THE ASSESSMENT OF ELECTRONIC-WASTE GENERATION AND MANAGEMENT IN SELECTED INSTITUTIONS IN NAIROBI, KENYA

By

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A Thesis Submitted in Partial Fulfillment for the Degree of Master of Environmental Science in the School of Environmental Studies of Kenyatta University

February, 2012
DECLARATION

I hereby declare that this thesis is my original work and has not been submitted for a degree in any University.

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DEDICATION

This thesis is dedicated to my wonderful parents, Mr. and Mrs. Munyugi, and my sisters Joyce, Lilly and Carol who have raised me to be the person I am today. To my loving fiancé Gibran Mwashigadi and family, you have been with me every step of the way, through good times and bad. Thank you for all the unconditional love, guidance, and support that you have always given me, helping me to succeed and instilling in me the confidence that I am capable of doing anything I put my mind to. Thank you for everything. I love you!

Also this thesis is dedicated to the late Professor C.T. Kithinji who was a great source of motivation and inspiration. May the Almighty God rest your soul in eternal peace aunty. Thank you.

Finally, this thesis is dedicated to all those who believe in the richness of learning.
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Thank you all

Lucy Kanana
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<td>BAN</td>
<td>Basel Action Network</td>
</tr>
<tr>
<td>CCK</td>
<td>Communications Commission of Kenya</td>
</tr>
<tr>
<td>CRT</td>
<td>Cathode Ray Tube</td>
</tr>
<tr>
<td>CSK</td>
<td>Computer Society of Kenya</td>
</tr>
<tr>
<td>CTBC</td>
<td>Canadian Tamil Broadcasting Corporation</td>
</tr>
<tr>
<td>DfE</td>
<td>Design for Environment</td>
</tr>
<tr>
<td>DfR</td>
<td>Design for Recycling</td>
</tr>
<tr>
<td>EEE</td>
<td>Electrical and Electronic Equipment</td>
</tr>
<tr>
<td>ELDA</td>
<td>End of Life Design Advisor</td>
</tr>
<tr>
<td>EoL</td>
<td>End of Life</td>
</tr>
<tr>
<td>ELSEIM</td>
<td>End of Life Strategic Environmental Impact Assessment</td>
</tr>
<tr>
<td>e-waste</td>
<td>electronic waste</td>
</tr>
<tr>
<td>EMCA</td>
<td>Environment Management and Coordination Act</td>
</tr>
<tr>
<td>EPR</td>
<td>Extended Producer Responsibility</td>
</tr>
<tr>
<td>GoK</td>
<td>Government of Kenya</td>
</tr>
<tr>
<td>GSM</td>
<td>Global System for Mobile Communication</td>
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<td>ICT</td>
<td>Information and Communication Technology</td>
</tr>
<tr>
<td>ICs</td>
<td>Integrated Circuits</td>
</tr>
<tr>
<td>IPMI</td>
<td>Intelligent Platform Management Interface</td>
</tr>
<tr>
<td>KEBS</td>
<td>Kenya Bureau of Standards</td>
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<tr>
<td>KPA</td>
<td>Kenya Ports Authority</td>
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<td>KRA</td>
<td>Kenya Revenue Authority</td>
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<tr>
<td>LCD</td>
<td>Liquid Crystal Display</td>
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<td>Abbreviation</td>
<td>Full Form</td>
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<tr>
<td>MPPI</td>
<td>Mobile Partnership Initiative</td>
</tr>
<tr>
<td>NEMA</td>
<td>National Environment Management Authority</td>
</tr>
<tr>
<td>OECD</td>
<td>Organization for Economic Cooperation and Development</td>
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<tr>
<td>PCs</td>
<td>Personal Computers</td>
</tr>
<tr>
<td>PWB</td>
<td>Printed Wiring Board</td>
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<tr>
<td>RoHS</td>
<td>Restrictive on Hazardous Substances</td>
</tr>
<tr>
<td>SCI</td>
<td>School of Computing and Informatics, University of Nairobi</td>
</tr>
<tr>
<td>SVTC</td>
<td>Silicon Valley Toxic Coalition</td>
</tr>
<tr>
<td>UNEP</td>
<td>United Nations Environment Program</td>
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<tr>
<td>WEEE</td>
<td>Waste Electrical and Electronics Equipment</td>
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ABSTRACT
Disposal of computers, mobile phones and its accessories in developing countries including Kenya adds to the waste management problem. The study was carried out from September 2009 to March 2010. The aim of this study was to quantify e-waste generated by the institutions, to identify the methods currently employed in the management and disposal of e-waste by the selected institutions, to evaluate current e-waste management policies and strategies implemented and recommend strategies that may be used to improve the management of the e-wastes by the institutions. The respondents were drawn from the major potential e-waste generators in the city including: medium to large scale computer and mobile phone importers and assemblers, end users of computers and its accessories, formal e-waste recyclers and key ICT and e-waste management institutions such as the CCK and NEMA provided key information. The researcher administered questionnaires to key informants, used observation record sheets, and secondary data from relevant institutions as the main sources of information. Analysis of data focused on generating-waste flow stream, quantifying the amount of e-waste generated and evaluating national and institution policies on e-waste management. T-test was used to quantify the amount of e-waste generated by the stakeholders. The results showed the tonnage of mobile phones and computers that remained undistributed by importers was statistically significant at 95% confidence level (t = 6.52, df = 2; p = 0.00456) and (t = -0.63294, df = 2; p = 0.0322), respectively. In the category of end users the tonnage of e-waste generated was insignificant at (t = 8.4, df = 2; p > 3.18) for universities and (t = 7.97, df = 2; p > 3.18) for ministries. This could be attributed to the long period of possession of equipment by end users. Analysis of the results further showed that tonnage of e-waste generated by recyclers was statistically significant at 95% confidence level (t = -13.82, df = 2; p = 0.00089). Further analysis of the e-waste flow stream from the importer to recycler has showed that significant amount of e-waste is being generated importers in comparison to other stakeholders. This means that a high percentage of equipment brought into the country by importers is potential e-waste due to the high amount of electronic equipment that remains undistributed and this poses a great threat to the environment. The methods employed for disposing e-waste included dropping off old IT technology at garbage collection point, storing in offices room, selling scrap, donation and re-use, selling to staff, friends, family or public, take back schemes and extended producer responsibility. The implication of these methods used is that e-waste generation is likely to increase downstream as a result of channeling e-waste to end users and recyclers. Approximately 75% of the stakeholders in the study lacked a policy on e-waste management and only 36.1% planned to have a policy in place. While the Government has recognized the challenges posed by e-waste, the level of preparedness in terms of policies and legislation is low. The study recommends that specific policies and regulations on e-waste be developed. These should govern e-waste from collection to final disposal, and licensing of key actors. A national collection system needs to be developed, and consumer awareness enhanced. Capacity building programmes should be launched in the sector, possibly funded by fees levied on importers of second-hand equipment.
CHAPTER 1
INTRODUCTION

1.1 Background

In developed countries, electrical and electronics waste equals 1% of total solid waste on an average and is expected to grow to 2% by 2010 (Li et al., 2006). In USA, it accounts for 1 to 3% of the total municipal waste generation. In European Union, electronic waste increases by 16-28% every five years, which is three times faster than average annual municipal solid waste generation. A recent source estimates that the total amount of electronic waste generation in EU ranges from 5 to 7 million tonnes per annum or about 14 to 15 kg per capita and is expected to grow at a rate of 3 to 5% per year (UNEP, 2007).

In developing countries, it ranges from 0.01 to 1% of the total municipal solid waste generation. E-waste has raised concern considering that many components of such equipment are considered as toxic and are not biodegradable. The toxicity is due in part to lead, mercury, cadmium and a number of other inorganic but toxic substances (UNEP, 2007).

Responding to these concerns, many European countries banned e-waste in landfills in the 1990s. The European Union further advanced e-waste policy in Europe by implementing the Waste Electrical and Electronic Equipment directive (WEEE) in 2002 which holds manufacturers responsible for e-waste disposal at end-of-life. Similar legislation has been enacted in Asia, with e-waste legislation in the United States limited to the state level due to stalled efforts in the United States Congress regarding multiple e-waste legislation bills. Due to the difficulty and cost of recycling used electronics as well as lack-lustre enforcement of legislation regarding e-waste exports, large amounts of used electronics have been sent to
developing countries where lower environmental standards and working conditions make processing e-waste more profitable (Li et al., 2006).

Growth in the Information Technology sector in developing countries has been intensified by the importation of "hand me-down" used equipments from rich developed countries, whose consumers are all too happy to find buyers for it. As a result many brokers and businesses have sprung up to channel used equipment from North to south, rich to poor. Much of the trade is illegal under international rules governing trade in toxic waste such as the Basel Convention (Basel Action Network, 2005).

These trades are often justified under the name of 'bridging the digital divide'. This expression is also used as excuses to obscure and ignore the fact that these bridges double as toxic waste pipeline to some of the poorest communities and countries in the world. While closing the 'digital divide' we are opening a 'digital dump' and electronic manufacturers to evade their responsibilities over the ultimate fate of the products they put out in the market (Basel Action Network, 2004).

The environmental pollution resulting from inappropriate management of e-waste in the developing countries is potentially immense considering that about 40% of lead found in the soil originates from the electronic waste (Milojkovic, 2005). In addition, 70% of heavy metals found in the soil are from electronic origin (Milojkovic, 2005). Disposal of computers and its accessories in developing countries adds to the waste management problem, because these countries are not as likely to have adequate resources and waste management infrastructure to protect human health and the environment. The disposal of computers thus needs to be
managed in an environmentally sound way, to minimize releases into the environment and threats to human health (BASEL/MPPI, 2004).

The current transboundary movement of e-waste to developing countries and the subsequent inappropriate management/disposal will exacerbate the present high level of environmental pollution in these countries. But information on e-waste management in Africa needed to drive this process is scanty (Williams, 2005). Kenya has experienced a remarkable growth in the ICT sector in the last decade. A growing number of Kenyans today have access to computer facilities at home, school, business centers and internet cafes. A greater number also have access to mobile phones and this is now playing a huge role in the development of the Kenyan economy (Basiye, 2011).

The influx of cheap imported refurbished or otherwise known as second hand computers, cell phones, printers and solar panels among other electronic gadgets is slowly but surely contributing to what can be termed “a silent epidemic” that will have tremendous adverse effect on the well being of many Kenyans and environmental degradation (Mbalo, 2008).

1.2 Problem Statement and Justification

Nairobi is reputed to be the fastest growing city in the World after Guadalupe, Mexico City (Mexico) and Maputo (Mozambique) (GoK, 2003). A 2003 quarterly report by the computer society of Kenya (CSK, 2003) showed mobile phone subscription rose from a mere 5,345 in 1997 to 250 thousand in 2001, and then to about 1.2 million by the end of 2002. With over 11 million subscribers at the end of 2007 (CCK, 2007), the International Telecommunications Union (ITU) ranks Kenya as the sixth among the nations with the highest number of mobile
phones in Africa (African, 2008). A report produced in 2007 by SCI, 2007 showed that in Nairobi, there are over 850,000 owners of computers. For every two computers, one has a printer. The total amount of computers, monitors and printers, mobile phones disposed yearly as per 2007 is approximately 2,984.35 tonnes. The rate at which these mountains of obsolete electronic products are growing will reach crisis proportions unless measures are taken to manage the menace in Nairobi which is already saddled with the problem of poor solid waste management. This coupled with the fact that institutions are receiving “hand me-down” used equipment’s from rich developed countries in form of ‘donations’ and lack of policy interventions and systematic management strategies has aggravated the problem of e-waste management in Nairobi.

The situation in Kenya, is reaching crisis proportions, because in the official dumpsite (Dandora dumpsite) there is evidence of electronic waste ranging from obsolete computers to mobile phones and batteries - all containing highly toxic substances (Mbalo, 2008). This is an indication that e-waste is not considered as hazardous or special type of waste and therefore efforts for special handling of this type of waste is not yet effective. E-waste has been associated with a myriad of risks for the human and environmental well being (CTBC, 2004). The prospect of this threat is made worse when one considers that Kenya is at the verge of an IT revolution.

Therefore, this research set out to investigate and evaluate the current practices of handling electronic wastes and suggest best practices for the management of e-waste.
1.3 Research Questions

The study sought to address the following research questions

i. What is the estimated quantity of e-waste generated by the institutions?

ii. What are the methods currently in use for the management of e-waste by the selected institutions?

iii. How effective are the methods employed?

iv. What strategies should be employed to improve the management of the e-wastes in the selected institutions in Kenya?

1.4 Research Objectives

1.4.1 Main Objective

The main objective of the study was to investigate the current e-waste management practices used by specific institutions.

1.4.2 Specific Objectives

The specific objectives of the study were as follows:

i. To determine the frequency and quantity of e-waste generated by specified institutions.

ii. To establish the methods currently employed in the management and disposal of e-waste by specified institutions.

iii. To evaluate current e-waste management policies and strategies in Kenya

1.5 Research Hypotheses

The study was guided by the following null hypotheses

i. Institutions are not generating significant amount of electronic waste
ii. Institutions are using appropriate methods for handling e-waste

iii. E-waste management strategies are adequate in Kenya

1.6 Research Assumptions

In the category of end users, the number of universities sampled is directly proportional to the number of ministries sampled.

1.7 Significance of the Study

E-wastes pose a serious public health challenge in the near future since they contribute to the highest percentage of heavy metals such as lead and mercury which accumulate in the environment and have adverse human and environmental health effects.

The research work intended to assess the methods of disposal and policies for management of e-waste due to their variability and quantity of hazardous e-waste generated by different institutions and stakeholders.

It also intended to evoke a serious need for public awareness and training of all stakeholders so as to prevent increase in obsolete wastes through proper handling to reduce environmental and health risks to the society. It sought to emphasize the need for implementation of effective policies to effectively manage e-waste.

The study aimed at developing an improved information base on selected types of used and end-of-life electrical and electronic equipment and products, including generation, methods of handling and disposal. The study also aimed at providing recommendations on sound technologies or processes for repair, refurbishment, recycling and final disposal of used and end-of-life electrical and electrical equipment is established.
1.8 Scope and Limitations of the Study

i. Constraints of time and distance were some of the factors that limited the investigation. With regards to time, most respondents took time to complete the questionnaire.

ii. The study also covered specific institutions in Nairobi and not end user generators. This was based on the premise that institutions represent the heaviest end user of ICT products and consequently will generate critical mass of e-waste which requires management.

iii. The study did not focus on mobile phone end users because of methodological limitations of the study.

iv. Product scope was limited to IT equipment; specifically personal computers, laptops, flat panel monitors, printers, mobile phones and related computer and mobile phone accessories.
2.1 Introduction

Since the problem of managing e-waste surfaced only relatively recently, research on the specific topic is still in its nascence. However waste management strategies, in general, have been under constant development and many theories exist for correcting the externalities, or social costs, created by discarded materials. In this chapter, traditional and more recent waste management strategies are discussed as well as a few studies related to managing e-waste. The chapter concludes with the identification of the gaps in the research so far with respect to e-waste management.

2.2 Health and Environmental Impacts of E-waste

E-waste is unique and different from any other form of solid waste in Kenya, and has currently increased in the environment due to the uptake in information and telecommunication technology. This kind of waste is regarded as e-waste based on the characterization of the inherent constituent components including heavy metals such as lead, mercury, silver, cadmium and other Hexavalent chromium elements. Other harmful materials include plastics made of polyvinyl chromium (PVC) and Brominated Flame Retardants (BFR). The above elements, which are common in ICT products such as computers and mobile phones have both chronic and acute effects on the human system when exposed at variant levels in the human environment. A computer monitor contains 6.3% lead, which if not well contained and recovered, infiltrates the water, soil and/ or air system as a result of burning of wastes.
Table 2.1: Toxic compounds found in ICT equipment and effects on human health and environment.

<table>
<thead>
<tr>
<th>Source of e-wastes</th>
<th>Constituent</th>
<th>Health Effects</th>
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<tbody>
<tr>
<td>Solder in printed circuit boards, glass panels and gaskets in computer monitors</td>
<td>Lead (PB)</td>
<td>Damage to central and peripheral nervous systems, blood systems and kidney damage. Affects brain development of children</td>
</tr>
<tr>
<td>Chip resistors and semiconductors</td>
<td>Cadmium (CD)</td>
<td>Toxic irreversible effects on human health; Accumulates in kidney and liver; Causes neural damage; Teratogenic.</td>
</tr>
<tr>
<td>Relays and switches, printed circuit boards</td>
<td>Mercury (HG)</td>
<td>Chronic damage to the brain; Respiratory and skin disorders due to bioaccumulation in fishes.</td>
</tr>
<tr>
<td>Corrosion protection of untreated and galvanized steel plates, decorator or hardener for steel housings</td>
<td>Hexavalent chromium (Cr) VI</td>
<td>Asthmatic bronchitis.</td>
</tr>
<tr>
<td>Cabling and computer housing</td>
<td>Plastics including PVC</td>
<td>Burning produces dioxin. It causes reproductive and developmental problems; Immune system damage; Interfere with regulatory hormones</td>
</tr>
<tr>
<td>Plastic housing of electronic equipments and circuit boards.</td>
<td>Brominated flame retardants (BFR)</td>
<td>Disrupts endocrine system functions</td>
</tr>
<tr>
<td>Front panel of CRTs</td>
<td>Barium (Ba)</td>
<td>Short term exposure causes: Muscle weakness; Damage to heart, liver and spleen.</td>
</tr>
<tr>
<td>motherboard</td>
<td>Beryllium (Be)</td>
<td>Carcinogenic (lung cancer); Inhalation of fumes and dust. Causes chronic beryllium disease or berylliosis. Skin diseases such as warts.</td>
</tr>
</tbody>
</table>

(Source: Gitau, 2010)

Poor conventional methods of disposing e-waste, which are mainly Open dumping and Open burning results into oxidation of plastics made of BFR, this releases dioxins, furans and toxic Respiratory Suspended Particles (RSP) that cause risks to human health on exposure, and alters environmental systems.

Best e-waste management systems should consist of the 4R strategy, which includes; Reduce, Reuse, Recover, and Recycle. There is need for an e-waste policy regulatory environment that encourages investment right through the ICT value chain to ensure minimization of the waste and environmentally safe disposal.
2.3 Traditional Waste Management Strategies

Waste management strategies essentially try to close the gap between the socially optimal price and the market price of a good. The difference between these prices is a reflection of the existence of an externality. Among the most common economic instruments to internalize the externality, is a tax imposed on the polluter, as proposed by Pigou in 1920. ‘Command and control’ strategies are also common, when the government legislates on the standards to be met and specific technologies which could be used or not used. Mandatory information disclosure policies make use of market and non-market mechanisms by increasing the amount of environmental information available to stakeholders through product labels. Tax/subsidy measures tax goods with higher externalities while subsidizing complementary goods with fewer externalities (Gall, 1993). Tradable permits, most popular for the carbon dioxide emission trading program, are an increasingly popular instrument of waste management. Prakash and Kollman (2004), Pearce and Howarth (2000), and Porter (2002) among others explain the various policies, classifying them into various categories, examining their impacts on firms and analyzing the response to these policy measures. The volume of literature on environmental regulation in general and waste management strategies and policies in particular, has at least kept pace, if not exceeded the growth of waste generation. A concise definition of various environmentally related taxes and chargers can also be found in Annex 2 of the OECD Guidance Manual for EPR (OECD, 2001).

2.4 Recent E-Waste Management Strategies

From an e-waste management perspective, one of the most promising approaches for managing post consumer waste is the fairly recent concept of Extended Producer Responsibility’.
Some of the leading contributors in the e-waste management field are Lifset and Lindhqvist (2000), Tojo (2001), Sturges (2003) and Walls (2003), among others. Walls (2003) addresses what EPR goals should be, the conditions under which EPR and recycling would be the preferable choice and specific policy instruments to implement EPR and recycling policies. Sturges (2003) evaluates the environmental effectiveness and economic efficiency of EPR and recycling programs. He advocates a cost-benefit analysis approach to evaluating EPR and recycling performance, and develops a framework for the same. Leasing, dematerialization and servicing of products, as an EPR strategy, to increase producer involvement in the end-of-life management of their products are studied by Lifset and Lindhqvist (2000) and Thomas (2003). 'Extended Producer Responsibility: A Guidance Manual for Governments' (OECD, 2001) is an excellent resource on EPR and outlines roles, responsibilities, challenges and implementation strategies as well.

A parallel development to the emergence of EPR policies is the ‘voluntary approach’, a rapidly spreading phenomenon favored by companies to shoulder their producer responsibilities. Several authors have investigated the use of voluntary approaches for environmental improvement and compliance. They are: Lyon and Maxwell (2002); Paton (2000); Segerson and Micelli (1998); Rennings et al., (1997); Aurora and Cason (1996).

However, EPR and voluntary agreements remain controversial and policy makers are often challenged to prove that the environmental benefits goals of such programs are met.
2.5 EPR and Recycling as E-Waste Management Strategies

While there is a growing volume of work on EPR and recycling as a policy measures, the literature on its application to manage e-waste remains sparse. Naoko Tojo's thesis analyses EPR policies and legislation through a comparative study of selected EPR programs for electrical and electronic equipment (EEE), which is based on an in-depth study of the Japanese EPR regulation. It is one of the most comprehensive studies of its kind in the field of e-waste management (Tojo, 1999). Kawakami (2001) also outlines the EPR based law for recycling home appliances in Japan and presents the state of implementation and its challenges. The OECD guidance manual for governments on EPR has a tabular comparison of the characteristics of several EPR programs for EEE in Japan, The Netherlands, Sweden and the EU. A short summary of the various EPR systems for ewaste management, including the Swiss system, is given in the Microelectronics and Computer Technology Corporation's environmental roadmap for the electronics industry (Pedersen et al., 1996). However it focuses only on the recycling system for computers and does not fully explain the system in depth. Lindhqvist (2000), in his thesis on EPR, only briefly touches on the topic of using EPR to manage e-waste, focusing mainly on the Swedish system.

2.6 Studies on End-of-Life Management of E-Waste

One of the pioneering works for the estimation of the quantities of e-waste is a Carnegie Mellon study first presented in 1991, and updated in 1997 (Matthews et al., 1997). The European Environment Agency's report, prepared by Crowe et al., (2003) developed a Four-Phase Model, based on the 'unit process approach' for estimating the path from EEE (Electrical and Electronic Equipment) to WEEE (Waste Electrical and Electronic Equipment). The report attempts to quantitatively estimate the amount of WEEE that would be generated
in Europe, summarizes the dangerous substances and emissions and lists measures that need to be taken to manage WEEE.

Mclaren et al., (1999) use dynamic modeling techniques, and using data from a pilot take back study on cell phones in the UK, present the environmental implications of different take back scenarios. Jung and Bartel (1999) analyze the feasibility and economics of taking back and recycling computers, based on a pilot study in San Jose, California. Boon et al., (2002) studied the economic sensitivity for end-of-life planning and processing of personal computers, analyzing the sensitivity of recycler profits to six main variables. The study emphasizes the dependence of recycler profits on the cost of disassembly and sorting and the revenues realized from the sale of the breakage.

Rose et al., (2002) describe a structured methodology for formulating end-of-life strategies for products, using specific examples from consumer electronics. They differentiate product wear out life from technology life cycle of the product and present two software tools to understand environmental impacts of products – the End-of-Life Design Advisor (ELDA) and the End-of-Life Strategy Environmental Impact Model (ELSEIM). There are several studies on the applicability of Design for Environment (DfE) and Design for Recycling (DfR) as a strategy for end-of-life management (Rose et al., 2008, 2009).

2.7 Studies of E-Waste Management in Kenya

The e-waste problem in Kenya was brought to the spotlight in September 2006, during the eighth Conference of Parties (COP 8) to the Basel convention on Trans-boundary waste management that was held in Nairobi. Before that it was not considered urgent due to the
assumed relatively low consumption of EEE and the general trend by households to store EEE, reuse it or dump it along with the MSW. To date there has been no comprehensive study conducted on e-waste generation and management in the country.

There is a variety of EEE found in the country ranging from computers, cellular phones, televisions sets, refrigerators, and entertainment electronics amongst others. Kimutu (2008) states that the ewaste in Mombasa in relation to mobile phones is basically the battery and the accessories. On the status of e-waste in Kenya UNEP’s Executive Director Achim Steiner (2007) stated that...Right now we see the emergence of e-waste being dumped here in Kenya. He pointed out that the dumping is carried out under the guise of donations. His views have been echoed by other people. Musili (2008) the Director of Computer for Schools Kenya claimed that there were too many computers coming to Kenya and that there was no system in place to handle ewaste in the country. The unusable computers donated to Kenya are shipped back to the donor countries by NGOs, up to a quarter of the donations sent to the recipient countries are unusable and are in effect dumped in the recipient countries. 10 to 20 per cent of the computers in Kenya received from the United Kingdom and the United States are unusable (Make it Fair, 2008). Kenya just like any other developing countries has a huge market for second hand computers; due to the low prices as compared to the price of new computers (Waema, 2008).

It is estimated that in the period from 2007 to 2010 a billion computers would be recycled globally and that Africa should take advantage of half of them (Diarra, 2008). While such enthusiastic forecast seems to be addressing the problem of bridging the digital divide between the developed countries and Africa the main worry is the high influx of these
computers in countries that have neither infrastructure nor policies on the EoL management of these equipments. This raises the issue of transfer of financial guaranteed goods from an EPR jurisdiction to a non EPR jurisdiction (van Rossem, 2006). Most of the EEE goods in Europe have a financial guarantee allocated to the product in some instances an advanced disposal fee, so should the financial guarantee of these goods be transferred when the goods are transferred to developing countries for their recycling at the products end of life? The price difference between a used PC and a new PC can be 30% of the cost of the new product and the functionality of these PCs as viewed by the buyers largely depends on simple applications such as emailing and use of the Microsoft office function. The speed of the PC does not really matter if it can handle the applications desired by the users. The telecommunication sector is one of the fastest growing sectors in the country; it has witnessed continued growth due to the introduction of wireless systems for providing fixed telephones services and heavy investment in the mobile sub sector. The mobile telephony has been a preferred option over the fixed land line by majority of the people due to the ease of acquiring the mobile phone as compared to the installation of the fixed landline and the widespread coverage including the rural and remote areas and the better services provided.

There are many other services provided by the mobile service providers that have attracted the large numbers in subscription, which include the ‘M-Pesa’ money transfer services and the credit transfer services. The number of mobile subscribers grew from 6.4 million in 2005/06 to 9.3 million in 2006/07; this represents a 43% increase in the subscriber base (CCK, 2007). This growth has in effect increased tele-accessibility in the country by about 28% (CCK, 2007). The growth in the mobile subsector in effect means that there has been an increase in the number of mobile phones purchased. The mobile market segment had an annual turnover
of KSh 58 billion (60 million Euros) in the period 2006/07, against the previous year’s KSh 45 billion (47 million Euros) (CCK, 2007). There has been an influx of second hand computers, mobile phones and accessories from Europe and Asia. The development in the ICT sector at large depends on second hand/reconditioned EEE that is imported into the country.

There is no data or statistics on the availability of various EEE in the country. The data available for computers is contradictory with one source estimating that in the year 2004 only 17% of Kenyans owned a Personal computer (Omosa and McCormick, 2004), while the other states that in 2005, 32% of Kenyans owned a computer (Intermedia, 2004). The other studies like Waema (2008) indicate that approximately 1 million people own a Personal computer in Kenya out of the total population of 33 million. The discrepancies in the numbers can be attributed to the fact that no study has been conducted to validate the computer ownership in the country. It has been difficult to own a Computer due to the high cost, but the repair of old computers and importation of second hand computers has made it easier. Currently on the market there is an influx of cheaper computers from Asia both second hand and new sets. Now more and more people can afford to purchase these products, and the contentious issue is the end of life disposal of these EEE as they have a short life span, especially the second hand personal computers.

The amount of pollutants in the computers is much higher than in other EEE such as the washing machines and refrigerators. Computers contain hazardous and toxic components such as lead and mercury (Barba- Gutierrez et al., 2007).
In general little has been done in management of e-waste in Kenya however; there have been various initiatives of e-waste management in Kenya after the eighth COP to the Basel convention. The Forum for the Future and the Practical Action Aid in collaboration with Vodafone conducted an e-waste pilot project primarily focusing on mobile phone waste with the aim of determining the volume of the waste and the possible collection methods. Nokia in the last two years has been setting up a take-back scheme for the EoL mobile phones. Several NGOs have developed project proposals on e-waste management with special focus on ICT equipment. Currently Computer for Schools Kenya (CFSK) program has a functioning computer repair and refurbishing centre and intends to expand the program into a fully fledged e-waste management centre.

2.8 Institutional mechanisms/Regulators

![Categories of Stakeholders](image)

**Figure 2.1 – Categories of Stakeholders**
The ICT sector just like the other sectors is regulated by different state agencies charged with different responsibilities. The actors listed here should not be viewed as an extensive all inclusive listing of the actors. Figure 2.1 indicates the categories of stakeholders in the ICT sector and Figure 2.2 depicts the main regulator agencies in the ICT sector in Kenya.

Figure 2.2 Main regulators of various components in the ICT sector

The regulator main roles in relation to e-products and e-waste entails:

i. Pre-export verification of products as conducted by the Kenya Bureau of Standards (KEBS)

ii. Import verification at the point of entry conducted by Kenya Revenue Authority (KRA), Kenya Ports Authority (KPA), and KEBS

iii. Type approval of telecommunication EEE is conducted by Communication Commission of Kenya in consultation with KEBS

iv. Development of e-product standards is conducted by KEBS in consultation with the relevant government agencies
v. Development of e-waste regulations and management of e-waste falls under the docket of the National Environment Management Authority (NEMA) in consultation with the other relevant agencies and stakeholders

vi. The approval of environmental impact assessments (EIA) in line with the telecommunication transmission stations is the prerogative of the NEMA in conjunction with the relevant line ministries

vii. Waste management i.e. collection, transportation and disposal falls under the Local Authority’s docket

2.8 Research Gap

As seen in the literature, most studies focus on e-waste as a problem in developed countries. However, in today’s global markets, the same electronic and electrical products penetrate markets worldwide, in developing and developed countries alike. Thus, in developing countries, like Kenya, essentially the same goods come into the e-waste stream as in developed countries like Switzerland. By focusing on e-waste as a ‘developed’ world occurrence, the problems it causes, which are often more acute in the developing world are ignored. While NGOs such as the Basel Action Network (Puckett and Smith, 2002) and Toxics Link (Agarwal et al., 2003) have presented ground breaking investigation reports on the problems developing countries face due to e-waste, so far there has been no serious scientific effort to document and analyze the problem and possible solutions for developing countries.

Neither has there been any effort to transfer the learning’s from implementing e-waste management systems in developed countries to developing countries. This is particularly
acute because there are few in-depth case studies outlining the evolution of an e-waste system, the issues discussed, the problems faced during implementation and how they were overcome. The thesis attempts to bridge a part of the research gap by analyzing e-waste management strategies in Nairobi, understanding the methods used by selected institutions in Nairobi as compared to other countries and what we can learn from each. The study has helped in identification of the different problems and challenges of managing electronic waste in Nairobi, and the issues that need to be considered for possible policy interventions. Finally, implications and recommendations based on the lessons learnt are discussed.
CHAPTER 3
METHODOLOGY

3.1 Introduction
This chapter gives a description of the approach that was used in carrying out the study. It covers: description of the study area, research design, population and sample size, sampling procedure, and data analysis technique.

3.2 Study Area and Location
The study was conducted in Nairobi which is the capital and largest city of Kenya. It is located on coordinates: 1° 18'13.96" S and 36° 48' 46.79" E as indicated on Figure 3.1. It is also the most populous city in East Africa, with an estimated urban population of about 5 million inhabitants lived within 684 km² (GoK, 2009). It is also the central hub for commercial activities and transit goods. Nairobi is also the heaviest consumer of Information and Communications Technology (ICT) products. This is because of the many commercial activities and institutions that are located in Nairobi and use many ICT accessories. The selected institutions represent the major end users of ICT equipments and potential major e-waste generators. The specific institutions included both public and private companies.
3.3 Sample Collection

The research involved collection of both quantitative and qualitative data so as to establish the flow of e-waste and subsequent disposal. This involved the use of semi-structured questionnaires and open-ended interview guides with flexible probing, ideal for such studies. Observation was employed during site visits.

Secondary data was collected through institutional documents and relevant national policy and regulation documents such as Local Government Act (Cap 265), Environmental

3.4 Study Sampling Design

This study was a cross-sectional study collecting both quantitative and qualitative data so as to establish the flow of e-waste and subsequent disposal. The initial pilot study survey showed that e-waste generation in Nairobi included stakeholders ranging from importers, assemblers, end users, recyclers, designated final waste disposer and policy makers. A research methodology framework customized from a generic framework adopted from Swedish Federal Laboratory for Materials Testing and Research (Empa), which involves description of various stakeholders, the indicators for which data needed to be collected and the possible sources of data was used (figure 3.1) (Widmer, 2005; SCI, 2007).
<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Description</th>
<th>Qualitative issues or indicators</th>
<th>Quantitative indicators</th>
<th>Sources of data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Importers</td>
<td>Organizations importing technology electronic and electrical goods</td>
<td>Modes of consumption, Modes of disposal, Adoption to new technology, Awareness of social and environmental issues</td>
<td>Annual imports of new equipment, Annual imports of second-hand equipment, %import vs % domestic</td>
<td>Major importers, Assemblers, Distributors</td>
</tr>
<tr>
<td>End users</td>
<td>End users of technology that discard them as waste when at the end of useful life</td>
<td>Consumer pays or is paid for e-waste, Any take back scheme, Municipal collectors of waste generally, Sector organization (formal/informal), E-waste recycling industry, Which fractions produced, Disposal of non-valuable fractions, Degree of formality (registration, pays taxes, etc.)</td>
<td>PCs per 100 inhabitants, E-waste in tons generated annually, Life span</td>
<td>Research institutions such as KU, Strathmore that have implemented e-learning.</td>
</tr>
<tr>
<td>Recyclers</td>
<td>Organizations that collect, dismantle, separating fractions, and recover and repair material from e-waste</td>
<td>How is e-waste treated? Formal or informal (dump sites, open burning, etc), Agencies in charge of solid waste disposal infrastructures for handling hazardous waste</td>
<td>E-waste collected per inhabitant, Persons employed per ton collected, No. of employees on e-waste collection, No. of fractions produced, No. of fractions disposed of, By-products per ton of e-waste, Yearly tons handled by recyclers, % of repairable e-waste, Lifespan of refurbished equipment, Average age of equipments to repair</td>
<td>Formal collectors and recyclers e.g CFSK, Kimathi Resource Centre, Nokia, Safaricom</td>
</tr>
<tr>
<td>Designated final disposers</td>
<td>Organizations in charge of final disposal of waste through incineration or landfilling</td>
<td>Yearly tons handled by disposers, % of e-waste in municipal solid waste</td>
<td>Yearly tons handled by disposers, % of e-waste in municipal solid waste</td>
<td>Formal disposing companies, Informal (e.g. dumping sites, open burning, etc), Government, Secondary sources</td>
</tr>
<tr>
<td>National institutions and regulators</td>
<td>Institutions with capacity to support implementation of an e-waste management system</td>
<td>Organizations active in solid waste management, Organizations working with informal sectors, International funding for e-waste</td>
<td></td>
<td>NGOs, International bodies, NEMA, CCK, Ministry of Environment and ICT</td>
</tr>
</tbody>
</table>
3.5 Study population

The study population included: ICT managers, procurement officers and head of relevant departments for various institutions and ministries. They mainly acted as key informants to help provide insight on acquisition, use and disposal methods of computers and its electronics. Key policy makers in National institutions and regulators were also consulted to provide information on status of electronic waste management strategies in Nairobi.

3.6 Sampling Unit

The study involved a multi-stage sampling design. The study participants were selected using stratified random sampling. The goal of stratified random sampling was to achieve desired representation from various subgroups in the population (Mugenda and Mugenda, 2003). Nairobi city formed the strata for sampling stakeholders who included importers/assembly companies, recycling companies, ministries and universities that are medium to large scale generators of electronic waste. An income tax payers list from Kenya Revenue Authority was used as a sampling frame from which importers and assemblers of computers and its accessories were selected for the study. Using stratified sampling, only those companies that imported and assemble over 3,000 computers and 10,000 mobile phones formed part of the sampling frame. The total number of companies identified was 100 computer companies and 40 mobile phone companies. A traders list from Ministry of Trade was used as a sampling frame from which companies that recycle over 500 computers and 1,000 mobile phones per month were identified. According to the list, there were only four companies. Using the National Directory, a sampling frame of all ministries and universities located in Nairobi were identified. They included 44 ministries and 7
From each stratum, critical mass (30% of the target population) was used to determine the minimum number of institutions to be sampled as shown in table 3.2.

Table 3.2: Sampling frame and size that was used for institutions that deal with computers and mobile phones:

<table>
<thead>
<tr>
<th>Category</th>
<th>Total number of institutions identified</th>
<th>Target sample(identified using the critical mass)</th>
<th>Total number of institutions interviewed</th>
<th>Total number of respondents interviewed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Importers/Assembly companies</td>
<td>100</td>
<td>30</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Recycling companies</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Ministries</td>
<td>44</td>
<td>13</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Universities</td>
<td>7</td>
<td>2</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Sub Total</td>
<td>153</td>
<td>46</td>
<td>69</td>
<td>69</td>
</tr>
<tr>
<td>Mobile phones</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Importers/Assembly companies</td>
<td>40</td>
<td>12</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Recycling companies</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Sub Total</td>
<td>42</td>
<td>13</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>195</td>
<td>49</td>
<td>89</td>
<td>89</td>
</tr>
</tbody>
</table>

Key informants who were the main representatives of the sampled institutions were interviewed to provide crucial information on e-waste management strategies adopted in Kenya and more specifically Nairobi. A total number of 89 questionnaires were administered to institutions sampled as indicated on Table 3.2.
3.7 Inclusion Criteria

The inclusion criterion was medium to large scale stakeholders in the ICT sector. They include the following:

i. Companies that import and assemble over 3,000 computers per month and 10,000 mobile phones per month.

ii. Companies that recycle over 500 computers per month and 1,000 mobile phones per month.

iii. Companies that have a user base of 500 computers and over.

iv. Key Informants in CCK, NEMA, Ministry of Environment and Information on policy issues.

3.8 Data Analysis and Presentation

Analysis of data focused on generating-waste flow stream, quantifying the amount of e-waste generated and evaluating national and institution policies on e-waste management. The statistical package for social sciences (SPSS) was used for quantitative data analysis. Descriptive statistics was used to summarize the collected data. Mean and mode as measures of central tendency were used to summarize the waste stream flow of various stakeholders. Further analysis of sample characteristics was done using frequencies and percentages. Presentation of data was done in tables, graphs, histograms, bar charts and pie charts. T-test has been used to test for significance level at 0.05.

A conversion rate of 29.26 Kgs and 0.1Kgs was used to calculate the tonnage of computers and mobile phones respectively. The conversion was as follows:
Weight of mobile phones = \( \frac{\text{No of units of mobile phones} \times 0.1 \text{Kg}}{1000} \)

Weight of computers = \( \frac{\text{No of units of computers} \times 29.26 \text{Kg}}{1000} \)

Extended Producer Responsibility (EPR) was one of the e-waste management strategies that were analyzed. EPR analysis was done using Sinha (2004) Methodology. The methodology involved comparative analysis of five major comparison indicators – Actor Involvement, Material flows and controls, externalities, Financial Metrics and Market Metrics comprising of 19 sub-indicators. The indicators were chosen on their ability to illustrate the most important characteristics of an e-waste management system. The indicators were scored using a 3 point scale on a subjective basis, and are relative in value (1 = Low, 2 = Medium, 3 = High). ‘High’, ‘Medium’ and ‘Low’ values are not absolute. The comparison indicators are explained in detail in Appendix 5.6, including what they attempt to indicate and why they were chosen.

3.9 Qualitative Analysis

Common themes were obtained from the data collected and clustered in a patterned order so as to identify variables that depict general concepts and isolate repetitions. Inferences were made from particular data under each theme and conclusions drawn from findings (Borg and Gall, 1993).
CHAPTER 4
RESULTS AND DISCUSSION

4.1 Introduction

Four categories of respondents were interviewed. They included importers/suppliers/assemblers/distributors, consumers, and e-waste recyclers. These respondents came from various institutions. These included: Government, Private companies, Non-governmental organizations and international companies. They all dealt with various types of computer and mobile phones and related accessories.

4.2 Quantity of E-Waste Generated by Institutions

4.2.1 Importers

The study shows that over the years, advancement in technology and reduction in taxes on ICT equipment has led to increased importation of computers and cell phones in the country. Waema (2008) has also confirmed this position in a study carried out in 2004 whereby a total of 5760 tons of electronic equipment was imported in 2004 and since then there has been an upward trend of importation of electronic equipment.

The study revealed that there is a general increase in the weight of computers and mobile phones imported into the country. See figure 4.1 (a) and (b) below. The highest tonnage of mobile phones imported into the country was experienced in 2008. See Figure 4.1 (a). This could be attributed to the reduction in taxes on imported cell phones and computers from 5% in 2000 to zero rated computers and cell phones in 2008 (National Export Strategy, 2003; Jevans, 2010). This led to reduction in prices of handsets thus making them affordable. Figure 4.1(a) also shows that 2009 had the highest tonnage of ICT equipment that was
undistributed. This could be attributed to technological advancement increasing at a decreasing rate. That is there was a decline in technology advancement as compared to previous years as market entry of new models had reduced and demand for old models reduced leading to the increase in tonnage of mobile phones that was undistributed. Secondly, most end users possess handsets thus demand has declined resulting in increase of mobile phones in the custody of importers. Similar study carried out by Waema (2008) indicated that in 2007, approximately 10,000 tons of mobile phones remained undistributed. The study revealed that this value had increased to 72,030 by 2009. This implies that over the years, the tonnage of mobile phones that remains in the possession of importers is increasing and this is potential e-waste.

Analysis of the results further established that the total tonnage of mobile phones that was undistributed is statistically significant at 95% confidence level (t=6.52, df = 2; p= 0.00456). The implication is that importers have in their custody potential e-waste that poses a threat to the environment.
Figure 4.1(a): Total tons of mobile phones imported, distributed and undistributed from 2006 to 2009

Figure 4.1(b): Total tons of computers imported, distributed and undistributed from 2006 to 2009

Figure 4.1 (b) shows 2009 as the year that experienced highest distribution of computers.

This could be attributed to the reduction in taxes on imported cell phones and computers from 5% in 2000 to zero rated computers and cell phones in 2008 (National Export Strategy, 31)
2003; Jevans, 2010). This led to reduction in prices of computers thus making them affordable. In addition, advancement in technology has led to introduction of more sophisticated computer models which are small in size. Therefore, demand for ICT equipment has increased leading to rise in distribution.

From the study, 2007 had the highest tonnage of undistributed computers. This could be attributed to the political turmoil that engulfed the country during the early period of 2007. As a result, there could have been a drop in the demand for ICT equipment thus supply was affected, consequently resulting in rise in stock of computers held by importers.

Analysis of the results further showed that the differences in the tonnage of computers distributed and that which remained in the custody of suppliers was statistically significant (t =-0.63294, df=2; p=0.0322). Pearson correlation results showed that there is significant negative correlation between the tonnage of computers that is distributed and undistributed (r=0.97, p<= 0.05). Decrease in tonnage of computers distributed leads to an increase in tonnage of undistributed computers. The implication of this is rise in tonnage of undistributed computers poses a serious threat to the environment.

Similar studies in other developing countries such as Nigeria showed that the tonnage established in this study is lower than what was established for instance in Nigeria (Osibanjo, 2007). This implies that e-waste is a world wide problem.
4.2.2 End Users

End users interviewed included ministries and universities. The end users purchase either new or second hand equipment and utilize the equipment up to the end of life or discard the equipment before it becomes obsolete.

The study established that there is a general increase in the tonnage of new and second hand equipment purchased by ministries and universities within the four years. Expansion of universities, recruitment of staff and rise in number of student admissions are factors that led to the increase in purchase of ICT equipment by universities while for the ministries, attempt to try to keep abreast with new technology contributed to the general increase as shown in Figure 4.2 (a) and (b).

![Graph showing total tons of new and second hand computers purchased and disposed off by universities from 2006 - 2009](image)

Figure 4.2(a): Total tons of new and second hand computers purchased and disposed off by universities from 2006 – 2009
The highest purchase of new and second hand equipment was in 2009 for both ministries and universities. This could be attributed to zero rating on taxation of imported new ICT equipment by the government. This led to reduction in prices of equipment making them affordable. In addition, rapid expansion of universities and creation of new ministries are some of the factors that could have contributed to the rise. Further analysis of the results showed that the differences in the tonnage of new equipment purchased by both categories of institutions was statistically significant as compared to second hand equipment at \((t=6.89, df=2; p<0.02)\) for universities and \((t=7.23, df=2; p=0.02)\) for ministries. The implication of this is that new equipments have a functional lifespan of approximately two to five years maximum therefore, reducing the tonnage of e-waste generated by these institutions.
However, from figure 4.2 (a) and (b) the amount of second hand equipments found in the possession of universities is considerably high as compared to that of ministries. This could be as a result of universities receiving donations from foreign companies, government institutions and non-governmental organizations. The implication is that they have a short life and will soon be finding their way into the waste stream.

The study established that there is a general increase in the tonnage of e-waste generated by the institutions. See figure 4.2 (a) and (b). This could be as a result of increase in tonnage second hand equipment which has a short life span. There is a significant positive correlation between the tonnage of ICT equipment purchased and e-waste generate \( r = 0.9998, p <= 0.05 \). This is an indication that as institutions continues purchasing more equipment more e-waste is likely to be generated, posing a serious environmental threat. Further analysis of the results showed that the differences in tonnage of e-waste discarded to that which was purchased by ministries and universities is statistically insignificant at 95% confidence level \( t = 8.4, df = 2; p>3.18 \) for universities and \( t = 7.97, df = 2; p>3.18 \) for ministries. This implies that the amount of e-waste generated by consumers is low.

This could be attributed to the average life span of the equipment and period the consumers possess the equipment before discarding. Key informants interviewed indicated that the average life span of the equipment ranged from 3-5 years. This implies that in approximately four years, the ICT equipment will have reached end of life. Therefore, this reduces accumulation of potential e-waste by consumers as the duration of use of equipment is lengthened.
The tonnage of equipment discarded by universities is lower compared to what is discarded by ministries. A majority of key respondents in the category of ministries indicated that they possess computers for a period of 1 month to 1 year while in the category of universities, 27.27% of the respondents indicated that they possess the equipment for 1 month to 1 year and 27.27% indicated that they possess the equipments for more than 5 years. Therefore the period of possession of equipment by the ministries is lower than universities and this has contributed to the high amount of e-waste discarded by ministries being higher than the one of universities and large volumes of obsolete equipment will enter the waste stream in coming years.

The results are similar to findings in other developing countries. In Morocco, in the year 2006, two thirds of home computers and one third of company computers disposed off were less than a year old (HP, 2009). In India, the low income households use the PC for 5.94 years and mobile phones for 2.34 years while, the upper income class uses the PC for 3.21 years and mobile phones for 1.63 year (Kurian, 2007).

4.2.3 Recyclers
The study established that e-waste recycling has been a growing business enterprise in Kenya. In Nairobi for example, the study identified four e-waste recycling enterprises. These included: Computer for Schools (CFSK), Safaricom and NOKIA.

The average e-waste collected for recycling by the four enterprises has been increasing overtime. See Figure 4.3 below.
Analysis of the results showed that the rate of e-waste collection has been on the rise at a rate of approximately 17% per year from 2006 which was the baseline year. See Table 4.1 below. The increase could be attributed to increase in the number of collection points by recycling companies.

Table 4.1: Rate of e-waste collection per year

<table>
<thead>
<tr>
<th>Year</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>e-waste collected (in tons)</td>
<td>1882</td>
<td>2012</td>
<td>2253</td>
<td>2675</td>
</tr>
<tr>
<td>percentage change</td>
<td>0%</td>
<td>7%</td>
<td>20%</td>
<td>42%</td>
</tr>
</tbody>
</table>

Some of the materials that are collected are recycled and the irreparable parts are disposed off. From Figure 4.3 the amount of e-waste that is recycled has been on the rise from 116.1...
tons in 2006 to 199.3 tons in 2009. This increase could be attributed to the expansion of the market for recycling (HP, 2009). Section 4.2 discusses methods used to dispose off e-waste.

From the study, the amount of e-waste that is to be disposed off by recyclers has been on the increase over the four years (Figure 4.3). The highest tonnage of e-waste disposed off was in 2009. This could be attributed to lack of adequate infrastructure and high cost of recycling as established in the study. Section 4.3 discusses the challenges facing e-waste recycling as an e-waste management strategy. Analysis show that the tonnage of e-waste disposed off is statistically significant at \( t = -13.82, \text{df} = 2; p = 0.00089 \). There was also a significant positive relationship between amount of e-waste collected and amount disposed \( (r = 0.9995, \text{at } p \leq 0.05) \).

### 4.3 Methods Used by the Institutions in the Management of E-Waste

The study established that there are several methods employed by stakeholders to dispose off e-waste. The study categorized the stakeholders into 3 groups: importers/distributors, consumers and recyclers.

#### 4.3.1 Importers

Key informant interviews during the study showed that various mechanisms have been employed by importers in managing electronic waste. The mechanisms commonly used by importers are the extended producer responsibility which entails use of take back to supplier, establishment of collection points and processing. The other mechanism used, was selling the undistributed electrical and electronic equipment at a discounted price in order to clear their stock.
The study also established that few companies sampled had a policy on extended producer responsibility. This means that the e-waste management strategies employed by importers are still inadequate.

The research study identified that 2 out of 18 (11%) cell phones companies and 1 out 40 (2.5%) computer companies employed extended producer responsibility. These companies have introduced few collection points to gather e-waste from consumers. During take back, 50% of the e-waste is brought back to their shops while 50% is taken to their collection points distributed in the country. One of the companies takes back the e-waste collected to the mother country while two of the companies recycle e-waste collected and the irreparable material is shipped back to the mother country. This was also confirmed by a previous study conducted by Basiye (2010).

The other importers, 60% sold the equipment at a discounted price, 17.1% sold the equipment as junk to scrap dealers, 15% donated them to schools and 6.9% disposed of their electronic waste. The implication of these methods used is that e-waste generation is likely to increase downstream as a result of channeling e-waste to end users and recyclers. Therefore, extended producer responsibility is the more appropriate method to be employed by institutions to avoid initial e-waste into country.

4.3.2 End Users

The field study established that the average new desktop PC has a functional lifespan of roughly two to five years maximum. The length of the lifespan greatly depends upon the type of system purchased, advances in hardware components and changes in the software
that are run. Second hand computers have an average life span of 1 month to 2 years. Once computer reaches end of life, various methods of disposal are used. They include: take back schemes, donation to schools, selling to relatives, storing the e-waste in their offices and auctioning.

The study established there was high level of awareness on where to get information on disposal of the e-waste by institutions. These were mainly: asset disposal policies, company guidelines and procedures, Government regulations (for example Government Disposal Act which specifies how to dispose of waste), and internal procedures stipulated by management.

Although there was high level of awareness on sources of information on e-waste management, 41.67% of universities and 80.77% of ministries sampled did not have an e-waste management policy in place (Figure 4.4 (a) and (b) ). The implication of this is that management of e-waste by these institutions is still a potential problem.
Analysis of the results further showed the method of disposal mostly employed by end users is auctioning (table 4.2).

**Table 4.2: Methods of e-waste disposal used by institutions**

<table>
<thead>
<tr>
<th>Institution</th>
<th>Disposal Method</th>
<th>Ranking of methods employed by institutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ministry</td>
<td>Take back scheme</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Donation</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Auctioning</td>
<td>1</td>
</tr>
<tr>
<td>University</td>
<td>Take back scheme</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Donation</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Auction</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Sell equipment to scrap dealers</td>
<td>4</td>
</tr>
</tbody>
</table>

Government ministries and universities have to bond the computer and invite competitive tenders for disposal as scrap in line with procurement procedures. This is a slow and cumbersome process. This suggests that excessive stock is held by the consumer and structures that are not developed enough to handle e-waste disposal and therefore cause a ‘drag’ on waste volumes. Therefore, obsolete computers are still in government and varsity stores waiting auctioning (for example figure 4.5 below).
The results are similar to a study carried by BAN. It was established that about 75 percent of old electronics are in storage (BAN, 2007). Consumers store them, feeling they have some value but uncertain about how to dispose them. In Morocco, for example, nearly a third of the households stored unwanted computers at home (HP, 2009). In India, only a fraction of the e-waste (estimated 10%) finds its way to recyclers due to absence of an efficient take back scheme for consumers (Radha, 2002).

The study further established that approximately 2% of the e-waste generated by both institutions is disposed together with general waste and ends up in the open dump. Although the percentage is negligible, this is a time bomb if measures are not put in place to regulate disposal of e-waste together with general waste.
From the study, 54.55% of equipment discarded by universities was in broken unfixable condition and 45.45% in working condition while for Ministries 94.73% of the equipment discarded was broken equipment and 5.26% was in working condition (table 4.3).

Table 4.3: Condition of equipment when discarded

<table>
<thead>
<tr>
<th>Institution</th>
<th>Condition of equipment when discarded</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>University</td>
<td>Broken equipment</td>
<td>54.55</td>
</tr>
<tr>
<td></td>
<td>Working condition</td>
<td>45.45</td>
</tr>
<tr>
<td>Ministry</td>
<td>Broken equipment</td>
<td>94.73</td>
</tr>
<tr>
<td></td>
<td>Working condition</td>
<td>5.27</td>
</tr>
</tbody>
</table>

This implies that approximately 62% of the equipment auctioned, donated or sold to second hand market is in a broken and unfixable condition, and can be considered e-waste (although some parts of this equipment may be salvaged). Thus there is potential of e-waste accumulation downstream. This poses a major environment threat.

Similar studies in other developing countries such as Morocco show that half the equipment discarded by households and institutions is in working order, and a quarter is irreparable. This scenario is contrary to the one in Kenya where only 25% of the disposed material is in working condition (HP, 2009). The reason for the variance between Kenya and Morocco is that in Morocco most IT equipment purchased is new and most of the equipment discarded is less than a year old, therefore it is still in good working condition. However, in Kenya half the equipment imported and sold to consumers is second hand. Therefore, these institutions
should emulate the good e-waste management strategies employed by a country like Morocco.

The study identified that 63.64% of universities and 83.64% of ministries kept an inventory of the e-waste discarded. This is as illustrated on figure 4.6 (a) and (b). This implies that most institutions keep track of the equipment they are disposing. Therefore, they are able to monitor the amount of e-waste they are generating per year and identify appropriate methods to manage the e-waste. They are also able to identify which models have a shorter life span thus making an informed decision when purchasing equipment.

The study also established that 50% of the universities indicated that they were aware of some companies that collect discarded e-waste for recycling while for the ministries only 39.13% were aware. This has largely influenced the methodology used for e-waste management employed by the institutions. For instance, 34.62% universities employ take-back schemes as compared to the ministries which is 25%.
Analysis of the results further established that 11.20% of the respondents sold their equipment between 10-20% of the equipment’s original purchase price, while 77.78% indicated that they sold at less than 10% equipment’s original price as indicated in Table 4.4 below and Appendix 5.8.

Table 4.4: Market value of end-of-life equipment in relation to its original purchase price

<table>
<thead>
<tr>
<th>Selling price of the equipment</th>
<th>Percentage of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10% of the original buying price</td>
<td>77.80%</td>
</tr>
<tr>
<td>10-20% of the original buying price</td>
<td>11.10%</td>
</tr>
<tr>
<td>&gt;20%</td>
<td>11.10%</td>
</tr>
</tbody>
</table>

Low price incentives offered by dealers of used ICT equipment has largely contributed to many institutions opting to store them in their premises as established in the study. This leads to accumulation of potential e-waste by these institutions.

Majority of key informants interviewed, indicated that they were not ready to pay for discarded equipment to be collected and recycled. The unwillingness of the consumers to pay for collection and recycling has further promoted the consumers to store e-waste in their facilities thus causing a ‘drag’ in waste volumes. Similar studies carried out for example in India, show that the willingness of the public to pay for e-waste management ranges from 3.57 to 5.92% of the product cost for PC and 3.4 to 5% for the mobile phones (Kurian, 2007).

The results also showed that 18.2 % of the respondents were aware of what happens to the equipment once disposed off using the methods discussed in table 4.2 while 81.8% had no idea. The implication of this is that low level of awareness has contributed to consumers
employing inappropriate methods in e-waste management which pose a threat to the environment.

4.3.3 Recyclers

From the study it was established that recycling has been a growing business area in Kenya although majority of recyclers are not specific on brands they recycle.

Seventy five percent of the institutions employ take back schemes to collect their e-waste. Once collected, the e-waste goes through the process of recycling. This involves: dismantling, segregation, cable stripping, shredding, precious metal recovery and separating fractions. 100% of the institutions dealt with dismantling and cable stripping, 67% segregated and recovered precious metals while 33% of the respondents shredded the electronic waste. Therefore, the most commonly employed method by institutions is dismantling and cable stripping which is done manually and thus exposes workers to health risks.

Key informants in the study revealed that recycling companies did not have the capacities to extract all of the value from e-waste. These industries have the capacity to recover plastics, ferrous metals and aluminum, and sell the same to various users, including the informal market. The materials that cannot be recycled are disposed off. Seventy five percent (75%) of companies sampled shipped back the non-recyclable materials to mother country. The remaining institutions, store fifty per cent of the e-waste, 35% is disposed off with rubbish and 10% burn the waste. Therefore, management of e-waste is still a problem to recyclers. Lack of proper e-waste management strategies is a potential environmental threat.
The study also showed considerable gains are made from recycling e-waste. 66.7% of the institutions indicated that they earned approximately Kshs.1 million per month. This shows that there are considerable gains in terms of revenue being generated by the refurbished/recycled equipments. Therefore recycling of e-waste is a good business venture.

Figure 4.7: Percentage of institutions that earn over Kshs. 200,000 from recycling e-waste

4.4.1 Policy, Regulations and Legislative Considerations

From the study, Kenya has no specific policy on e-waste in place. However, there is recognition of international conventions regulating hazardous waste, among them the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, and the Bamako Convention, which aim at introducing preventive measures and guaranteeing appropriate disposal of hazardous waste in Africa. The Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their Disposal was adopted in 1989 and came into force on 5th May 1992. One hundred and sixty two (162) countries party to the Convention commit to reduce the generation of hazardous waste to a minimum and ensure that it is managed in a manner that will protect human health and the environment from its adverse impacts and reduce the transboundary movement of such wastes, making their illegal traffic a criminal offence.

List A of Annex VIII (A1180) characterizes ‘waste electrical and electronic assemblies or scrap containing components such as accumulators and other batteries, mercury switches, glass from cathode-ray tubes, PCB-capacitors, or contaminated with constituents (for example polychlorinated biphenyl, compounds of cadmium, mercury, lead, beryllium, hexavalent chromium, arsenic) as hazardous substances and therefore under the jurisdiction of the Basel Convention. However, the convention does not cover discarded electronic equipment, in working condition, which might be sent to other countries as second hand products.
Annex IX (B1110) even includes ‘electrical and electronic assemblies (including printed circuit boards, electronic components and wires) destined for direct reuse, and not for recycling or final disposal’ in the decontrolled list, if they do not contain the hazardous substances listed in Annex I or certain hazardous characteristics, such as inflammability or toxicity. For most practical purposes, any kind of WEEE would fall under the Basel Convention, given the hundred of parts and materials that most electronics are made of. An Amendment to the Convention, commonly known as the Basel Ban, calls for prohibiting the export of hazardous waste, which includes e-waste, from OECD countries to non-OECD countries, for any purpose. However, the Ban Amendment is still to come into force, as it has not been ratified by a majority of the signatories to the Convention. However, there are several grey areas in the convention which are open to interpretation, making the implementation less effective than expected.

The Bamako Convention aims to criminalize the import of hazardous waste into Africa from outside the region and from non-contracting parties and also prohibits dumping hazardous waste at sea as well as incinerating it. However, its implementation is still a challenge as Kenya continues to receive second hand ICT equipment which contains hazardous components from developed countries in form of donations.

The study also established there are provisions found in other laws governing the environment, air, water, public health, waste and hazardous substances. Before enactment of Environmental Management and Coordination Act (1999), local authorities (LAs) had monopoly control over sanitation and solid waste management services in Kenya, largely under the Local Government Act (CAP 265) and Public Health Act (CAP 242). The former
empowers LAs to establish and maintain Municipal Solid Waste (MSW) management services while the latter requires them to provide the services. The Acts, however, neither set standards for the service nor require waste reduction or recycling. In addition, the Acts do not classify waste into municipal, industrial and hazardous types or allocate responsibility over each type. The main shortcoming with these statutes is the fact that they are silent on sound environmental management of waste especially e-waste.

Environmental Management and Coordination Act (EMCA) 1999 addresses waste management in Kenya. Specific provisions in the Act outline how one should handle e-waste. “...No person shall discharge or dispose of any wastes in a manner that would cause pollution, to the environment or ill health to any person; no person shall transport wastes except to a licensed wastes disposal site established and in accordance with a valid license issued under the Act” (EMCA, 1999).

EMCA (1999) also has a general definition of hazardous waste in the Fifth Schedule which describes e-wastes as having five distinct characteristics which are explosivity, flammability, oxidizivity, toxicity and corrositivity. The waste contains compounds of metals classified as hazardous wastes by virtue of its constituents. Section 5 of the Waste Management Guidelines requires the waste generator to minimize waste and eliminate waste altogether as well as identifying and eliminating potential negative impacts of the product, enabling the recovery and reuse of the product, reclamation and recycling and incorporating environmental concerns in the design and disposal of a product. Sections 17-23 require the generators of hazardous waste to conduct an EIA and labeled clearly the “hazardous waste”. 

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The Dignated National Authority, uses Basel Convention guidelines, and NEMA over sees the entire transport of such materials.

This Act mandated the National Environmental Management Authority (NEMA) to develop regulation on waste management including hazardous waste management. In line with the mandate NEMA developed waste management regulation in 2006. Part IV of this regulation deals with hazardous waste in totality that is the hazardous waste specifications, requirement for Environmental Impact Assessment (EIA), handling, storing and transporting, export permit and its validity, transit of hazardous waste and insurance amongst other issues. The waste management regulation 2006 is not explicit on addressing e-waste; the components of e-waste are covered under various facets of the regulation such as hazardous waste management and chemical waste management. The lack of explicit and detailed mention on e-waste has created loopholes in the regulation as the e-waste handlers and actors do not comply with the regulation’s requirements on waste handling as they state that the regulation does not cover e-waste. In addition an average Kenyan reading the regulation would not link hazardous waste to EEE and especially to the ICT goods.

From the study, it was established that the main issues with e-waste management in Kenya are: low level of awareness, the amount of secondary e-waste imported into the country and lack of waste segregation. The main challenge facing mobile phone e-waste management is disposal of batteries. The second hand and refurbished phones often have batteries with a shortly life span. These batteries are dumped alongside other MSW due to lack of awareness on the contents and the danger they pose to the environment. Therefore, there is
need for well organized collection points with protection against theft and existing take back schemes could be used by NEMA field offices as collection points

ICT issues are regulated under various statutes including but not limited to: The Science and Technology Act, Cap. 250 of 1977, The Kenya Broadcasting Corporation Act of 1988 and the Kenya Communications Act of 1998. These statutes are inadequate in dealing with end of life management of the ICT equipment. They basically cover the licensing and frequency distribution. The National ICT policy (2006) is cognizant of e-waste and states that “as a prerequisite for grant or renewal of licenses, applicants must demonstrate their readiness to minimize the effects of their infrastructure on the environment. This should include provision of appropriate recycling, disposal facilities for waste that may contain toxic substances.” While the intention has not been incorporated in ICT regulations to make it binding, the universal Licensing Framework implemented by the CCK from July 1st, 2008 takes step towards enforcing this statement of intent.

The environmental considerations mentioned in the policy are in line with the government promoting environmentally-friendly IT products that will address the cost issues and the environment issues. In line with this is the development of regulations for recycling and disposal facilities. However, these are mentioned in the policy but in reality none of these great ideas has been implemented. For example, CCK regulations in ICT sector tend to favor service providers given that so far, no license has been cancelled, for having emitted e-waste to the environment. The mobile phone telephony is regulated under this sector, but the mobile phone as a good is not regulated in this sector although it is associated with the services under this sector. Kenya is therefore in a kind of dilemma referred to as a Catch-22.
situation, where the state encourages ICT development yet, does not have in place measures to manage related e-waste in place.

The Ministry of Environment and Mineral Resources acknowledges the emerging threats and management challenges in ICT and Environment Sectors during the Hi-tech revolution in Kenya today. However there is no policy or strategy to manage electronic waste in isolation except for the EMCA 1999, which does not specify how e-waste can be managed in a sustainable way, separate from normal solid waste.

The main concerns of the Ministry of Environment regarding e-waste and other municipal waste management in Kenya, include; the design of Sustainable Systems (Behavioural and strategy development); Determination of the amount and composition of waste in Kenya; Accessibility to waste during collection from premises; Extent of Collaboration in Waste Management with key stakeholders; Institutions involvement and development of legal policy and regulatory framework, comprising of Ministry of Environment and NEMA, Public Health, Kenya Bureau of Standards and CCK; Disposal mechanisms and specifics of e-waste that could be contributing to Climate Change; and Management, Regulation and Control of Influx of E-waste in Kenya through, Donations and trade in ICT products.

It’s evident that there is need for a comprehensive multi-sectoral strategy on e-waste management in Kenya, just like the existing the Climate Change Strategy, which will create room for policies that may take long to be realized. The Ministry is currently working on a comprehensive environment policy in line with EMCA 1999. In the meantime, government continues to show commitment in protecting her human health and the environment.
development of environment regulations aimed at managing environment through the NEMA.

The Kenya Bureau of Standards (KEBS) was established in July 1974 by an act of Parliament to act as a trade facilitator. The objectives of the KEBS that are relevant to this study include preparation of standards relating to ICT products, testing and quality management and the pre-export verification of conformity to standards. Kenya has standards on some electrical and electronic equipment but not on mobile phones.

However, where there are no national standards, KEBS used international standards to regulate the goods entering into the country. The pre-export verification of conformity program (PVOC) was formed with the objective of verifying the quality of certain regulated goods coming into Kenya. The inspections are carried out at the country of export by appointed contractors to minimize the risk of unsafe and substandard goods entering the Kenyan market and to protect Kenyans’ health, safety and environment. The PVOC programme covers most of the high risk goods including electronic goods which require a certificate of conformity before being accepted into Kenya. The inspections are based on Kenyan standards, and where Kenyan standards are not sufficient or there are no standards they can be based on equivalent international standards or manufacturer/company standards. With the influx of second hand electronic equipment and refurbished equipment the PVOC comes in to ensure that the products entering the Kenyan market are not waste or EoL products.
The PVOC team has rejected some EEE, including mobile phones which were old and refurbished. But it is an onerous task regulating the ICT products, especially mobile phones, as they can be brought into the country undetected in some ports of entry. Most communication equipment is high value goods and they are flown into the country as opposed to importation via the Mombasa port.

The main challenge facing the KEBS is the safe disposal of the rejected hazardous goods as the country lacks the necessary infrastructure to destroy these goods although it is stipulated in the law that the importer of the rejected good is to meet the disposal cost.

The other challenge lies in the regulation of donations which in most cases entail computers and laptops. The donations of computers and laptops that have less than one year life left should not be allowed into the country. Donations are a new conduit through which e-waste is dumped into the country; donations in good-will do not necessarily have to be forty year old computer. Two new computers are a better and worthy donation. The communities that receive these donations view KEBS as an obstacle in bridging the digital divide.

Kenya Ports Authority (KPA) was established in 1978 through an act of Parliament as a statutory body under the Ministry of Transport (KPA, 2008). Then KPA covers the following ports: Kilindini, Malindi, Mtwapa, Kilifi, Kiunga, Shimoni, Funzu and Vanga all along the Indian Ocean. Kilindini harbour in Mombasa is the only fully equipped port. It is the second biggest port in the region after Durban in terms of tonnage and containers handled (KPA, 2008). It has 17 shipping lines and is directly connected to 80 ports worldwide. It also handles 14 million tons of cargo annually (KPA, 2008). The interest in KPA lies in its role
in the verification of imports with special reference to the EEE imports. The data on the total imports is computerized but there is no specific data on the number of EEE that enter the country: the only data that can be retrieved would be on the number of containers received at the port. The EoL computers for the KPA are sold to the members of staff at low prices so as to motivate the employees to buy the computers in an auction that was based on first come first served (Basiye, 2008). The KPA transferred the computers from their custody into individual employees' hands. The concern here is what will happen to these computers when they reach the EoL?

Kenya Revenue Authority (KRA) was established in 1995 by an act of Parliament with the sole mandate of collecting revenue on behalf of the Government of Kenya. The role of KRA of interest to the research is the custom services and KRA's role as the watch dog function for the Government agencies by controlling exit and entry points to the country to ensure that prohibited and illegal goods do not pass through Kenyan borders.

Hazardous wastes and their disposal as provided for under the Basel Convention are listed as part of the restricted goods that are controlled by the customs services department of KRA (KRA, 2008). Over and above the fiscal responsibilities of the custom services department, KRA is also responsible for the facilitation of legitimate trade and protection of society from illegal entry and exit of prohibited goods. Computers and computers parts are not charged any duty and any media containing computer software is exempted from import duty too (The East African Community Customs Management Act, 2004). This has triggered importation of second hand computers which are cheaper and have a short life span. This poses a threat to the environment.
The Kenya National Cleaner Production Centre (KNCPC) was established in July 2000 through the Kenya Industrial Research and Development Institute (KIRDI), the United Nations Development Programme (UNDP) and the Government of Kenya. The centre’s core function is to build national capacity to implement Cleaner Production (pollution prevention) programmes in industry and businesses (KNCPC, 2008). The centre has been instrumental in coordinating waste minimization and resource efficiency projects through continuous awareness and training activities, demonstration projects and policy dialogues. Therefore, KNCPC could be used as one of the avenues to regulate the tonnage of e-waste generated by stakeholders through sensitization of stakeholders of waste minimization strategies.

4.4.2 Recycling as an E-Waste Management Strategy

The study showed that the great obstacle to proper recycling as lack of infrastructure and policy within the companies. Fifty-four percent of the key informants felt that lack of legislation was an obstacle, while the absence of recycling possibilities was rated third by 50% of the respondents. Cost was given the least ranking with 45% of the respondents finding it an obstacle. The obstacles were ranked as shown in table 4.5 below:

Table 4.5: Obstacles to recycling

<table>
<thead>
<tr>
<th>Obstacles to recycling</th>
<th>Ranking in Percentages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrastructure</td>
<td>1(60%)</td>
</tr>
<tr>
<td>Policy and Legislation</td>
<td>2(54%)</td>
</tr>
<tr>
<td>Absence of recycling possibilities</td>
<td>3(50%)</td>
</tr>
<tr>
<td>Cost</td>
<td>4(45%)</td>
</tr>
</tbody>
</table>
It was further established that lack of awareness and designated dumping sites, limited support for local initiatives, absence of any framework for end-of-life (EoL) product take-back or implementation of Extended Producer Responsibility (EPR), lack of separation of at source, have made the situation more complex.

The study established that the volumes of e-waste handled by the recycling companies were low as compared to the anticipated volumes of e-waste. Therefore, the informal recycling companies that lack proper infrastructure and mechanisms to handle e-waste have been left to handle more e-waste. Most of the e-waste ends up being dumped thus polluting the environment. In addition, policies and legislation in place do not have recycling components nor do they provide for the safety of workers. This means that much e-waste remains in storage and also puts both recycler and local population at risk. The study established that residents near dump sites report waste fumes, chemical inhalation, and air and water pollution. This scenario has been confirmed by Waema (2008) in his study on e-waste management in Nairobi.

The study identified that EMCA (1999) requires the waste generator to minimize waste and eliminate waste altogether as well as identifying and eliminating potential negative impacts of the product, enabling the recovery and reuse of the product, reclamation and recycling and incorporating environmental concerns in the design and disposal of a product. However, this policy is deficient as the component of recycling should commence from collection of Advance Recycling Fee at the point-of-sale of electrical equipment components, disposal of electronic waste at dedicated collection points at their end of life and the final recycling/ safe
disposal of e-waste by recyclers. The study further established that small volumes of e-waste are collected by the sampled institutions through few collection points and the e-waste goes through the process of final recycling. The most commonly recycling method employed is dismantling and cable stripping. The process is largely manually operated. This practice exposes the workers and communities involved in dismantling e-waste to serious, environmental problems, danger and health hazards because of the nature of hazardous components of the electrical equipment.

4.4.3 Extended Producer Responsibility as an E-Waste Management Strategy

The study established that EPR is one good component of managing e-waste which should be emulated by most institutions. EPR analysis was done using Sinha (2004) methodology that involved comparative analysis of five major comparison indicators—Actor Involvement, Material flows and controls, externalities, Financial Metrics and Market Metrics comprising of 19 sub-indicators. The indicators were chosen on their ability to illustrate the most important characteristics of an e-waste management system.

4.4.3.1 Stakeholder (Actor) Involvement

From the study the level of involvement by all actors is still low. The Government has not developed clear policies and legal frameworks for management of e-waste. Producers in this case the importers/suppliers are importing equipments with short life span and the take back schemes are still underdeveloped. The highest involvement is that of collectors and recyclers who bear the physical and economic burden of the end-of-life management of the appliances. The retailers and consumers deserve the 'medium' score because of their
involvement in the second hand market and their role in extending the product life through reuse and repair. This is illustrated in Figure 4.8.

![Actor Involvement Diagram](image)

**Figure 4.8: Actor Involvement in Nairobi**

Similar studies done by Sinha (2004) showed that the Swiss system entails a high degree of involvement for all actors, who share the responsibility of the product equitably as compared to Nairobi. The consumer pays the Advanced Recycling Fees (ARFs) and must bring back the product, the retailer is obligated to take it back, the recycler must ensure that the e-waste is properly recycled and the producers. Through the Producer Responsibility Organizations (PROs), producers bear their share of the responsibility by ensuring that the environmental impacts of their products are minimal through its entire life cycle. The government is given only a ‘medium’ involvement score because the government does not participate in the system on a day-to-day as indicated in table 4.6.
Table 4.6: Comparison Indicator - Actor Involvement in Kenya and Switzerland

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Kenya</th>
<th>Switzerland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Producer Involvement</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Consumer Involvement</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Retailer Involvement</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Collector/ Recycler Involvement</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Government Involvement</td>
<td>Low</td>
<td>Medium</td>
</tr>
</tbody>
</table>

4.4.3.2 Material Flows and Controls

From the study, the per capita generation of e-waste was substantially lower as compared to a country like Switzerland. This study was confirmed by EMPA (2009) which showed that the per capita generation of e-waste was substantially lower. This is as a result of the low market penetration of electronic and electrical equipment. It was further established that the variety of e-waste processed by selected institutions in Nairobi is similar in characteristics to that of Switzerland and India. Both systems encompass all (or most) types of discarded electronic and electrical appliances. However, in Nairobi, no formal demarcation of responsibilities exists. Only a few recycling companies are specific on brands that they recycle (brand specificity). The study also established that the recycling companies in Nairobi get a low score due to complete lack of control over the flow of material as shown in Figure 4.9.
Similar studies conducted by Sinha (2004) in Switzerland show that the country has a high score on e-waste generation per capita. Generally, the Swiss Association for Information, Communication and Organizational Technology (SWICO) and Stiftung für Entsorgung Schweiz (hereafter S.EN.S) systems used in Sweden do not discriminate on the basis of product brand, accepting any equipment from all manufacturers, irrespective of when or where the product was sold. The main difference between Kenya and Switzerland systems is in terms of the controls and monitoring mechanism, whereas in Switzerland gets a high score because of the multiple levels of controls through the entire system, Nairobi gets a low score due to the complete lack of control over the flow of material as indicated in table 4.9.
### Table 4.7: Comparison Indicator – Material flow in Kenya and Switzerland

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Kenya</th>
<th>Switzerland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Flows &amp; Controls</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Per capita e-waste generation</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Waste stream variety</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Brand specificity</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Control &amp; monitoring</td>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
</table>

#### 4.4.3.3 Externalities

Externalities exist in both systems, both positive as well as negative. The study established the most positive aspect about the Kenyan system is the large number of jobs it generates, giving employment to many more people. However, the low emission and occupational health standards are the negative aspects of the Kenyan system and need to be improved as shown in as indicated in 4.10.

![Externalities](image)

**Figure 4.10: Comparison Indicator - Externalities in Nairobi**
Similar studies conducted by Sinha (2004) showed that on the positive side, the Swiss system has high emission standards thus is able to have lesser soil, water and air pollution. Not only are the standards higher, the actors fulfilling these requirements as well. The Swiss system also enforces high occupational health standards for people involved in the handling and treatment of e-waste. However, number of jobs it generates is low as shown in table 4.8.

Table 4.8: Comparison Indicator - Externalities in Kenya and Switzerland

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Kenya</th>
<th>Switzerland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emission standards</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Health &amp; safety standards</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Employment generation</td>
<td>High</td>
<td>Low</td>
</tr>
</tbody>
</table>

4.4.3.4. Financial Metrics

From the study, the labour cost involved in managing the e-waste system is low as compared to other countries. In addition, there is value addition to the waste at each step, as it passes from collector to dealer to recycler. The low cost of labour and the minimal investment required make it viable to finance the entire system through a wholly market mechanism, without requiring additional external financing as indicated in Figure 4.11.
Similar studies show that the financial metrics of Switzerland is a mirror image of that of Kenya. In Switzerland the labour cost involved in managing the e-waste system is substantially higher than that of Kenya. In addition, investment in specialized machinery and logistics infrastructure entails high fixed costs as well. However, the value added to the waste as it goes through the process is minimal, therefore necessitating external financing to cover the difference between the end value of the recyclate and the costs incurred as indicated in table 4.9.
Table 4.9: Comparison Indicator – Financial Metrics in Kenya and Switzerland

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Kenya</th>
<th>Switzerland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour Costs</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Fixed Costs</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Value Addition</td>
<td>High</td>
<td>Low</td>
</tr>
</tbody>
</table>

4.4.3.5 Market Metrics

The research established that the market saturation is such that ownership of electrical and electronic appliances is sparse. Appliances in Kenya are used for much longer than other countries; in part because it is cheaper to get the appliance repaired than purchase a new one, as well as reuse in the form of second hand appliances. The income disparity in Kenya ensures that there are takers for appliances at different price points, resulting in robust demand for most second hand consumer durables. The demand for secondary raw materials depends on several factors such as the quality of the material, the price differential between primary and secondary, and the sophistication of the manufacturing industry. The main reasons for a high demand for secondary raw materials in Kenya are the diverse manufacturing industry, as well as the price differential. The biggest factor which affects this indicator is the recycling of plastics. In Kenya the use of secondary plastic is widespread. See figure 4.12 below.
Similar studies conducted by Sinha (2004) show that the market metrics indicators between Switzerland and Kenya are almost opposites of each other. The high market saturation in Switzerland is on account of widespread ownership and high per capita spending on electronics and electrical appliances. The market saturation in Kenya is quite the opposite, with ownership of electrical and electronic appliances being sparse. In Switzerland; the electrical equipment are used for a shorter duration than Kenya. Switzerland also has reasonable demand for secondary raw materials given the large scale recycling sector and the high quality of the secondary material achieved. The biggest factor which affects this indicator is the recycling of plastics. Switzerland has negligible plastic recycling from e-waste and chooses to incinerate plastics for energy recovery while in Kenya the use of secondary plastic is widespread as indicated in Table 4.10.
Table 4.10: Comparison Indicator – Market Metrics in Kenya and Switzerland

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Kenya</th>
<th>Switzerland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average product life</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Market Saturation</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Demand for secondary raw material</td>
<td>High</td>
<td>Medium</td>
</tr>
</tbody>
</table>

4.4.4 Awareness programmes as an e-waste management strategy

The study established that capability, awareness and training of the people involved in the management of e-waste are an important factor. Most of the e-waste activities have not yet been regulated thus making it impossible to know the e-waste handlers and their level of awareness on the hazardous nature of e-waste. While conducting the interviews it was very clear that the waste handlers were not aware of the contents in the EEE that they were handling. Most recyclers dismantled e-waste without appropriate protection. The lack of awareness applies to the end users too. Most of the end users interviewed had no information on how to dispose of their EoL EEE, thus necessitating creation of awareness on e-waste management and safe disposal channels.

End users perceive e-waste as a resource that can generate income thus the unwillingness of consumers to give out their EoL goods for free. This perception is further enhanced by the value attached to products by the consumers; there is a tendency to store EoL EEE especially mobile phones and computers in their offices even if these products are obsolete as opposed to disposing them. The end users’ reluctance to pay for recycling and disposal services reinforces the notion that nothing goes to waste and that garbage is money. The
above perceptions make end users reluctant to freely participate in EoL management of EEE that has not benefit to them.

The study also showed that end users are an important link in the production-consumption chain. End users have certain rights including the Right to Satisfaction of Basic Needs, Right to Safety, Right to Information, Right to Choose, Right to be Heard, Right to Redress, Right to Consumer Education and Right to a healthy environment. Unfortunately end users tend to be unaware of some of these rights, for example in Kenya we still have purchase receipts indicating that ‘goods once sold cannot be returned’ while in developed countries the statement changed to read ‘if you are not satisfied you get a refund’.

From the study end users have responsibilities including Critical Awareness, Action, Solidarity, Empathy and Maintaining a Healthy and Sustainable Environment. End users of electronic products have a responsibility to buy smart, use right, and manage well and at the end of useful life, to dispose well. Items that have not reached the end of their useful life can be donated or repaired for continued use.
CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The results showed the tonnage of mobile phones and computers that remained undistributed by importers was statistically significant at 95% confidence level \( t = 6.52, \text{df} = 2; p = 0.00456 \) and \( t = -0.63294, \text{df} = 2; p = 0.0322 \), respectively. In the category of end users the tonnage of e-waste generated was insignificant at \( t = 8.4, \text{df} = 2; p > 3.18 \) for universities and \( t = 7.97, \text{df} = 2; p > 3.18 \) for ministries. This could be attributed to the long period of possession of equipment by end users. Analysis of the results further showed that tonnage of e-waste generated by recyclers was statistically significant at 95% confidence level \( t = -13.82, \text{df} = 2; p = 0.00089 \). Further analysis of the e-waste flow stream from the importer to recycler showed that significant amount of e-waste is being generated importers in comparison to other stakeholders. This means that a high percentage of equipment brought into the country by importers is potential e-waste due to the high amount of electronic equipment that remains undistributed and this poses a great threat to the environment.

The study established that the methods employed in e-waste management were still inadequate. Most importers disposed of the undistributed computers and mobile phone at a discounted price to retailers and consumers. Very few importers used extended producer responsibility. In addition, majority of the end users used auctioning as a method of e-waste management. This is a slow and cumbersome process. This suggests that excessive stock is held by the end user and structures that are not developed enough to handle e-waste disposal and therefore cause a ‘drag’ on waste volumes. Therefore, obsolete computers are still in government and varsity stores waiting auctioning. Most common method employed by
recyclers to manage the e-waste was dismantling and cable stripping which is done manually and thus exposes workers to health risks.

In addition, e-waste management strategies are inadequate, and there is no proper legislation to deal with the e-waste problem. Therefore, there is a higher chance of volumes of e-waste finding their way to the dumpsite.

5.2 Recommendations

5.2.1 Frequency and Quantity of E-waste Generated

5.2.1.1 Comprehensive Studies on E-Waste Status in Kenya

In light of the findings, discussions and gaps identified in the current system, there is need to conduct a national study to determine the status of e-waste in the country. The study will also develop an inventory of the different e-waste in the country. This study will then provide the basis for the formulation of a strategy to handle e-waste. On the issue of lack of data on imports of EEE into the country, there is need for a compilation of available data on the EEE imports and maintaining of credible data base on the imports and flows of EEE. This calls for a comprehensive national strategy on e-waste that will extensively address the management of the various e-waste issues in the country, the importation of second hand e-products and the donations.

5.2.2 Methods for Handling E-Waste

5.2.2.1 Need to Review Existing System

Discussion on the existing system with the various stakeholders reveals that there is a need for the manufacturer to review the current system in place to accommodate the stakeholders.
There is a need for the manufacturer to design a system which provides incentives to consumers to bring back products to the appropriate collection points. The incentives can be used in the beginning of the collection scheme as a way of advertising the scheme and when the scheme is well established the manufacturer can review and determine if there is need for incentives or not.

5.2.2.2 Stakeholder Involvement and Level of Convenience
The current scheme is heavily run by the customer care centers that are independent of the manufacturer and the customer care centers determine which stakeholders along the life cycle of the e-waste will be involved. The interviews indicate that there is a need to formulate and calculate working relations with the various stakeholders for the collection scheme to be effective and efficient. As the scheme driven by private industries, the manufacturer needs to define the roles of the various actors and determine how the e-waste collection scheme will interact with the existing initiatives. The collection scheme should be convenient to the end users thus the need to establish more collection points across the country. A few suggested areas that can have collections points include the supermarkets, schools and community centers.

5.2.3 E-waste Management Policies and Strategies
5.2.3.1 Strategic Impact Assessment
There are various regulations relating to components of waste management in the country. It could be important to conduct a strategic impact assessment (SIA) of the various regulations with the aim of streamlining the regulations that address the same issues but under different regulators so as to achieve synergy within and between the regulations and avoid duplication
of efforts and waste of tax payer's money. For instance the ICT policy has provisions for
development of regulations for recycling and disposal facilities by the government but just
for the ICT sector. The recycling and disposal regulations will be aimed at promoting use of
environmentally-friendly IT products to address environment and cost issues. While
generally environment affairs are managed under a different docket, such inclusions in
policies should form the basis for synergistic inclusion of the relevant players so as to avoid
duplication of regulations that maybe be contradictory in nature and also make them
comprehensive.

5.2.3.2 Adoption and Implementation of EPR

E-waste is an emerging waste stream that is inadequately addressed in the existing
regulations. In order to fill the gaps identified in the existing policies, institutional and
regulatory mechanisms in addressing e-waste there is need to incorporate EPR into Kenyan
dresses various components of waste management ranging from solid waste, hazardous
waste, industrial waste, pesticides and toxic substances, biomedical waste and radioactive
substance management but does not take cognizance of e-waste as an explicit waste stream
or category. The interviewees from the NEMA pointed out that e-waste is presumably
covered under chemical waste and hazardous waste. The stakeholders did not link e-waste
with the two categories; the term e-waste does not feature anywhere in this regulation. This
calls for the clarification of the regulation or inclusion of e-waste as a waste category in the
regulation. This can also be done by developing a legislation/regulation specifically on e-
waste handling the collection, storage, recycling and disposal of e-waste. The regulation can
introduce EPR mandating the producers and importers to take responsibility of their
products at the EoL, it can also introduce standards, specifications and mandatory labeling of second hand products, donations and refurbished products as a way of keeping track on these products and differentiating them from new products.

5.2.3.2 Awareness and Information Disseminations
From the interviews conducted it is apparent that the end users are not aware of the existence of the collection scheme by the manufacturer. There is a need for the manufacturer to create awareness on the schemes existence and purpose. The awareness can be created through various channels such as: media advertisement especially the radio as it has a wider coverage, and through the road shows at times conducted by the manufacturers in advertising new phones. There is a need for the manufacturer to dedicate funds to the promotion of the take-back scheme. The manufacturer could also promote the scheme through schools as a way of reaching a wider population.

5.3 Suggestions for Further Research
Areas for future research are enormous especially in a Kenya and Africa as a whole as e-waste issues are now emerging and there is a big information gap on e-waste and strategies of managing it. I recommend the following general thematic areas to be considered for future research:

i. The first area should deal with the identification of the flows and quantities of e-waste generated in the country and the e-waste imported into the country.

ii. The second research area can look into adoption and integration of EPR into national legislations and what impact it would have to the various players and actors in the e-waste scene.
iii. The third thematic area would involve knowledge transfer and the possibilities of transfer of the products along with the EoL fee from jurisdictions with the provisions to the jurisdictions not covered but are grappling with management of e-waste from the covered jurisdictions.
REFERENCES


Most, E. (2003). Calling all cell phones, Collection, reuse, and recycling programs in the US. New York, INFORM Inc.


Nyakang’o, J. (2006). Launching of the National Cleaner Production Network. 9th Extended Producer Responsibility for the Management of Waste from Mobile Phone


Economics International Environmental Technology Centre.


APPENDICES

Appendix 5.1

E-waste Assessment Questionnaire

A. General

1. Date: .................................................................

2. Interviewee: ........................................................ Position: .................................................................

3. Name of institution: ...........................................................................................................................................

4. Type of institution

   Government □ Private co. □ NGO □ International □ Informal Business □

   Other (Specify) ................................................................................................................................................

5. Type of Stakeholder (please tick).

   Importer □ Supplier □

   Assembler □ Distributor □

   Corporate consumer □ Collector □

   Recycler □ Final disposer □

6. Principal activity of the institution: ..................................................................................................................

7. Is your institution ISO 14001 certified? YES □ NO □

8. What brand of computers (desktop) do you deal with?

   IBM □ Dell □ HP Compaq □

   Others (Specify) ..............................................................................................................................................

9. What Brand of laptop do you deal with?

   Toshiba □ Sony □ HP/Compaq □ IBM □ Dell □

   Others (Specify) ..............................................................................................................................................

10. What type of mobile phones do you deal with? (section to be filled in by those dealing with mobile phones)

    Nokia □ Samsung □ Motorola □ Sony Ericson □ Blackberry □

    Others (Specify) ...............................................................................................................................................

   83
B. ICT Importers, Suppliers, Assemblers and Distributors

1. Which products do you deal with?

- Desktop
- Mobile phones
- UPS
- Monitors (CRTs)
- Modems
- Printers
- Flat screens (LCDs)
- Fax Machines
- Photocopier
- Laptops
- Others (Specify)

2. How many of the equipment of the following types did you import or assemble in the last four years?

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Desktop computers</td>
<td>......</td>
<td>......</td>
<td>......</td>
<td>......</td>
</tr>
<tr>
<td>Laptop</td>
<td>......</td>
<td>......</td>
<td>......</td>
<td>......</td>
</tr>
<tr>
<td>Monitors (CRTs)</td>
<td>......</td>
<td>......</td>
<td>......</td>
<td>......</td>
</tr>
<tr>
<td>Flat screens (LCDs)</td>
<td>......</td>
<td>......</td>
<td>......</td>
<td>......</td>
</tr>
<tr>
<td>Printers</td>
<td>......</td>
<td>......</td>
<td>......</td>
<td>......</td>
</tr>
<tr>
<td>Photocopier</td>
<td>......</td>
<td>......</td>
<td>......</td>
<td>......</td>
</tr>
<tr>
<td>Fax machines</td>
<td>......</td>
<td>......</td>
<td>......</td>
<td>......</td>
</tr>
<tr>
<td>Modems</td>
<td>......</td>
<td>......</td>
<td>......</td>
<td>......</td>
</tr>
<tr>
<td>UPS</td>
<td>......</td>
<td>......</td>
<td>......</td>
<td>......</td>
</tr>
<tr>
<td>Other, specify</td>
<td>......</td>
<td>......</td>
<td>......</td>
<td>......</td>
</tr>
</tbody>
</table>

3. How many of the imported or assembled equipments did you distribute in the last four years?

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Desktop computers</td>
<td>......</td>
<td>......</td>
<td>......</td>
<td>......</td>
</tr>
<tr>
<td>Laptop</td>
<td>......</td>
<td>......</td>
<td>......</td>
<td>......</td>
</tr>
<tr>
<td>Monitors (CRTs)</td>
<td>......</td>
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<td>......</td>
<td>......</td>
</tr>
<tr>
<td>Flat screens (LCDs)</td>
<td>......</td>
<td>......</td>
<td>......</td>
<td>......</td>
</tr>
<tr>
<td>Printers</td>
<td>......</td>
<td>......</td>
<td>......</td>
<td>......</td>
</tr>
<tr>
<td>Photocopier</td>
<td>......</td>
<td>......</td>
<td>......</td>
<td>......</td>
</tr>
<tr>
<td>Fax machines</td>
<td>......</td>
<td>......</td>
<td>......</td>
<td>......</td>
</tr>
<tr>
<td>Modems</td>
<td>......</td>
<td>......</td>
<td>......</td>
<td>......</td>
</tr>
<tr>
<td>UPS</td>
<td>......</td>
<td>......</td>
<td>......</td>
<td>......</td>
</tr>
<tr>
<td>Other, specify</td>
<td>......</td>
<td>......</td>
<td>......</td>
<td>......</td>
</tr>
</tbody>
</table>

84
4. What happened to those that were not distributed?

5. What percentage of your imported or assembled equipment is 2nd hand?

- None
- Less than 10%
- 11-20%
- 21-30%
- 31-50%
- 51-70%
- 61-80%
- 81-90%
- 91-100%

6. What percentage of your computers are clone computers?

- None
- Less than 10%
- 11-20%
- 21-30%
- 31-50%
- 51-70%
- 61-80%
- 81-90%
- 91-100%

7. How did you distribute your computer equipment?

- Sell directly to customers
- Through appointed distributors
- Sell directly to retail outlet chains
- Others (Specify)

8. How many retail outlets sell your computer equipment in Nairobi?

9. What in your opinion is the proportion of the second hand market for computer equipment in Kenya?

- Less than 10%
- 11-20%
- 21-30%
- 31-40%
- 41-50%
- over 50%

10. What in your opinion is the proportion of non-branded (clone) market for computer equipment in Kenya?

- Less than 10%
- 10-20%
- 21-30%
- 31-40%
- 41-50%
- over 50%

11. Do you have a policy on Extended User Responsibility (EUR)? (a policy of re-owning/purchasing equipment from consumer after equipment's end-of-life) YES NO

12. If YES, Please explain
C. Consumer (Government, Universities)

1. How many of the following new or second hand equipment do you have?

<table>
<thead>
<tr>
<th>Equipment</th>
<th>New</th>
<th>2nd hand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computers accessories (including cables, cartridges, mouse, keyboard)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desktop Computers (PCs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laptops</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flat screens (LCDs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Printers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Photocopiers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fax Machines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others, specify</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Where do you get your ICT equipment from? (Tick 2 of the most common)

3. In the last five years, have you discarded any of the following equipment?

<table>
<thead>
<tr>
<th>Equipment</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computers accessories (including cables, cartridges, mouse, and keyboard)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desktop Computers (PCs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laptops</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flat screens (LCDs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Printers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mobile phones</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Photocopiers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fax Machines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others, specify</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. If the answer to qn.25 is yes, please specify how many

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Number discarded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computers accessories (including cables, cartridges, mouse, keyboard)</td>
<td></td>
</tr>
<tr>
<td>Desktop Computers (PCs)</td>
<td></td>
</tr>
<tr>
<td>Laptops</td>
<td></td>
</tr>
<tr>
<td>Flat screens (LCDs)</td>
<td></td>
</tr>
</tbody>
</table>
5. What was the lifespan of the equipment?

1 month-1 year  □  2-3 years  □  3-4 years  □
4-5 years  □  5-6 years  □  Over 6 years  □

5. For how long did you possess them in their obsolete state before discarding?

1 month-1 year  □  1-2 years  □  3-4 years  □
4-5 years  □  5-6 years  □  Over 6 years  □

6. In what condition was the equipment when you discarded it?

Broken-unfixable  □
Broken fixable  □
Working condition  □

7. Do you keep inventories of the equipment you discard/dispose?

YES  □  NO  □

8. Does your company have a policy for the management of e-waste?

YES  □  NO  □

9. If yes, please share a copy with us

A copy available for sharing  □  A copy not available for sharing  □

10. If not, does your company plan to adopt a policy of e-waste management?

YES  □  NO  □

11. Are you aware that some electronic parts may be profitably recycled?

YES  □  NO  □

10. If the equipment was sold, who did you sell it to?

, 87
11. Are you aware of any company that collects discarded e-waste for recycling?

YES ☐ NO ☐

12. If yes, would you be ready to pay for your discarded equipment to be collected and recycled?

YES ☐ NO ☐

13. Does the company (waste collectors) come and pick-up waste at your institution?

YES ☐ NO ☐

14. If yes, do they buy the waste from you? At what percent of the cost price?

Less than 10% ☐ 11-20% ☐ 21-30% ☐
31-40% ☐ 41-50% ☐ over 50% ☐

15. If NO, what process do you use to discard the e-waste equipment?

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

16. Are you aware of what happens to the equipments you discard or that you discard?

YES ☐ NO ☐

17. If yes, are you aware of the social and environmental consequences of discarded electrical and electronic equipment?

YES ☐ NO ☐

18. What social consequences have you noticed of the discarded electrical and electronic equipment?

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

19. What environmental consequences have you noticed of the discarded electrical and electronic equipment?

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

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20. Would you be ready to give away your e-waste for free?

YES □ NO □

21. If YES, with what conditions? (e.g. pick-up service, guarantee of proper disposal, etc.) Provide details:

_________________________________________________________________________________________________________________________________________________
D. E-waste Collectors/Refurbishers/Recyclers

Section 1: Collection

1. How do you source for e-waste to be collected?

2. How do you do the actual e-waste collection?
   - Pick-up e-waste door to door
   - Have a common collection point
   - Pick up from garbage disposal gardens
   - Send municipal collection lorries
   - Others (Specify)

3. Under what financial arrangements do you collect the waste?
   - Consumer pays for collection of e-waste
   - Purchaser pays for collection of e-waste
   - Others (Specify)

4. Do you separate general waste from e-waste?
   - YES
   - NO

5. How many of your staff members are assigned to collect e-waste?

6. Is the staff capacity adequate to handle e-waste?
   - YES
   - NO

6. How many tons of computer electronic waste did you collect in 2008?

7. On average, how many tons of e-waste do you collect per month?

8. Is the way e-waste is currently collected convenient to you?
   - YES
   - NO

If no, what can be improved?
Section 2: Recycling/Refurbishing

1. Which kind of processes takes place at this site?
   - Dismantling
   - Segregation
   - Shredding
   - Precious metal recovery
   - Separating fractions
   - Recovering material from e-waste

2. Describe the re-furbishing or recycling chain.

3. What equipment do you refurbish or recycle? (Tick where appropriate)
   - Desktop
   - Mobile phones
   - Monitors (CRTs)
   - Modems
   - Flatscreens (LCDs)
   - Laptops
   - UPS
   - Printers
   - Fax Machines
   - Photocopier
   - Flat screen
   - Printer Cartridge refill
   - Others (Specify)

4. What percentage of this is repairable e-waste?
   - Less than 10%
   - 11-20%
   - 21-30%
   - 31-40%
   - 41-50%
   - Over 50%

5. What percentage of the e-waste collected is disposed of?
   - Less than 10%
   - 11-20%
   - 21-30%
   - 31-40%
   - 41-50%
   - Over 50%

6. What was the average revenue per ton of refurbished or recycled equipment?

7. What is the average life span of refurbished equipment?
   - 1 month - 1 year
   - 1 - 2 years
   - 2 - 3 years
   - 3 - 4 years
   - 4 - 5 years
   - Over 5 years

8. What main products are produced from the refurbishment or recycling processes?
   a.
   b.
   c.
   d.
   e.
9. What protective mechanisms are put in place for staff handling e-waste?

Gloves [ ]
Face masks [ ]
Overall uniforms [ ]
Boots (shoes) [ ]
Others (Specify) ............................................................................................................................

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

YES [ ]
NO [ ]

11. Have you and members of your organization undergone any training on e-waste collection and management?

YES [ ]
NO [ ]

12. Have you and members of your organization undergone any training on e-waste collection and management?

YES [ ]
NO [ ]

13. Have you and members of your organization undergone any training on e-waste collection and management?

YES [ ]
NO [ ]

14. What key expertise is needed in the refurbishing or recycling business?

a. ...........................................................................................................................

b. ..........................................................................................................................

c. ..........................................................................................................................

15. Visual assessment of the amount of material processed (kg per year; daily figures come in table input) photos of site (e.g. overview, storage area)
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................

16. What happens to the materials that are no longer useful?

Dispose off with other rubbish [ ]
Keep in the store [ ]
Burn [ ]
Others (specify) ..........................................................................................................................

17. Visual assessment of the environment in terms of gas emissions, dirty water etc. (Condition of the buildings and vegetation around to be noted)
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................

18. What do you think can be done to implement proper recycling channels in Kenya?
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................

19. On average, how much do you make per month from e-waste recycling and refurbishing?

Less than 50,000 [ ]
50,100-100,000 [ ]
100,100-200,000 [ ]
200,100-500,000 [ ]
500,100-1,000,000 [ ]
Over 1,000,000 [ ]

20. Have you and members of your organization undergone any training on e-waste collection and management?

YES [ ]
NO [ ]

21. Have you and members of your organization undergone any training on e-waste collection and management?

YES [ ]
NO [ ]

22. Have you and members of your organization undergone any training on e-waste collection and management?

YES [ ]
NO [ ]

23. Have you and members of your organization undergone any training on e-waste collection and management?

YES [ ]
NO [ ]
12. On average, how much do you make per month from e-waste collection?

<table>
<thead>
<tr>
<th>Range</th>
<th>Box</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 15,000</td>
<td>☐</td>
</tr>
<tr>
<td>15,100-30,000</td>
<td>☐</td>
</tr>
<tr>
<td>30,100-50,000</td>
<td>☐</td>
</tr>
<tr>
<td>50,000-100,000</td>
<td>☐</td>
</tr>
<tr>
<td>Over 100,000</td>
<td>☐</td>
</tr>
</tbody>
</table>
F. Final Disposers

1. What are the main materials that you dispose off?

- Plastic [ ]
- Metal [ ]
- Desktop Computer [ ]
- Mobile phones [ ]
- Monitors (CRTs) [ ]
- Modems [ ]
- Laptop screens [ ]
- Computer cables [ ]
- Computer screen [ ]
- Keyboard [ ]
- Mouse [ ]
- Mobile phones [ ]
- Printers cartridge [ ]
- Others (Specify) [ ]

2. Where do you dispose off the material?

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

3. How many tons do you dispose of in a year?

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

4. Have you undergone any training on E-waste disposal and management?

YES [ ]
NO [ ]

5. Do you encounter any problems in e-waste disposal? (e.g. from Government, Municipal Council etc)

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

6. In your view, does Kenya have infrastructure for hazardous waste disposal?

YES [ ]
NO [ ]
G. More General Questions

1. What is to your point of view the most important obstacles to proper recycling of electric and electronic equipment in Kenya? (Rank starting with the most important)

- Costs
- Lacking infrastructure and/or policy within your company
- Absence of recycling possibilities
- Lack of legislation
- Expertise, skills
- Other, (specify)

2. How do you recruit your member of staff?

- Advertise through the print media
- Advertise through electronic media
- Referrals by friends
- Walk in looking for jobs
- Look for volunteers and pay a fee
- Other, (specify)

3. Are you aware about the environmental hazards caused by discarded electronic equipment?

- YES
- NO

4. Are you aware that some hazardous fractions in e-waste need a special treatment in order to be disposed of?

- YES
- NO

5. Does your company have a policy for the management of e-waste?

- YES
- NO

6. If yes, please share a copy with us

- A copy available for sharing
- A copy not available for sharing

7. If not, does your company plan to adopt a policy of e-waste management?

- YES
- NO

8. Do workers have the following?

- Union
- Medical Cover
- Flexible working hours
- Annual leave

9. What key issues you would you like to be included in the policy

- [Your specific issues here]
10. Least five organizations that you think should take an active role in the management of e-waste from importation to the point at which they need to be discarded.

a. 

b. 

c. 

d. 

e. 

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### Appendix 5.2: Observation checklist

<table>
<thead>
<tr>
<th>S.NO</th>
<th>Activity</th>
<th>Audit/status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>What health and physical risks are workers exposed to</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Is it obvious that the workers have undergone/use the following</td>
<td>Masks and other protective gadgets</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Have undergone training on e-waste handling</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Others(Specify)</td>
</tr>
<tr>
<td>3.</td>
<td>Describe the geographic setting of major e-waste treatment facilities and sites.</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>a) Are the collection points, refurbishment, recovery or disposal sites located in or nearby populated areas</td>
<td>yes No</td>
</tr>
<tr>
<td></td>
<td>b) If yes, describe the socio economic set-up of the settlement (economic basis, typical kind of housing -structure, population density (above/ below local average), distance to e-waste treatment.</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 5.3: Interview Guide

1. In your view, how is the e-waste situation in Kenya?

2. What effect is e-waste having on your ministry/institution?

3. What are some of the opportunities of e-waste?

4. What are the negative impacts?

5. What actions are being taken to benefit from the opportunities (if any) and minimize the negative effects (if any)?

6. Do you have any e-waste management policy in the ministry/institution?

7. If no, why is there no e-waste policy and do you see a need for one? If there is, get copy.

8. What is your general view of e-waste management in Kenya?
9. Should the quality of imported computers and accessories (new and second-hand) be audited and regulated? If yes, by who? (NEMA/CCK/KEBS)

10. Which Ministry/institution should be tasked with the responsibility of coming up with a national e-waste policy?

11. What key issues should the National e-waste policy take into consideration?
Appendix 5.4: CFSK e-waste management service fees

Computers for Schools Kenya offers e-waste management services at the following fees:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>Kshs</th>
</tr>
</thead>
<tbody>
<tr>
<td>A complete computer (system unit, monitor, keyboard &amp; mouse)</td>
<td>1,500/=</td>
</tr>
<tr>
<td>Monitors*</td>
<td>1,000/=</td>
</tr>
<tr>
<td>Floor Printers</td>
<td>1,500/=</td>
</tr>
<tr>
<td>System Units</td>
<td>500/=</td>
</tr>
<tr>
<td>Desk Printers and Fax Machines</td>
<td>500/=</td>
</tr>
<tr>
<td>UPS with battery</td>
<td>750/=</td>
</tr>
<tr>
<td>Keyboards</td>
<td>50/=</td>
</tr>
<tr>
<td>Mice</td>
<td>25/=</td>
</tr>
</tbody>
</table>

We hope to expand our list in due course to include other electrical and electronic equipment as our capacity grows. The CFSK e-waste Management Process is keeping with the Basel Convention and UK WEEE Guidelines.

We collect decommissioned equipment from clients at a small fee to cover the cost of transporting the same to the Centre, the actual amount determined by the distance from the Centre. However, we hope to shortly establish convenient drop off points for some of the items that we recycle.

The CFSK e-Waste management process is done by competent technical personnel in a manner that protects both the environment and public health.
## Appendix 5.5: Comparison indicators explained

<table>
<thead>
<tr>
<th>Indicator</th>
<th>What it indicates</th>
<th>Reason for inclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Actor Involvement</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Producer Involvement</td>
<td>Level of involvement in the system through physical, financial, informational responsibility individually or through a PRO.</td>
<td>Producers are in the strongest position to influence the characteristics and flow of their product.</td>
</tr>
<tr>
<td>Consumer Involvement</td>
<td>Level of involvement in the system through physical or financial responsibility.</td>
<td>The consumer is the starting point in the reverse logistics chain and consumer involvement is therefore important.</td>
</tr>
<tr>
<td>Retailer Involvement</td>
<td>Level of involvement in the system through physical, financial, or informational responsibility.</td>
<td>As the interface between the consumer and producer, they represent an important link in both the forward and reverse supply chain.</td>
</tr>
<tr>
<td>Collector/ Recycler Involvement</td>
<td>Level of involvement in the system through physical or financial responsibility.</td>
<td>Collectors and recyclers are an integral part of an environmentally sound ewaste management system.</td>
</tr>
<tr>
<td>Government Involvement</td>
<td>Level of involvement in the system through legislative, physical or financial responsibility.</td>
<td>As the legislative authority, the government has the power to influence all the actors in the system.</td>
</tr>
<tr>
<td><strong>Material Flows &amp; Controls</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Per capita</td>
<td>e-waste generation</td>
<td>The per capita waste generated indicates the volume of EEE coming into the waste stream.</td>
</tr>
<tr>
<td>Waste stream variety</td>
<td>The diversity of product categories in the e-waste stream managed.</td>
<td>The diversity in waste stream reflects the coverage of EEE in the system.</td>
</tr>
<tr>
<td>Brand specificity</td>
<td>The degree of brand specific collection and treatment</td>
<td>Brand specificity in collection and treatment of the e-waste plays an important role in the system design and associated costs.</td>
</tr>
<tr>
<td>Control &amp; monitoring</td>
<td>The degree of control and monitoring of the system, either through independent or government bodies.</td>
<td>System controls are important to measure flows and make the system more transparent.</td>
</tr>
<tr>
<td><strong>Externalities</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emission standards</td>
<td>Maximum permissible emission standards (air,</td>
<td>Emission controls in the system ensure that emissions to the air,</td>
</tr>
<tr>
<td>Indicator</td>
<td>What it indicates</td>
<td>Reason for inclusion</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Health &amp; safety standards</td>
<td>Minimum health &amp; safety requirements for actors in the system.</td>
<td>Health &amp; safety standards ensure that the employees are not overly exposed to hazardous substances.</td>
</tr>
<tr>
<td>Employment generation</td>
<td>Number of jobs created by the system.</td>
<td>Potential for job creation is important as it leads to further macroeconomic multiplier effects.</td>
</tr>
<tr>
<td>Financial Metrics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labour Costs</td>
<td>Minimum wage level of labour</td>
<td>Labour costs involved in the e-waste management affect the profitability of the system.</td>
</tr>
<tr>
<td>Fixed Costs</td>
<td>Minimum fixed costs in terms of infrastructure setup for recycling, collection etc.</td>
<td>Fixed costs determine the entry barrier and also affect profitability of the system.</td>
</tr>
<tr>
<td>Value Addition</td>
<td>Value addition to the e-waste as it goes through the system.</td>
<td>The value added to the waste influences the financing mechanism of the system. Systems with high value addition are market driven while low value add requires external financing.</td>
</tr>
<tr>
<td>Market Metrics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average product life</td>
<td>The average life (years) of an appliance from purchase to disposal.</td>
<td>Product life influences when the appliance comes into the waste stream. Product life is extended by reuse as 2nd hand appliance.</td>
</tr>
<tr>
<td>Market Saturation</td>
<td>The per capita ownership of electronic and electrical appliances.</td>
<td>Market saturation determines growth potential to new or replacement customers, wherein the latter generate larger quantities of waste.</td>
</tr>
<tr>
<td>Demand for secondary raw material</td>
<td>Level of demand for secondary raw material.</td>
<td>A flourishing market in secondary raw material is a driver for recovery and recycling industries.</td>
</tr>
</tbody>
</table>
### Appendix 5.6: Comparison indicators tabulated

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Switzerland</th>
<th>Kenya</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Actor Involvement</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Producer Involvement</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Consumer Involvement</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>Retailer Involvement</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Collector/Recycler Involvement</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>Government Involvement</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Material Flows &amp; Controls</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Per capita e-waste generation</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Waste stream variety</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Brand specificity</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Control &amp; monitoring</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Externalities</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emission standards</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Health &amp; safety standards</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Employment generation</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td><strong>Financial Metrics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labour Costs</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Fixed Costs</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Value Addition</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td><strong>Market Metrics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average product life</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Market Saturation</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Demand for secondary raw material</td>
<td>Medium</td>
<td>High</td>
</tr>
</tbody>
</table>
## Appendix 5.7: E-waste road map

<table>
<thead>
<tr>
<th>Issues</th>
<th>Challenges</th>
<th>Strategy</th>
<th>Who is responsible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policy matters</td>
<td>Inefficient and fragmented policy and regulatory framework</td>
<td>formulation of policies on waste management especially e-waste</td>
<td>MoPHS, MENR, MoLG, MoIC, MoTI, consumers, suppliers, manufacturers, other governmental and non governmental organizations</td>
</tr>
<tr>
<td></td>
<td>lack of policy on waste management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advocacy</td>
<td>Inadequate awareness</td>
<td>Awareness creation</td>
<td>KEPSA, NEMA, KRA, MoPHS, MENR</td>
</tr>
<tr>
<td>Regulation matters</td>
<td>EMCA act does not adequately address e-waste management</td>
<td>Amendment of the EMCA act to address e-waste regulation</td>
<td>NEMA, KEBS Consumers, suppliers, manufacturers, other governmental and non governmental organizations</td>
</tr>
<tr>
<td>Regulatory framework</td>
<td>There is lack of regulatory framework for e-waste management</td>
<td>issuance of licenses to e-waste handlers establish training standards for e-waste handlers Awareness on e-waste management</td>
<td>NEMA, MoPHS, MENR, MoLG</td>
</tr>
<tr>
<td>Infrastructure for e-waste management</td>
<td>Inadequate/inefficient infrastructure for e-waste management</td>
<td>Establishment of adequate and efficient infrastructure for e-waste management</td>
<td>-MoPHS, MENR, MoLG, MoIC, MoTI, Consumers, suppliers, manufacturers, other governmental and non governmental organizations</td>
</tr>
</tbody>
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