to exclusively perform within its mandate of acting as a government watchdog on environmental matters. With no provision for setting up an independent court to take care of environmental concerns, the Authority has since been unable to carry out prosecutions for any arbitrators with the designated high court.

4.4 Compliance and Enforcements in Solid Waste Management Regulations.

Fig 7.0 below shows that in all the different zones i.e. high income, middle income and low income, majority of the households do not separate the waste into hazardous and non hazardous waste.



Figure 7.0 Solid waste separation into hazardous and non-hazardous waste

From Table 8.0 below, waste separation is clearly low in all income zones. This could largely be due to lack of awareness on the existing regulations on solid waste

management in Kenya. If a high level of awareness is utilized through proper involvement, it can easily result to transformed thinking and behavior towards the environmental issues including the household waste management.

Table 8.0 Statistics on waste separation into Hazardous and Non-hazardous waste.

	High income		Middle income		Low income	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Yes	6	10	7	11.67	2	3.33
No	49	81.67	49	81.67	55	91.67
I don't know	5	8.33	4	6.67	3	5
Total	60	100	60	100	60	100

The above findings contradict Part 2 of EMCA, 1999 and Part II, section 4/5 of the waste management regulations which stipulate that any person whose activities generate waste shall collect, segregate and dispose or cause to be disposed off such waste in the manner provided for under both Regulations.

Moreover, Part II- EMCA, 1999 and Section 5 of the waste management regulations clearly state that all generated waste supposed to be disposed, must be disposed only in the areas that are stipulated by the authorities.

Table 9.0 Observed and expected households properly separating waste

Area	Observed number of Households properly depositing Waste (O)	Expected number of Households (E)
High income	38	60
Middle income	51	60
Low income	41	60

$$\chi^2 = \sum \frac{(O-E)^2}{E} = 15.43333 \dots \text{Eqn 3.0}$$

From values shown in Table 9.0, the *p*-value of chi – square of 15.43333 at 2 degrees of freedom is 0.000445. Since 0.000445 is less than 0.05, we reject the null hypothesis that null hypothesis (H_0) that the Nairobi households perform proper waste disposal of waste.

Further analysis in Table 10 below, indicates that open lorries are commonly used during transportation often causing littering and bad odour. In the middle and low income zones, pushcarts are used at 10% and 51.67 % respectively. Human transport and pushcarts also cause waste spills and an eyesore to the public and in many occasions such waste is normally dumped along rivers or roads other than the designated disposal site in Dandora. The result is devastating environmental pollution of natural resources as shown in Appendix 1.

Table 10.0 Solid waste transportation in the different income categories

	High income		Middle income		Low income	
	Frequency	Percentage	Frequency	percentage	Frequency	percentage
Closed lorries	50	83.33	18	30	2	3.33
Open lorries	10	16.67	36	60	6	10
Push cart	0	0	6	10	31	51.67
Human transport	0	0	0	0	21	35
Total	60	100	60	100	60	100

Part II - SWM regulations provides for collection and transportation of waste to be conducted in such a manner that it will not cause scattering, escaping and/or flowing out of the waste. Moreover, any person licensed to transport waste is responsible for waste collection from the designated area of storage and tasked to deliver such waste to the designated disposal site or plant. Though part II – EMCA, 1999 safe guards the right to a clean and healthy environment, this right is violated. The high court is another institution that has the jurisdiction to issue such orders should the law enforcers fail to act but the judicial process is lengthy and costly and thus most people fail to use it. Information on how to seek for justice in the courts and customer service charter to serve the public is also not available to everyone. Therefore appropriate measures need to be taken to educate these people on their rights and institutions.

4.5 Solid Waste Management in high, middle and low income zones

In Table 11 below, the p -value of the ANOVA test compares the mean mass of waste generated by the different zones. This value was $0.0000 > 0.05$ indicating that at 95% confidence interval the means and the variances of the mass of waste generated from the different zones is different; thereby the need to analyze the categories differently.

Table 11.0 ANOVA on waste generated in the sampled income zones

Source	Partial SS	<i>df</i>	MS	F	p – value
Zones	313.219896	2	156.609948	125.50	0.0000
Residual	220.878508	177	1.24790117		
Total	534.098404	179	2.98378997		

Similarly, from Table 12, 13 and 14 below, the p -values indicate that the means and the variances of the mass of waste generated by the different estates within the low, the middle and the high income areas are significantly the same, thereby analysis within same income class was clustered.

Table 12.0 Waste generated by the different estates within the high income zone

Source	Partial SS	<i>df</i>	MS	F	P value
Estates	3.47498706	3	1.15832902	0.78	0.5109
Residual	83.3249505	56	1.48794555		
Total	86.7999376	59			

Table 13.0 Waste generation by the different estates within the middle income

Source	Partial SS	<i>df</i>	MS	F	P value
Estates	4.41643635	3	1.47214545	0.77	0.5174
Residual	107.495425	56	1.91956116		
Total	111.911861	59	1.89681121		

Table 14.0 Waste generated by the different estates within the low income zone

Source	Partial SS	<i>df</i>	MS	F	P value
Estates	0.877145783	3	0.292381928	0.77	0.5162
Residual	21.2895628	56	0.380170763		
Total	22.1667085	59	0.37570692		

4.5.1 Solid Waste Composition in different Socioeconomic Groups

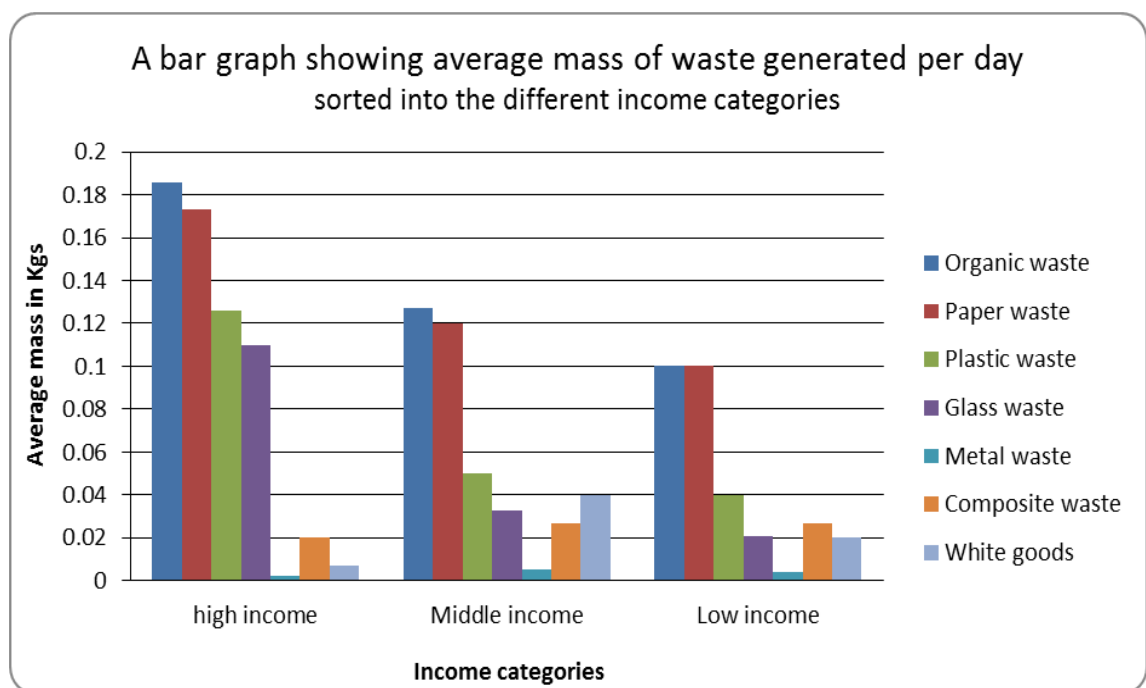


Figure 8.0 Average mass of waste generated in the sampled zones

From Fig. 8 above, results indicate that income levels greatly influences ability to meet different needs, which in turn may result to the production of waste at different levels in each households. The high income households are mostly owned by people in more dominant managerial and craftsmanship related careers. These disciplines have good market in terms of jobs availability with excellent packages. Poverty is not an issue as there is enough food, shelter and clothing for all members of the

households in this zone. This boost the people’s purchasing power and thus more waste is generated compared to the middle and low income zones.

More so, high income zones do not practice recycling, probably due to commitments to the contemporary lifestyles. Sleep over food is thrown away in bins while in other income zones it is stored, to be reheated for use the following day. The main recycled waste materials are food remains which are used as compost manure and also building material such as iron sheets, pieces of wood and charcoal dust. The later component are further molded into balls and then used as fuel for domestic cooking. This has helped some poor families to survive while saving on the source of small income for other needs.

Table 15.0 Total mass generated per day in sampled income classes

Class	Organic waste	Paper waste	Plastic waste	Glass waste	Metal waste	Composite waste	White goods	Total mass
High income	1.86	1.73	1.26	1.10	0.02	0.20	0.07	6.24
Middle income	1.27	1.20	0.50	0.33	0.05	0.27	0.40	4.02
Low income	1.00	1.00	0.40	0.21	0.04	0.27	0.20	3.12
Total mass	4.13	3.93	2.16	1.64	0.11	0.74	0.67	13.38

Table 15 above, shows that organic wastes constitute the highest percentage composition of waste collected in high income zone contrary to middle and low income zones. Low percentage of waste from White goods and metals in low income

zones maybe attributed to high practiced behaviors in waste sorting and recycling. This helps low income earners decrease their cost of living and at times offers employment.

From table 15 above, plastic wastes form majority of the waste disposed in the city's zones. This presents a big challenge as material is not biodegradable and if consumed by animals can be detrimental to health. Most local market vendors and supermarkets are packaging retail/wholesale commodities in polyethene bags and these calls for immediate action to take corrective measures. It was noted that some household swept their compound gardens and added the resulting waste to the daily household waste generated. Such additional waste created difficulties for the research team in terms of the quantities, separation and analysis. Such practices were so common that the household waste collected was too bulky and unfriendly in many aspects.

Table 16.0 Average mass $\times 10^{-1}$ generated per person in the sample

Class	Average total mass generated per day (1)	Average number of people per household (2)	Average mass generated per person per day (3) = (1) ÷ (2)
High income	6.24	4	1.56
Middle income	4.02	8	0.51
Low income	3.12	10	0.31

Based on computations in Table 15 and 16 above and as shown in Fig. 8 above, high income areas produce more waste than in the middle/low income areas. The trend

reverses as low income areas are more populus (see Table 17 and Fig. 9.0) than both the middle/high income areas; making the total waste mass generated from the low income areas the largest amount. This shows the effect of family sizes on waste generation is quite significant and low income areas need to be equally in government focus on SWM.

Table 17.0 Estimated total mass $\times 10^{-1}$ of waste generated from the classes

Class	Average mass generated per person (1)	Population (2)	Estimated total waste generated per day (in Kg) (3) = (1) \times (2)	Percentage (%)
High	1.56	92566	144403.0	29.11
Middle	0.51	292516	149183.2	30.07
Low	0.31	653218	202497.6	40.82
Total	2.38	1038300	496083.8	100

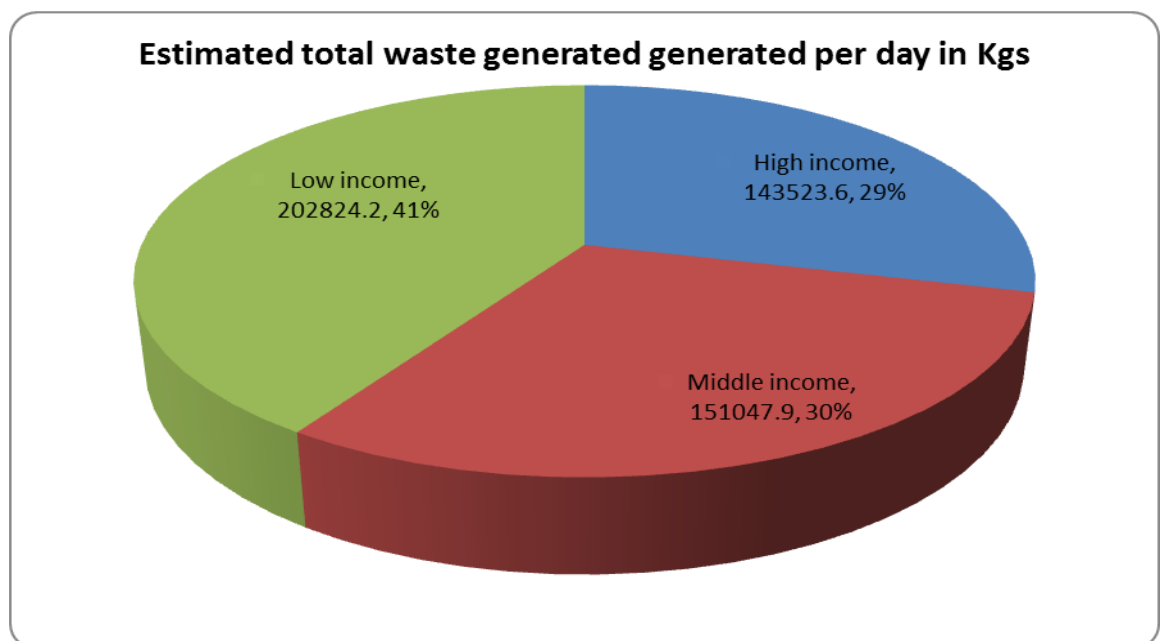


Figure 9.0. Proportion of waste generated by the different income classes

4.6 Analysis of household perceptions, attitudes and behavior in relation to SWM

4.6.1 Socio-economic and demographic factors affecting SWM

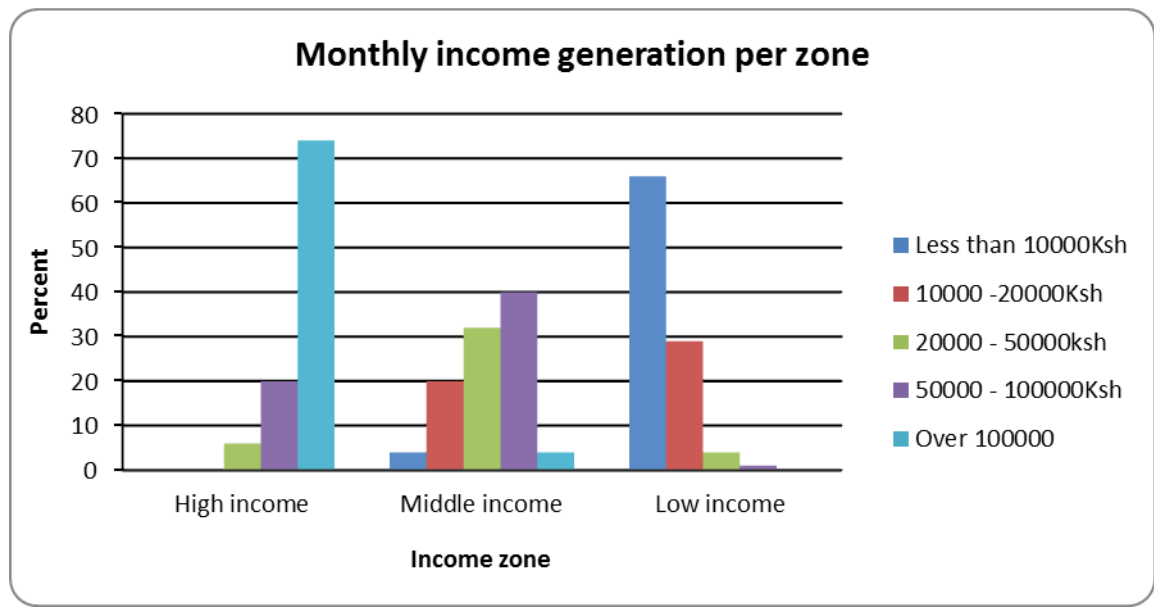


Figure 10.0 Income category status in the sampled zones

From Fig. 10 above, majority (74%) of people in the high income zones have a monthly income of over KShs 100,000 per month. In the middle income zones, majority of people, 40% have an income of between KShs 50,000 to 100,000 and in low income zones majority (66%) earn a monthly income of below KShs 10,000 (Refer Appendix 4-Table 18). Purchasing power is high for high income dwellers and most goods/items are purchased with relative ease. This is not the case with low income zone where residents live with the basic needs and expenditure is always pegged on necessity.

In terms of the number of families and household size (Fig. 11 below), majority (60%) of the high income zone had household size of 1-3 persons. The extremely

large households and extremely small household was not greatly noted phenomena. Similarly, (Table 19) 40% of the families in middle income zones had the size of 4 -6 persons and 45% of the families in low income zone had the household size of over 6 persons.

Table 18.0 Statistics on Household family size in the sampled zones

Family sizes	High income		Middle income		Low income	
	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
1 – 3	36	60	22	36.67	24	40
4 – 6	17	28.33	24	40	9	15
Over 6	7	11.67	14	23.33	27	45
Total	60	100	60	100	60	100

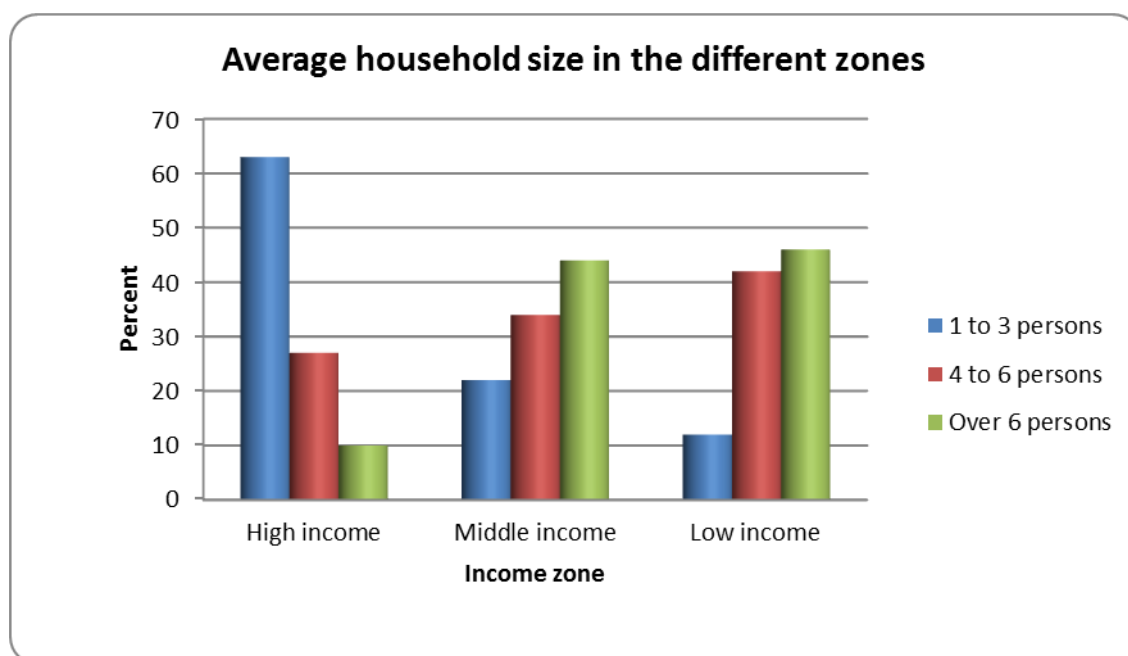


Figure 11.0 Average household sizes in the different sample zones.

From the pilot survey, it was established that the average household size calculated from the collected data, which is 4, 8 and 10 for high, middle and low income zones

respectively, was more than the initial household size 2.86 in high income zone, calculated from the zone 1999 population census data. This means the population of the zone has nearly doubled in the last 11 years.

In terms of the number of children in the household, 60% of the households in low income zone had children below 5 years while 40% had children above 5 years (Table 20). The presence of the under 5 years in the household is an important factor contributing to high waste generation and city population increase. Population pressure is putting a lot of stress on the city’s infrastructure and hence, the reasons why households were not able to handle the waste generated sustainably.

4.6.2 Cultural factors affecting SWM



Figure 12.0 Solid Waste Management in the high income areas

Table 19.0 Responsibility of solid waste management in the high income areas

Item	SA	A	D	SD	mode
Private collectors	40(66.67%)	15(25.00%)	4(6.67%)	1(1.67%)	SA
House helps	5(8.33%)	45(75.00%)	9(15.00%)	1(1.67%)	A
NCC	4(6.67%)	4(6.67%)	44(73.33%)	8(13.33%)	D
Female family members	1(1.67%)	1(1.67%)	47(78.33%)	11(18.33%)	D
One self	1(1.67%)	4(6.67%)	15(25.00%)	40(66.67%)	SD
NEMA	2(3.33%)	4(6.67%)	13(21.67%)	41(68.33%)	SD
Male family members	0(0.00%)	0(0.00%)	13(21.67%)	47(78.33%)	SD

Fig. 12 above shows the number of people sorted according to their views on who should be responsible for the house hold waste management practices in the high income areas. In the high income zones most people (40%) strongly preferred private collectors while 44% had no confidence with the public institutions such as NCC in the waste management. Noted in the study was reluctance by residents to take personal responsibility in managing their own waste probably because people in the high income areas are too busy and solid waste management (SWM) is considered by many as an undignified job. This shows gaps in awareness and knowledge on waste management even at rich residents. There is a high burden placed on the female genders in taking the wastes to the storage sites and ensuring its subsequent collection. Sometimes if the mother or maid is busy with other household chores, the failure of the waste removal from the house results to uncollected waste. This waste accumulates in the kitchen or compound causing foul smell and an environmental nuisance both internally and externally.

Appendix 4, Table 22 shows the number of people sorted according to their views on who should be responsible for house hold waste management practices in the middle income areas.

Most respondents (70%) preferred private waste collectors though some felt CCN could improve and do better. This zone clearly revealed that solid waste management had a gender bias as most interviews linked waste management to house helps and female members. Most respondents (70%) in low income areas (refer appendix 5-Fig 13) expressed satisfaction with male members taking lead in waste management at households. Waste is dumped along road ways in heaps awaiting collection by NCC trucks, most collectors from household are men who sort collected waste for recycling before NCC ferries waste for disposal.

4.7 Analysis Effects and Gaps in present city solid waste management strategies

This section analyzes the effects and gaps in the households waste management strategies. The section has two subsections, one section presenting information of the solid waste generation and collection in the sampled households and the second section presenting the gaps in the solid waste storage and disposal in the households.

4.7.1 Solid Waste generation and collection in Nairobi Households

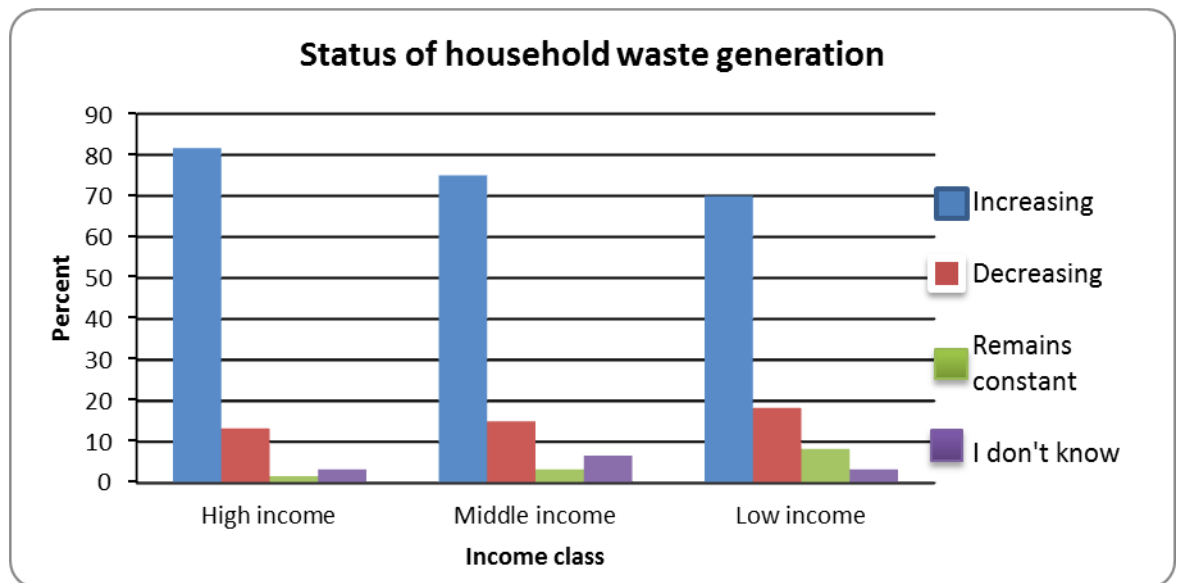


Figure 13.0 Perceived status of solid waste generation in Nairobi households

From Fig. 13 above, when individual households in the zones were asked about the status of waste generation and composition, 81.67%, 75% and 70% in high, middle and low income areas acknowledge that the household waste quantities were increasing. This can be as a result of absence of waste management practices and policies from the local authority, private collector or even the households. Thus a threat to the residents in terms of health and environmental pollution is high. The factors influencing household waste generation are monthly income, number of persons in the house, presence of under 5 years of age, family size, education, level of environmental awareness, adherences to policy and legislations, culture and sometimes season of the year.

Table 20.0 Solid waste collection in the sampled income zones

	High income		Middle income		Low income	
	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Once weekly	6	10	26	43.33	0	0
Twice a week	52	86.67	10	16.67	0	0
Every fortnight	2	3.33	18	30	13	21.67
Never	0	0	6	10	47	78.33
Total	60	100	60	100	60	100

For most of the households in the high income zones, the collection of the waste is done on a regular basis; refer to table 22 above. Majority (87%) of the respondents confirmed that waste is collected at least twice a week. This is healthy and advisable since it avoids rotting of organic materials. About 10% of the waste in middle income zones is not collected at all. The trend is similar in low income zones with majority (79%) experiencing the same practice. The uncollected waste usually accumulates in front of the gates, next to the roads, dumped in manholes and drainage systems. These uncollected wastes are always being tampered on by animals and street boys. This uncollected waste leads to rotting of organic materials, exposure to risk from the hazardous waste and pollution of environment.

4.7.2 Solid Waste Storage and Disposal in the City

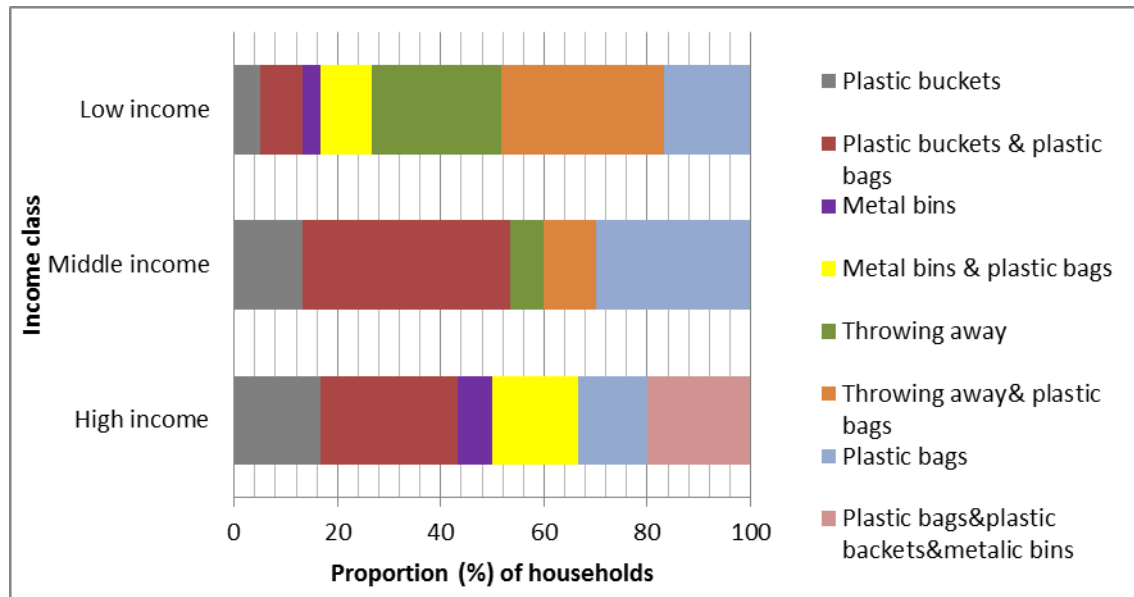


Figure 14.0 Solid waste storage in city's households

From Fig. 14 above, households in the high, middle and low income zones used plastic bags for storage in a way or the other. Plastic polyethene bags are largely available and light to pick; however, their use with constant accumulation is alarming given their non-biodegradable nature. The plastic bags are also a threat to the young children at home and domestic animals. Therefore a working arrangement is required between the plastic producers, users and policy enforcers. Policy and legislation on the plastic reduction, reuse and recycling is urgently needed as an environmental protection measure as physical littering by plastic material is an eye sour while burning them is dangerous to the atmosphere.

Table 21.0 Solid waste storage materials in city's households

	High income		Middle income		Low income	
	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Plastic buckets	10	16.67	8	13.33	3	5
Plastic buckets & plastic bags	20	33.33	24	40	5	8.33
Metal bins	0	0	0	0	2	3.33
Metal bins & plastic bags	10	16.67	0	0	6	10
Throwing away	0	0	4	6.67	15	25
Throwing away & plastic bags	0	0	6	10	19	31.67
Plastic bags	0	0	18	30	10	16.67
Plastic bags, plastic buckets & metallic bins	20	33.33	0	0	0	0
Total	60	100	60	100	60	100

From Table 21 above, high income areas have all the waste storage facilities available to most of the households. More than three quarter of all the sampled households in the high income areas used plastic bucket, in these, 40 households also had metallic bins and/or plastic bags. This could be related to by their ability to afford a variety and/or hire private waste collectors who supply storage facilities as an incentive to their clients. In the middle income 8 households used plastic buckets only, 48 used plastic bags while 10 households disposed them by throwing them away. The plastic bags were sometimes recycled shopping bags from the retail

supermarkets if not coloured disposable bags supplied by waste collectors; some households did not have a proper way of disposing waste and disposed waste by throwing them in heaps a few meters from their estates. More interrogations revealed that the households were unsatisfied with frequency in waste collection by the private collector and preferred throwing waste further from their estate than paying for unreliable services. In the low income areas, more than 50% of the households did not have a proper method of waste storage and threw waste away as a means disposal. In some instances, the waste was stored in plastic bags from retail shops and small-scale market grocers and heaped along pathways. The households pay KShs 30-50 per month to a sect deemed as individual waste collectors who rarely collect refuse in push carts to dump along rivers. NCC sometimes collects waste especially where huge heaps of garbage have accumulated over time. The reason is mainly due to the greater laxity among the law enforcers in watching over the process of waste disposal.

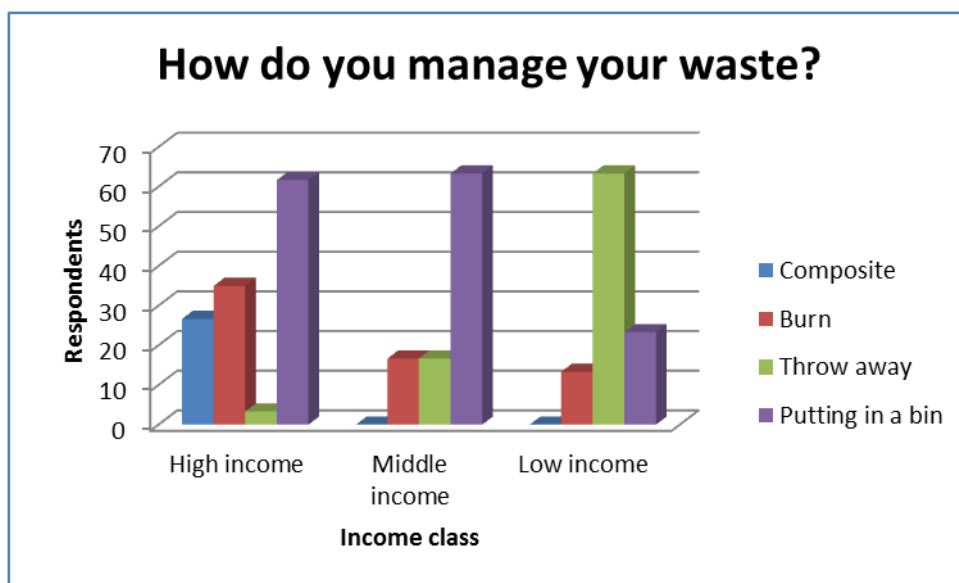


Figure 15.0 Strategies for solid waste disposal in city’s households

According to Fig. 15 above, in the high income zone, majority of households dispose their waste in bins and thereafter waste is taken by the relevant authorities for disposal. Moreover, 27% of the households also dispose their waste through compositing, 35% through burning and 3% through throwing them away. In the middle income 63% of the households dispose their waste through putting them in bins, 17% through throwing it away, 17% through burning and 3% make composite with their waste.

Table 22.0 Strategies for solid waste disposal in city's households

	High income		Middle income		Low income	
	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Composite	16	26.67	2	3.33	0	0
Burn	21	35	10	16.67	8	13.33
Throw away	2	3.33	10	16.67	38	63.33
Putting in a bin	37	61.67	38	63.33	14	23.33
Total	60	100	60	100	60	100

From Table 22 above, in the middle income unlike the high income areas household's compositing and open burning are not majorly practiced due to lack of space within the compounds. In the low income 63% throw their waste away, 13% of the households' burn theirs, 23% put them in dustbins and no households practiced compositing of waste.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

All the four objectives of the study were met and a road map proposed for successful solid waste management in Nairobi is given in the recommendations. Overallly, the research findings indicate major weaknesses in the City's household waste management systems which will require immediate action if we are to avoid being submerged in rubbish.

For instance, Kenya developed its environmental legislation that gave birth to the NEMA before the mother policy and this has caused a big confusion. It is the policy that drives the process of the legislative framework development and related institutional arrangement. With respect to governance and coordination of the environmental issues, NEMA is not strong in many aspects due to the existence of legal conflicts between EMCA, 1999 and many other sectoral laws on the environment, for example, Ministry of Water Resources and Irrigation (MOW&I), Local government Act (NCC)among others.

Research findings revealed that the amount of waste generated from households varies from house to house and from day to day. The key factors contributing to such change in waste generation and composition include socio-economic characteristics of the household, type and size of the families, season and culture. According to this study, the main concerns observed are the large volume of waste generation, low waste collection capacity, low recovery, and uncoordinated disposal mechanisms.

These issues must be addressed to achieve effective system for household waste management practices.

5.2 RECOMMENDATIONS

Based on the research, there is a great need to identify efficient waste management strategies as one of our top priorities for Kenya and reverse the alarming trend of waste pollution.

The Kenya approach to waste management should be based on these principles:

- *Waste prevention:* The countries primary objective should be to decouple waste generation from all economic activity, so that our economic growth will no longer lead to more and more waste.
- *Reuse, Recycle, Repair and Reduce Concept:* If waste cannot be prevented, as many parts of the materials as possible should be recovered, preferably by recycling. The East African Community should be involved to give more priority direction with respect to the generated 'waste streams'. The aim being to reduce overall environmental impact and create wealth (Ntiba and Gichuki, 2006 and 2007).
- *Improving final disposal and monitoring:* Where possible, waste that cannot be recycled or reused should be safely incinerated, with dumpsites used only as a last resort. Both these methods need close monitoring because of their potential to cause severe environmental damage. Kenya has approved a waste management regulation setting strict guidelines for landfills, incinerators, transfer stations, and composting for improved waste management. NEMA should strongly enforce the regulation in order to reduce emissions of dioxins

and acid gases such as nitrogen oxides (NO_x), sulphur dioxides (SO₂), and hydrogen chlorides (HCL), which can be harmful to human health and often causes acid rain.

- *Community participation, awareness and education:* It crucial to launch a sustained, education and communication campaign informing residents on the importance of managing waste properly and its importance to their health, the environment and cleanliness of the city.
- *Policy, Institutional Arrangement and Legal Framework:* Environmental policies should be designed to respond to people's aspirations. Policies to guide environmental management include the Environment and Development Policy, 1999, the Poverty Reduction Strategy, Economic Recovery Strategy for Wealth Creation and Employment embedded Millennium Development Goals (MDGs) and recently acquired vision 2030 that has got strong environmental management component. These policies, however, have not realized the desired environmental outcome relating to sustainable solid waste management. The enactment of the Environmental Management and Coordination Act (EMCA) of 1999 with subsequent waste regulation and other related guidelines have not seen the light of the day due to the deeply politicized environmental issues and inter-institutional conflicts. The EMCA of 1999 provides for establishment of specific institutions, agencies and organizations that administer, enforce, coordinate, and monitor environmental management practices. Environmental degradation has been a phenomenon despite this institutional arrangement and this failure has been attributed to lack of political goodwill, massive corruption, patronage,

sectoral conflicts and lack of facilitation from the Treasury. These happen to be a big challenge to the Kenya NEMA. More effective solid waste management is yet to be achieved and sustained.

- *Expanding Knowledge Base (Research and Data Basing):* Research and knowledge building process is virtually neglected, hence the problem of poor decision making process. Expanding knowledge through research and database helps establish demographic information, quantities and qualities of solid waste generated, collection and transportation plan (coverage, frequency, complaints), strategies for processing and resource recovery with final disposal plan.
- *Financing Waste Management through Public-Private Sector Responsibilities:* The local government has primary responsibility to provide solid waste management services and they may rely for funding on variety of sources including central government, international partners' donations, reserves, loans and grants. Initial capital investment to develop a sustainable system of waste management service is essential through public-private sector responsibilities where the burden of the waste management is shared between local authorities and other agents (the private sector, NGOs and communities).
- *Enforcing Laws and giving Incentives:* There is great need to enforce environmental laws and regulations including sectoral laws in order to change the mind and attitudes of the public towards improved environmental management practices. The law enforcement systems should be accompanied by the public education, awareness, rewards and penalties.

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APPENDICES

Appendix 1: Photos showing uncoordinated solid waste dumping in Nairobi

Plate 1: A section showing part of an open dumpsite in Nairobi



Plate 2.0 A section showing part of solid waste dumped along the Nairobi River



Appendix 2: A Map of Nairobi city showing selected Socio economic clusters



Appendix 3: Interviewing Protocol

The interview guide was intended to collect information on Nairobi household solid waste management practices/strategies and evaluate the levels of compliance/enforcement of the existing regulations that touch on solid waste management. It was subjected to the participants working in institutions that deal with solid waste management in Nairobi.

1. Name of the institution in question
2. Management position of the respondent

3. For how long has the institution been in existence?

4. How do you see the general trend of waste management in the city?
 - a) Well managed
 - b) Fairly managed
 - c) Poorly managed
 - d) Don't know
5. What is the level of enforcement by officers in relation to solid waste management in Nairobi?
 - a) Not satisfied
 - b) Slightly satisfied
 - c) Satisfied
 - d) Very satisfied
6. Do you accept goods from recycled products?
 - a) Most often
 - b) Reluctantly
 - c) Occasionally
 - d) Not at all
7. What is the level of waste recycling in Nairobi?
 - a) High
 - b) Low
 - c) Average
 - d) Doesn't exist
8. Who are responsible for this exercise?

9. What incentive and motivation is needed to promote waste separation/ recycling?

10. Why are some households successful in managing their waste properly?

11. Why are some households not successful in managing their waste effectively?

12. Why is the city facing poor waste management problems? (Indicate in order of preference by numbering in ascending order)

- a) Lack of political will
- b) Absence of waste management policies
- c) Poor enforcement of existing regulations
- d) Corruption practices in service delivery
- e) Any other (specify)

13. What could you suggest as the solutions to waste management?

14. What are some of the approaches to the sustainable households waste management practices? (Indicate in order of preference by numbering in ascending order)

- a) Incineration
- b) Compositing
- c) Burning in open air
- d) Re-use, reduce and repair
- e) Any other (specify)

15. What actions should be taken towards improvement of the city waste management practices?

16. What are some of the factors that affect waste generation rates?

17. In your own opinion, how can waste management be improved?

Appendix 4: Results Presented in Tabular Form

Table 23.0 Statistics on monthly income generation in sampled zones

b	High income		Middle income		Low income	
	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Currency in Ksh						
Less than 10,000	0	0	0	0	0	0
10,000 – 20,000	0	0	15	25	15	25
20,000 – 50,000	3	1.8	15	25	15	25
50,000 – 100,000	13	7.8	24	40	24	40
Over 100,000	44	26.4	6	10	6	10
Total	60	100	60	100	60	100

Table 24.0 Statistics on Household Age in the sample zones

	High income		Middle income		Low income	
	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Age (years)						
<5	18	30	13	21.67	36	60
5 – 18 (Children)	24	40	19	31.67	18	30
Over 18 (Adults)	18	30	29	48.33	6	10
Total	60	100	60	100	60	100

Table 25.0 views on responsibility on waste management in the middle income

Item	SA	A	D	SD	MODE
Private collectors	3 (5.00%)	42 (70.00%)	10 (6.67%)	3 (1.67%)	A
House helps	7 (11.67%)	41 (68.33%)	6 (10.00%)	6 (10.00%)	A
NCC	7 (11.67%)	38 (63.33%)	10 (16.67%)	5 (8.33 %)	A
One self	4 (6.67%)	11 (18.33%)	43 (71.67%)	2 (3.33%)	D
NEMA	5 (8.33%)	7 (11.67%)	45(75.00%)	3 (1.67%)	D
Female family members	2 (3.33%)	5 (8.33%)	46 (76.67%)	7 (11.67%)	D
Male family members	10 (16.67%)	5 (8.33%)	13(21.67%)	32 (53.33%)	SD

Appendix 5; Diagrammatic presentation of results obtained from study



Figure 16.0 Solid waste management in middle income areas

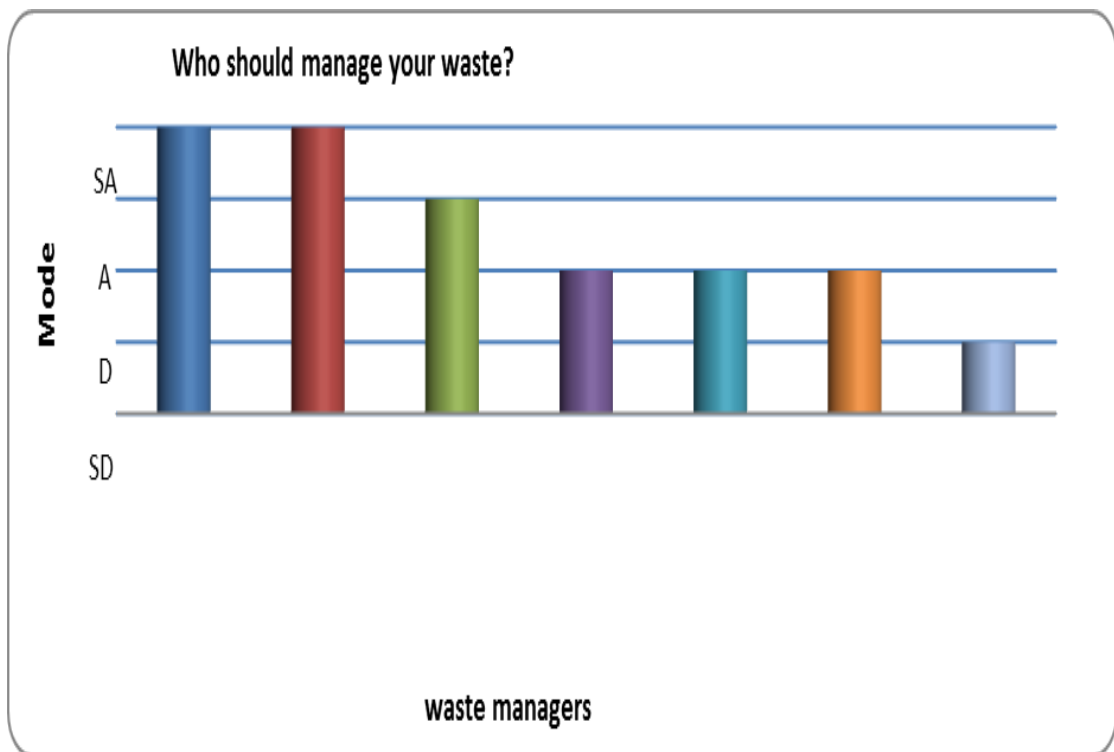


Figure 17.0 Solid waste management in the low income areas

APPENDIX 6: Sample Questionnaire

1.0. Preamble

The questionnaire is intended to facilitate in collection of information on Nairobi household solid waste management practices/strategies in the selected residential areas.

2.0. Part A. (Bio-data)

The following questions are for analytical purposes only. They will not be used to neither try nor identify any individual. Please tick where appropriate:

1. Name of respondent
2. What is your gender
 - a) Male
 - b) Female
3. What is the name of your residential zone?

4. Number of the members of your family
 - a) One
 - (b) None
 - (c) Two
 - (d) More than three
5. What is your estimated monthly income before tax?
 - a) Less than Ksh. 10,000
 - b) Ksh. 10,000 to Ksh. 20,000
 - c) Ksh. 20,000 to Ksh. 50,000
 - d) Ksh. 50,000 to Ksh100,000
 - e) Over 100,000
6. Number of people in your household
.....

7. Level of education of parent/guardian?
a) Primary (b) Secondary (c) College (d) University
8. Age level of guardian/parent
a) 20 - 30 (b) 30 - 40 (c) 40 - 50 (d) >50

Part B. (Household waste generation, storage, collection and disposal)

9. Presumed status of household waste generation in that zone?
a) Increasing (b) Decreasing (c) Remains constant (d) I don't know
10. How often is waste storage, collection and disposal done in your area?
a) Every day
b) Once a week
c) Twice a week
d) Once a fortnight
e) Irregularly/haphazardly
f) No waste collected at all
11. Who collects the waste for disposal in your area?
a) Nairobi city council
b) Private collector
c) Myself
d) People unknown to us
e) Waste not collected at all
12. How do you rate the management of waste collection in your area?

- a) Well managed (b) Fairly managed (c) Poorly managed (d) Don't know

13. Rate the waste collection and disposal costs (KShs)

- a) 100-300 b) 301-500 c) 501-1000 (d) above 1000 (e) Don't know

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

- a) Plastic bucket c) Metallic bins e) Haphazardly
- b) Plastic bags d) Throw it away

15. To what level are you satisfied with waste collection and disposal services?

- a) Not satisfied b) Slightly satisfied c) Satisfied d) Very satisfied

16. Who do you think should perform waste collection and disposal services?

17. a) Do you perform any sorting of waste in your household before disposal?

Yes ----- No -----

b) If yes, how is it done?

c) Are you compelled to carry out sorting or you do it voluntarily?

18. Have you ever asked your collector where the waste is taken after collection?

19. How do you manage your waste at home?

- a) Compositing
- b) Burning
- c) Throw it outside in a heap
- d) Put it into a bin
- e) Other (specify)

20. Does waste management have any gender issues? If yes, why?

21. Why do you think this area faces poor waste management problems?

What are the sources for public information on waste management in the area?

22. What are the environmental problems associated with poor waste management strategies?

23. a) Is waste disposal managed collectively by the residents of this area?

Yes -----

No -----

b) If in the affirmative, how is it done?

25) How do you feel the following should be involved in household waste management?

Waste managers	SA	A	D	SD
Private collectors				
House helps				
NCC				
One self				
NEMA				
Female family members				
Male family members				

26) Do you separate waste into hazardous and non hazardous waste?

Yes

No

Part C. Solid Waste Collectors

1. How do you identify the solid waste to be collected?

2. How do you do the actual solid waste collection?

a. Pick-up e-waste door to door?

b. Have a common collection point

c. Pick from garbage disposal gardens

d. Send municipal collection lorries

e. Others, specify

3. Under what financial arrangements do you collect solid waste?

4. Do you separate the general waste from solid waste?

5. How many of your staff members are assigned the task of collecting solid waste?

- -----
6. How many tons of solid waste did you collect in 2008?

7. Is the current waste collection convenient to you?
Yes No.....
8. If no, what can be improved?

9. After collecting the solid waste, what do you do with it?

10. Have you and members of your organization undergone any training on
solid waste collection and management?

Appendix 7: Provisions Relevant to Solid Waste Management in Kenya's Statutes

Environmental Management and Co-ordination Act, 1999

The Environmental Management and Coordination Act (EMCA) was enacted in 1999 and received presidential assent on the 6th of January 2000. The act provided an avenue for the harmonization of about 77 existing sectoral statutes, which address the various aspects of the environment. The Act provides legal, institutional frameworks and procedures for management of the environment as well as modalities for conflict resolution.

Waste Management Regulations, 2006

In exercise of the powers conferred by Sections 92 and 147 of the Environmental Management and Co-ordination Act No. 8, of 1999, the Minister for Environment and Natural Resources, on the recommendation of the National Environment Management Authority and upon consultation with the relevant lead agencies made the waste management regulations. The waste management regulations are aimed at providing a road map on the way all type of waste should be managed.

The Public Health Act

The objective of the Act is to make provision for securing and maintaining public health. Articles 115 to 126 of the Act provide for, among other matters, rules and regulations on sanitation and housing. The Act stipulates that- nuisances are to be prohibited. It defines a nuisance as anything likely to be injurious to health

.The Act further stipulates that;

- Every Local Authority must prevent nuisances within its jurisdiction.
- The Medical Officer of Health must give notice for removal of nuisances.
- It is the duty of the Local Authority to protect water supply and articles of food from pollution.

The Act prescribes various penalties for failure *to* remove nuisances.

The Water Act

This Act provides for the management, conservation use and control of water resources and for the regulation and management of water supply and sewerage services. It creates structures for the regulation of the use of water at national, provincial, district and city/town levels. Among these structures is the Water Services Regulatory Authority which is given power to among other things;

- Determine standards for the provision of water services to consumers nationally.
- Monitor the compliance of Local Authorities with the set national standards of for management of water supplies. In addition, Section 75 of the Act lays out procedures for execution of physical works such as those on sewerage that may result in pollution of water

sources. The other organs created by the Act for the purpose include;

- The Water Services Regulatory Board
- Regional Water Boards
- Water Services Providers

The Physical Planning Act

The Act sets standards for the erection of buildings and other physical works. According to the provisions of the Act, all permanent buildings erected within urban areas must conform to the set standards for the purpose of protecting and enhancing the hygiene as well as the physical safety of tenants /owners and the public at large. The Act is implemented by the Physical Planning Department of the Ministry of Lands and Housing.