AN INVESTIGATION INTO ELECTRONIC WASTE MANAGEMENT

A CASE STUDY OF NAIROBI'S CBD AND DANDORA DUMPING SITE

A RESEARCH PROJECT PAPER SUBMITTED FOR

PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF

DEGREE OF BACHELOR OF ARTS IN LAND ECONOMICS

UNIVERSITY OF NAIROBI

SCHOOL OF BUILT ENVIRONMENT

DEPARTMENT OF REAL ESTATE AND CONSTRUCTION MANAGEMENT

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B04/0330/2004

DECLARATION

I hereby declare that this project is my original work and has not been presented for a degree award in any other university.

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ACKNOWLEDGEMENTS

The completion of this report could not have been possible without the generous, tireless, moral, material and physical support accorded to me by a number of people and institutions, far too many to mention individually.

First and foremost, I would like to thank the almighty God for giving me the gift of life and enabling me to pursue this course to the end.

I wish to sincerely thank my supervisor, Prof.W.H.A. Olima, for his invaluable input and dedication to this work. His counsel, guidelines and positive criticisms has formed the matrix upon which this work has successfully progressed.

I am also equally indebted to Mr. Nicky Nzioki who contributed valuable criticisms and constructive comments during the entire research work.

My sincere gratitude also goes to all members of staff of the Department of Real Estate and Construction Management, University of Nairobi for their encouragement and support for the four years that we have interacted. You have taught me that there is always a life after tomorrow.

I would also like to thank Mr. Kigo, of CCN Department of Environment, cleansing section for his valuable guidance and kindness during my study.

I am also grateful to my mum for her love, guidance and the prayers that she said every day for me and the sacrifices she has made so far for me. You are my greatest inspiration in life. Thanks a million times. And to my late dad, you were the best in instilling discipline. Rest in peace.

A class would not be complete without classmates. I would like to thank all my classmates for being there to offer the much needed teamwork and friendship to keep this noble task of knowledge acquisition humane. We are an unbeatable team. Keep it up. To you all, I wish you God's blessings and happiness all the days of your life.

DEDICATION

This project is dedicated to my mum, Magdalene, brothers and sisters and my late dad. Thanks for your support and understanding.

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LIST OF ACRONYMS

NEMA- National Environmental Management Authority

UN – Habitat United Nations Human Settlement Programme

COP8_ Eighth Conference of Parties to the Basel Convention

NGO- Non-Governmental Organization

UNEP – United Nations Environment Programme

3RS – Reduce, Reuse and Recycle

EMCA- Environmental Management and Co-ordination Act

3 K Campaign – Keep Kenya Klean

CCN – City Council of Nairobi

EMS – Environmentally Sound Management

PS –MENR- Permanent Secretary Ministry of Environment and Natural Resources

E- Waste – Electronic Waste

EEE – Electrical and Electronic Equipment

LDCs-Least Developed Countries

CBD-Central Business District

ICT-Information Communication and Technology

EIA-Environmental Impact Assessment

CBO's- Community Based Organizations

NGO's- Non Governmental Organisations

ABSTRACT

E-waste is a popular informal name for electronic products nearing the end of their useful life. E-waste is considered dangerous as certain components of some electronic products contain materials that are hazardous depending on their conditions and safety. The hazardous contents in these materials pose a threat to human health and environment.

This research project is a study on e-waste management in the Nairobi's CBD.It looks at the present e-waste management practices, if any, in the city. E-waste management like other SWM is one of the major responsibilities of local government the world over. The responsibility is complex and depends very much on organization and cooperation between households, private enterprises and the municipal authorities. Successful e-waste management depend largely on wise identification and application of appropriate technology solutions in its collection at generation point, transfer, recycling, and disposal

E-waste management is an essential public service that benefits all the rural and urban residents. Although there is inadequate infrastructure dealing generally with SWM service delivery in the country, limited finances, inadequate storage and collection equipment, poor institutional management, lack of community participation and awareness are some of other problems.

Existing disposal methods that are used to dispose of solid wastes and their application to e-waste are also explored. The study also evaluates the problems of E-waste management and what constitutes E-waste. The literature lists and explains the several activities that are involved in SWM and application of these activities in E-waste management. The provisions of the Basel Convention and their application on E-waste management is also brought on fore.

The 3K Campaign is clearly analyzed as a strategy aimed at redeeming the environment of the existing waste threatening basic human and animal health. The need for proper E-waste management is also explored

This study attempts to highlights the actual situation in the Kenyan context and has suggested ways and means of improving the situation. In view of the major findings, the study concludes that e-waste management in the country is wanting, unsatisfactory or totally missing. It hence settles down on key policy recommendations that inculcate institutional, technical and legislative approaches. These are envisioned as the most crucial components for strategic planning and management of e-waste.

CHAPTER ONE

INTRODUCTION

1.0 Introduction

E-waste is a generic term encompassing various forms of electronic and electrical equipment (EEE) which are old, end-of-life electronic appliances and which have ceased to be of any value to their owners. The advance of science and technology has given us a whole new array of electrical and electronic products, and rendered many of them affordable to billions of people known as the "global consumer class" both in developed and developing countries. On the one hand, this advance has revolutionized the world with widely used cheap products. On the other hand it means that they become rapidly obsolete. The result is a tremendous and ever increasing quantity of electronics and electrical appliances being discarded, since it is often cheaper to buy new than to repair or to upgrade a broken or obsolete product. This has given rise to a new environmental challenge: waste from electrical and electronic equipment or "e-waste".

It is well known that there are toxic substances in e-waste such as lead and cadmium in circuit boards; lead oxide and cadmium in monitor cathode ray tubes (CRTs); mercury in switches and flat screen monitors; cadmium in computer batteries; polychlorinated biphenyls (PCBs) in older capacitors and transformers and brominated flame retardants on printed circuit boards, plastic casings cables and polyvinyl chloride (PVC) cable insulation. The hazardous contents in these materials pose a threat to human health and environment. Discarded computers, VCRs, stereos, copiers, fax machines, cell phones, lead batteries, e.t.c are some of the examples of e-wastes. However, e-waste can also be valuable since it also contains precious and strategic metals and other high-tech materials. Discarded equipment can also often be repaired, and its components can be refurbished and reused. In some developing countries, the recycling and separation of electronic waste has become the main source of income for a growing number of people.

In the absence of suitable techniques and protective measures, recycling e-waste can result in toxic emissions to the air, water and soil and pose a serious health and environmental hazard. While the largest generators of e-waste are industrialized economies, the most vulnerable to the hazards of e-waste are informal recyclers in developing and emerging economies.

Industrial revolution followed by advances in I.T during the last century has radically changed people's lifestyles. Although this development has helped the human race, mismanagement has led to new problems of contamination and pollution. The technical prowess acquired during the last century has posed a new challenge in the management of e-waste.For instance; the hazardous contents in these materials pose environmental and human health threat. E-waste management presents a serious challenge due to poor collection, disposal and treatment, which remains far below the standards.

The country continues to be a recipient of cheap electronic goods through donations and cheap imports. However, failure to segregate waste at source is the fundamental challenge that tends to defeat its effective handling, recycling and reuse as various types of waste are disposed off together.

If you ask someone to tell you how we get wire from cables, the answer will be quick and simple "burn it". Like everyone else, we hardly give a thought as to what happens when our computers, TV, digital watches or mobile phones etc ages. We probably give them out to friends or relatives who are not privileged to have them. It is a win-win, hand-me-down culture we have practiced over the years. But whatever lifecycle a gadget takes, there will always be an end to it, when it becomes obsolete and of no use to any one.

There is no problem with clothes and other organic stuff like timber –they will. What should worry us is the junk from the gizmos; those electronic waste, or e-waste. They die and kill [Saturday nation, March 15, 2008] .Simple things like dry cells, batteries used in torches etc, when they are dead, we just throw them away. They leak into the soil and cattle eat the grass and we consume the animal products. The toxic materials

used in making energy sources like batteries thus get into the food chain and harm us or kill us. This is the price to pay for modernity or is it affluence?

As technology continues to develop at amazing speeds, consumers constantly upgrade electronic appliances to keep up with **the cutting edge technologies** out there [Saturday Nation March 15, 2008].In addition, lots of the generous donations of computers are sent to Africa every year from the developed countries when they have little life left. This leads to more and more electronic devices being discarded and therefore, what is supposed to be a good gesture to bridge the **digital gap** ends up building a **"Digital Dump"**

Electrical and electronic waste not properly disposed of is an environmental hazard. The United Nation Environmental Programme [UNEP, 2006], estimates that up to 50 million tones of e-waste is generated world wide annually. Unfortunately, a big chunk of this ends up in African countries such as Kenya, who have no e-waste management systems.

The Basel Convention on control of Trans-boundary Movement of Hazardous Wastes and their Disposal, which Kenya is a party sets rules for e-waste disposal.

Locally, NEMA is developing guidelines and policies for e-waste management. Whereas it is proper to have structures and laws that guide all those handling hazardous waste, there are a few issues that need to be addressed as a matter of urgency before the problem gets out hand. Private institutions that are grappling with these monstrous, dangerous issues must be supported financially and technically in their recycling efforts. They need to break computers and separate hard plastics from the electronic boards .Some metals will be useful locally but others will need to shipped to foreign countries where there are special facilities to dispose them safely. The Basel Convention sets out agreements for re-shipping.

E-waste management is not without its advantages. It could provide the much needed employment opportunities for the youth who are, in any case, the digital gurus in the society. In China, e-waste recycling is carried out by an informal sector that would otherwise be unemployed

Perhaps, recycling efforts ought to start at our doorsteps. In urban areas where the bulk of electronic disposal occurs, a useful throwaway culture must evolve around the cities.

Waste Bin making companies could make more money if they encouraged people to separate rubbish by giving different colors for collection bags, e.g. **white** paper for paper material; **green** for biodegradables and **red** for electronic materials. It makes **sense** and **cents** to group materials before disposing them. Old newspapers make good toilet papers, while vegetable materials can be turned into manure. This is innovation. But at dumpsites such as Dandora in Nairobi, you will find cabbages and motherboards sitting in forced communal destiny. There is therefore the need for sustained sensitization of these life threatening issues. Of most important to this research study is the fact that poor hazardous waste management and the pollution of the environment remain the single most challenge to environmental management in the country.

1.1 Problem Statement

Poor hazardous waste management practices and the pollution of the environment remain the single most challenge to environmental management in the country. This is because waste disposal in Kenya is predominantly through open dumping. This form of waste disposal exposes people to health hazards due to exposure to poisonous emissions and contamination. The challenge of managing e-waste is further compounded by inadequate facilities, poor and unreliable collection methods.Morever, the prevalence of open dumping, lack of segregation at source, low levels of compliance and awareness on the value of clean and healthy environment have made the already bad situation worse. Further, the majority of the citizenry lack the sense of individual responsibility in safeguarding quality of the environment and thus the environment in most parts of the country is polluted.

The eighth Conference of parties [COP8] to the Basel Convention which took place from 27th November to 1st December, 2006 in UNEP headquarters in Nairobi whose main theme was e-waste is of great reference on e-waste management. It pointed out that hazardous waste [e-waste included] management presented a serious challenge due

to its poor collection, disposal and treatment, which remains far below the modern standards. It further stated that failure to segregate waste at source is the fundamental challenge that tends to defeat its effective handling, recycling and reuse as various types of wastes are disposed of together.

An excerpt of the conference noted the following "Electronic waste contains a lot of lead ,mercury and cadmium (that) cause multiple toxic problems," A new trend which sees developed nations dump e-waste -- costly to treat or recycle -- has been allowed to develop in the vacuum left by the Kenyan authorities, the conference noted. We already have evidence of Africa generally being used as a dump site for electronic waste with very heavy metals in them," UNEP Executive Director Achim Steiner told reporters in COP8 2006 [Conference of parties] Right now...we see the emergence of e-waste being dumped here in Kenya," he added.
He said dumping was often carried out under the guise of schemes claiming to donate second-hand computers. According to UNEP [2006], between 20 to 50 million metric tonnes of e-waste are produced globally each year, much of which finds its way to the African continent as charitable donations.
The conference noted that the foreign countries are exploiting the weaknesses of environmental instruments of the countries where the charitable donations are taken and Kenya was indeed not an exception.
A study carried out by UNEP earlier in 2006 revealed that 10 to 20 percent of the computers sent to Kenya each year - mainly from the United States and United Kingdom - are unusable. There are too many computers coming ... There is a saturation and there's no system to handle e-waste" in the country, the conference noted. Benjamin Langwen, in charge of compliance and enforcement on environmental issues at the state-run National Environment Management Authority, conceded that Kenya had little infrastructure to deal with e-waste. It's going to be a major problem in future," he told the COP8. "The state of industrial, electronic and solid waste management is not good. Computer donations "are giving us more problems", Langwen argued, and "cause an enormous impact on environment in Kenya... It will cost the country a lot of money, even more than the donation given."Dump sites are poisonous if not handled properly," Steiner stressed

E-waste is a relatively new concept in Kenya hence there is no specific legislation governing its handling or recycling [UNEP, 2007]. The fact that there are no clear and well defined mechanisms in place for recycling, disposal and transportation of e-waste it means that these are confined to unorganized and small scale industry sectors and scavengers which lack proper and clean technologies. Lack of regulations and / or lax enforcement in disposal methods using risky technologies where the participants are not aware of the risks involved has led to poor management of e-waste.

1.2 Objectives of the Study

1. To establish the different categories of e-waste

2. To identify the challenges and/ or constraints of e-waste management

3. To evaluate the measures that has been put in place to deal with the problem of e-waste.

4. To suggest ways and means of enhancing proper e-waste management.

1.3 Hypothesis of the Study

Bad e-waste management practices exist due to lack of general public awareness on e-waste.

1.4 Significance and Justification of the Study

Issues of environmental sustainability have taken centre stage in the world in the recent past and therefore first and foremost this study will help to enhance a clean and healthy environment through the use of the 3K campaign. The study also endeavours to create public awareness about the problem of e-waste. This will enlighten the public and act as wake up call thus improving the quality of the environment.

The study emphasizes on use of environmentally sound management of hazardous wastes as defined in the Basel Convention. It stipulates that practicable steps should be taken top ensure that hazardous wastes or other wastes are disposed of in a manner,

which will protect human health and the environment against adverse effects, which may result from such wasters.

E-waste management could provide the much needed employment opportunities for the youth who are, in any case, the digital gurus in the society. In China, e-waste recycling is carried out by an informal sector that would otherwise be unemployed

E-waste can also be valuable since it also contains precious and strategic metals and other high-tech materials. Discarded equipment can also often be repaired, and its components can be refurbished and reused. In some developing countries, the recycling and separation of electronic waste has become the main source of income for a growing number of people.

Justification

Rapid industrialization and urbanization the world over has led to a number of environmental challenges such as indiscriminate dumping of e-waste. As envisioned in vision 2030, Kenya is committed along the ideas of sustainable development which include among other things environmental protection.

In Kenya, there are very little studies, if any, which have been conducted on e-waste management. Perhaps this can be explained to some extend by the fact that it is in the recent past that the magnitude of the e-waste problem has attained sizeable proportions in the major urban areas, hence attracting the public attention. Indeed, it was not until COP8 held in Kenya in 2006 that the menace that is e-waste was brought to fore. The realization that e-waste in Kenya is relatively new phenomenon provoked the researcher to look into the strategies and management practices of e-waste.

Like many cities in the developing countries today, Nairobi is producing e-waste at a rate which outpaces the capacity of the CCN to collect and dispose it. Hence, the current approaches to waste management generally are neither effective nor sustainable. Further, many developing countries are heavily dependent on imported hardware, software's, expertise and large amounts of foreign exchange are spent in the provision of e-waste management services. It is against the above background that the researcher

undertook this study and focused mainly on the programmes to stimulate resource recovery and reuse, addressing appropriate technologies for increasing service coverage and ensuring environmentally sound e-waste disposal through stakeholder participation.

1.5 **Scope of the Study**

The study is restricted to the Nairobi's CBD and Dandora dumping site. The cyber cafes in the CBD are examples where e-wastes are produced in large quantities. Dandora dump site receives all the e-waste that is produced in the CBD.This study confines itself to e-waste management in the CBD.It endeavours to probe the generation, handling, storage, disposal and recycling of products that produce e-waste. The study will also focus on the categories of e-waste. Specific waste streams such as nuclear waste, mining waste, munitions wastes, space waste and waste linked to chemical weapons lie outside the scope of this study.

As part of this exercise, the study also seeks to find out the various practices, strategies, measure and legislation that govern the management of e-waste, locally, if any, and internationally. This study also focuses on the adoption of the Keep Kenya Klean [3K] campaign which is a strategy aimed at redeeming the environment of the existing waste threatening basic human and animal health. Most importantly, the study seeks to holistically address how to prevent and minimize products that produce e-wastes by maximizing reuse, recycling and reduction.

1.6 **Organization of the Study**

Including this introductory chapter, there are in all five chapters to this study. Chapter two forms the theoretical framework of the study. It consists of the review of literature related to solid waste management in general and in particular e-waste management in Kenya. The information in this chapter form the theoretical framework on which efforts to propose steps to be followed in undertaking proper e-waste management practices are founded. This chapter is thus the basis of evaluation of the field information which is used to make research conclusions.

The third chapter introduces the reader to the research area[s].It gives the historical background of the Nairobi's CBD and Dandora dumping site.

Chapter four presents the fieldwork. Here data is collected, analyzed, presented and findings deduced from the data.

Chapter five is the final chapter and it contains the findings from the study area[s] in relation to e-waste management. The later part of this chapter contains conclusions and recommendations that are based on the findings and objectives of the study.

1.7 **Definition of Terms**

a. **Environmentally sound management** of waste means taking all practical steps to ensure that waste is management in a manner which will protect human health and the environment against the adverse effect which may result from the waste.

b. **Prior informed consent (PIC)** means the international operation procedure for exchanging, receiving and handling notification information by the competent authority on waste.

c. **Recycling of waste**- Means the processing of waste material into a new product of similar chemical composition.

d. **Reuse** – Means waste reused with or without cleaning and/or repairing.

e. **Segregation at source** means any activity that separates waste materials for processing.

f. Storage- Means temporary placement of waste in a suitable location of activity where location, environment and health protection and human control are provided in order to ensure that waste is subsequently retrieved or treatment and conditioning and/or disposal.

g. **Waste management** – means the activities, administrative and operational, that are used in handling, packaging, treatment, conditioning, reducing, recycling, reusing, storage and disposal of waste.

h. **Disposal site**- Means any area of land on which waste disposal facilities are physically located or final discharge point without the intention of retrieval but does not mean a re-use or recycling plant or site.

i. **"Act"** in this research project means Environmental management and co-ordination Act No.8 of 1999.

j. Waste **Generator** – Means any person whose activities of activities under his or her direction produces waste or if that person is not known, the person who is in possession or control of that waste.

k. **Authority** – means the Natural Environmental management Authority (NEMA) established under section 7 of the Act.

l. **Waste** – Syagga (1992) defines waste as any material which a person discards and attaches no value to.

"Waste" includes 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 to the environment (NEMA, 2006).

m. **E-waste** – Is a popular informal name for electronic products nearing the end of their useful life The obsoleteness is due to; advancement in technology and changes in fashion, style and status. Discarded computers, VCR's Stereos, copiers, Fax machines, electronic lamps, cell phones radio equipment, batteries, DVD's Video games, TV sets, cartridges etc are some of the examples of electronics appliances which when discarded forms e-waste.

n. **Hazardous waste** – Means any waste which has been determined by the Authority to be hazardous waste or belong to any other category of waste provided for in section 9 of Environmental Management and Co-Ordination Act. (EMCA, 1999).It goes further to define hazardous waste as any used liquid, solid or gaseous material that may pose a substantial threat to the natural environment and to human heath to the natural environment and to human health unless it's handled transported, stored and disposed of properly

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

The rapid increase in the volume and types of solid waste and hazardous waste generation as result of economic growth, urbanization and industrialization represents a growing problem to both national and local governments in their endeavors to ensure the effective and sustainable management of waste. Notwithstanding the considerable efforts made by many governments, international and national organization and agencies in tackling waste-related problems, international reports indicate that there are still major gaps to be filled in this area (UNEP 2007).

The decreasing cost of replacing computers, mobile phones and other electronic gadgets, and the speed with which technology goes out of date, mean there is more and more to be disposed of. Traditionally, much of the waste found its way to Asian countries such as China and India, but tighter regulations means more and more is ending up in Africa .Local experts estimate that between a quarter to 75% of these items including old TVs, CPUs and phones are defunct - in other words e-waste.

Increase in the populations of countries worldwide accompanied by their ever increasing demand for Electrical and Electronic Equipment (EEE) has led to an increase in the production of E-waste. Kenya is no exception [NEMA, 2006). E-waste belongs to the category of **hazardous waste**. National Environmental Management Authority (NEMA) notes that effective control of generation, storage, treatment, recycling and reuse, transport, recovery and disposal of hazardous waste is of paramount importance for proper health, environmental protection, natural resource management and sustainable development of the country. Therefore special consideration needs be given to the management of E-waste so that adverse effects on public health and safety and to the environment can generally be minimized.

2.1 Categories of waste (generally)

There are a number of waste categories according to various definitions and criteria. For the purpose of this study, hazardous and other waste are broadly classified as follows (United Nations Environment Programme, 2007)

(a) **Municipal waste** from households and commercial centers, including hazardous waste such as batteries, paint containers and mixtures.

(b) **Industrial waste** from processes or manufacturing and services including hazardous waste and sludge from waste H2O treatment plants.

(c) Discarded **products** and **appliances**, motor vehicles, e.t.c which constitutes the emerging waste streams of **E-waste** and end-of-life vehicles. Some of these discarded products and appliances may end up in municipal waste.

(d) **Healthcare** and **laboratory waste** from hospitals and clinics, medical and nursing facilities and offices and labs; also called biomedical wastes.

(e) **Construction** and **demolition waste** from construction activities or renovation of buildings; and post-disaster waste(the recent past election violence in Kenya is the best case scenario)

(f) **Agricultural waste**, crop residues manure and chemical waste such as pesticides, including persistent organic pollutants(POPs) polychlorinated biphenyls(PCB), come-depleting substances and

(g) **Marine –related waste** such as the marine litter, products dumped at sea, land-based waste discarded in the marine environ, waste from dismantled ships and ship recycling.

It should be noted here that category [c] above is paramount and other categories of waste lie outside the scope of this study.

Source: United Nations Environment Programme, 2007(UNEP)

2.2 Classification of E-waste

E –waste encompasses the ever growing range of obsolete electronic devices such as computers ,servers , mainframes, monitors, TVs and display devices, telecommunication devices such as cello phones and pagers,calculators,audio and

video devices, refrigerators, air conditioners, washing machines, scanners, copiers, fax machines, microwave ovens.E-waste also covers recording devices such as DVDs, CDs, floppies, tapes, printing cartridges, military electronic wastes, automobile catalytic converters, electronic components such as chips, processors, monitor boards, printed circuits boards, industrial electronic wastes such sensors, alarms, sirens, security devices, automobile electronic devices e.t.c.

Plate1showing monitors as examples of e-waste.

Source; Field study, 2008

Plate 2- showing mobiles as examples of e-waste

Source: Field Study, 2008

2.3 The Keep Kenya Klean (3k) Campaign strategy (NEMA, 2006)

2.3.1 Background

grown strategy dubbed **Keep Kenya Klean (3K)** Campaign. The strategy is aimed at redeeming the environment of the existing waste (E-waste not an exception) threatening basic human and animal health. The initiative provides a tool for both resource and stakeholder mobilization to enhance a clean and healthy environment

2.3.2 **Relevance of 3 K campaign to EMCA, 1999.**

The 3K Campaign is relevant to the provisions of Environmental Management and Co-Ordination Act. 1999 that gives every Kenyan a right to a clean and healthy environment while safeguarding the same. Besides, the initiative fulfils the principle of public participation that ensures the involvement of the public as stakeholders in the sound management of the environment.

The 3K Campaign is therefore a mechanism for the authority to fulfill the statutory obligation for sound environmental management as stipulated by the Act and hence contributing to the achievement of National Environmental Management Authority mandate, mission and vision.

The initiation of 3K Campaign could not have come at a better time as this as the authority strives to enforce compliance to environmental standards. National Environmental Management Authority has the legal mandate to mobilize both resources and stakeholders to clean the environment. These include waste collectors, handlers, and treatment mangers and the general public. The 3K Campaign is therefore very timely and likely to influence the change towards the environment among the citizens.

The strategy is designed to be implemented through a broad stakeholders participation framework in which City Council of Nairobi take the lead responsibility in implementing the strategy while the United Nations Environment Programme, and other collaborating agencies would facilitate the required institutional and technical support. A series of consultations have been held with partner institutions with the objective of defining possible role and contribution that could be made by partner institutions.

2.3.3. **The Implementation Strategy of 3k Campaign**

The 3K Campaign stated in August 2006 with several clean up activities in various divisions of city of Nairobi, the initiative will then be replicated in other parts of the country spearheaded by Provincial directors of environment and District environment officers respectively in their areas of jurisdiction. Some of the immediate 3K Campaign implementation strategies include;

(h) Stakeholders and resources mobilization

(ii) Awareness creation through corporate social responsibility

(iii) Awareness creation through sports dubbed, Mazingira cup tournament

(iv) Development of economic instruments.

The 3K Campaign was officially launched during the Clean-up the World day on 16th Sept 2006 in Dandora Phases 1 and II, Embakasi Division of Nairobi. During the occasion graced by the Assistant minister for Cooperative Department and Area Member of Parliament Hon. David Mwenje and PS Ministry of Environment and Natural resources Prof. George Khroda, the need to embrace sustainable waste management and disposal was emphasized.

As the residents recounted the numerous woes encountered due to the presence of the dumpsite, it became apparent that human health had been adversely affected over the years of open dumping in the country. The event provided an opportunity for policy makers and local leaders to converge and deliberate on the challenges of all sorts of waste management as well as the potential interventions likely to be considered in the near future aimed at providing a lasting solution to waste management challenges. The PS-MENR declared the 3K Campaign a five year funded programme for addressing waste management in the country.

Since the clean-up in Dandora, a taskforce has been put in place to compile available information towards identification of alternative sites and the adoption of modern methods of waste management especially the establishment of sanitary landfills.

The 3K Campaign offers the opportunity to create awareness on the value of a clean environment and enhance a positive change of attitude and behavior of citizenry towards environment. Guided by the slogan; **"Be proud of a clean and healthy environment ,"** the 3K Campaign will take the environment agenda a notch higher on the patriotism ladder as the Authority strives to offer the people of Kenya a clean and healthy environment

2.4 **Basel Convention Simplified (By NEMA, 2006)**

2.4.1Introduction

Modern lifestyles and its benefits exist because of industry. From pharmaceuticals to automobiles and ships, paints to personal computers with all these goods there exists a flipside- the hazardous waste that they generate. These are varied and include chemicals such as Arsenic, that's used as a wood preservative that may cause cancer, asbestoes that is used as a roofing material though it is known to cause lung cancer, clinical wastes such as syringes that may spread pathogens and mercury that may cause brain damage. The Convention seeks to protect human health and the environment from the dangers posed by hazardous waste.

Drawing on the principle of "Environmentally sound management" or EMS the convention sets out a three-step strategy for minimizing waste generation.

The first is: Minimizing the generation of hazardous waste including e-waste. The less waste there's to start with, the less money involved in companies to monitor and control every step of their production processes. Industry shares responsibility for the waste generated and only industry has tools, technology and financial resources for minimizing these wastes.

The most successful industries for the future will be those that become better at minimizing unwanted by-products, designing those with fewer hazardous components and increasingly being adept at recycling or re-integrating left over materials back into the manufacturing cycle. The Convention in partnership with industry seeks to identify and disseminate best practices as part of efforts to promote

the goals of the Convention. However, a critical aspect of the ESMs is to lower consumer demand for products and services that result in hazardous by-products.

Current production techniques mean that generation of hazardous waste is unavoidable. The preferred option for disposing of this waste is to do so locally which is the second step.

The benefits of local disposal are two-fold; it reduces the risk of accident or spillage during transportation and it ensures that the costs of disposal of these hazardous wastes are borne by the generators. Local solutions are possible if necessary legislations and infrastructure are in place. The condition gives guidelines on the sound management of these wastes and also addresses disposal methods relevant to a range of wastes. These guidelines give governments the tools and information they need to ensure the environmentally safe management of hazardous waste, the Convention's technical guidelines help reduce pressure for transporting these wastes elsewhere.

The third step in the strategy is minimizing international movement of hazardous wastes. This is by identifying the kinds of wastes that are considered hazardous and subjecting them to rules on Tran's boundary movement. The Convention requires that any brokers or companies wishing to export such waste must receive written notification from the exporting state to the competent authorities in the importing state and any transit states. All shipments must be accompanied by a movement document with details about the contents and their disposal requirements. In 1995 a **"Ban Amendment"** was adopted that lists countries where hazardous waste can be exported to, due to these countries having the financial, technical, legal and institutional capacity to manage these wastes in an environmentally sound way. It is a protocol on liability that ensures adequate prompt compensation for any damages.

Thus as the global economy expands, the generation of such waste could reach unmanageable proportions. Kenya is no exception. Governments should have to work together and provide the necessary resources to strengthen the institutional economies to better manage hazardous wastes. Only by giving the issues a high

profile on the international agenda can government ensure that the Basel Convention leads to environmentally sustainable future, free from dangers of hazardous wastes.

2.5 Challenges and/or constraints to E-waste management

Like any other hazardous solid waste, E-waste management is not without its challenges. Makopa (1996) saw the problem of solid waste management as stemming from increasing amount of waste due to increasing number of waste generators (people). Constraints to proper E-waste management include inter-alia;

[a] **Shortage of sites**

Finding sites for processing and disposal of the growing burden of wastes is increasingly difficult. Major concern to local residents is the nuisance factors of poorly managed sites, litter odours and traffic congestion. Dandora dumping site is the best case scenario.

Furthermore, land is becoming harder to find and prices are rising especially in urban areas due to increased urban population and strict state environmental standards. This is why dumping sites are found at the outskirts of the cities.

[b]Inadequate trained personnel- There is little success in proper E-waste management where this situation persists especially in most LDCs. E-waste management requires personnel with good skills and experience which is lacking in most developing countries including Kenya.

[c] Lack of funds- E-waste management requires a lot of funds in terms of recycling and recovery of products. Most Local Authorities lack finance to purchase sophisticated equipment and vehicles required for recycling and transportation of E-waste. Repairs and maintenance of the same is all slowed down by lack of funds to carryout the work, hence most of them remain out of service for many days. The problems of funds is worsened by the fact that most developing countries rely on external borrowing to finance waste handling equipment (Kiplangat, 02)

[d] Lack of suitable equipment in both public and private laboratories to test for chemicals and the content of hazardous waste in EE appliances. The equipment that exists are very expensive and therefore most developing countries can't afford them and as a result this leads to poor methods of disposal of E-waste like open dumping.

[e] High cost of new technologies in E-waste management. E-waste management is complex and calls for sophisticated technology which is unavailable to most LDCs.

[f] Inadequate legislations to control illegal international traffic in toxic and dangerous products e.g. Kenya and most developing countries are used by developed countries as dumpsite for cheap electronic products nearing their end-of-life.

[g] Poor administration and management. This can be attributed to problems that plague Local Authorities such as bureaucracy, administrative overload, inefficiency, inadequate coordination of programmes and departments, insufficient resources and the conflict between government and people in relation to service delivery. These problems lead to the inability of Local Authorities to provide basic infrastructure and services such as collection and disposal of solid waste.

2.6 **Impact of E-Waste (UNEP, 2006)**

Disposal of e-wastes is a particular problem faced in many regions across the globe. Computer wastes that are land filled produces contaminated leachates which eventually pollute the groundwater. Acids and sludge obtained from melting computer chips, if disposed on the ground causes acidification of soil. For example, Guiyu, Hong Kong a thriving area of illegal e-waste recycling is facing acute water shortages due to the contamination of water resources.

This is due to disposal of recycling wastes such as acids, sludge's etc. in rivers. Now water is being transported from faraway towns to cater to the demands of the population. Incineration of e-wastes can emit toxic fumes and gases, thereby polluting the surrounding air. Improperly monitored landfills can cause environmental hazards.

Mercury will leach when certain electronic devices, such as circuit breakers are destroyed. The same is true for polychlorinated biphenyls (PCBs) from condensers. When brominated flame retardant plastic or cadmium containing plastics are land filled, both polybrominated dlphenyl ethers (PBDE) and cadmium may leach into the soil and groundwater. It has been found that significant amounts of lead ion are dissolved from broken lead containing glass, such as the cone glass of cathode ray tubes,

Not only does the leaching of mercury poses specific problems, the vaporization of metallic mercury and dimethylene mercury, both part of Waste Electrical and Electronic Equipment (WEEE) is also of concern. In addition, uncontrolled fires may arise at landfills and this could be a frequent occurrence in many countries. When exposed to fire, metals and other chemical substances, such as the extremely toxic dioxins and furans (TCDD tetrachloro dibenzo-dioxin, PCDDs-polychlorinated dibenzodioxins. PBDDs-polybrominated dibenzo-dioxin and PCDFspoly chlorinated dibenzo furans) from halogenated flame retardant products and PCB containing condensers can be emitted. The most dangerous form of burning e-waste is the open-air burning of plastics in order to recover copper and other metals. The toxic fall-out from open air burning affects both the local environment and broader global air currents, depositing highly toxic by products in many places throughout the world.

The increase in the amount of waste and the concomitant in the hazards which it poses are having a severe impact on global and local environments, natural resources public health on local economies and living conditions and in this way threatening the attainment of relevant millennium development goals.

Various diseases, including cancers, result from exposure to hazardous emissions, mainly from open burning and substandard incineration of E-wastes. Communities living near the dumpsites [Dandora] are suffering from associated littering, odour, insects and rats. Human scavengers incur even greater health risk

Wastes accumulated over decades and leachate from unmanaged landfalls and wastes dumps have contaminated ground H_2O and soil across the world. Waste dumping into rivers lakes and sea has caused damage that threatens agriculture, H_2O suppliers and people livelihoods which depend on there aquatic systems. Unbiodegradable E-waste

chokes sewage and irrigation systems, leading in turn to damage to infrastructure and local economy.

Substandard landfills and E-waste dumps emit among other gases, methane, a major greenhouse gas which is of concern for climate change. Promoting modern waste management in developing countries can contribute in a significant way to greenhouse reduction at a global level. Being inflammable, methane has also been the cause of repeated accidents involving fires, explosions and collapses at landfills and dumps e.g. more than 200 people died and hundreds were injured when payatas dumpsite in Philippines collapsed in 2002.

For many components of the waste streams(such as plastics, metals, glass and others) as well as E-waste, the environmental impacts are not only produced by the waste treatment and disposal processes themselves but also derive indirectly from the loss of potential resources from the economy loop. This means that these resources have to be produced again from urban materials(often non-renewable) thus not only depleting the valuable stock of natural resources but also perpetuating the vicious cycle of environmental degradation and resource depletion.

Table2.1 summarizes the health effects of certain constituents in e-wastes. If these electronic items are discarded with other household garbage, the toxics pose a threat to both health and vital components of the ecosystem. In view of the ill-effects of hazardous wastes to both environment and health, several countries exhorted the need for a global agreement to address the problems and challenges posed by hazardous waste. Also, in the late 1980s, a tightening of environmental regulations in industrialized countries led to a dramatic rise in the cost of hazardous waste disposal. Searching for cheaper ways to get rid of the wastes, "toxic traders" began shipping hazardous waste to developing countries. International outrage following these irresponsible activities led to the drafting and adoption of strategic plans and regulations at the Basel Convention. The Convention secretariat, in Geneva, Switzerland, facilitates the implementation of the Convention and related agreements. It also provides assistance and guidelines on legal and technical issues, gathers statistical data, and conducts training on the proper management of hazardous waste

Table 2.1: Effects of E-Waste constituents on health

Source of e-wastes	Constituent	Health effects
Solder in printed circuit boards, glass panels and gaskets in computer monitors	Lead (PB)	• Damage to central and peripheral nervous systems, blood systems and kidney damage. • Affects brain development of children.
Chip resistors and semiconductors	Cadmium (CD)	• Toxic irreversible effects on human health. • Accumulates in kidney and liver. • Causes neural damage. • Teratogenic.
Relays and switches, printed circuit boards	Mercury (Hg)	• Chronic damage to the brain. • Respiratory and skin disorders due to bioaccumulation in fishes.
Corrosion protection of untreated and galvanized steel plates, decorator or hardner for steel housings	Hexavalent chromium (Cr) VI	• Asthmatic bronchitis. • DNA damage.
Cabling and computer housing	Plastics including PVC	Burning produces dioxin. It causes • Reproductive and developmental problems; • Immune system damage;

		• Interfere with regulatory hormones
Plastic housing of electronic equipments and circuit boards	Brominated flame retardants (BFR)	• Disrupts endocrine system functions
Front panel of CRTs	Barium (Ba)	Short term exposure causes: • Muscle weakness; • Damage to heart, liver and spleen.
Motherboard	Beryllium (Be)	• Carcinogenic (lung cancer) • Inhalation of fumes and dust. Causes chronic beryllium disease or beryllicosis. • Skin diseases such as warts.

Source;www.basel.int/draftsratek.

2.7 **E-waste Disposal Methods**

E-waste like any other solid waste has its characteristic disposal methods.

The selection of the right E-waste disposal method is of paramount importance.

It's not easy to obtain the best disposal methods because of the heterogeneity of urban E-waste. The selected methods should be able to allow for recycling of materials, if possible, and should not pollute the air, the ground water, surface water and land (RGO, 1991; 402).

There are various methods being employed in different parts of the world and include:-

[i] Open Dumping- It is also called crude tipping. This is the method that's very common in developing countries e.g. Kenya and India (Rao, 1991, 402)

Under this method, waste is dumped on open fields which are found on the outskirts of the cities. Wastes are deposited in an uncertain fashion and no supervision is provided.

Open dumping has got characteristics different from others (UNEP, 1999; 45). It's poorly sited, has unknown capacity and no planning. Furthermore, there's little or no site preparation, no lacheate management, only occasional cover and no compaction of waste. In addition, there's no record keeping, no fence and allows waste picking and trading (Kiplangat, 2002). Since the wastes are untreated they are likely to infect the surrounding environment.

The advantage of this method is that it's cheap compared to controlled tipping and also it requires no planning.

This is the method used by the City Council of Nairobi where the **Dandora dumping** site receives lots of the waste collected by the City Council of Nairobi and private companies among other collectors.

[ii] Sanitary landfill (Controlled tipping)

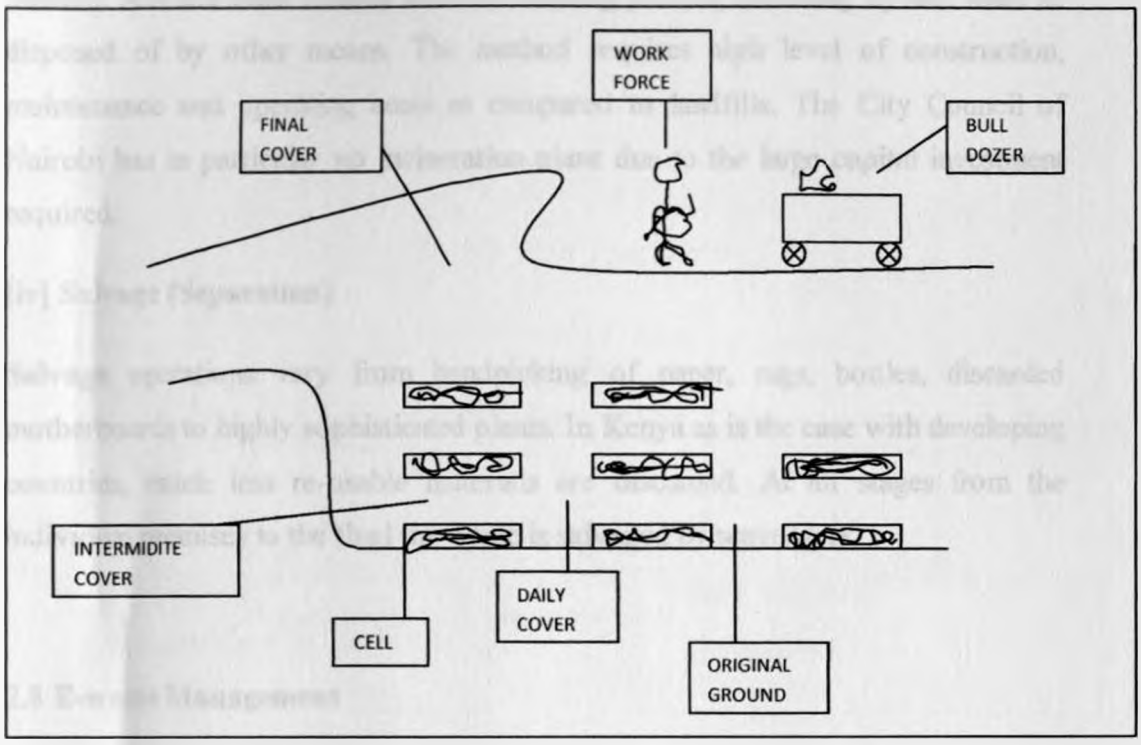
This is seen as a biological method of waste treatment. It's mostly applied in the developed world. "Sanitary land filling is an engineered operation, designed and operated according to acceptable standards," (RGD, 1991;402) This is seen as a way of disposing waste on land without creating nuisances or hazards to public health or safety.

Under this method, waste is spread and compacted in thin layers to form a cell. This cell is then covered with a thin layer of soil and the depth of the cell should not exceed 2 meters. New cells are built on top of the others daily, till the desired level is reached. A final cover of about one metre of earth is placed and it's again compacted.

Advantages of this method include; it minimizes air pollution, minimizes hazards and minimizes the possibility of polluting surface and underground waters. Besides, it minimizes vector breeding by eliminating all possible harborage and food supply of rats, flies and other vermin.

Furthermore, finished landfill can be used in the development of parks and playing grounds. In this method however, there is danger of ground water pollution from leachates or surface water pollution if the landfill site is improperly chosen. This polluting of ground water may be avoided through lining of plastic membrane or other water tight linings.

Diagram 2.1Sanitary Land Filling Operation



Sanitary land filling operation

Source:Rao,[1991]: Environmental Pollution Control Engineering P. 403

[iii] Incineration- This involves the burning of wastes, at very high temperatures

This method eliminates the need for tipping sites, which are difficult to find near some large cities (Makau, 2004). Left over ashes, glass, metals and unburnt combustibles amount to perhaps 25% of the original waste.

Incineration is however an expensive undertaking in that incineration plant and equipment must be installed. It doesn't emerge as an option unless money and technical expertise are readily available. Incineration on the other hand causes air pollution unless the plant is designed, equipped and operated to comply with air pollution standards.

Wastes which are not combustible are removed from the waste by gravity or magnetic separation; separated materials like glass and metal can be recycled and generate income. Incineration does not pollute ground water.

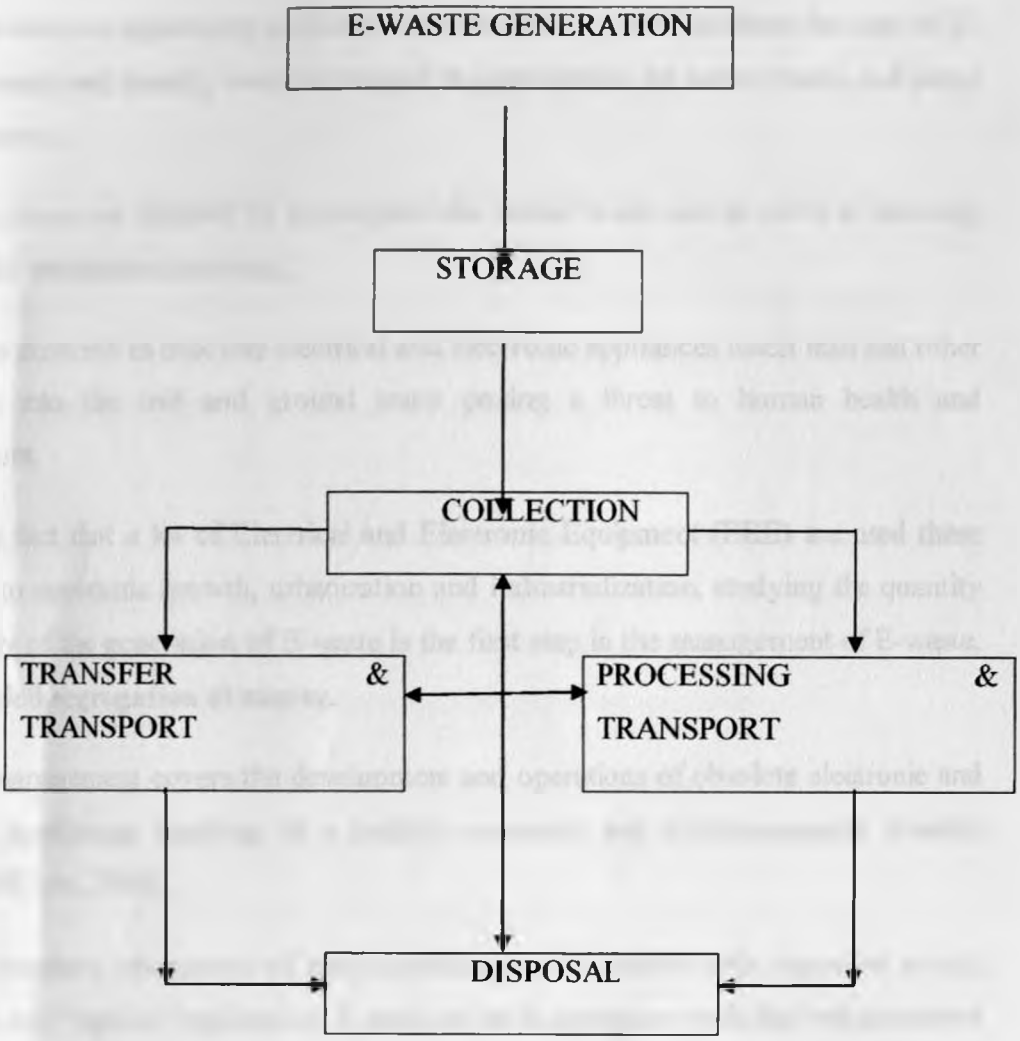
Those who oppose this method argue that incineration is not a complete disposal method. Ash and other residue from the burning process, including fly ash, must be disposed of by other means. The method requires high level of construction, maintenance and operating costs as compared to landfills. The City Council of Nairobi has in particular no incineration plant due to the large capital investment required.

[iv] Salvage (Separation)

Salvage operations vary from handpicking of paper, rags, bottles, discarded motherboards to highly sophisticated plants. In Kenya as is the case with developing countries, much less re-usable materials are discarded. At all stages from the individual premises to the final tip, waste is salvaged by scavengers

2.8 E-waste Management

Simplified diagram 2.2 showing inter-relationships of the functional elements in an e- waste management system.



SOURCE: Kiogora, [1995]

E-waste is a solid and hazardous waste because it contains certain compounds/elements such as lead, mercury, arsenic etc which are toxic.

E-waste management is the management of activities associated with generation, storage, collection, transfer and transport and processing which should be environmentally compatible adopting principles of economy, aesthetics, energy and convention. It encompasses the general principles (functions) of management like planning, organizing, forecasting, directing, controlling and staffing, in ensuring all the various parts of our undertakings function accurately and efficiently.

In cases where we experience ineffective and inefficiency as it has been the case of E-waste globally and locally, waste is dumped in open spaces, on access roads, and along water courses.

Dumping places are invaded by scavengers who scatter waste and so serve as breeding grounds for mosquitoes and rats.

Hazardous contents in obsolete electrical and electronic appliances leach lead and other substance into the soil and ground water posing a threat to human health and environment.

Given the fact that a lot of Electrical and Electronic Equipment (EEE) are used these days due to economic growth, urbanization and industrialization, studying the quantity and quality of the generation of E-waste is the first step in the management of E-waste. This is called **segregation at source.**

E-waste management covers the development and operations of obsolete electronic and electrical appliances handling in a healthy economic and environmentally friendly manner (NEMA, 2006).

It is an important component of environmental quality control with important social, economic and financial implication. It needs to be in agreement with the best principles of health, economics, engineering, conservation, aesthetics and other environmental considerations and should be responsive to public attitude.

It's estimated that 75% of electronic items are stored due to uncertainty of how to manage them. These electronic junks lay unattended in houses, offices, warehouses etc and are normally mixed with household wastes, which are finally disposed off at landfills. This necessitates implementable management measures.

In industries, management of E-waste should begin at the point of generation. This can be done by waste minimization techniques and by sustainable product design. Waste minimization in industries involves adopting.

- Inventory management

- Production-process modification
- Volume reduction
- Recovery and Reuse.

Proper control over materials used in the manufacturing process is an important way to reduce waste generation (Freeman, 1989). By reducing both the quantity of hazardous material used in the process and the amount of excess raw materials in stock, the quantity of waste generated can be reduced. This can be done in 2 ways; i.e. establishing material-purchase review and control procedures and inventory tracking system.

Developing review procedures for all material purchased is the first step in establishing an inventory management program. Procedure should require that all materials be approved prior to purchase. In the approval one is to examine if they contain hazardous constituents and whether alternative hazardous materials are available.

Another inventory management procedure for E-waste reduction is to ensure that only the needed quantity of a material is ordered. This will require the establishment of a strict inventory tracking system.

Purchase procedures must be implemented to ensure that materials are ordered only on an as- needed basis and that only the amount needed for a specific period is ordered.

2.8.1 **Production – Process modification**

Changes can be made in the production process which will reduce waste generation. Potential waste minimization techniques can be broken down into 3 categories.

(I) improved operating and maintenance procedures,

(ii) Material change.

(iii) Process-equipment modification

Improvements in the operation and maintenance of process equipment can result in significant waste reduction. This can be accomplished by:-

- Reviewing current operations procedures or lack of procedures and examination of the production process for ways to improve its efficiency.
- Instituting standards operation procedures, which can optimize the use of raw materials in the production process.
- Having a strict maintenance program, which stresses corrective maintenance, can reduce waste generation caused by equipment failure. An employee training program is a key element of any waste reduction program. Training should include correct operating and handling procedures, proper equipment use, recommended maintenance and inspection schedules and proper management of E-waste materials.

Installing more efficient process equipment or modifying existing equipment to take advantage of better production techniques can significantly reduce waste generation. New or updated equipment can use process materials more efficiently producing less waste.

Additionally, such efficiency reduces the number of rejected products, thereby reducing the amount of material which has to be disposed of. Modifying existing equipment can be a very cost effective method of reducing waste generation, e.g. in many electronic manufacturing operations, which involve coating a product, such as electroplating or painting, chemicals are used to strip off coating from rejected products so that they can be recoated. Thus by reducing the number of parts that can be reworked, the quantity of waste can be significantly reduced.

2.8.2 **Volume Reduction**

These include those techniques that remove the hazardous portion of a waste from a non-hazardous portion. These techniques reduce the volume as well as the cost of disposing of a waste material. Segregation of waste at source is a simple and economical technique for waste reduction.

2.9 Factors for Efficient E-Waste Reduction [UNEP, 1991]

a. Promote educational campaigns

This involves educating government authorities responsible for waste management, private collectors and the general public. This education should be seen as to enlighten people on the environmental, health and economic impacts of the current e-waste generation and disposal habits. This education will also help promote involvement by the public [community participation]

b. Study e-waste streams [quantity and quality]

There is inadequate information in developing countries related to the quantity, quality and composition of the e-waste stream. This information is crucial to enable the setting up of recovery and recycling systems, market for recyclables and to identify problems within existing e-waste management practices.

c. Reduce waste via legislation and economic instruments

The majority of non-biodegradable waste including e-waste in developing countries waste streams is derived from the importation of packaged goods. Packaging could be reduced through selective waste reduction legislation. Special measures such as surcharges, taxes e.t.c may be justified for plastics, cans, obsolete electronic appliances, unfunctional cell phones e.t.c.

d. Promote innovation

This is meant to create new uses for goods and materials that would otherwise be discarded after initial use or converting materials into new products for local public, to tourists, or for export

e. Reducing use of substances which produce toxic or hazardous wastes.

This is done through education of the public, providing information on hazardous or toxic goods, alternative products that are not toxic and implementing legislations which prevent the importation of such products.

f. Recovery and Reuse.

This technique if used could eliminate waste disposal costs, reduce raw materials costs and provide income from saleable waste. Waste can be recovered on-site or at an off-site recovery facility, or inter industry exchange. Electrolysis electrolytic recovery, filtration etc are some of the techniques that can be used.

g. Sustainable product design.

Minimization of hazardous wastes should be at product design stage itself keeping in mind the following factors:-

- Rethink the product design-efforts should be made to design a product with fewer amount of hazardous materials e.g. the efforts to reduce material use are reflected in some new computers designs that are flatter, lighter and more integrated.
- Use of renewal materials and energy – Bio-based products are recommended e.g. bio-plastics, toners e.g. solar computers also exist but are very expensive.
- Use of non-renewal materials that are safer because many of the materials used are not renewable, designers could ensure the products are built for re-use, repair and/or upgradeable e.g. some computer manufacturers such as Dell and Gateway lease out their products thereby ensuring they get them back to further upgrade and lease out again.

2.10 Kenya's Legal Perspective on Waste Management

The Kenyan government, in realization of the need to protect and conserve the environment and the need to safeguard the public health has enacted several laws to regulate and protect the same. There is no specific legislation that deals with e -waste in Kenya. However, various legislations can be read to impact on e-waste. . The overall objective of these legislations is to reduce the generation and environmental impact of all forms of waste and to ensure that the health of the people and the quality of environmental resources are no longer significantly affected.

The **Public Health Act, cap 242** of the laws of Kenya defines what constitutes nuisance to include "any accumulation or deposits of refuse, offal, manure or other matter whatsoever which is offensive or which is injurious or dangerous to health. Section 118 [i][h] further defines nuisance to include, "any accumulation of stones, timber or other material if such in the opinion of the medical officer of health is likely to harbors rats or other vermin {section 18[1] [i] }.

This Act does not give any guidelines on how solid waste management should be carried out.Infact as part of this research work it fails to recognize that special wastes such as e-waste exists and that there are no direct links with what is provided in the Act to what really happens on the ground. There are no recommended ways of storage, collection, transportation, processing and disposal of waste. The Act only gives out penalties for those who fail to comply with the notice given by the Medical officer of health to remove the nuisance.

The Environmental Management and Co-ordination Act, 1999, is now in operation. This Act was enacted to provide for the establishment of an appropriate legal and institutional framework for the management of the environment and for matters connected therewith and incidental thereto.

The Act gives every Kenyan a right to a clean and healthy environment while safeguarding the same [NEMA, 2006].According to the Act, hazardous wastes can either be corrosive, carcinogenic ,flammable, persistent, toxic, explosive, radioactive, or reactive. NEMA which is the principal instrument of the government on policies relating to the environment has gazetted regulations for the management of hazardous waste. These regulations prescribe the procedure and the criteria for the classification of toxic and hazardous chemicals with their toxicity and the hazard they present to human health and environment; labeling, packaging and processing of chemicals and materials, control of imports and exports of toxic and hazardous chemicals and materials permitted to be imported or exported; distribution , storage , transportation and handling of chemicals and materials ; monitoring of their residue on human health and environment.

The Act provides for the establishment of standards and enforcement Review Committee [section 70[i].This Committee has the duty to recommend to NEMA, measures necessary to;

[i] Prescribe standards for waste, their classification and analysis, and formulate and advise on standards of disposal methods and means for wastes or

[ii] Issue regulations for handling, storage, transportation, segregation and destruction of any waste.

Every person whose activities generate wastes shall employ measures essential to minimize waste through treatment, reclamation and recycling"{section 87[4]}Any person contravening this section is guilty of an offence and is liable to imprisonment for a term of not less than 2 years or to a fine of not more than one million or to both.

EMCA further gives provisions for projects that are to undergo **Environmental Impact Analysis [EIA].** This is provided for in section 58[1][4].Examples of these projects are in the second schedule. Project No. 11 on the schedule is the most crucial in this research study. It provides that; sites for hazardous wastes disposal, sewage disposal works ,works involving major atmospheric emissions and works emitting offensive odours should NOT be undertaken before an EIA is carried out.E-waste disposal is therefore no exception.

EMCA defines EIA in part I [preliminary] as a systematic examination conducted to determine whether or not a programme, activity, or a project will have any adverse effects/impacts on the environment.EIA ensures that development does not take place at the expense of the natural environment. One of the greatest benefits of EIA is its capacity to bring together a wide range of environmental, social and economic considerations of a project before investments are committed. As a general policy EIA is carried out early in the project cycle at the pre-feasibility stage for proposed activities, policies, programmes and development projects which are shown by preliminary screening as likely to have significant adverse environmental impacts. Monitoring is carried out during and after implantation [NEMA, 2006].

Before e-waste is disposed of, it is therefore mandatory that an EIA is conducted to determine its impacts on the environment. More often than not this never happens in Kenyan scenario.

Moreover, section 64[2] of the Act provides that ", Any person who fails, neglects or refuses to comply with the directions of the Authority shall be guilty of an offence and shall, on conviction, be liable to a fine of not less than one million shillings, or to imprisonment for a term of not less than 2 years or to both.

Under section 160 of **the Local Government Act, cap 265**, laws of Kenya, the local authority has power to establish and maintain sanitary services for the removal and destruction of , or otherwise dealing with all kinds of refuse and effluent and where any such service is established to compel the use of such service by persons to whom the service is available. Further, section 201 of the same Act empower Local Authorities to make by-laws regarding matters which are necessary or desirable for the maintenance of health, safety and well being of the inhabitants

2.10.1 Conclusion on Legal Framework

The existing body of legislations concerning solid waste is fragmented into several laws and very incomplete at local and national level. This makes waste management in general inadequate because legislations are enforced by different institutions. This result into duplication of responsibilities in the regulatory provisions for the development of effective planning for SWM systems.

Currently, there is no single legislation that attempt to address the entire process of e-waste management. This tends to make an already bad situation worse. The Public Health Act, cap 242, the Local Government Act, cap,256,and EMCA,1999 are the only Acts in Kenya which expressly covers the responsibility of Local authorities in dealing with solid waste. These Acts are covered in a general way and therefore provide a very limited basis for proper regulation of solid waste including e-waste.Infact; the Acts are deficient in setting standards and conditions covering the special waste stream which is e-waste. The Acts also do not define standards for proper management of sanitary landfills and they do not refer to waste reduction or recycling. Further, the CCN by-laws

exhibit many limitations. They deal with minor aspects of SWM, leaving out the very hazardous wastes that pose threat to human health and environment. Thus a comprehensive legislation that avoids the duplication of responsibilities, fills the gaps of important regulatory function, and that is also enforceable is required for sustainable development of e-waste management system in Kenya.

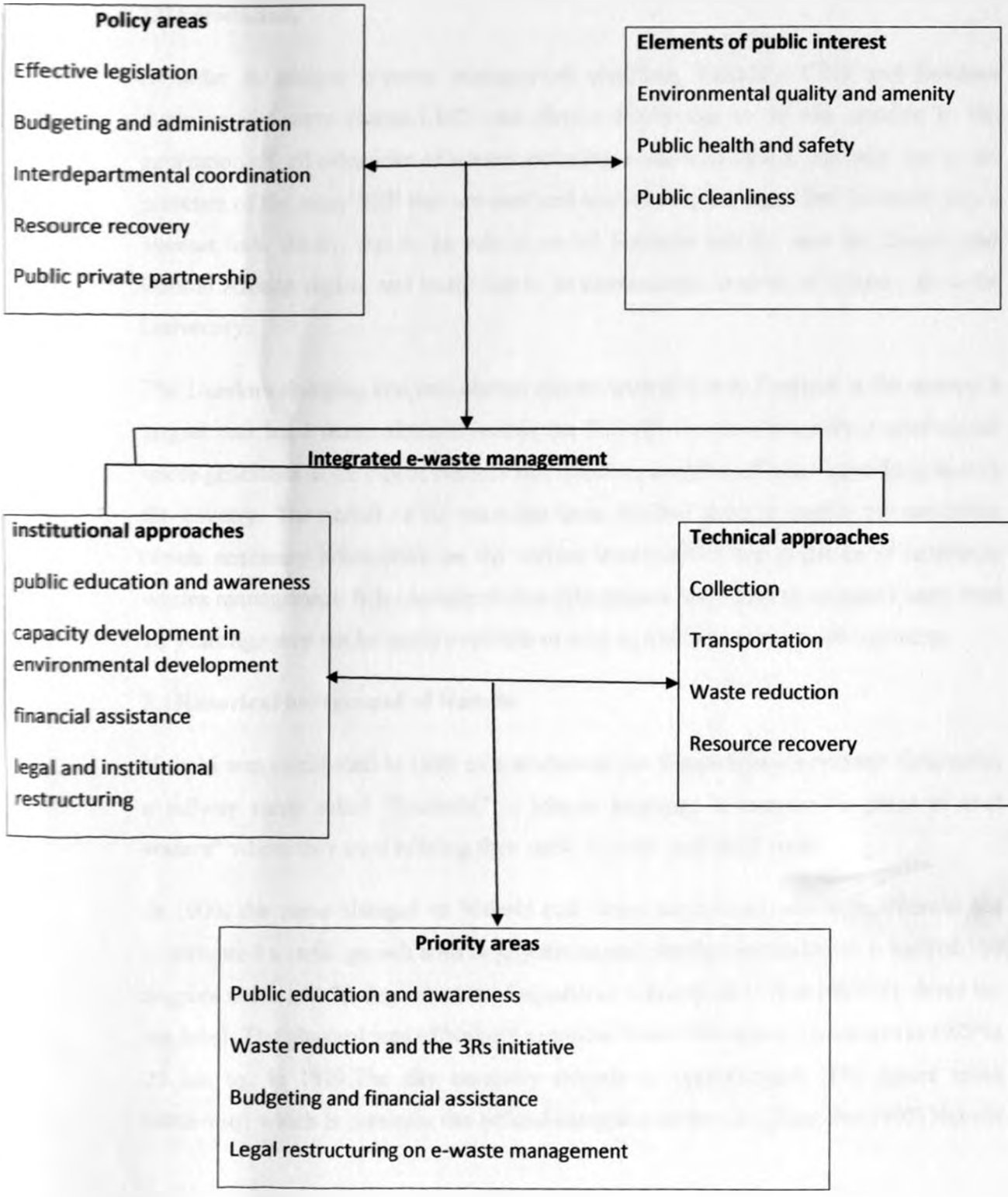
2.11 Conccptual Framework

The foregoing literature has revealed that the rapid urbanization, industrialisation and advancement in I.T in Africa, Asia and Latin America tend to be characterized by obsoleteness of electronic equipment. This has led to the problem of e-waste management. In this regard, Kenya is no exception. In the context of this study and by drawing experience from the pertinent literature already reviewed, rapid advancement in I.T ,changing lifestyles and poor planning in e-waste within the CBD which is occasioned by poor e-waste management practices as a result of inadequate awareness is among the notable factors undermining effective e-waste management. This equally reveals the research gap that this study seeks to address.

Because the council provides an institutional link between the community and the central government, there is need to adopt a holistic approach concerning e-waste management in the country. This study envisions that the objectives and hence the elements of public interests in e-waste management should be three fold; to improve public health and safety, to ensure environmental quality and amenity and finally to improve public cleanliness.

To attain efficiency in e-waste management, it is conceptualized that sound policies that would encompass community participation, public awareness, cross-sector partnership, human resource development, sound legal framework, and adequate operational capacity among others should form the basis of e-waste management. A combination of these policies in the context of aforementioned elements of public interests should carefully be inculcated and entrenched into e-waste management process. The product of this synthesis would be an integrated e-waste management shown in the figure

CONCEPTUAL MODEL



CHAPTER THREE

The Study Area and Research Methodology

3.0 Introduction

In order to analyze e-waste management practices, Nairobi's CBD and Dandora dumping site were chosen.CBD was chosen firstly due to its top position in the generation of all categories of wastes including e-waste in Kenya, secondly due to the presence of the many EEE that are used and myriad of cyber cafes that forms the city's internet hub, thirdly, due to its role as an I.T business hub for both the Eastern and Central African region, and lastly due to its convenience in terms of distance from the University.

The Dandora dumping site was chosen due to several factors.Firstly,it is the country's largest and legal dump site and within the Nairobi Province.Secondly,it receives all waste generated in the city of Nairobi and therefore a replica of other legal dumpsites in the country. The period of 10 years has been decided upon to enable the researcher obtain necessary information on the various interventions and practices of hazardous wastes management. It is considered that information older than or acquired more than 10 years ago may not be easily available or may be old to be of no much use today.

3.1Historical background of Nairobi

Nairobi was established in 1889 as a product of the Kenya-Uganda railway. Originally, a railway camp called "Enairobi" in Maasai language to mean a **"a place of cool waters"** where they used to bring their cattle to graze and drink water

In 1900, the name changed to Nairobi and future capital city was born. Nairobi has experienced a rapid growth both in population and physical extension. It is located 100 degrees north and 38 degrees east of equator at a height of 1670m [5495ft] above the sea level. The physical area of Nairobi expanded from 3.84 square kilometers in 1920 to 25 km sq. in 1919.The city currently extends to approximately 270 square miles [680kmsq] which is currently the official extension of the city [Gacocho,1997].Nairobi

is bordered by Kiambu District to the North, Machakos District to the East and Kajiado District to the West and South.

According to the 1999 National Census, the city had an estimated population of 2.1 million. However, it is estimated that there are over 4.5 million inhabitants [economic survey, 2007] and it is thought to be growing at 5% per annum.Projections indicate that this population is expected to the 8 million figure by the year 2030.

The city's brief development was designed by the colonial authorities assigning different functions to specific zones. The CBD occupies the original triangular site contained between the Nairobi River, Uhuru Highway and the Railway [Moss, 1999]

3.2 Nairobi as an Economic Centre

Nairobi is the economic hub and international centre for east Africa. Both the Tras-African highway from Mombasa to Lagos and the Great north road from Cairo to Cape Town pass via the city. Additionally, the city has one of the most modern airports in the East African region in the form of Jomo Kenyatta International Airport [J.K.I:A] which link it to the rest of the world by air. The service and manufacturing industry is also advanced and being a rapidly expanding city [a regional business hub for Eastern and Central Africa], it has a good number of fast growing I.T and electronic industry centers'. Further, Nairobi hosts international banks, headquarters of several UN organizations, as well as other centers of employment in secondary and tertiary sectors of the economy.

The city of Nairobi contributes slightly over 51% to national GDP.It also accounts for the largest proportion of wage employment in the country.

Nairobi is a cosmopolitan city, with a modern CBD, suburban business districts, large affluent suburbans and shopping centres.

3.3 Climate, Drainage and Altitude

Nairobi is located at a mean elevation of 1700m above the sea level with the highest altitude of 2600m in the west that gradually slopes to the East. It enjoys a favorable

climate with an average rainfall of 1750mm per year while the temperatures vary from 22 to 33 degrees centigrade. The drainage pattern conforms to the physical outlay with rivers running in an approximately east –west direction.

3.4 The Nairobi's Central Business District [CBD]

Nairobi is a cosmopolitan city, with a modern CBD. The CBD takes a rectangular shape, around the Uhuru Highway, Haille Selasse Avenue, Moi Avenue and University Way[Moss,1999]. It includes many of Nairobi's important buildings, including the City Hall and Parliament Building. The city square is also located within the perimeter. A feature of the central business district that strikes foreign tourists the most is the skyline. Nairobi's skyline has been compared to many Asian and American cities. This is due to a construction boom after independence, and another construction boom in the late 1990s and early 2000s. Most of the skyscrapers in this region are the headquarters of businesses and corporations, such as I&M and the iconic building, Kenyatta international conference center. The United States Embassy bombing took place in this district, prompting the new embassy building to be located in the suburbs.

In 2006, a large beautification project took place in the CBD, as the city prepared to host the 2006 Afri-Cities summit. Iconic buildings such as the Kenyatta International Conference Centre had their exteriors cleaned and repainted.

The district is bordered to the south-west by Nairobi's largest park: Uhuru Park and Central Park. The Mombasa to Kampala railway runs to the south-east of the district.

3.5 Waste Management in the CBD

Waste collection and disposal is the responsibility of the CCN though it has been forced to contracts the services of private firms due to the increasing number of waste generators. The collection and disposal solid waste in the CBD has become increasingly insufficient. This can be attributed to rapid growth of the CBD due to urbanization and development in I.C.T.Solid waste generation rate is given by CCN as 1860 tons per day,[CCN,2004].In the CBD, waste collection services are provided sporadically due to

the very high rate of waste generation which can not be handled with the available vehicle and equipment. Other problems encountered by the CCN include inadequate financing, lack of recognition of the importance of satisfactory and effective waste management by the policy makers and inadequate training of managers to have special hazardous wastes like e-waste.

Privatizing waste collection has been considered as a possible remedial measure. As the CBD grows and the volume of waste increases, the CCN is planning to promote reclamation, reuse and recycling of materials as a way of reducing the problem. Such activities would create employment for a section of the population as well as being a source of raw material.

3.6 The Dandora Dumping Site

Dandora is an Eastern suburb in Nairobi, Kenya. It is part of the Embakasi division. Dandora is divided into five phases. Dandora was established in 1977, with partial financing by the World Bank in order to offer higher standard of housing. However, the estate has turned into high-density slum with high unemployment. Dandora is the only open dumpsite in Nairobi. It is managed by CCN, which provides heavy equipment such as compactors and bulldozers, to distribute garbage in a controlled manner. Approximately 30% of the City's garbage, excluding medical waste, is dumped at Dandora. Access roads to the disposal place are in poor condition. During the rainy season, trucks are unable to clear the road and as result dump garbage at random locations. Since sufficient funds are unavailable, a proper land fill operation to prevent pollution is yet to be created. The 30-acre large Dandora dumping site receives 2,000 tonnes of rubbish every day, including plastics, rubber and lead paint treated wood, generated by some 4.5 million people living in the Kenyan capital. A study conducted by UNEP in 2006 also found evidence of the presence of hazardous waste, such as chemical and hospital waste, on the dumpsite

locations. Since sufficient funds are unavailable, a proper land fill operation to prevent pollution is yet to be created. The 30-acre large Dandora dumping site receives 2,000 tonnes of rubbish every day, including plastics, rubber and lead paint treated wood, generated by some 4.5 million people living in the Kenyan capital. A study conducted by UNEP in 2006 also found evidence of the presence of hazardous waste, such as chemical and hospital waste, on the dumpsite

Dandora is also infamous for its high crime rate. Nairobi's principal dumping site is situated in Dandora, probably causing health problems for local residents. There is a presence of strong urine stench with the many waste problems.

Dandora is far and wide the largest refuse dump in the 4.5-million-strong Kenyan capital, and with 2,000 tons of fresh waste every day, it also holds the dubious distinction of being a member of the "dirty 30" club of the world's most polluted sites.

Dandora was listed by the Blacksmith Institute as one of the most polluted sites in the world. According to a 2007 report by the Blacksmith Institute, the festering eyesore on the outskirts of the city is one of the two most polluted sites on the continent, the other being a lead mine in Zambia. Yet Dandora's 75 acres of fuming waste-a sea of plastic bags, used medical supplies, car batteries, dismantled printers and computers -- is a blot in the picture that is causing growing concern.

Plate 3 Dandora dumpsite showing an assortment of e-waste.

Source: Field Study, 2008

Electronic waste contains a lot of lead and also mercury and cadmium (that) cause multiple toxic problems," said Njoroge Kimani, a biochemist who authored a report commissioned by the United Nations Environment Programme (UNEP), in 2006.

3.7 The Research Design

design also refers to a method of investigation in which data is collected and analyzed for the purpose of describing a problem in its current status or condition[Adams, et al,1985]. It is a process of investigating a large population by selecting a small portion of it [sample] for measurement and observation. The results from the sample are used to make interpretation for the whole population.

3.8 Sampling Technique

Since a reconnaissance survey in the CBD had shown a mixed-up pattern in the location of cyber cafes, it was difficult to acquire the random sample from the field. Chava, 1996, underscores that stratified sampling, which is known to increase precision especially when the stratifying factor is well defined, can be best applied. In the context of this study, cyber cafes and household units formed the main strata [sources of e-waste in the study area].Simple random sampling was then applied to select the units of observations from each stratum. It was seen as the best way of achieving unbiased sample. Simple random sampling is a procedure that gives each of the sampling units of a population an equal and known none zero probability of being selected. Selection of any sampling unit is random, that is, independent of the selection of previous sampling unit. Sampling unit is a simple member of the sampling population [Chava, 1996].This technique eliminates bias in the sampling procedure. Also one can estimate parameters with the confidence that they are representative of the real values you would find in the total population. Simple random sampling is amenable for use with small populations. The sampling technique was based on;

- Location of the buildings where the cyber cafes are situated within the CBD;
- Size of the cyber cafes
- Comparable indicators such as services provided and customer availability[client base]

- Proximity of the residential units to the dumping site
- Dealers of computers and other electronics in large volumes of sales

3.9 Population and the Sample

Within the CBD, a total population of 100 cyber cafes was identified. To pick the random sample, 100 pieces of paper were cut.80 papers[80%] were assigned numbers of cyber cafes then the papers were folded and mixed up in a container and out of these 35 papers [43.8%] of total population were randomly picked. The numbers picked meant that the cyber cafes listed on the numbers corresponding to the papers were interviewed and issued with questionnaires. This process was repeated in order to come up with the random sample on the household units neighbouring the dump site.. In Dandora, a total population of 80 households was chosen. To pick the random sample, 80 pieces of paper were cut.60 papers [75%] were assigned numbers of household units. The papers were then folded and mixed up in a container and out of these 35 papers [58%] of total population were randomly picked. The numbers picked meant that the household units listed on the numbers corresponding to the papers were interviewed and issued with questionnaires. In determining the sample size required, the rule of thumb should be to obtain as big a sample as possible[Mugenda, 1999].However, resources and time tend to be major constraints in deciding the sample size to use. Gay [1981] points out that the sample size depends on factors such as the number of variables in the study, the type of the research design, the method of data analysis and the size of the accessible population. Gay [1981] goes further and suggests that for correlational research, 30 cases or more are required, for descriptive studies, 10% of the accessible population is enough and for experimental studies, at least 30 cases are required. Fisher et al [quoted Mugenda and Mugenda.1999] has recommended that if there is no estimate available of the proportion of the target population assumed to have the characteristics of interest, 50% of the population should be used. Based on this, it was felt that 50% of the buildings identified both in the CBD and Dandora estate would be large enough to represent the salient characteristics of the target population. A random sample of 80 and 60 was chosen to represent the CBD and Dandora respectively. This sample was then

reduced to 35 and 35 and represented the CBD and Dandora respectively. Some of the reasons responsible for this attrition were;

- ✓ Non response from cyber café managers for purely uncooperative reasons
- ✓ Decline to participate for fear that the solicited information was too sensitive;
- ✓ Lack of information needed in the research because such information had not been kept.

The attrition occurred for reasons beyond the control of the researcher. This attrition is however, not a cause of concern as the figure 70 comprising of both households units and cyber cafes forms 50% of the initial sample of 140 units and is a good representation. Mugenda and Mugenda [1999] are of the opinion that a response rate of 50% is adequate for analysis and reporting. The study had a response rate of 65% and the non respondents formed only 35%.A sample of 35 and 35 in the CBD and Dandora respectively was, therefore, considered to be large enough to give valid and reliable results.

3.10 Data Collection Instruments

Secondary data sources involved the systematic identification, location and analysis of documents containing information related to the research problem under investigation.

Secondary data was obtained through reviewing both published and unpublished literature. The purpose for reviewing secondary data was to get an overview of the theory on the principles of e-waste management and eventually build a sound conceptual framework that would envision the way forward for e-waste management in the study area. It enabled the researcher to obtain data related to e-waste management practices in other areas in the country and other parts of the world and thereby make inferences for e-waste management in the case study area. It involved reading books, periodicals including journals, both published and unpublished theses, magazines and internet.

Primary data was obtained through conducting interviews, physical observation and administering of questionnaires. Physical observation was important because the study

concentrated on visible and tangible parameters. Photography was used to capture a view of these parameters and gives the reader an opportunity to see for himself the situation of e-waste on the ground.

The most important research methodology in this study was questionnaires and interviews. The questionnaires contained both structured and unstructured questions as these were found appropriate by the researcher. The questionnaires were administered to four sets of people including the city council officers-DOE- cleansing section, NEMA officers-waste management unit, Dandora residents, managers of cyber cafés. Interviews were used where the respondents were unable to fill the questionnaires. They were also used to capture issues not addressed by the questionnaires. Further, interviews coupled with discussions enabled most respondents to open up as some of them were reluctant to put down their responses in writing.

CHAPTER FOUR

DATA ANALYSIS AND PRESENTATION

4.0 Introduction

This chapter gives a detailed analysis and presentation of the data and information that the researcher collected from the field. Data collected was analyzed quantitatively and qualitatively. The qualitatively analyzed data is presented in the form of photographs as well as written text, whereas, quantitatively analyzed data is presented in the form of tables, pie charts, and bar graphs.

The data presented and analyzed in this chapter was collected mainly by use of questionnaires integrated with direct interviews for more efficiency. Observation, street surveys as well as photography were also used to capture the existing state and features in the case study area that are pertinent to the study. The computer was used to key in the data and help in the analysis.

The data analysis was guided by the objectives and the hypothesis of the study. Four categories of questionnaires were prepared and issued for the purpose of data collection. The target groups for the questionnaires included CCN officials in the department of environment, managers of cyber cafes in the CBD, NEMA officials in the waste management unit and Dandora residents neighbouring the dump site. This distribution of questionnaires was tailored to see to it that diverse views were collected from the various groups in the relation to the study. Table 3.1 below gives a representation of how the questionnaires were distributed amongst the various categories and the number that was recovered from each of the groups.

Table3.1: Distribution of questionnaires

Respondents	Total No. of questionnaires issued	Total no. of questionnaires received	% response
Cyber café managers	35	28	80
Nema	5	3	60
CCN officials [DOE]	5	4	80
Dandora residents	35	25	71.4
TOTAL	80	60	75

Source: Field survey, 2008.

From the above it can be seen that there was a response rate of 75% and the non respondents formed only 25%.Mugenda, [1999], underscores the fact that a response rate of 50% is adequate for analysis and reporting. A response rate of 75% in this study was therefore considered adequate enough to give valid and reliable results.

4.1The Different Types/Categories of E-wastes

The first objective of the study sought to establish the different categories of e-waste. The researcher did this through examining the categories of e-waste known to the Dandora residents and the cyber café managers.

Discarded electronics-generally referred to as e-waste was found to include the following;

4.1.1Among the residents,

The following were the most quoted discarded electronics; TVs, mobile phones, DVD players, tapes, amplifiers, fridges, electronic iron boxes, radios, CDs and DVDs, calculators, refrigerators. Further,80% of the residents neighbouring the Dandora dump site pointed out that mobile phones, TVs, VCDs and DVD players , electronic iron boxes, radios, CDs and DVDs comprised most of their discarded electronics.

4.1.2 Among the cyber café managers

The following discarded electronics were found; monitors, servers, photocopiers, scanners, printers, joysticks, fax machines, laptops, modems, computer power supplies, hard drives, digital and video cameras, mobile phones, mother boards, CDs and DVDs, floppy discs, network cables among others

From the field survey, 63% of the cyber café managers said that, computers, CDs and DVDs, scanners, printers, network cables, floppy discs, photocopiers and mobile phones formed the highest percentage of the discarded electronics.[e-waste].

Therefore the researcher concluded that though the residents knew some of the categories of e-waste, they were unaware of the most unique categories of e-waste like computers, scanners, printers, photocopiers e.t.c. This therefore requires a concerted effort by all stakeholders, that is, the City Council, NGOs, CBOs, the private sector and the government at large, so that awareness is created about this sensitive waste.

4.2 **Challenges Facing Effective E-waste Management.**

The second objective this study sought to examine the challenges facing effective e-waste management. This was done by thoroughly evaluating the challenges faced by the main respondents in the research study .These respondents included the NEMA, CCN,Cyber café managers and Dandora residents neighbouring the dumpsite.

4.2.1**Challenges facing CCN**

63% of the CCN officials stated the following challenges which they face in the course of their service delivery;

1. Lack of adequate finances to support the following e-waste management practices;

- ✓ To purchase equipment, spare parts, and the relevant tools'
- ✓ To repair and maintain existing tools and equipment,
- ✓ To provide or construct collection points for their clients,
- ✓ To train and hire trained personnel

2. Lack of land to locate dumpsite as the one already existing is filled up and unsightly

3. Lack of policy guidelines and by-laws on e-waste and inability to enforce the existing by-laws

4. Lack of technical know how to handle e-waste management. E-waste management requires personnel with good skills and experience which is lacking in most developing countries including Kenya.

5. Irresponsible behavior of their clients as well as failure of the business community to sort out their waste thus exposing workers and the general public to health problems.

6. Long and bureaucratic processes in the purchase of sparc parts, equipments and materials required for service delivery,

7. Lack of protective clothing like aprons, gloves and nose pads further restraint their work

8. Unfair weather conditions coupled with poor conditions of the roads interfere with the collection and transportation of the collected waste.

9. The CCN lacks a proper, comprehensive and up to date SWM policy that is necessary in addressing the current trends and problems in SMW such as privatization and community participation in the city.

Out of the above, the most mentioned constraints included the following;

Table 3.2 summary of constraints facing CCN

Problem	Number of respondents	% respondents
Lack of adequate finance	4	26.7
Lack of current legislation	3	20
Lack of technical know how	4	26.7
Long and bureaucratic processes	4	26.7
Total	15	100.1

SOURCE: Field Survey, 2008.

Figure 4.1

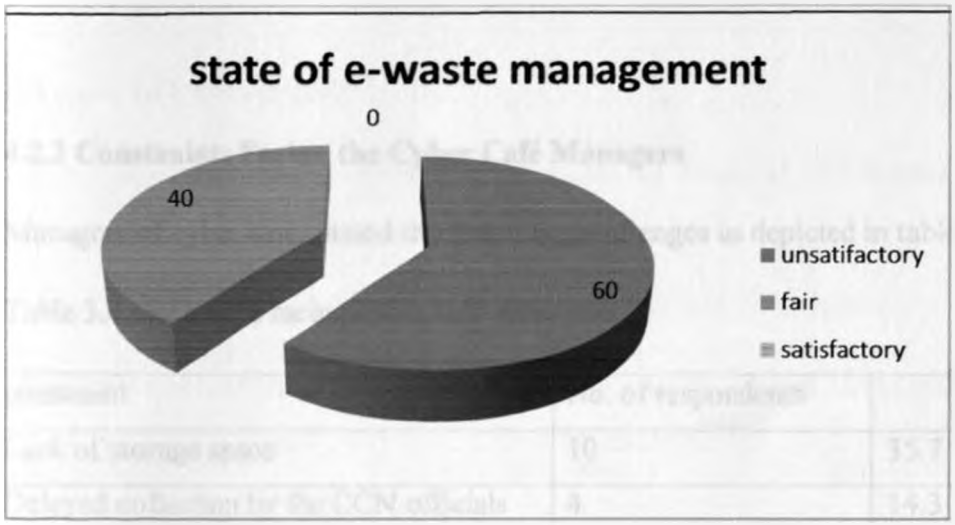
SOURCE: Field Survey, 2008.

The CCN officials in citing the challenges that dogged their service delivery were also quick to point out the state of e-waste management in the country. The following was the rating;

Table3.3-Rating of current state of e-waste management by the CCN officials [DOE]

	RESPONSE			EXPECTE TOTAL
	SATISFACTORY	FAIR	UNSATISFACTORY	
FREQUENCY	3	3	0	5
PERCENTAGE	60	40	0	100

Figure 4.2



Source: Field Survey, 2008.

None of the officials rated the state as satisfactory. Only 40% described the state as fair and a big percentage of 60% described the state as unsatisfactory.

LGA cap 265 laws of Kenya empower local authorities to provide solid waste management. The provision of these services has always been poor. From the research, it was established that only 10 trucks belonging to the CCN operates in the whole city and other trucks are used by the city askaris to control the hawkers within the CBD.Downing of the trucks was pinned to the financial constraints of the council and

the bureaucratic procedures of spare parts procurement. From the interviews conducted, it was established that a vehicle can be out for minor repairs for a period of 1-3 years and for major repairs, can take as long as 10 years. This means that the tremendous increase in all categories of wastes generation and the commensurate demand for services combined with CCN's financial constraints has meant that CCN can not adequately provide the much needed services of waste management.

4.2.2 Constraints Facing the Cyber Café Managers

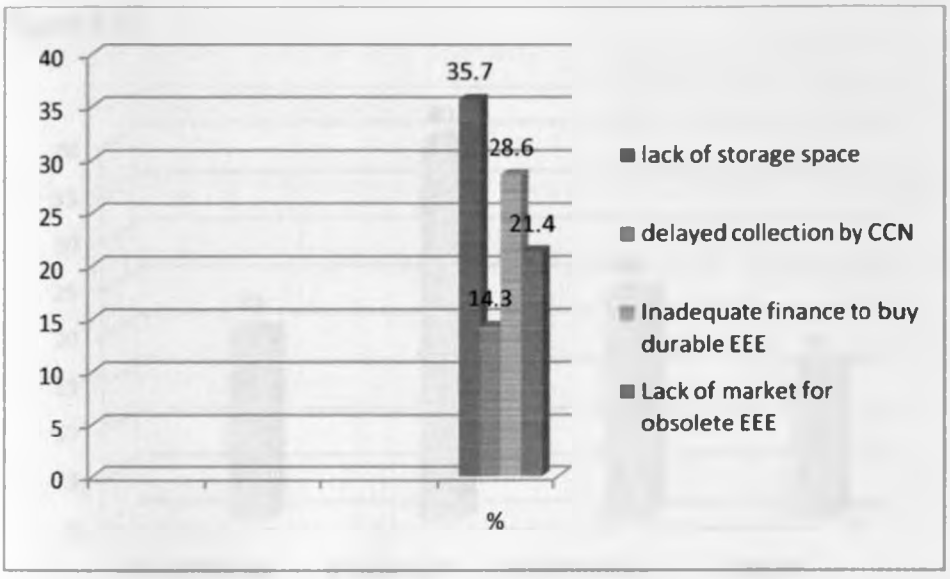
Managers of cyber cafes stated the following challenges as depicted in table 3.4 below

Table 3.4 challenges facing cyber café managers

constraint	No. of respondents	%
Lack of storage space	10	35.7
Delayed collection by the CCN officials	4	14.3
Inadequate finance to buy durable EEE	8	28.6
Lack of market for obsolete EEE	6	21.4
Total	28	100

Source: Field Survey, 2008.

Figure 4.3



Source: Field Survey, 2008.

4.2.3 Constraints Faced By the Households in Disposal of Obsolete Electronic Equipments

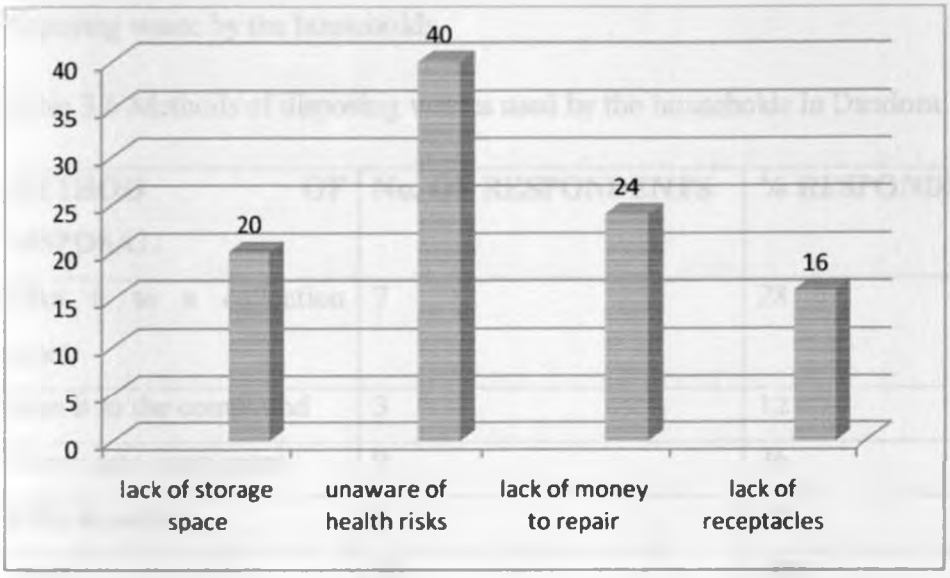
Table 3.5 presents the challenges that are mostly faced by households

Table3.5 – Problems faced by households in disposal of obsolete electronic equipment

Constraint[s]	No. of respondents	% respondents
Lack of storage space	5	20
Unaware of health risks	10	40
Lack money to repair	6	24
Lack of receptacles	4	16
Total	25	100

Source: Field Survey, 2008.

Figure 4.4



Source: Field Survey, 2008.

Other than the major problems pointed above, the interviews conducted by the researcher revealed the following;

- The residents lamented about the lack of collection of the waste by the city council. About 42% of the residents interviewed singled out delayed collection as one of the many problems facing them.
- About 28% of the respondents lamented about the haphazard and careless dumping of waste by fellow area residents as a problem that the area faces.
- About 12% of the residents interviewed said that though the services of informal business establishments are generally considered to be affordable, some residents are reluctant to use them. This is because such groups are considered as a source of security breach and the community in general looks them with lots of mischief.

Further, the residents pointed out that apart from the above constraints; they never had a systematic mode of e-waste disposal because to them it was a waste like any other

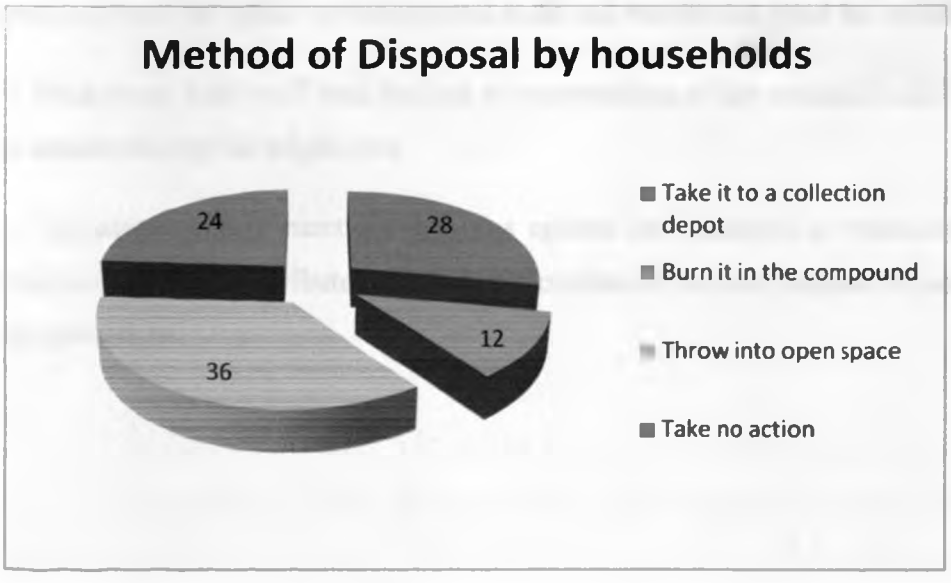
waste. The researcher felt that this was a major constraint to effective e-waste management even though the area residents never considered this as a major constraint. The field survey revealed the following as the most commonly used methods of disposing waste by the households

Table 3.6 Methods of disposing wastes used by the households in Dandora

METHOD OF DISPOSAL	No. OF RESPONDENTS	% RESPONDENTS
Take it to a collection depot	7	28
Burn it in the compound	3	12
Throw into open space	9	36
Take no action	6	24
Total	35	100

Source: Field Survey, 2008.

Figure 4.5



Source: Field Survey, 2008.

4.2.4 Constraints Faced by NEMA in Enforcing Legislations about SWM

The main challenges stated by the NEMA officials in the waste management unit included the following;

a. Lack of adequate funds to;

- ✓ Carry out surveys which will assist in proper management and conservation of the environment
- ✓ Coordinate research, investigation, and surveys on best practices of environmental protection
- ✓ Monitor and assess activities carried out by the relevant lead agencies in order to ensure that the environment is not degraded by such activities
- ✓ Publish and disseminate manual codes relating to environmental management
- ✓ Prepare and issue an annual report on the State of the Environment in Kenya,

b. Lack of capacity to implement legislations and coordinate various environmental activities being undertaken by the lead agencies,

c. Lack of operator education and training to render advice to entities engaged in natural resources management and environmental protection and inability to identify projects and programs for which environmental audit and monitoring must be conducted

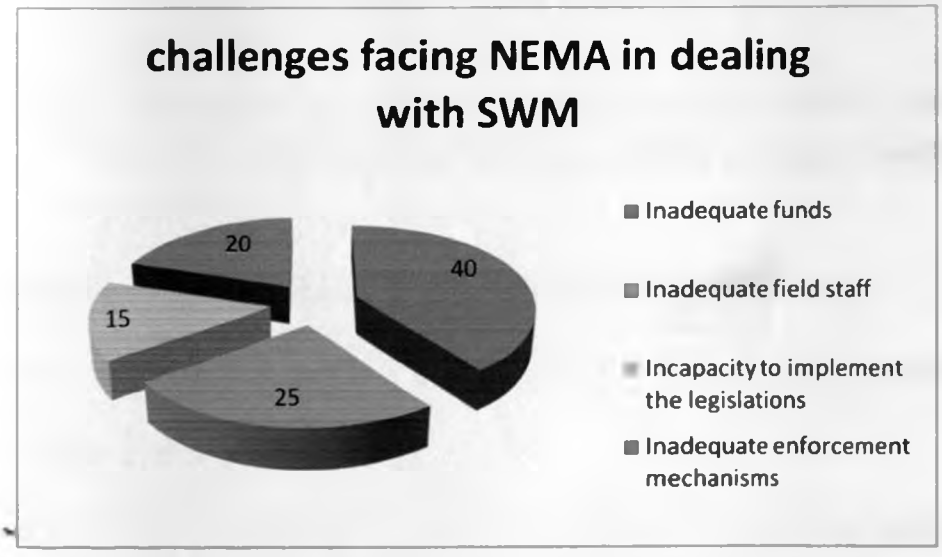
d. Inadequate field staff thus leading to overworking of the available staff. This results to apathy among the employees.

e. Inadequate enforcement mechanisms against law breakers in waste disposal. This they claimed has contributed towards the continued careless disposal of solid waste by the generators.

Table 3.7 Constraints Facing NEMA

constraint	% respondents
Inadequate funds	40
Inadequate field staff	25
Incapacity to implement the legislations	15
Inadequate enforcement mechanisms	20
Total	100

Figure 4.6



Source: Field Survey, 2008.

NEMA officials in the waste management unit unanimously pointed out that indeed there were no specific legislations governing the collection, transportation, treatment and final disposal of e-waste. They further pointed out that solid waste management in general and in particular e-waste in Kenya continues to be inadequate because legislations are enforced by different government institutions. For example, whereas the

Physical Planning Act is administered by the Physical Planning Department within the Ministry of Lands and settlement, the EMCA on the other hand is administered by the MENR. This results into duplication of responsibilities in the regulatory provisions for the development of effective planning and management of solid wastes in general. Further, the fact that there are no special legislations governing e-waste, this tends to make the already bad situation worse. Thus a comprehensive legislation that avoids the duplication of responsibilities, fills the gaps of important regulatory functions, and that is also enforceable is therefore required for sustainable development of e-waste management system in Kenya. NEMA officials explicitly stated that in order to effectively and efficiently manage e-waste the following needs to be done;

- Collaboration with lead agencies in coming up with specific legislations concerning e-waste generation, transportation, treatment and final disposal,
- Through coordination of the various actors involved in waste management, e.g. NGOs,the private sector, CBOs, municipal councils, informal sector and the government.
- Through creating public awareness on e-waste problems and management practices. This would be through the media, workshops, chief's barazas, and e.t.c.

4.3 Measures Put In Place to Deal with the Problem of E-Waste

The fourth objective sought to suggest ways and means of enhancing proper e-waste management.

The researcher found out that in the Kenyan context there were hardly any tangible measures to be relied upon as the CCN and NEMA officials concerned with the preservation and maintenance of the environment confirmed that e-waste was a relatively new concept in Kenya. NEMA on its part confirmed that the 2006 eighth Conference of Parties to the Basel Convention [COP8] acted like a wake up call to the problems of e-waste and therefore from since plans are underway to enact legislations specific to this hazardous waste. Thus, this compelled the researcher to explore those

measures that have been applied in other countries and have worked which have a direct bearing on the Kenyan scenario. These measures include inter alia;

4.3.1 Waste minimization and resource recovery-The success of the electronics industry over the last decade in developing a mass consumer market for computers, cell phones and other personal electronic equipment has been phenomenal. The society must therefore find ways of safely and economically recovering materials that are embedded in these products. This requires significant investment by the government, industry, and individuals in technology and education to reshape societal attitudes towards e-waste disposal.

Waste minimization works under the principle of the 3Rs initiative. This initiative has been found to be the most effective and efficient method of e-waste management [Rethink initiative, 2006].The 3Rs stand for, **Reduce**, **Reuse**, and **Recycle.**

Reduce involves maintaining and keeping electronic equipments as long as possible. For instance, a typical computer life span is 2-3 years but can be extended by 1-2 years with some upgrading.

Reuse involves donating used electronics to schools, non-profit making organisations and lower income families. This makes it easy for these groups to use equipment that they otherwise could not afford. Further, a more recent computer for instance can often be fixed, upgraded and reused instead of being replaced.

Recycling –this is where electronic equipment is recycled for the recovery of metals, plastics, glass and other materials. Basel convention allows countries without proper recycling of hazardous waste facilities to ship their equipment directly to a recycler. Recycling reduces the volume of waste hence reducing the cost of transportation by drastically reducing the number of travels to the dumping site [Kiplangat, 2002].Salvaged materials can be sold thereby generating income. Generally, the 3Rs initiative is a **resource recovery** strategy where waste is not directly disposed but recyclables are sorted out, cleaned and used as resource thereby acting as raw materials for manufacturing other products. This practice of treating waste materials as a resource is becoming more common, especially in metropolitan areas where space for new land

fills is scarce and disposing of waste materials is unsustainable in the long run, as there is finite supply of raw materials, [Miller, 1986].

4.3.2 Creation of awareness and environmental education among all the stakeholders for better e-waste management though the media and holding of barazas at the community level. This initiative can work wonders in the Kenyan context.

4.3.3 Councils partnering with neighbouring local authorities where they could acquire a common disposal site, share collection vehicles, search and share information related to e-waste management. This will greatly reduce operations cost as well as offering access to resources that would otherwise have been inaccessible. This has greatly worked in Canada.

4.3.4 Segregation of waste at source. This involves sorting out of e-waste from other solid wastes. The sorted out waste can sold to earn income.

4.3.5 Privatization of e-waste collection services-This will lead to reduced illegal dumping, creation of employment, extends services to areas that the council can not reach, and application of appropriate technology in land filling and incineration of obsolete electronics since these private firms are financially stable.

4.3.6 Municipal councils taking the lead initiative to train their workers on specific areas such as e-waste health hazards, proper methods of e-waste disposal and the importance of sorting out e-waste from other solid wastes.

4.3.7 Use of NGOs-these offers advocacy services to residents, help in creating awareness on the importance of good e-waste management practices as well as educating how to do it. They also offer credit facilities and financial assistance to CBOs dealing with waste management. They also liaise with the government at local level, national level and regional level to promote regulations governing e-waste management. They also offer financial and technical assistance to the municipal authorities for improved e-waste management. They assist scavengers and the informal waste collectors by offering safety clothing.

4.3.8 Use of the CBOs-these play the role of dissemination and teaching the residents how to reuse, recycle or employ other eco-friendly methods of e-waste management. They act as collective voices for the residents and can be used to

persuade the government officials to notice the problem of e-waste and can influence the industries to be more mindful of their responsibilities.

4.3.9 Empowering the manufacturers and retailers of electronic products to take active roles in e-waste management through; take back programs, use label materials to assist in recycling, educating consumers and the general public regarding the potential threat to the public health and the environment posed by their products, undertake responsibility of recycling/disposal of their own products and creating computer components and peripherals of biodegradable materials.

4.4 Summary

Qualitative analysis of e-waste management components is summarized in the form of a matrix proposed by the researcher with an arbitrary marking scale from A to D. The A mark represents a high score and the D mark represents an unsatisfactory performance. The N/A means that data was unavailable to the researcher

Table 3.8 Summary

COMPONENT OF E-WASTE MANAGEMENT	PERFORMANCE
COLLECTION RATE	D
SEPARATION AT SOURCE	D
RECYCLING	D
WASTE PICKERS/ BUYERS	C
PUBLIC EDUCATION AND AWARENESS	D
LEGISLATION	C
GOVERNMENT PRIORITY	C
PRIVATIZATION	N/A
LAND FILLS	C
OVERALL	D

Source: Field Survey, 2008.

The accuracy of the data included in this report is directly related to the accuracy of the reviewed literature and the information given by those contacted during the research work.

It is evident that the situation of e-waste management in Kenya is wanting. Thus a number of issues must be addressed if e-waste management in Kenya is to be successful. Some of the issues to be addressed include but not limited to; establishment of acceptable standards of collection and disposal of e-waste, selection of appropriate technology, arrangement of institutions for planning and management of e-waste from generation to final disposal, arrangement of financial resources, development of regulatory and enforcement framework, provision of public education and participation programs and incorporation of incentives to facilitate e-waste success.

The council in collaboration with NEMA has therefore a duty of care for the provision of and regulation of SWM including the special waste stream that is e-waste. The council main responsibilities towards e-waste should be;

- To regulate and implement SWM policies.
- To provide services for the collection, transportation, treatment and disposal of solid waste.
- To regulate and monitor the activities of all generators of solid waste.
- To formulate and enforce laws and regulations relating to SWM.

  CCN should deliver e-waste management services through the DOE which is one of its administrative departments.DOE depends on the **cleansing section** for waste collection and transportation from the city of Nairobi. The cleansing section also does street cleansing, night soil collection, refuse disposal, destruction of contaminated foods and other goods and issuance of destruction certificates.

  DOE is headed by the Director of Environment who is assisted by Deputy Director. The DOE also manages Nairobi city parks through its parks section.

  The main responsibilities of the department toward e-waste management should be to;

- ✓ Implement CCN's SWM policies formulated by the council's Environmental Committee
- ✓ Maintain public cleanliness, protect public health and the environment and keep public places aesthetically acceptable by providing services for collection, transportation, treatment and disposal of solid waste.
- ✓ To regulate and monitor the activities of all generators of solid wastes,
- ✓ To regulate and monitor the activities of private companies engaged in solid waste activities in e-waste,
- ✓ To formulate and enforce laws and regulations relating to e-waste management,
- ✓ Co-ordinate with other departments within CCN, donor agencies, NGOs and other government organizations involved in SWM generally.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.0 **Introduction**

This final chapter delves into the findings, conclusions and recommendations of this study with the aim of providing a framework for a sustainable approach to e-waste management in Kenya and in any other developing country where it may be applicable. Here, the researcher summarizes the relevant practices, principles, regulations and methods of disposal of e-waste.

5.1**Summary of Findings**

As from the outcome of this research, it is evident that the conventional means of providing SWM services are no longer feasible on e-waste. The CCN can no longer single handedly provide the e-waste management services in the face of the vast population increase, declining financial resources, inadequacies in technical and technological resources among other challenges. This resulted to CCN contracting private firms to offer services of waste collection, transportation and final disposal.

It was found out that there exists no e-waste management, collection or recycling program in Kenya; indeed such systems are rare in Africa. Thus, the very significant amounts of e-waste in Kenya have nowhere to go other than where all waste goes; to the dumps. This phenomenon of e-waste is expected to increase due to the phenomenal rate of growth in use of computers and I.T equipment and it must be remembered that much of e-scrap arriving in the country does not function upon arrival, either it is too obsolete for resale, or has a very short life.

E- Waste categorization data specific to Kenya is not available. This was confirmed by the officials from the Department of Environment [DOE] of the Nairobi city council.

There is lack of current specific regulatory initiatives to manage e-waste minimization, with the potential for reducing the hazardous waste problems. The existing legal

provisions governing SWM date back to the 1970s.There is therefore need to repeal these by-laws.

There is no separation of waste at source. This was found to be the case in Dandora dump site where dead monitors, motherboards, radios, TVs among others were found dumped with other solid wastes.

Plate 4 E-wastes mixed with other solid wastes-no segregation at source

Source: Field Study, 2008.

Education and communication channels between the sectors especially the government and the civil societies are inefficient and inadequate. A lack of right to know, secrecy and misinformation has also been a major contributing factor to poor e-waste management practices in Kenya and in many African countries. This implies that due to lack of vital information on e-waste, there is general lack of public awareness on the same.

It was found that because most of the imports of electronic equipment are not pre-tested for functionality [NEMA, 2006]; it is not possible to know whether these exports are legally defined as hazardous. From a regulatory standpoint, diligent enforcement discretion would demand testing be performed prior to allowing export. This usually never happens in the Kenyan context.

There is a don't care attitude in e-waste management especially amongst the cyber café managers. Their mode of handling e-waste remains unsatisfactory, wanting and questionable. They study confirmed that the cyber café managers store the junk in their stores or throw it in waste polythene bag awaiting collection by the city council workers. This remains a big challenge to e-waste management.

Dandora residents near the dump site said that they are not at all guided by any proper waste management program. They dump the waste that they collect from their households' at the most convenient, nearest and accessible open space irrespective of the close proximity of the dump site and the likely problems that this can cause.

It was also found out that the CCN does not operate an incineration plant. It also lacks a land fill .This can be attributed to lack of enough financial resources and technical expertise to operate them.

The DOE lacks professional training on e-waste management. From this perspective, it is clear that no comprehensive e-waste management can be conceptualized, successfully implemented and eventually appraised if most of the officers lack the critical theoretical orientation towards the subject matter.

The foregoing findings indeed serve to prove the hypothesis, "Bad e-waste management practices exist due to lack of general public awareness on e-waste", as true. For instance, it was found out that education and communication channels between the sectors especially the government and the civil societies on e-waste and other wastes are inefficient and inadequate. Further, this problem of poor e-waste management practices is aggravated by the fact that there has been a don't care attitude in e-waste management especially amongst the cyber café managers. Their mode of handling e-waste remains unsatisfactory, wanting and questionable. This remains a big challenge to e-waste management.

5.2 **Conclusions**

Having elaborately examined the state of e-waste management practices in Kenya and the foregoing on findings, principle conclusions have been drawn thus far. The researcher has therefore concluded that;

- The development and transfer of cleaner technologies and processes needs to be adopted and accelerated. Without a dramatic increase in such technologies over

the coming 10 or 20 years, the generation of e-waste by an expanding global economy could reach unmanageable dimensions.

- Only by giving the issue a higher profile on the local, national and international agenda can the government ensure that action under the Basel Convention will lead to an environmentally sustainable future free from danger of hazardous e-wastes
- Kenya needs a serious capacity building program from the grassroots [farm level], district level and national level. This argument is based on the low level of awareness and information packaging and dissemination on e-waste management practices. There is therefore increased need to use targeted electronic and print media and especially in the main local languages if the program is to be effective.
- A sustainable integrated approach to e-waste management practices can only be achieved by a closely knit consultative consortium between the government, private stakeholders and community participation. With the now popular "Kenya vision 2030" in place, there is optimism that the menace that is e-waste can be effectively handled.
- The next 10 years must be spent to holistically address how to prevent and minimize e-waste generation and maximize reuse, recycling and use of environmentally friendly alternative materials. This will require the participation of the government authorities and all stakeholders, in order to minimize the adverse environmental effects of pollution and improve resource efficiency. In order to achieve this, there will be a need for financial, technical and other assistance from developed countries as set out in principle 15 of the Rio Declaration on Environment and Development.
- Waste management in general and in particular e-waste has continued to play an important role in the theatre that is environmental quality protection and is expected to do so for a long time to come. As ICT evolve, there is a need to closely examine this entity and take into consideration the myriad of problems that are facing it today. A great deal of proper e-waste management practices can be learnt from what has worked and not worked elsewhere, and from an

understanding of the evolutionary nature of I.T, successful e-waste management practices are not static, rigid strategies, but are constantly changing to meet new demands and opportunities. Therefore, with careful planning and investment, along with effective legislation and management, e-waste management can result to sustainable local economies and community life.

- E-waste management in the CBD is a key contributor to environmental degradation and this is not only caused by the general lack of public awareness on e-waste as the research sought to find out, also due to lack of proper coordination of the activities of all actors. There is therefore the need to develop this coordination as well as the improvement of the participation by all actors in order to improve the situation. In order for the different actors to be able to play an integrative role in e-waste management, there is need to establish a framework that will accommodate them all. Such a framework will call for the CCN to act as a regulator, a coordinator, a catalyst and a partner for all their action to develop a sustainable e-waste management.

5.3 **Recommendations**

In logical pursuit to the research findings and consequent conclusions drawn out above, the following are the recommendations tailored for the Kenyan context. These recommendations are intended to be strongly peculiar to this region and may therefore not be generally applicable elsewhere in the developing countries, at least not without the appropriate contextual modifications considering the differences in climatic, political and socio-economic environments. These recommendations can be grouped as financial, technical, socio-economic, policy and regulatory. The recommendations include but not limited to the following;

5.3.1 Availability of resources for developing, implementing and operating e-waste

Management systems [both preventive and those at the post generation stage], needs to be enhanced. Millennium Development Goals on water, sanitation and poverty reduction cannot be met without adequate waste management generally and

particularly e-waste management. Accordingly, donors should intensify support to e-waste management,

5.3.2 Establish public-private partnerships-these are needed in order to increase the availability of and to improve access to financial resources. Access to financial resources will meet the growing demand for the construction and operations of e-waste management systems. Involvement of private sector and local communities, will ensure that building and running of e-waste management system are strengthened and made more effective

5.3.3 Creation of public awareness- this is required to change the attitude of e-waste generators, particularly municipal and industrial e-waste generators, to raise their awareness of the need for proper segregation and disposal of e-waste. Awareness should also be intended to promote education at all levels on the adverse effects of e-waste in the environment, including the provision for dissemination of such information such that their socio-economic effects can be considered, particularly in respect of prevention versus management.

5.3.4 The government needs to develop an access to cutting-edge e-waste management technologies. This will ensure that there is use of best practices in management of e-wastes the country over.

5.3.5 There is need for capacity building-this need to be strengthened at the national and local level in order to implement and operate e-waste management technologies,

5.3.6 The government needs to prepare and disseminate technical guidelines, case studies, and demonstration and pilot projects for integrated e-waste management. Simultaneously, research and development work is required to adapt these technologies to suit local conditions. Establishment of information exchange and networking infrastructure to facilitate e-waste information dissemination could be of much help,

5.3.6 Establish an integrated e-waste management system-this is a key priority area in the current "one United Nations" approach. At the local level, integrated e-waste management strategies and action plans for municipalities, needs to developed and implemented,

5.3.7 The government needs to establish a greater conceptual clarity, supported by practical application strategies to promote resource augmentation through e-waste recovery, reuse and recycling[the 3Rs] both nationally and locally,

5.3.8 There is need for the strengthening of the national policy frameworks. These are intended to shift needs to put an emphasis from an end-of-pipe approach to an integrated resource management approach, including implementation of standards on e-waste management,

5.3.9 Compliance with the Basel Ban Amendment- this prohibits all exports of hazardous wastes from the developed to developing countries. Member governments should not only prohibit the dumping of hazardous e-wastes on developing countries via international trade, but ensure also that testing is done to make sure that materials exported foe alleged reuse are in fact functioning and are truly destined for reuse in the recipient countries. If not the export to developing countries must stop,

5.3.10 Improve and implement international definitions- all of the Basel Convention parties should work to eliminate any remaining ambiguity regarding hazardous e-waste definitions. If there is any doubt, we should err on the side of greater trade controls for greater environmental protection,

5.3.11 Establish producer-consumer responsibility-manufacturers and retailers of electronic products should consider establishing a take back policy/ program for the end-of-life products. This is an ideal opportunity especially for most developing countries like Kenya to join in partnership to devise e-waste collection systems and environmentally sound e-waste management for electronics that become waste. Further, consumers of electronics should take responsibility for their electronic waste by separating it from other wastes and subsequent safe disposal. They should ensure that e-waste does not find its way to the dumpsite where it may be subjected to open burning,

5.3.12 There is need for the provision of an adequate system of laws, controls and administrative procedures for hazardous waste management (Third World Network, 1991).Existing laws regarding hazardous waste disposal be reviewed and revamped. A comprehensive law that provides for E-waste regulation and

management and its proper disposal is required .Such a law should empower the agency to supervise and regulate the relevant activities of E-waste management which could be contained in an Act of parliament to be called "E-waste Management and Co-ordination Act" The Act will provide among other things;

- ✓ Guidelines for collection, transportation, storage, recovery and disposal of e-waste,
- ✓ Specify the procedure through which the municipal authorities could be technically and financially aided to deal with the problem of e-waste management and guidelines for rewarding innovative manufacturers, technologists, e.t.c
- ✓ Formulating legal procedures to ensure reporting of illegal e-waste dumping by the general public,

5.3.13 The government should strengthen **" the polluter pays principle"**- legal procedures should be used in cases of default with stiff penalties for defaulters based on the toxicity of the waste, severity of environmental pollution, severity of health hazards and the degree of nuisance to the public,

5.3.14 Encourage use of cleaner production methods. These would promote waste prevention and minimize its generation. Further, cleaner production technologies would assist in avoiding the use of hazardous substances where less hazardous materials could be substituted without significant detrimental effects or other risks on product quality or economic costs. Whenever possible, promote the adoption of environmentally sound methods of resource recovery by direct reuse, alternative use, reclamation or recycling,

5.3.15 Promote and continue to strengthen the effectiveness of international cooperation in the field of e-waste management, particularly that involving the trans-boundary movements of hazardous wastes, including its control and monitoring in accordance with international legal instruments.

5.4 **Limitations of the Study**

The researcher faced a number of difficulties in the field study which hindered effective data collection. The problems encountered include;

a. Most questionnaires taken to the field and left to the respondents got misplaced or got lost and could not therefore be collected. The respondents complained of lack of time to fill the questionnaires and this was not an easy task to deal with.
b. Respondents from some private firms especially the cyber cafes felt that , some information required was too sensitive to divulge and this ended up filling the questionnaires with irrelevant information,
c. The questionnaires were generally administered to respondents with different levels of education, understanding, honesty, social class, among other variations. The responses were therefore diversified and multivariate as the respondents themselves,
d. Some respondents faced the researcher with a lot of arrogance. They were occasionally uncooperative and/or very demanding. In some cases they demanded too much personal details concerning the researcher as a precondition for granting an interview,
e. There was the inability of some respondents to answer or adequately understand the questions in the questionnaires. In such situations assistance was sought from friends and relatives and sometimes the researcher himself. This might have doctored ones responses causing bias and lack of effectiveness or representativeness of the data collected

5.5 **Areas of Further Research**

1. The study found out that there was minimal or total lack of partnership among all stakeholders in management of e-waste. Thus an investigation into public private partnership on management of e-waste can be pursued as an area of further research.

2. It was also clear from the research findings that there is no clear and well defined mechanism for recycling e-waste hence a further area of study can be an investigation into e-waste recycling methods.

3. Due to the limited scope and research methodology of this study, the researcher feels that the area of e-waste impacts on the environment was not exhaustively addressed, thus an evaluation of e-waste generation effects on the environment can be pursued s as an area of further research.

BIBLIOGRAPHY

Cointreau, J.S [1982]: Environmental Management of Urban Solid Waste in Developing Countries; a Project guide, Washington D.C

Flintoff, F. [1987]: Management of Solid Wastes in developing countries, WHO publication, SE Asia.

Freeman M.H. [1989]: Standard Handbook of hazardous waste treatment and disposal, Mc Graw-Hill, USA.

Holmes, J. [1984]: Solid Waste Management Decisions In Developing Countries. New York: John Wiley &Sons

JICA [1998]: the Study on Solid Waste Management in Nairobi City In The Republic Of Kenya

Kiogora, J.[1995] :Solid Waste Management in low income residential areas of Nairobi city. Unpublished M.A, [planning] Thesis, University of Nairobi.

KIPLAGAT, W.K. [1999]: Alternative Options for Solid Waste Management in Eldoret Municipality. Unpublished M.Phil [Environmental Planning and management] Thesis, Moi University, Eldoret.

Mutai, P.K. [1997]: An Assessment of Solid Waste Management in Kericho Town. Unpublished M.A.[Planning] Thesis, UON.

Muthoni, A.M. [1999]: Community Participation in Solid Waste Management within urban informal settlements: a case study of Kibera, Nairobi. Unpublished M.A.[Planning] Thesis, UON.

Mugenda, A. and Mugenda, G. [1999]: Research methods: Quantitative and Qualitative Approaches, Nairobi; Act Press.

Republic of Kenya [1999]: Environmental Management and Co-ordination Act, Nairobi

; Government printers

Republic of Kenya [1972]: The Public Health Act, cap 242, laws of Kenya, Government printers, Nairobi.

Republic of Kenya [1972]: Local Government Act, cap 265, laws of Kenya, Government printers, Nairobi.

Republic of Kenya [1999]: Kenya Population and Housing Census, volume.1. Government printers; Nairobi.

Rutoh, D.K. [1988]: An investigation of solid waste collection and disposal systems. A case study of Nairobi City Council. B.A [Land Economics], unpublished research project, University of Nairobi.

RAO, C.S. [1991]: Environmental Pollution Control Engineering.Willey Eastern Ltd.New Delhi, India.

Syagga, P. [1992]: Solid Waste Management Cycle in the City of Nairobi. A Paper Presented at the Workshop on Urban Waste Management in Kenya, University of Nairobi.

Third World Network, [1999]: Toxic Terror; Dumping of Hazardous Wastes in the Third World Network, Malaysia.

UNEP, [2007]: Waste Management, report of the executive director.

UNEP, [1999]: A Directory of Environmentally Sound Technologies for the Integrated Management of Solid, Liquid and Hazardous Waste for Small Island Developing States [SIDS] in India Mediterranean and Atlantic region.

Internet References

http://www. Basel. Int

http://www. Iqes.or.jp/en/pub

http://www.stvc. Org

http://www.ban org/ plrdge1.html

http:// www. Basel. Int/ Drafts rate

Wikipedia, the free encyclopedia

Http: // www. Africa . com

MKPNews>Annunci>inter-religious committee for the Dandora anti-dumping campaign

Http:// www.basel.int/draftsratek

http:// www.ehproiect.org/ a publication of environmental health projects.S

Appendix I: Questionnaire to City Council of Nairobi [Department of Environment]

This questionnaire is in aid of a research being conducted by Kimanthi M. Nicholas, a student at the University of Nairobi as partial fulfillment for award of a degree in Land Economics. The study title is "**an investigation into electronic waste management".** The information collected through this questionnaire shall be treated as confidential and will be used only for the purpose of this research. Your assistance and cooperation will be highly appreciated.

1. How long have you been working with the City Council? Tick appropriately;

Under 5years [ ]

Between 5-10years [ ]

Over 10 years [ ].

2. What categories of solid wastes do you manage? Tick appropriately;

Garbage [ ]

Paper [ ]

Plastics [ ]

Rubber [ ]

Metals [ ]

Glass [ ]

Obsolete monitors, TV sets, copiers, e.t.c [ ]

Others [specify]

3. How often is the waste generated in the City of Nairobi collected? Tick appropriately;

Daily [ ]

Weekly [ ]

Monthly [ ]

On irregular basis [ ]

4 What waste management activities does your department undertake?

Tick appropriately;

Storage [ ]

Collection [ ]

Transport [ ]

Incineration [ ]

Scavenging [ ]

Others-specify

5. Do you partner with other organizations in any of the above functions in no.5 as they relate to solid waste management?

YES [ ] NO [ ]

If yes, list the partners

.....

.....

.....

6. What factors did you consider when sitting the Dandora dumping site?

.....

.....

.....

8. Are there plans to shift the dumping site any time soon?

YES [ ]

NO [ ]

If yes in the above, give the reasons as to why

.....

.....

.....

9. [i] Do you know what a hazardous waste is?

YES [ ]

NO [ ]

[ii] If yes, give some of the examples that you know constitute hazardous waste

.....

.....

.....

[iii]Is waste from obsolete electronic and electrical equipments and/or appliances [otherwise called e-waste] belong to the category of hazardous waste?

YES [ ]

NO [ ]

10. Are there any by-laws concerning disposal of hazardous waste that you follow?

YES [ ]

NO [ ]

If yes, name some that govern disposal of hazardous waste like e-waste.

.....

.....

.....

11.[i] How do you dispose obsolete electronic appliances after collection?

Open dumping [ ]

Sanitary land fill [ ]

Composting [ ]

Incineration [ ]

Others [specify]

[ii] Where do you dispose the waste?

.....

.....

.....

12. Do you recycle any waste related to electronic and electrical appliances?

YES [ ]

NO [ ]

If yes, what types of electronic waste do you recycle?

.....

.....

.....

13. What type of products do you recover after recycling of e-waste?

.....

.....

.....

14. After recycling of e-waste, do you have any residue products to be disposed?

YES [ ]

NO [ ]

If yes in above where do you dispose such residue?

.....

.....

.....

15. Do you have an incineration plant?

YES [ ]

NO [ ]

16. In disposing the residue named in [14] above, what measures do you take to make sure that the disposal method used comply with health standards?

.....

.....

.....

17 Have you attended any training about disposal of hazardous waste?

YES [ ]

NO [ ]

If yes, what kind of training?

.....

.....

.....

18 List some of the equipment and tools you normally use in collection and disposal of the different types of waste.

.....

.....

.....

19 [i] Are you provided with protective devices when collecting and disposing wastes?

YES [ ]

NO [ ]

If yes list them.

.....

.....

.....

[ii] In which areas do you think the NCC should put more effort to improve on environmental quality?

.....

.....

.....

20.[i] Name some of the challenges you face in carrying out solid waste management in general.

.....

.....

.....

[ii] Are there specific challenges that relate specifically to e-waste?

.....

.....

.....

[iii] How can the Local Authority and the community work together to better environmental maintenance through waste management?

.....

.....

.....

[iv] What health hazards do you think are associated with the dumping site?

.....

.....

.....

21. What is the City Council doing to change the situation at the Dandora dumping site?

.....

.....

.....

22. How would you rate the state of waste management in the country generally?

Satisfactory [ ]

Fair [ ]

Unsatisfactory [ ]

THANK YOU.

Appendix II: Questionnaire to Residents of Dandora

This questionnaire is in aid of a research being conducted by Kimanthi M. Nicholas, a student at the University of Nairobi as partial fulfillment for award of a degree in Land Economics. The study title is "**an investigation into electronic waste management".** The information collected through this questionnaire shall be treated as confidential and will be used only for the purpose of this research. Your assistance and cooperation will be highly appreciated.

1. How long have you been living in Dandora? Tick appropriately;

Under 5 years[ ]

Between 5-10 years [ ]

Over 10 years[ ]

2. What categories of waste do you normally collect in your household? Tick appropriately;

Refuse [ ]

Paper [ ]

Metals [ ]

Plastics [ ]

Glass [ ]

Others [specify]

3. How do you discard the waste that is of no value to your household?[Tick appropriately]

a. Burn it

b. Leave it on the street

c. Throw it in the river

d. Discard it in the communal containers

4. What do you do with your recyclable products?

a. Discard them with other solid waste

b. Separate them for selling to junk shop collector

c. Separate them for own reuse

d.Dont know

5. [i] Name some of the electrical and electronic appliances that you know exist

.....

.....

.....

[ii] Of the ones mentioned above, which ones do you have in your house?

.....

.....

.....

[ii] Have they been damaged?

YES [ ]

NO [ ]

6. In your opinion, how do you dispose of the above appliances after they are damaged, cease to operate/function or after they become obsolete?

.....

.....

.....

7. Is there a common place where you take your solid household wastes?

YES [ ]

NO [ ]

If yes, name the place.

.....

.....

.....

8. Who manages the place? Tick appropriately;

a. The City Council [ ]

b. Private firm [ ]

c. Nearby residents [ ]

d. Others [specify]

9. Other than disposing old, obsolete or damaged electrical appliances, what else do you do with them?

a. Sell to scrap metal dealers

b. Donate to relatives

c. Throw them away

d. Do nothing

10. Have you ever visited the Dandora Dumping site?

YES [ ]

NO [ ]

11. If yes above, name some of the categories of waste you were able to identify?

.....

.....

.....

12. What is your opinion about the present site where you dispose your waste

a. Anyone can throw his waste there

b. Anything can be thrown there

c. The site produces foul odours

d. No opinion/don't know

13 What is your opinion about the current situation of the disposal of solid waste in your neighbourhood?

a. I'm doing it because everyone else is doing it

b. There will be problems in the end

c. Nothing is wrong with what I'm doing now

d. No opinion/don't know

14. What do you consider the most urgent problem related to the present site in your neighbourhood where you dump your waste?

a. Public health risk

b. Groundwater contamination

c. It becomes an eyesore with unpleasant odours

d. Uncontrolled dumping at the area

e. Nothing is wrong with the dump site

15. Would you be willing to contribute to the safe disposal of the solid waste in your neighbourhood?

a. Yes

b. No

16. How would you be willing to contribute?

a. Bringing my own garbage to the communal container as whatever the neighbourhood identifies as container

b. Separate recyclables

c. Separate organic waste

d. Paying for an amount agreed upon by the community for a solid waste collection system

THANK YOU.

Appendix III: Questionnaire to Managers of Cyber Cafes in the CBD

This questionnaire is in aid of a research being conducted by Kimanthi M. Nicholas, a student at the University of Nairobi as partial fulfillment for award of a degree in Land Economics. The study title is "**an investigation into electronic waste management".** The information collected through this questionnaire shall be treated as confidential and will be used only for the purpose of this research. Your assistance and cooperation will be highly appreciated.

1. How long have you been managing the cyber café?

Under 5 years? [ ]

Between 5-10 years? [ ]

Over 10 years? [ ]

2. Name some of the many electronic and electrical appliances you have in your cyber café?

.....

.....

.....

3. How often do you replace them? Tick appropriately;

Weekly [ ]

Monthly [ ]

After 3 years [ ]

Others [specify] [ ]

4. Do you get to repair them?

YES [ ]

NO [ ]

If yes, how often? Tick appropriately;

Weekly [ ]

Monthly [ ]

Yearly [ ]

Others [specify] [

5. Do you often donate some of your electronic equipments?

YES [ ]

NO [ ]

If yes, where, to who, when?

Where?.

To Who?

When?

6. Give categories of obsolete/unfunctional and/ or functional electronic and electrical equipments that are present in your cyber café?

7. Are there any defined methods of disposal and storage that you use after the electronic equipments become obsolete?

YES [ ]

NO [ ].

If yes, tick appropriately;

Open dumping [ ]

Composting [ ]

Burning [ ]

In a waste paper polythene bag [ ]

Others [specify]

8. How do you dispose of the obsolete electronic products? Tick appropriately;

Throw them away [ ]

Sell to scavengers [ ]

Put in a waste polythene bag [ ]

Do nothing [ ]

9. Who collects obsolete electronic equipment in your business premises? Tick appropriately;

The City Council [ ]

Private firm[s] [ ]

Joint venture of the public and private sector [ ]

10. Do you encounter any problems in disposal and collection of obsolete electronic equipments?

YES [ ]

NO [ ]

If yes, name the problems encountered

.....

.....

.....

11. In what ways do you think unfunctional electronic equipments can be managed satisfactorily?

.....

.....

.....

12. How would you rate the state of e-waste management in your cyber café?

Satisfactory [ ]

Fair [ ]

Unsatisfactory [ ]

THANK YOU.

Appendix IV: Questionnaire to NEMA [Waste Management Unit]

This questionnaire is in aid of a research being conducted by Kimanthi M. Nicholas, a student at the University of Nairobi as partial fulfillment for award of a degree in Land Economics. The study title is "**an investigation into electronic waste management".** The information collected through this questionnaire shall be treated as confidential and will be used only for the purpose of this research. Your assistance and cooperation will be highly appreciated.

1. How long have been working with the NEMA? Tick appropriately;

Under 5 years [ ]

Over 5years [ ]

2. Do you know what electronic waste, otherwise called e-waste is?

YES [ ]

NO [ ]

If yes, list some of the examples that you think constitute e-waste

.....

.....

.....

3. Are there any specific regulations on waste management that apply directly on this special waste stream called e-waste?

YES [ ]

NO [ ]

If yes, cite some of the regulations

.....

.....

.....

4. In your opinion is e-waste hazardous or not. In either case give reason[s]

.....

.....

.....

5. How do you ensure that regulations, if any, governing environmental conservation and protection are effectively and efficiently enforced?

.....

.....

.....

6. Have you attended any training or workshop about management of hazardous waste in general and in particular e-waste?

YES [ ]

NO [ ]

If yes above, what was the training about?

.....

.....

.....

7. Did you attend the Eighth Conference of Parties [COP8] held at UNEP headquarters in 2006 about e-waste?

YES [ ]

NO [ ]

If yes above, give a brief account of what was discussed in the conference about e-waste.

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8. Name some of the challenges that you face in enforcing rules about proper solid waste management in general.

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9. What is NEMA doing to change the poor practices of hazardous wastes disposal including e-waste?

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10. Apart from the Basel Convention, which other Multilateral Environmental Agreements [MEAs] governs the trans-boundary movement of hazardous wastes and their disposal?

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11. Give some examples of projects that require mandatory EIA and Environmental Audit

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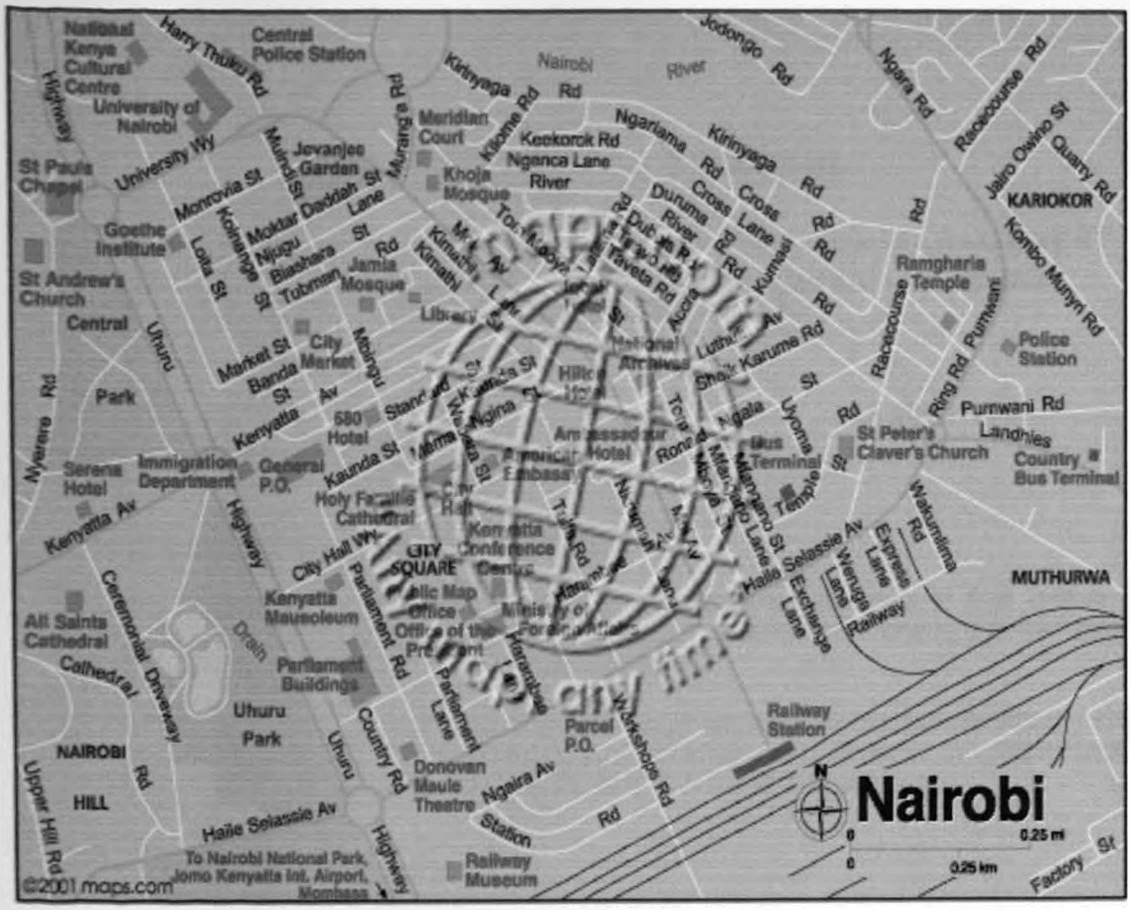
THANK YOU

Appendix v: Map of Nairobi Central Business District



Appendix Vi:An Introductory Letter From The Department

UNIVERSITY OF NAIROBI

DEPARTMENT OF REAL ESTATE AND CONSTRUCTION MANAGEMENT

P.O. Box 30197, 00100 Nairobi, KENYA. *Tel: No. +254-2-2724525/9 Fax: +254-2-2718548*
E-mail: dept-recm@uonbi.ac.ke

19 March 2008

TO WHOM IT MAY CONCERN

RE: KIMANTHI M. NICHOLAS – BO4/0330/04

The above named is a student of this Department pursuing a Bachelor of Arts Degree in Land Economics. He is currently in his final year of the course and is writing a project paper titled: - ***"An investigation into e-waste management".***

The purpose of this letter therefore is to request you kindly to allow him access into any kind of material he may require from your organization to enable him complete the project paper successfully. The information given will be used for research purposes only.

Yours faithfully,

CHAIRMAN
DEPARTMENT OF REAL ESTATE
AND CONSTRUCTION MANAGEMENT
UNIVERSITY OF NAIROBI

Dr. Hezekiah Gichunge
Chairman
Department of Real Estate and Construction Management