



**UNIVERSITY OF NAIROBI  
SCHOOL OF COMPUTING AND INFORMATICS**

**A FRAMEWORK FOR SUSTAINABLE  
E-WASTE MANAGEMENT IN KENYA: THE CASE OF ICT**

**BY**

**Jecton Tocho Anyango  
P56/71165/2008**

**Supervisor  
Prof. Timothy Mwololo Waema**

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Submitted in partial fulfilment of the requirements of the Master of Science in Information Systems of the University of Nairobi.

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## DECLARATION

This research project is my own original work and has never been presented for any degree other than Master of Science in Information Systems of the University of Nairobi in the School of Computing and Informatics.

Candidate:  
Sign .....  
Name: Jecton Tocho Anyango.  
Reg. No: P56/71165/2008

Date...01/09/2011

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This research project has been undertaken by the student under my supervision and the submission is hereby made to the University of Nairobi School of Computing and Informatics with my approval as the student's supervisor.

Sign.....  
Name: Professor Timothy Mwololo Waama.  
School of Computing and Informatics  
University of Nairobi.

Date...01/09/2011

## ABSTRACT

This study focuses on the Responsibilities of various stakeholders in e-waste management in Kenya, how the various stakeholders dispose of e-waste and challenges they face. It further explores how other countries namely Switzerland, South Africa and India manage e-waste and what lessons Kenya can learn. It explores the background to e-waste problem and how it impacts on human health and environment.

E-waste poses serious negative health and environmental impacts. In spite of this, e-waste generated in Kenya is not properly managed. This study outlines and examines e-waste disposal practices by various stakeholders in Kenya and challenges they face. It also examines the responsibilities of various stakeholders in e-waste management in Kenya. Chapter 3 presents the research methodology used. Data for this study was collected using questionnaires, interviews and discussions with key policy officers in government agencies, recyclers, producers, consumers and collectors in Nairobi. Additionally secondary data was collected from review of literature.

In Kenya no policies and procedures were found to be in place to enable the management of electronic waste whereas these were present in Switzerland. In Kenya gaps were identified in awareness levels, technology to manage e-waste, e-waste financing, collection, disposal, e-waste policy and collaboration. It was found that Kenya does not have clearly laid out strategies for managing electronic waste whereas such strategies do exist in Switzerland. Amongst the three countries, Switzerland emerged as a good model of a country that has updated its legal provision to enable the management of electronic waste. In India e-waste management systems has organically developed from the informal sector and has created employment opportunities and income. In spite of the challenges faced, South Africa has taken great strides towards developing policies, procedures, strategies and legislation for the management of electronic waste. Kenya is seen as lagging behind in these areas.

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May the almighty bless you all.

## **DEDICATION**

With great affection to:

(i) My parents Meshack and Priscilla Anyango. My father for having taken me to school, and from whose vision, fatherly advice and wise counsel, hard work, concern, perseverance and keenness in education and self sacrifice, I got my inspiration. I want to thank my mother, for being there for the family.

(ii) My two children Wesley and Rosley, I cherish you.

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# TABLE OF CONTENTS

declaration.....	II
abstract.....	III
acknowledgement.....	IV
dedication.....	V
table of contents.....	VI
list of figures.....	IX
list of tables.....	X
list of abbreviations.....	XI
<b>1 INTRODUCTION.....</b>	<b>1</b>
1.1 BACKGROUND OF THE STUDY.....	1
1.1.1 <i>What is e-waste?</i> .....	2
1.1.2 <i>What is an e-waste management framework?</i> .....	3
1.1.3 <i>Impact of e-waste on environmental and human health</i> .....	3
1.2 NEED FOR THE STUDY.....	3
1.3 PROBLEM STATEMENT.....	4
1.4 RESEARCH OBJECTIVES.....	4
1.5 RESEARCH QUESTIONS.....	4
1.6 SIGNIFICANCE OF THE STUDY.....	5
1.7 JUSTIFICATION OF THE STUDY.....	5
1.8 ASSUMPTIONS AND LIMITATIONS OF THE RESEARCH.....	6
1.8.1 <i>Assumptions</i> .....	6
1.8.2 <i>Limitations</i> .....	6
1.9 THESIS OUTLINE.....	6
<b>2 LITERATURE REVIEW.....</b>	<b>8</b>
2.1 INTRODUCTION.....	8
2.2 GENERIC MASS FLOW.....	8
2.3 E-WASTE EXPERIENCE IN OTHER COUNTRIES.....	9

2.3.1	<i>E-waste management in Switzerland</i> .....	9
2.3.2	<i>E-waste management in India</i> .....	13
2.3.3	<i>E-waste management in South Africa</i> .....	16
2.4	<b>E-WASTE SITUATION IN KENYA</b> .....	17
2.4.1	<i>Statistics</i> .....	17
2.4.2	<i>Challenges facing e-waste management in Kenya</i> .....	18
2.4.3	<i>Flow of e-waste</i> .....	19
2.4.4	<i>ICT policy and regulatory framework in Kenya</i> .....	20
2.4.5	<i>E-waste management and legislative framework in Kenya</i> .....	21
2.5	<b>CONCEPTUAL RESEARCH FRAMEWORK</b> .....	22
2.6	<b>CHAPTER SUMMARY</b> .....	25
<b>3</b>	<b>METHODOLOGY</b> .....	<b>26</b>
3.1	<b>SCOPE OF THE STUDY</b> .....	26
3.2	<b>TARGET POPULATION AND DESIGN OF STUDY</b> .....	26
3.3	<b>DATA COLLECTION METHODS AND RESEARCH TOOLS</b> .....	26
3.4	<b>DATA ANALYSIS AND THEIR JUSTIFICATION</b> .....	32
3.4.1	<i>Quantitative analysis</i> .....	32
3.4.2	<i>Qualitative analysis</i> .....	32
3.5	<b>FIELD ADMINISTRATIVE PROBLEMS</b> .....	34
3.6	<b>CHAPTER SUMMARY</b> .....	35
<b>4</b>	<b>DATA ANALYSIS, PRESENTATION AND DISCUSSION</b> .....	<b>36</b>
4.1	<b>INTRODUCTION</b> .....	36
4.2	<b>KEY ISSUES IN E-WASTE MANAGEMENT FROM PRODUCERS PERSPECTIVE</b> .....	36
4.3	<b>KEY ISSUES IN E-WASTE MANAGEMENT FROM CONSUMERS PERSPECTIVE</b> .....	40
4.3.1	<i>E-waste separation at source</i> .....	40
4.3.2	<i>Consumer disposal practices</i> .....	42
4.3.3	<i>Why consumers do not return e-waste</i> .....	43
4.3.4	<i>Computers that have reached EOL</i> .....	46
4.3.5	<i>E-waste management policy</i> .....	46

4.3.6	<i>Awareness of a computer recycling scheme</i> .....	47
4.3.7	<i>Health issues related to e-waste</i> .....	48
4.3.8	<i>Percentage of consumers storing e-waste</i> .....	50
4.3.9	<i>Summary of key issues from the subsections</i> .....	50
4.4	KEY ISSUES IN E-WASTE MANAGEMENT FROM RECYCLERS AND COLLECTORS PERSPECTIVE.....	51
4.5	RESPONSIBILITIES OF VARIOUS STAKEHOLDERS AND CHALLENGES THEY FACE.....	58
4.5.1	<i>Responsibilities</i> .....	60
4.5.2	<i>Challenges</i> .....	62
4.6	E-WASTE MANAGEMENT IN SELECTED COUNTRIES.....	63
4.6.1	<i>E-waste management</i> .....	66
4.6.2	<i>Lessons Kenya can learn</i> .....	69
4.7	E-WASTE POLICY ISSUES IN KENYA.....	69
4.8	THE IDEAL E-WASTE MANAGEMENT FRAMEWORK.....	77
4.8.1	<i>Stake-holders</i> .....	77
4.8.2	<i>Other framework supportive conditions</i> .....	80
4.8.3	<i>The ideal e-waste framework and EMPA framework</i> .....	82
4.9	CHAPTER SUMMERY.....	84
<b>5</b>	<b>CONCLUSIONS AND RECOMMENDATIONS</b> .....	<b>86</b>
5.1	INTRODUCTION.....	86
5.2	CONCLUSION OF RESEARCH STUDY AGAINST OBJECTIVES.....	86
5.2.1	<i>Responsibilities of various e-waste stakeholders</i> .....	86
5.2.2	<i>E-waste disposal practices of stakeholders and challenges they face</i> .....	87
5.2.3	<i>Framework for e-waste management in Kenya</i> .....	87
5.3	CONTRIBUTION OF RESEARCH TO PRACTICE AND THEORY.....	88
5.4	LIMITATIONS OF THE RESEARCH.....	89
5.5	RECOMMENDATIONS AND DIRECTION FOR FUTURE RESEARCH.....	90
	<b>APPENDICIES</b> .....	<b>94</b>



## LIST OF FIGURES

Figure 2. 1 Generic mass flow. Source: Adapted from (Waema et al 2008, cited in Rochat. D; Schlupe. M (2007) .....	8
Figure 2. 2 The Switzerland e-waste “wheel of life”: Available at <a href="http://www.e-waste.ch/en/buy/index.html">http://www.e-waste.ch/en/buy/index.html</a> . Accessed on 3 March 2011. ....	12
Figure 2. 3 Detailed Switzerland e-waste “wheel of life”: Available at <a href="http://www.e-waste.ch/en/buy/index.html">http://www.e-waste.ch/en/buy/index.html</a> . Accessed on 3, March 2011. ....	13
Figure 2. 4 The Clean e-Waste Channels framework: Source Adopted from (Esther Mueller, e-waste guide).....	14
Figure 2. 5 Flow of e-waste. Source (IEEE 2008).....	19
Figure 2. 6 Conceptual Life Cycle of Electrical and Electronic Equipment Source: UNEP (2007b) .....	21
Figure 2. 7 E-waste management research conceptual framework. Source Adapted from Empa(2006).....	23
Figure 3. 1 Data management process. Source (Keakopa, 2006).....	33
Figure 4. 1 Summary of photos taken during Safaricom’s e-waste recycling campaign program during public exhibition on “go green” campaign at KICC on 3 April 2011. Source: Researcher. ....	38
Figure 4. 2 Pie chart showing whether consumers separate e-waste at source .....	41
Figure 4. 3 Pie chart showing consumer disposal practices.....	42
Figure 4. 4 Pie chart showing consumer's return of e-waste.....	44
Figure 4. 5 Pie chart showing distribution of consumers with computers that have reached EOL.....	46
Figure 4. 6 Bar graph showing awareness of a computer recycling scheme .....	47
Figure 4. 7 Graph showing health issues related to e-waste .....	48
Figure 4. 8 Graph showing percentage of consumers storing e-waste .....	50
Figure 4. 9 Summary of photos taken during the field visit to CFSK recycling plant at Mihango Embakasi on 3 April 2011. Source: Researcher. ....	53
Figure 4. 10 Open dumping of obsolete computers and fridges in a government office. Photographs taken on Wednesday, April 20, 2011 ay 3:40pm. Source: researcher.....	54
Figure 4. 11 Dumped computers in a secondary school computer laboratory; Wednesday, April 20, 2011, 3:40:20 PM .Source: researcher. ....	54
Figure 4. 12 Transportation of e-waste; April 28, 2011, 3:40:20 PM .Source: researcher.....	56
Figure 4. 13 The ideal e-waste management framework for Kenya.....	83

## LIST OF TABLES

Table 2. 1 Statistics on e-waste in Kenya: Source (Waema <i>et.al.</i> , 2008) .....	17
Table 3. 1 Number of questionnaires distributed in each category and responses received... 29	
Table 3. 2 Themes and issues discussed and lists of respondents identified by agency .....	30
Table 3. 3 Themes and issues discussed and lists of respondents identified by category .....	30
Table 4. 1 E-waste separation at source .....	41
Table 4. 2 Frequency tables for "Donate", "Auction", "Return" and "Store" .....	43
Table 4. 3 frequency table for disposal policy .....	46
Table 4. 4 Analysis of profit margins .....	57
Table 4. 5 Summary of findings from questionnaires for e-waste stake holders .....	59
Table 4. 6 Summary of how other countries manage e-waste compared to Kenya.Source: Researcher. ....	64
Table 4. 7 Cost of framework implementation.....	88

## **LIST OF ABBREVIATIONS**

<b>ARF</b>	<b>Advance Recycling Fee</b>
<b>B2B</b>	<b>Business to Business</b>
<b>B2C</b>	<b>Business to Consumer</b>
<b>CFSK</b>	<b>Computers for Schools Kenya</b>
<b>CRT</b>	<b>Cathode Ray Tube</b>
<b>EEE</b>	<b>Electrical and Electronic Equipment</b>
<b>EMCA</b>	<b>Environmental Management and Coordination Act</b>
<b>EMPA</b>	<b>Swiss Federal Laboratories for Material Testing and Research</b>
<b>EOL</b>	<b>End of Life</b>
<b>EPR</b>	<b>Extended Producer Responsibility</b>
<b>EU</b>	<b>European Union</b>
<b>ICT</b>	<b>Information and Communication Technology</b>
<b>KEBS</b>	<b>Kenya Bureau of Standards</b>
<b>KICC</b>	<b>Kenyatta International Conference Centre</b>
<b>KRA</b>	<b>Kenya Revenue Authority</b>
<b>MDGs</b>	<b>Millennium Development Goals</b>
<b>MEMR</b>	<b>Ministry of Environment and Mineral Resources</b>
<b>MoIT</b>	<b>Ministry of Information Technology</b>
<b>MoLG</b>	<b>Ministry of Local government</b>
<b>NEMA</b>	<b>National Environmental Management Authority</b>
<b>NCC</b>	<b>Nairobi City Council.</b>
<b>PCs</b>	<b>Personal Computers</b>
<b>SME</b>	<b>Small and Micro medium Enterprises</b>
<b>SPSS</b>	<b>Statistical Package for Social Scientists</b>
<b>UNEP</b>	<b>United Nations Environmental Program</b>
<b>UNIDO</b>	<b>United Nations International Development Organization</b>
<b>UN</b>	<b>United Nations</b>

# **1 INTRODUCTION**

This chapter introduces the research study. It is treated under sub-sections: background of study, need for the study, problem statement, research objectives, research questions, significance of the study, justification of the study, assumptions & limitations of study and finally thesis outline.

## **1.1 BACKGROUND OF THE STUDY**

Electrical and electronic waste is one of the topical environmental issues of the 21<sup>st</sup> century. It has been identified as the fastest growing waste stream in the world. Forecast indicates that it will soon reach 50 million tones per year while its generation is estimated at three times the rate of municipal solid waste. The useful life of consumer electronic products is relatively short (UNEP, 2009).

According to Ngwainmbi (2005), “Rapid advances in technology and the diminishing cost of acquiring new Information and Communications Technology (ICT) tools have opened new opportunities for African countries to accelerate economic growth. Mutua (2007), states that “One of the key catalysts in the attainment of Millennium Development Goals (MDGs) is inclusive access to and effective use of Information and Communication Technologies (ICTs) by the entire populace of every country on the globe. Universal access and universal service have emerged as key strategies that governments are using in their attempts to bridge the digital divide within their countries and with the rest of the world.”

The exact amount of e-waste generated is not known. Further studies are therefore needed to establish the exact position. Current disposal mechanisms in government through procurement pose a challenge in proper disposal (Bitange, 2010).

Kenya ICT Trust Fund is part of the team that generated the idea of managing e-waste approximately 4 years ago. Currently Microsoft through its Digital Pipeline Program is asking the companies making the donations to ship the same back to their countries for safe disposal at the end of their life (UNEP, 2010). An estimate of e-waste volumes in the market revealed that the total e-waste generated from only computers, monitors and printers in 2007

was about 3000 tons which was quite a substantial amount. This was best illustrated by the higher imports of IT in 2007 compared to previous years, with a growth of over 200% (Waema, 2007). This was likely to increase as the importation and use of computers would increase in the coming years (Waema et al., 2008).

Changing technology in ICT would mean more e-waste. At the same time much of e-waste from Europe finds its way to Africa and particularly Kenya due to weak laws (Bitange, 2010). It is estimated that Nairobi generates 1,500 tons of solid waste daily and only 25% of this waste is collected and sent to the Dandora dumpsite (this is an open dumpsite and covers 27 hectares) (UNEP 2005, cited in Basiye 2008). There is no data or statistics on the availability of various EEE in the country (IEEE 2008).

According to Waema (2007) much of the e-waste remain in storage because of lack of a policy and legislative framework, and the absence of a practical e-waste management system. This gap creates a potential e-waste danger in the future since more e-waste is generated over the years but there is no policy or legal framework in place to deal with it.

The broad research question in this study was, “what would an ideal e-waste management framework for Kenya entail”? Central to the study was the need to explore the responsibilities of various stakeholders in e-waste management in Kenya, how various stakeholders disposed of e-waste and what challenges they faced. Finally the study looked into how other countries managed e-waste and what lessons Kenya could learn from them. The purpose of this study was to develop an ideal e-waste management framework to handle the collection, transportation, recycling, safe disposal and monitoring of e-waste material flows in Kenya.

### **1.1.1 What is e-waste?**

According to Aniyie (2009), electronics waste or e-waste is electronics that have outlived their use or have exceeded their shelf life. They are what the original purchaser has no desire of keeping any longer thus amounting to waste. E-waste encompasses a broad and growing spectrum of electronic and electrical devices ranging from large house hold appliances such as fridges, air conditioners to personal computers and cellular phones.

### **1.1.2 What is an e-waste management framework?**

Waste management involves implementation of measures that afford protection of human health and the environment at large, including: collection, transportation, processing, recycling, disposal, onsite handling, storage, treatment and monitoring of waste (Starkey, 1998, cited in Raili (2009)). According to UNEP (2010) management system for WEEE / E-waste includes policies and regulations, institutions, financing mechanisms, technology for collection, storage, recycling and disposal and stakeholders' role. In this study therefore, e-waste management framework refers to a system that involves the policies and regulations concerned with the collection, transportation, processing, recycling or disposal, and monitoring of e-waste materials to create opportunities, and protect human health and the environment. Technology and e-waste stakeholder responsibility also forms an integral part of the definition.

### **1.1.3 Impact of e-waste on environmental and human health**

According to a recent report commissioned by HP Packard there was a 70% level of awareness of environmental hazards caused by discarded electronic equipment, yet little action was being taken (Army, 2010). Obsolete computers and other kinds of electronic junk are piling up every where, causing what some experts predict will be the largest toxic waste problem in the 21<sup>st</sup> century (Schmidt, 2002).

## **1.2 NEED FOR THE STUDY**

There is a silent fast growth in volumes of e-waste generated in Kenya whether in form of post-consumer goods or end-of-life equipment imports or generated domestically. However little is being done to address the myriad scientific, technological, policy, human and environmental health, as well as legal issues associated with e-waste management. There are serious challenges at the level of consumer awareness, collection, recycling, processing, uncontrolled burning and recycling of e-waste using rudimentary skills and technologies and the final disposal of e-waste among many other challenges.

There exists a serious gap with regard to integrated approach to e-waste management in Kenya. While the ministries concerned with environment, health and Information and Communication Technology (ICT) have recognized the challenges posed by e-waste, the

level of preparedness in terms of policies, legal frameworks and regulations remain low (Waema et al., 2008). These concerns call for collective action in dealing with e-waste challenge in Kenya, including developing appropriate practical policy, legislation and regulatory framework that take cognisance of the Kenyan context.

### **1.3 PROBLEM STATEMENT**

There is a silent accumulation of e-waste in Kenya and yet there is no policy framework to address the collection, transportation, treatment, safe disposal and monitoring of e-waste flows in Kenya. Due to lack of an e-waste policy and regulatory framework various stakeholders do not take up their responsibilities with regard to e-waste management consequently there is a problem with disposal. This poses serious danger to both human health and environment.

### **1.4 RESEARCH OBJECTIVES**

This study had the following objectives:

1. To identify the responsibilities of various e-waste stakeholders.
2. To investigate e-waste disposal practices of various stakeholders in Kenya and the challenges they face.
3. To develop a framework for sustainable e-waste management in Kenya called “the ideal e-waste management framework”.

### **1.5 RESEARCH QUESTIONS**

The overall research question was: “What should an ideal e-waste management framework for Kenya entail”? In order to answer the above question the study sought to answer the following research sub questions:

1. What are the responsibilities of the various stakeholders in e-waste management in Kenya?
2. How do the various stakeholders dispose of e-waste in Kenya and what challenges do they face?

### 3. How do other countries manage e-waste and what lessons can Kenya learn?

## **1.6 SIGNIFICANCE OF THE STUDY**

The findings of this study provide a reference point for implementation of an e-waste management system and go a long way in adding new knowledge as well as bridges knowledge gaps in the broad area of e-waste management in Kenya. Fringe socio economic benefits of recycling include reduced impact on the environment, reduced emission of green house gases, and increased opportunities in innovative job creation (Croppar, 2010). Its findings on e-waste recycling positively impact on the productivity and income levels among the youth; a group considered the productive segment of the society. Consequently, this would indirectly improve security and overall well being of communities especially in urban centers.

Findings of the study shed more light and inform e-waste policy and strategy process in Kenya by proposing a well regulated e-waste technology, inventory and knowledge management and a legal framework.

## **1.7 JUSTIFICATION OF THE STUDY**

Computer for Schools Kenya (CFSK) has five regional centers which act as support centers as well as collection centers for end of life computers having received them as donations. CFSK refurbish and dispatch them to schools. CFSK can be able to process up to 2000 units per month, but currently it receives only 200 -300 units a month (UNEP,2010).

Kenya is the first sub-Saharan country to have a NOKIA take back point with 6 points in Nairobi, Kisumu and Mombasa (Tanguy, 2010). In addition to this, Safaricom also has in place a take back model that mainly focuses on collection but relies on other partners for processing (Basiye, 2010). Safaricom and Nokia take back initiatives did not succeed.

It seems therefore that mobile phones and Computer equipments which have reached the end of their useful life are not collected back. This creates a serious health danger to the urban community. At the same time there lies great opportunity (positive impact) of recovering precious metals from WEEE. Lack of awareness, continued accumulation of e-waste in



households and offices, associated potential negative impact on health and the positive impacts that come with proper e-waste management informed the need for this study.

## **1.8 ASSUMPTIONS AND LIMITATIONS OF THE RESEARCH**

### **1.8.1 Assumptions**

- A1. The research respondents would be available and willing to participate in the study.
- A2. Data provided by the respondents would be accurate and reliable.
- A3. Nairobi city and its environs which had been chosen for this study would represent the overall e-waste situation in the country even though some other big towns were equally experiencing the same e-waste concerns.

### **1.8.2 Limitations**

This study was limited by the group of e-waste generators, the type of e-waste, by the geographical area under study, and finally by the limited information and availability of secondary data. The volume of e-waste generated at a single household was very insignificant, compared to e-waste generated by other generators such as government bodies, educational institutions and firms. Therefore only large e-waste generators were mapped leaving out household/single consumers.

## **1.9 THESIS OUTLINE**

This thesis appraises knowledge, awareness and practice in e-waste management. The main arguments (by researchers and e-waste stakeholders) in e-waste management policies and practice are reviewed. An ideal e-waste management framework is proposed for Kenya.

Chapter 1 introduces the thesis .Chapter 2 looks into literature on e-waste management from previous academic work, journals, and Internet. Issues on e-waste Policy and management Practice (of selected countries) are identified. A discussion of e-waste experience from other countries and the e-waste situation in Kenya is done.

Chapter 3 outlines the methodology used in the research study and a description of the research model used.

Chapter 4 tackles data analysis, presentation and discussion of the research findings.

Chapter 5 presents a summary of the study findings and discusses the theoretical and practical implications of the study. It acknowledges limitations of the study and points out areas for future research.



## 2 LITERATURE REVIEW

### 2.1 INTRODUCTION

This chapter presents a review of related literature and relevant citation of what other scholars have written on the research topic with an aim of pointing out the existing gaps. There exists knowledge gap on the flows and quantities of e-waste generated in the country and the e-waste imported into Kenya (Basiye, 2008). The chapter also gives a conceptual framework from literature and links between this framework and the defined problem. The chapter starts by discussing general mass flow of e-waste then proceeds to present e-waste management experiences from selected countries notably Switzerland, India and South Africa. It then discusses the e-waste situation in Kenya with reference to available data based on previous research. Lastly it looks into the existing e-waste legislative frameworks and ICT policy landscape in Kenya with a view of recommending the adoption and integration of EPR into national legislations.

### 2.2 GENERIC MASS FLOW

According to EMPA (Waema et al., 2008 p 16) all e-waste systems can be represented through some variation of generic model as shown in the Figure 2.1 below:

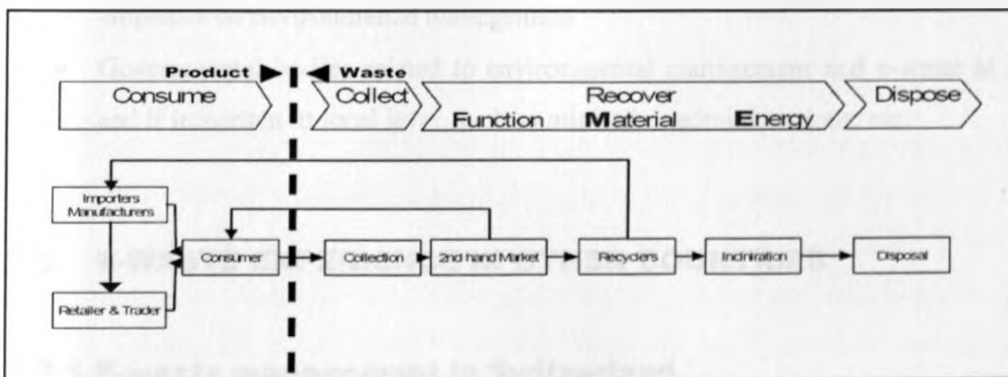


Figure 2. 1 Generic mass flow. Source: Adapted from (Waema et al 2008, cited in Rochat. D; Schluep. M (2007)

According to Waema et al. (2008, p16), the consumer gets a computer from the importer or manufacturer who directly supplies to the market or through a retailer. When a computer gets

to the end of useful life the disposal process begins. In well established frameworks formal or informal collection systems are used to collect the computer. The computer may then be fed into the secondary market that extends its life cycle by refurbishing it. Once it has been repaired the computer is sold back as second hand to a consumer and the cycle is repeated. A computer that is beyond repair is dismantled to recover the e-waste component material. Incineration can be used to recover energy from e-waste material.

According to Schluep et al. (2008, p3) the following information should be collected when using the generic methodology by HP-DSF-Empa project “e-Waste Management in Africa:

### **1. E-waste related policies and legislations information:**

- General environmental legislations applying to air, water, solid waste, hazardous wastes, etc.
- Specific legislation applying to e-waste, if any.
- Social legislations / policies applying to workers of the recycling chain, e.g. regulating child labour, freedom of association, programs fostering employment in the informal sector etc.
- International treaties and conventions, such as the Bamako convention and the Basel convention.

### **2. Institutional framework information:**

- Organization of the legislative, the executive and the judiciary systems with a special emphasis on environmental management
- Governmental bodies related to environmental management and e-waste at national and if important at local level, such as ministries, administrations, etc.

## **2.3 E-WASTE EXPERIENCE IN OTHER COUNTRIES**

### **2.3.1 E-waste management in Switzerland**

According to UNEP (2007), review of current practices of WEEE/ E-waste in different countries provides an understanding of policies/ laws/ regulations and institutional framework for WEEE/ E-waste management. The entire financial model in Europe is based on “Extended Producer Responsibility”, where the producing organizations are responsible for

WEEE/E-waste take back and treatment. The conceptual guidance for WEEE/ E-waste collection, transportation and treatment schemes has been provided by EU directive. These guidance features as per EU directive include:

- Producers are responsible for the costs of picking up WEEE/E-waste from collection facilities and for refurbishing waste products for reuse or for recycling and recovery.
- For “historical” products” (i.e., those put on the market before August 13, 2005), the costs of waste management are to be shared by all producers in existence at the time those costs are incurred. These producers may impose a separate “visible fee” (one that is explicitly designated, perhaps on the price tag) to cover these costs for eight years (ten years for large household appliances).
- End users other than households may be made partly or totally responsible for financing the management of historical products.
- For new products (i.e., those put on the market after August 13, 2005), producers have “individual responsibility”, i.e. they must pay the cost of managing their own products. They can do this through programmes set up by individual companies or through participation in collective schemes.
- No visible fees are permitted to fund the management of waste from new electrical and electronic products.
- When producers put a new product on the market, they must provide a financial “guarantee” that waste management of the product will be paid for. Producers can get waiver on this guarantee by participating in a producer responsibility organization (PRO), paying recycling insurance, or setting up a special bank account for this purpose.

According to UNEP (2007), the sustainability of WEEE/E-waste management is dependent on financial viability of WEEE/E-waste collection, transportation, treatment and disposal which in turn is dependent on regulatory system in place as it will define the standards and institutional mechanism for WEEE/E-waste management. Developed countries adopts a financial mechanism system that covers each aspect of WEEE/ E-waste management like collection, transportation and treatment costs of WEEE/ E-waste. The fee structure consists of different options including actual costs of recycling, projected costs of recycling per category and cross subsidization.

According to UNEP (2007), the Swiss system is based on EPR, both legally and operationally i.e. producers and importers are both physically as well as financially responsible for an environmentally sound disposal of WEEE/E-waste. The salient features of Swiss WEEE/E-waste supply chain model are:

1. The entire operative responsibility is shared with the two PROs—SWICO and S.EN.S, who manage and operate the system on behalf of their member producers.
2. Secured financing of the collection and recycling is ensured by way of the Advance Recycling Fee (ARF) charged on all new appliances. The ARF is used to pay for the collection, the transport and the recycling of the disposed appliances. The ARF can range from a minimum CHF (Swiss franc) 1 on small items, such as hair dryers and electric shavers, to up to CHF 20 for TVs or CHF 40 for refrigerators. Both SWICO and S.EN.S have distinct categories of products according to the approximate cost of recycling them. It is seen that the largest portion of the ARF goes to the recyclers.
3. The Swiss ARF is an intergenerational contract between appliances purchased in the past and those that will be purchased in the future, similar to a pension system. Therefore, it requires accurate estimations of how much waste will be generated and how many new products will be sold.
4. SWICO and S.EN.S have official collection points around Switzerland in addition to the thousands of retail locations which have to take back old equipment free of charge, irrespective of the brand or year of manufacture. It becomes easier for consumers to dispose their WEEE/E-waste at appropriate locations.
5. By having common collection points, the PROs are better able to manage logistics, benefit from economies of scale and provide a consumer friendly, all inclusive solution instead of a prohibitively expensive brand specific one.
6. Both material and financial flows are controlled at every stage.
7. The independent controls not only deter free riders, but also give credibility to the entire system. It also ensures participation of retailers and consumers.

UNEP (2007) summarizes policy, laws, regulations, and institutional roles of WEEE-E-waste in Switzerland as follows:

#### **1. B2C waste collection and B2B waste responsibility**

Distributors, Manufactures, and Retailers must take back free of charge (even if no equipment is purchased). Consumers fund collection and recycling through ARF.

## 2. National registry

It is the responsibility of Environment ministry but no registry implementation. It is done by Swiss cantons. There is no cleaning house while collective systems include SWICO-ICT, SENS-White Goods and SENS with SLG (Luminaries and illuminants).



Figure 2. 2 The Switzerland e-waste "wheel of life": Available at <http://www.e-waste.ch/en/buy/index.html>. Accessed on 3 March 2011.

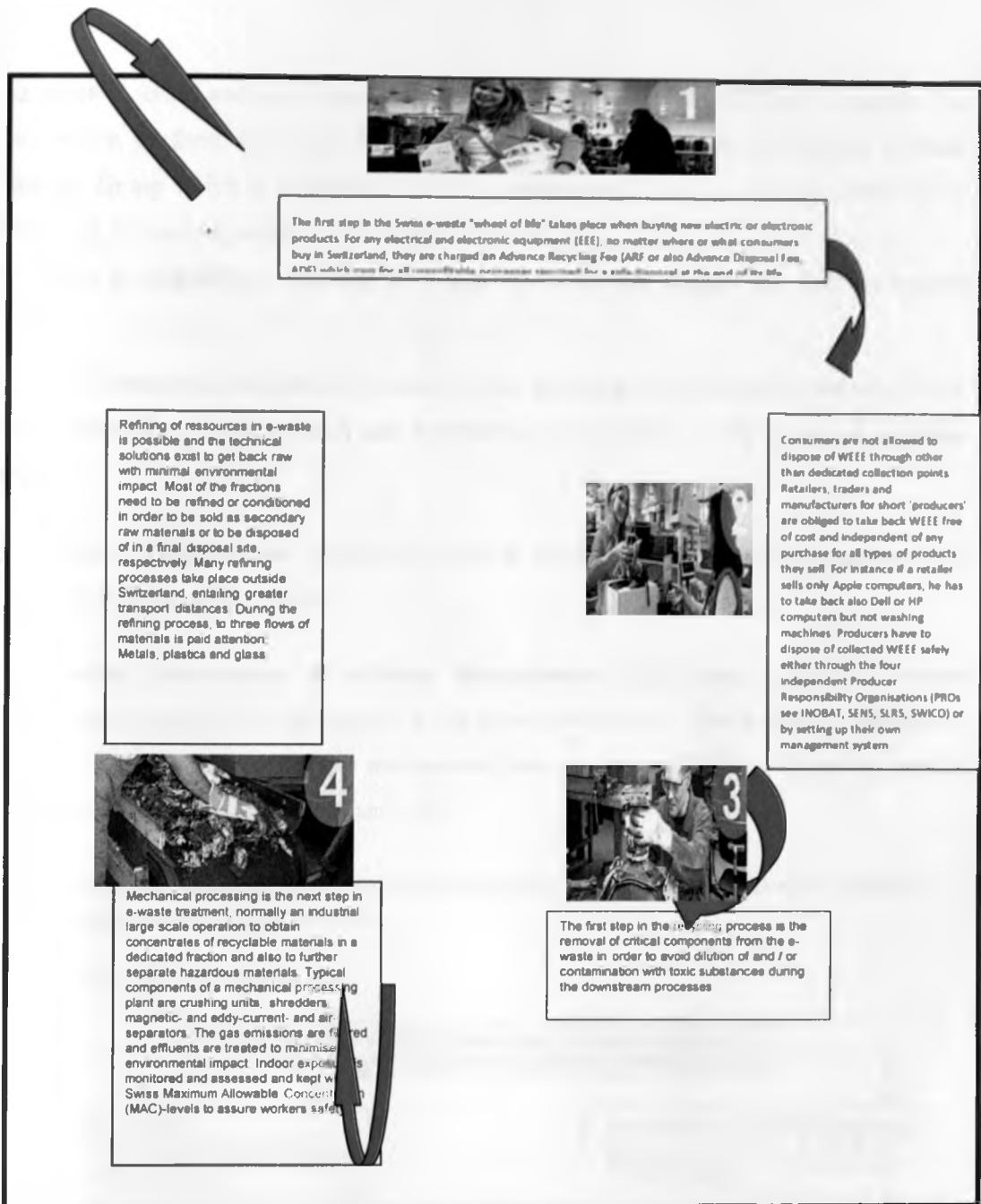


Figure 2. 3 Detailed Switzerland e-waste "wheel of life": Available at <http://www.e-waste.ch/en/buy/index.html>. Accessed on 3, March 2011.

### 2.3.2 E-waste management in India

According to Mueller (E-waste guide), in India EMPA is implementing a clean e-waste Channels in large Indian cities as well as developing a national e-waste strategy. A national framework developed in a joint effort by all relevant stakeholders is required as a basis for



the implementation and more importantly for the replication of Clean e-Waste Channels. The cooperation platform, led by the Ministry of Environment (MoE), is the National e-Waste Strategy Group which is subdivided into five committees. These committees work in the following crosscutting areas:

1. **Policy & Legislation:** Building up a legal framework to support the national e-waste strategy.
2. **Data & Baseline:** Studying the present e-waste recycling system in India, assessing the e-waste quantities in Indian cities and establishing relationships to the informal recycling sectors.
3. **Skills & Technologies:** Transferring expert knowledge in e-waste management and recycling technologies to India.
4. **Industry Participation & e-Waste Management:** Establishing a national e-waste management strategy to be accepted by the relevant stakeholders. This includes a stakeholder agreement on the applied e-waste management concept (responsibilities, financing, control and regulation of Clean e-waste Channels).
5. **Awareness & Campaigning:** Increasing the public awareness for the e-waste problem in India, especially in the large cities.

The summary is Figure2-4 below:

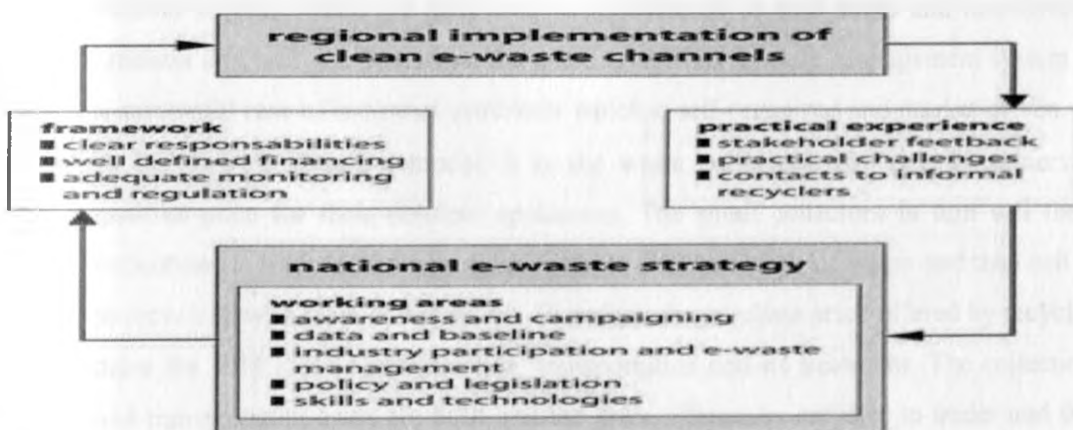


Figure 2. 4 The Clean e-Waste Channels framework: Source Adopted from (Esther Mueller, e-waste guide)

In implementing the clean e-Waste Channels in India's large cities EMPA follow a two stage strategy:

**Stage 1:**

Clean e-waste Channels for corporate consumers are implemented while EMPA helps to gather experiences for setting up and running a clean e-Waste Channel. At the same time the informal sector is trained to handle the critical recycling process.

**Stage 2:**

Private households and Small and Medium Enterprises (SME's) are linked to the established Clean e-Waste Channels. The informal recyclers are integrated in the formal recycling processes for labour intensive manual operations such as dismantling and material segregation.

According to Otini (2010), in India small scale entrepreneurs have benefited from training on informal recycling from the government to help in the reduction of the countries huge e-waste volumes due to their proximity to the electronics consumers. This in turn has enabled them to earn money from the business. The entrepreneurs also serve as collection centers for unprocessed components. According to a recent study (UNEP, 2007) the salient features of existing WEEE/E-waste collection, transportation and recycling system in India are:

- There is no regulatory mechanism, which stipulates the management and handling of post-consumer WEEE/E-waste generated within the country.
- The system has developed very organically, as a natural branching of the scrap industry which accepts scrap from many sources including old ships, end-of-life vehicles and building wastes.
- The established scrap metal industry absorbs the new WEEE/E-waste stream to recover metals, which are then used as a feedstock to steel mills and non-ferrous smelters and refiners. Therefore, the existing WEEE/ E-waste management system is a successful case of industrial symbiosis which is self-organized and market-driven.
- In the existing financial model, it is the waste collectors who pay consumers a positive price for their obsolete appliances. The small collectors in turn sell their collections to traders who aggregate and sort different kinds of waste and then sell it to recyclers, who recover the metals. Therefore, the purchase price offered by recycler drive the WEEE/E-waste collection, transportation and its treatment. The collection and transportation costs are built into the price offered by recycler to trader and the price offered by the trader to the collector. Finally, the raw material producer offers the price to the recyclers as per the local metals, glass, plastic and other items rate or as per wholesale domestic or international market.

- The recycling network consists of a series of private–private relationships among waste pickers, itinerant buyers, dealers, wholesalers and recycling enterprises. The entire industry is based on a network existing among collectors, traders and recyclers, each adding value, and creating jobs, at every point in the WEEE/E-waste trade value chain.
- Low level of initial investment is required to start a collection, dismantling, sorting or recovery business, it is therefore attractive for small entrepreneurs to join the industry.
- The main incentive for the players is financial profit, not environmental or social benefits. The biggest drawback of the current Indian system is the uncontrolled emission of hazardous toxics that are going into the air, water and soil. The health hazards from fumes, ashes and harmful chemicals affect not only the workers who come into contact with the WEEE/ E-waste, but also the environment.

According to *Managing E-waste: Indian perspective* some of the challenges India is facing include:

1. Rapidly increasing E-waste volumes.
2. No accurate estimates of the quantity of E-waste generated and recycled.
3. Low level of awareness amongst manufacturers and consumers of the hazards of incorrect E-waste disposal.
4. Open air burning using rudimentary techniques.
5. Inefficient recycling processes.

### **2.3.3 E-waste management in South Africa**

According to Schlupe et al., (2009, p 73), South Africa and China have been identified for sustainable e-waste recycling technologies by applying the UNEP technology transfer framework. South Africa is currently implementing a national e-waste recycling compliance scheme, which would ensure that framework conditions would be favourable for a successful technology transfer. This program is supported by Swiss e-Waste programme, Hewlett Packard, Dell and Nokia. Kenya, Uganda, Senegal and Peru are grouped together in Group A and are classified as promising for the introduction of pre-processing technologies with a strong support in capacity building (Schlupe, 2009 p70).

Setting up state of the art recycling infrastructure without considering the economic and social boundary conditions cannot meet the aims of technology transfer for e-waste recycling. Technology transfer without taking into account (i) the amount of e-waste to be processed in

such plants, (ii) social and cultural boundary conditions and (iii) role of existing informal sector hampered and resulted in failure pilot projects such as the case of China (Schluep, 2009). In South Africa e-waste processing has seen quite a significant level of investment due to the high amounts of waste generated, however huge volumes of waste continue to go uncollected as there are no proper strategies to encourage collection and transportation (Otini, 2010). A centralized national recycling system where the national plant breaks down more complicated components like plastics, ferrous metals and aluminium is used.

## 2.4 E-WASTE SITUATION IN KENYA

### 2.4.1 Statistics

Item	Assumptions	Tons of E waste per year
Overall	850,000 computers; 1 printer for every 2 computers	
PCS	10% discarded every year; 1.39 kg per computer	1,138.15
CRT Monitors	10% discarded every year; 15.87 kg per CRT monitor	1,348.95
Printers	10% discarded every year; 11.7 kg per printer	497.25
	Total e waste accumulated per year	2,984.35

Table 2. 1 Statistics on e-waste in Kenya: Source (Waema *et.al.*, 2008)

The above data gives the e-waste from computers, monitors and printers generated in 2007 depending on the accuracy of the number of computers and printers. Assuming similar numbers are generated every year, which in reality is not the case since ICT penetration increases every year, one could therefore argue that at least 3,000 tons is generated every year. If other forms of e-waste are included in this calculation, the e-waste generated every year is quite high. According to a UNEP study 11,000 tones of e-waste are generated annually in Kenya (UNEP, 2010). The accumulated e-waste (over the years) is consequently a lot because little is being done to get rid of the existing e-waste.

### **2.4.2 Challenges facing e-waste management in Kenya**

Challenges with regard to e-waste management include growth in technology, electrical equipment having no manufacture dates, inadequate forums for interaction and inadequate capacity and infrastructure (Onyancha, 2010). Lack of technical know-how on recycling e-waste and specific law on WEEE are additional challenges facing e-waste management in Kenya (Magangi, 2010). The current disposal mechanism in Government through procurement poses challenge in proper disposal (Bitange, 2010). Furthermore Kenya has regulations under the Basel convention on illegal trans-boundary movement of hazardous waste; however the challenge is enforcement (UNEP 2010).

Osibanjo (2009) reiterates that “the consignment of admixture of EEE and WEE are not shipped as wastes, but as second hand products. Therefore, technically they do not fall under the Basel Convention at this point. However, many of these products are near their end-of-life, so African countries have the challenge of dealing with these wastes in an environmentally sound manner. Yet many of these products come primarily from developed countries which prohibit export of e-waste to developing countries.” He points out the fact that there is no common understanding, definition, and classification at the international level, of what electronic waste and parts are to be regulated under hazardous waste law, rules and procedures.”

A recent study (Basiye, 2008) identifies the following as challenges facing e-waste management in Kenya.

#### **1. Consumer perceptions on e-waste**

Consumers perceive e-waste as money and are not willing to take back EOL EEE especially mobile phones for recycling unless they are paid. To consumers everything including waste is money.

#### **2. Lack of financial resources, infrastructure and relevant technology**

No funds or resources are kept aside for managing e-waste and also there is no infrastructure for recycling. Technology that can be applied to recycle e-waste is inadequate and very expensive.

#### **3. Stakeholder awareness**

There is serious lack of awareness on the potential hazards of e-waste amongst the Stakeholders such as collectors, consumers, recyclers and scavengers. There is also lack of information on e-waste.

#### 4. Illegal imports

The level of importation of second hand devices is high and uncoordinated hence zero rated products find their way into the country without being taxed. Mobile phones and accessories are easily sneaked in as hand luggage.

#### 5. Absences of regulations and lax regulatory control

E-waste management lacks the necessary regulatory framework, comprehensive policies and standards. There is also laxity in implementation of existing regulations.

With regard to guidelines for e-waste management in Kenya, the current situation on legal and Institutional Frameworks reveal lack of specific law on WEEE, availability of the Basel Convention, Nairobi Declaration (CoP 8), Sessional Paper No.6 of 1999, Environmental Management and Coordination Act ,(EMCA)1999,Waste Management Regulations 2006 and controlled substances regulations 2006 (Magangi, 2010 ).UNEP has developed integrated waste management strategy for Nairobi; however e-Waste component needs to be developed further. The report further adds that UNEP is working with UNIDO to develop global guidelines on management of e-waste (Croppar, 2010).

### 2.4.3 Flow of e-waste

According to (Basiye, 2008) E-waste flow among corporate and private consumers in Kenya is as summarized in Figure 2.5 below.

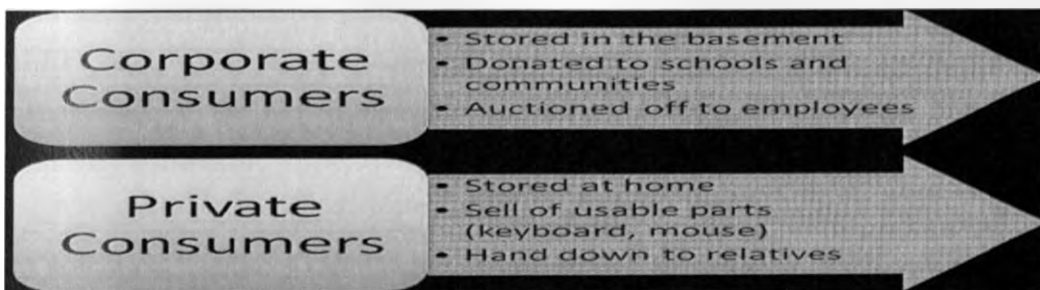


Figure 2. 5 Flow of e-waste. Source (IEEE 2008)

According to a report, “currently the main route of disposal of e-waste in most developed countries is through export to developing countries in the name of ‘bridging the digital divide’ “(UNEP, 2009).

Various reasons have been cited for movement of e-waste to Africa. This movement has been orchestrated by an agreement between the recipient and the generating country wherein the later promises aids, money or execution of a project with the territory of the recipient nation. The generating country thus easily saves on disposal costs while at the same time easily finds an easy opportunity of complying with legal requirements (Aniyie, 2009).

#### **2.4.4 ICT policy and regulatory framework in Kenya**

The first national ICT policy was approved in January 2006 and came into effect in March 2006. However the strategy for implementing the policy has not been yet drawn (Waema, 2007). ICT policy in Kenya remained in draft for long because of a disjointed institutional framework for policy development, lack of a high-level ICT champion in government and lack of adequate and sustainable funding for ICT (Waema, 2005). The Ministry of Local Government is developing a solid waste management policy but there is no mechanism to implement this while Nairobi City Council is developing an integrated solid waste management strategy in conjunction with the United Nations Environment Programme (Amy, 2009).

According to (Waema et al., 2010), in Kenya, ICT issues are considered under various pieces of legislation such as the Kenya Communications Act of 1998; the Science and Technology Act, Cap. 250 of 1977; and the Kenya Broadcasting Corporation Act of 1988. The national ICT policy (The Kenya Gazette, 2006) recognizes that these Acts are inadequate in dealing with issues of convergence, electronic commerce and e- Government. It also recognises the need for a comprehensive policy, legal and regulatory framework. According to Basiye (IIIEE 2008, p 44), these statutes are however inadequate in dealing with end of life management of the ICT equipment since they only basically cover the licensing and frequency distribution.

On policy and regulatory environment the ministries responsible for health, environment and ICTs have recognized the challenges posed by e waste but the level of preparedness in terms of policy and regulations is low. The ministry responsible for environment is concerned about the e-waste but has no policy to deal with e waste management while the ministry of health has no capacity to deal with e waste (Waema et al., 2008). The research findings point out

that the ministry of Information and communication technology is proactive regarding e waste.

According to (Waema et al., 2008), with regard to the national context of e-waste management, Kenya is a party to both Basel and Bamako conventions. At policy level, the Ministry of Environment and Mineral Resources (MEMR) has promulgated a strategic plan (2006-2010), its function being the full implementation of the environmental Management Coordination Act (EMCA, 1999). The Ministry's role is to create an enabling environment through policy, legal and regulatory reforms for environmental and mineral resources management (MEMR, 2006).

#### 2.4.5 E-waste management and legislative framework in Kenya

On e-waste management, UNEP admits that "WEEE/E-waste is a complex mixture of hazardous and non-hazardous waste, which consists of items of economic value. Therefore, it requires specialized segregation, collection, transportation, treatment and disposal" (UNEP, 2007). WEEE/E-waste management involves an understanding of WEEE/E-waste generation followed by its transformation into new material through its life cycle as shown below in Figure 2.6 below;

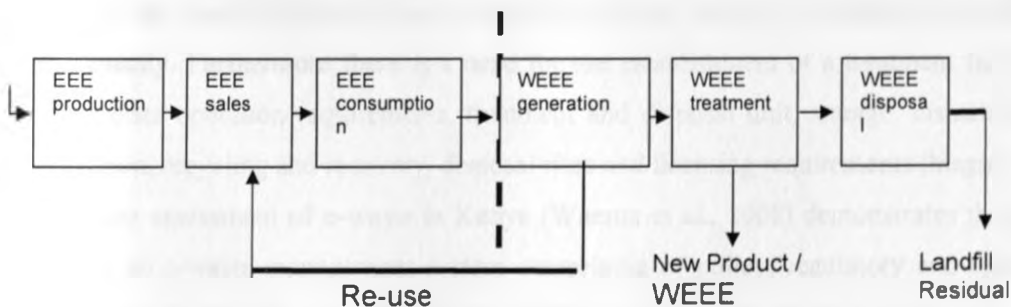


Figure 2. 6 Conceptual Life Cycle of Electrical and Electronic Equipment Source: UNEP (2007b)

According to Waema et al, (2008), the ministry of Information and Communication in Kenya is proactive regarding e waste and in 2006 formulated an ICT policy on e-waste that states that" As a prerequisite of grant or renewal of licenses, applicants must demonstrate their readiness to minimize the effects of their infrastructure on the environment. This should include provision for appropriate recycling /disposal facilities for waste that may contain toxic substances." A Universal Licensing Framework (ULF) has been implemented, by Communication Commission of Kenya (CCK) that requires telecommunication operators to



take responsibility of their discarded technology. There is limited capacity to collect and process e-waste, and no mechanism to separate it from solid waste (Amy, 2009)

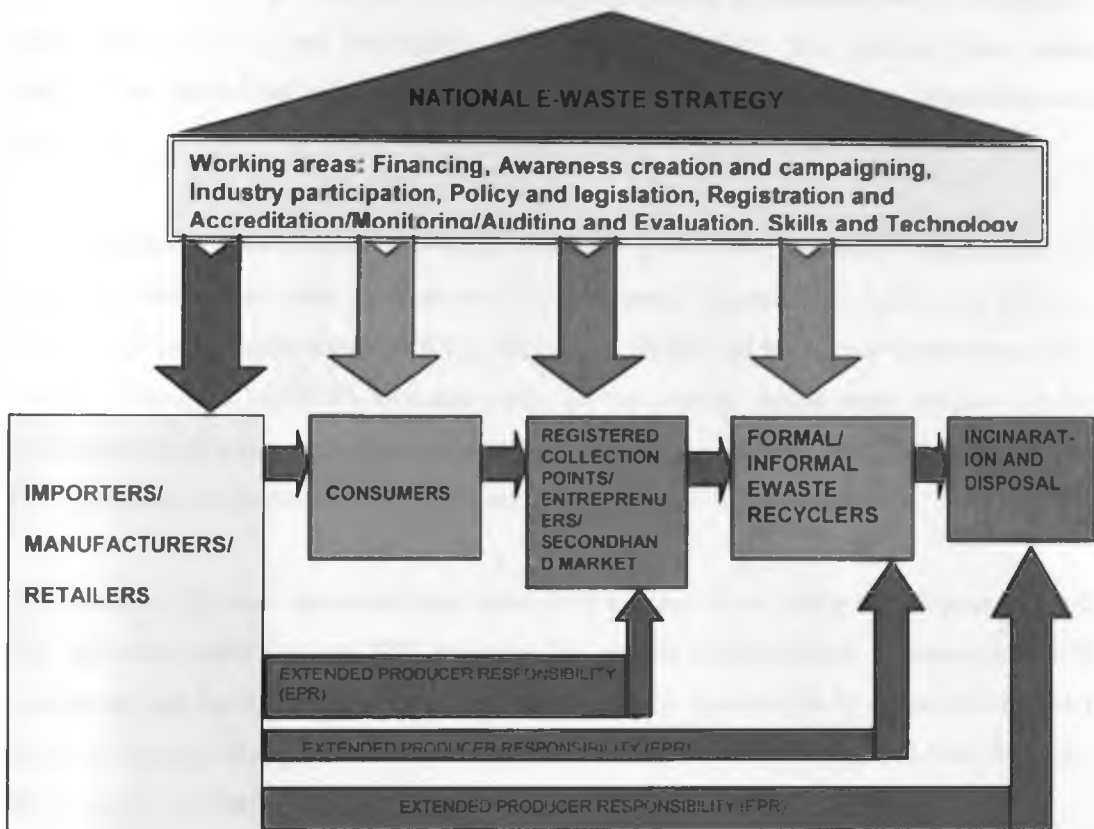
NEMA guidelines for e-waste management in Kenya identifies producers, manufactures, importers, assemblers, distributors, consumers, government institutions and refurbishers or recyclers as target groups for managing e- waste. On collection the guideline proposes the following as mechanisms for consideration when coming up with an e-waste legislative framework:

- Municipal collection
- Designation of collection centres
- Producer take back schemes
- Producer Responsibility Organization (PRO)
- Storage on site or offsite
- Transportation
- Training of handlers
- Licensing of collection centres

It is further suggested that storage facilities should put into consideration retailer take back, producer take back, municipal transfer stations, sorting (streams), Technical specifications and Capacity. Furthermore there is a need for the establishment of a treatment facility that encompasses operation requirements, treatment and disposal unit, storage, dismantling and segregation, recycling and recovery, disposal sites and licensing requirements (Magari, 2010). A baseline assessment of e-waste in Kenya (Waema et al., 2008) demonstrates the need to establish an e-waste management system comprising of policy, regulatory and operational components. A roadmap was suggested to address the challenges facing e-waste.

## **2.5 CONCEPTUAL RESEARCH FRAMEWORK**

The research framework for this study obtained from review of related literature. The study used a conceptual framework derived from EMPA's generic framework or model which describes the manufacturers or importers of e-waste, the consumers, the recyclers as well as the down stream market all of which will provide source of data for the study. The conceptual framework is as shown in Figure 2-7 below.



From the EMPA's generic framework the conceptual framework borrows EEE product consumption, WEEE collection, recovery and disposal. From the EMPA's national e-waste framework and two stage strategy in implementing the clean e-Waste Channels in India's large cities the framework borrows clear responsibilities, well defined financing and adequate monitoring and regulations. Also included are the following national e-waste working areas:

- Awareness creation and campaigning
- Data and baseline
- Industry participation and e-waste management
- Policy and legislation
- Skills and Technology

An addition to the conceptual framework is e-waste collection/transportation. Other addition include the informal e-waste recycling as used in Asian Countries like China and registered entrepreneurs used in India.

The national e-waste strategy looks into areas such as: financing, awareness creation and campaign, industry participation, policy and legislation, registration and accreditation, monitoring, auditing and evaluation, skills and technology. The strategy cuts across stakeholders such importers, manufacturers, retailers, recyclers, collectors consumers and disposers.

In implementing the national e-waste strategy, government agencies responsible for environmental issues such as National Environmental Management Authority(NEMA) , Ministry of Local Government(MOLG), Ministry of Health and Ministry of Environment and Natural Resources(MOENR) formulate and enforce e-waste management policies for the producers, distributors, recyclers/ refurbishers, and the consumers. The producers sell new ICT equipment to distributors and suppliers who in turn sell to the consumers.

Consumers of the new items take back some of the items for recycling and dispose the rest. The recyclers resell repaired ICT equipment as second hand products to consumers. ICT equipment that have reached end of their useful life is disposed of in an environmentally friendlier manner taking into consideration useful metals that can be extracted from them and the potential of creating jobs for the youth.

The government policy, legislative and regulatory framework applies to e-waste touching on; workers of the recycling chain, regulating child labour, freedom of association and employment in the informal sector.

EMPAs national e-waste framework and two stage strategy in implementing the clean e-Waste Channels in India's large cities were used to gather necessary data for the study. The conceptual framework looks into legal and regulatory framework that includes measures against illegal dumping, mandatory take-back, disposal bans and restrictions, material bans and restrictions. Another important aspect of the framework is economic and financial instruments which introduce specific laws/legislations that could send economic signals to manufacturers to reduce wastes from their products, such as deposit refund system (EPR), removal of subsidies on virgin raw materials, waste banks, tax rebates and subsidies.

Information instruments and public awareness such as environmental labelling, product hazard warnings, product durability warnings, and energy efficiency labelling are also an

integral part of the framework. Finally the conceptual framework considers technological dimensions to address the need for building national e-waste handling capacity.

## 2.6 CHAPTER SUMMARY

This chapter has presented literature from journals and other academics writings. It has revealed that Kenya faces serious challenges with regard to e-waste management. Switzerland has an e-waste management policy while South Africa and India are better off compared to Kenya on e-waste policy development. Finally the chapter has presented a conceptual framework developed from the EMPA<sup>3</sup>S framework.

## **3 METHODOLOGY**

### **3.1 SCOPE OF THE STUDY**

The study was limited to Nairobi and its environs with regard to geographical coverage. Nairobi was chosen because it is argued that Nairobi is the heaviest consumer of ICT products, consequently has more challenges related to e-waste (Waema et al., 2008). With regard to product it focused on Information and Communication Technology (ICT) equipment and specifically; personal computers, laptops and note books, flat panel monitors, cathode ray tube (CRT), printers and other computer related accessories.

### **3.2 TARGET POPULATION AND DESIGN OF STUDY**

According to Waema et al. (2008), "The e-waste 'universe' in Kenya comprises stakeholders ranging from importers, assemblers, retailers, consumers, refurbishers, recyclers, downstream vendors, and final waste disposers to policy-makers and selected households located near dumpsites. A working list was developed for the research since the licensing framework does not disaggregate ICTs from general trade. This means that no definitive list of stakeholders is available from the Ministry of Trade and Ministry of Industrialization or professional associations.

### **3.3 DATA COLLECTION METHODS AND RESEARCH TOOLS**

Data for the proposed study was collected through review of documents of policies and laws. Site visits to recyclers, refurbishers, municipal landfills and other collection points were also done. Research tools were customized from the proposed conceptual framework. The primary tool for data collection was the questionnaire. Questionnaires were self administered in hard copies to the identified respondents. Pilot questionnaires were circulated to colleagues and Electronic and Electrical Equipment consumers, other e-waste stakeholders and policy makers for comments and suggestions. Those accessible by e-mail were also involved in piloting the questionnaires. The feedback helped in identifying problems in the questionnaires. The questionnaires were then revised and corrected appropriately. Two sets of final separate questionnaires, one for policy makers and the other set for other e-waste stakeholders were developed. The questionnaires were both closed and open ended.

Questionnaires were administered during field investigation. The target respondents were policy makers, regulators and enforcers, suppliers, manufactures, consumers, collectors and refurbishers of electronic and electrical equipments.

Interviews with key stakeholders in e-waste management and observations by the researcher were also used. Interviews were used to follow up ideas, probe responses and investigate motives and feelings which a questionnaire could not be able to do. Interview questions were developed on specific issues that emerged and needed clarification. Given adaptability as the major advantage of interviews, where necessary the researcher adapted to the setting by following-up on leads provided by participants. In spite of this, the framework of interview questions ensured uniformity and consistency in the data collected. Before the interviews, the researcher produced an introductory letter stating the purpose of the study. This gave assurance to the interviewees that the study was conducted solely for educational purposes. Interviews were tape-recorded with the permission of interviewees and later transcribed for analysis. A diary of interviews and discussions were kept and used later in the analysis.

General observations were also made during field visits to map activities going on in scrap dealers places, repair shops, refurbishing, government agency offices and collection centers. Photos and where appropriate and necessary videos helped fill information gaps. Secondary data were mainly gathered from key government documents especially those related to waste management in Kenya.

Safaricom's take back model which mainly focused on collection but relied on other companies for processing failed due to many challenges such as location of collection centres, competition from refurbishers, lack of incentives for consumers and lack of consumer awareness (Basiye, 2010). General observations, specific research questions and interviews with relevant stakeholders were used to shade more light on these challenges.

For purposes of this study, secondary data was also collected from secondary sources including publications from scientific journals, reports, and web sites on e-waste management practices and challenges in comparable countries. Comparisons were then made with research findings from primary and secondary data collected on e-waste practices and challenges in Kenyan. Switzerland, India and South Africa were chosen to represent a realistic sample in this study. Three reasons informed the choice.

First, review of secondary data from literature on a larger area would have been too large to handle given the time for the study, whilst a smaller area would not suffice. Choosing only one country would not have offered diversity and would not have been representative enough. South Africa was included in the study for two reasons. First, according to Otini (Business Daily Friday December 10, 2010), the South African centralised national recycling model could easily be replicated in Kenya. Second, in Africa it was only in South Africa where formal recycling facilities and infrastructure for e-waste management existed (Osibanjo & Noorom 2007, cited in Finlay 2005).

The second reason for choosing the three countries was that it was unlikely that the three would have the same level of advancement in the fields of ICT and e-waste management. A study of the three would therefore provide an opportunity to draw lessons from each other's strengths, weaknesses and challenges.

Third, the three countries had common approaches to e-waste management, sound national economies and reasonably advanced technological infrastructure hence great potential of e-waste generation. Switzerland was chosen because it was among other European countries such as Norway, Belgium, Sweden, and the Netherlands which not only had established WEEE/E-waste management systems that met minimum WEEE/E-waste collection and recycling targets set in EU directives but also performed better (UNEP, 2007).

Questionnaire for policy makers (attached as appendix A) asked questions related to government policy and legislation on e-waste as well as technology transfer issues. Questionnaire for e-waste stakeholders (attached as appendix B) asked questionnaires related specific issues on e-waste from the perspective of various stakeholders. Questionnaire for policy makers was circulated among senior ICT officers, senior health administrative officers, directors, Telecommunication officers and waste management officers, environmental officers. Questionnaire for e-waste stakeholders was circulated among IT specialists, ICT technicians, e-waste recyclers, dismantlers, manufactures, collectors, and large scale consumers such as government agency staff and secondary school computer teachers.

The two different groups offered an opportunity to trace the movement of electronic and electrical equipments in Kenya from importation, distribution, consumption and finally to disposal adequately, to see e-waste disposal practices and challenges faced by various stake holders. This also provided basic information on existing local initiatives and e-waste management activities, available technical infrastructure and expertise, and the general attitude towards solid waste management in Kenya. All questionnaires were hand delivered and collected.

The respondents for questionnaire on policy issues were mainly chosen because of the experience they had in the relevant areas and their familiarity with the issues investigated by this study. Table 3.1 presents the number of questionnaires distributed in each category and the number of responses received, together with the totals.

**Table 3. 1 Number of questionnaires distributed in each category and responses received**

Questionnaire type		Number of questionnaires distributed and responses received.
Questionnaire for policy makers		(10) 7 = 70 %
Questionnaire for e-waste stakeholders	Consumers	(75) 60 = 80 %
	Producers	(12) 8 = 66 %
	Collectors / Recyclers	(10) 7 = 70 %
<b>TOTAL</b>		<b>71.5 %</b>

In Table 3.1, the numbers in brackets represent the number of each questionnaire type distributed under each category. The numbers next to them represent the number of questionnaire responses received and these are followed by response rates in percentages.

As the statistics show, in all the categories nearly everyone responded, making a total response rate of 70 % to questionnaire for policy makers and 80% of consumers, 66 % of producers while 70 % of collectors/ recyclers all to Questionnaire for e-waste stakeholders. All the responses put together gives a total response rate of 71.5 % to the two questionnaires which was a good response to the research study.

Table 3.2 is a summary of the themes discussed, responsible agencies and the list of respondents identified by agency.



**Table 3. 2 Themes and issues discussed and lists of respondents identified by agency**

<b>Themes and issues of interest discussed.</b>	<b>Responsible agencies</b>	<b>List of respondents identified by agency</b>
1. Policy and Regulatory framework	Ministry of Environment-NEMA	-2 officers: Compliance and Enforcement (Waste Unit -NEMA)
2. Public awareness and consumer education	Ministry of industrialization-KEBs	-2officers:Standards development (KEBs)
3. Strategy on e-waste	Ministry of public health	-1 Senior officer: Health Administrative and Policy(Ministry of Public health and sanitation)
4.Implementation, monitoring and evaluation: -standards -audits -monitoring ass flows	Ministry of Information and Communication Technology (ICT)	-1 Senior ICT officer: Ministry of Information and Communication Technology)
	Public / private universities and tertiary colleges	-1 Senior curriculum developer: ICT (NEMA)
	Ministry of Local government	-1 Senior officer: solid waste management (NCC)

Similarly the respondents for questionnaire for e-waste stakeholders were mainly chosen because of their familiarity with the issues investigated by this study. Table 3.3 is a summary of the stakeholder category, themes and issues discussed and the list of respondents identified by category.

**Table 3. 3 Themes and issues discussed and lists of respondents identified by category**

<b>Stakeholder category</b>	<b>Themes and Issues of Interest</b>	<b>List of stakeholders identified by category</b>
Producers	<ul style="list-style-type: none"> <li>• Extended Producer Responsibility –EPR (Establishing collection and take-back centers).</li> <li>• Extended Producer Organizations(EPO)</li> <li>• Finance</li> <li>• Awareness creation</li> <li>• E-waste Inventory</li> <li>• Challenges various stakeholders face in e-waste management</li> </ul>	<ul style="list-style-type: none"> <li>-1 waste management officer (Safaricom)</li> <li>-2 Telecommunication officers (Orange Telkom Kenya)</li> <li>- 10 Computer retail shop agents</li> </ul>

**Table 3.3 Themes and issues discussed and lists of respondents identified by category (continued)**

Stakeholder category	Themes and Issues of Interest	List of stakeholders identified by category
Consumers	<ul style="list-style-type: none"> <li>• E-waste separation at source</li> <li>• Return of equipment deemed to have reached end of life.</li> <li>• Finance</li> <li>• Awareness</li> <li>• Challenges various stakeholders face in e-waste management</li> </ul>	<ul style="list-style-type: none"> <li>-15 ICT officers, government ministries</li> <li>-10 Procurement Officers from government Ministries</li> <li>-1 IT operations and maintenance officer KPLC.</li> <li>-14 Secondary school Lab technicians</li> <li>-20 Secondary school Computer studies teachers</li> </ul>
Recyclers/ Refurbishers /Dismantlers/Repair shops/collectors	<ul style="list-style-type: none"> <li>• Proper processing of downstream fraction.</li> <li>• Skills and technology transfer of best practice in recycling.</li> <li>• Formalizing the informal sector</li> <li>• Environmental and health issues</li> <li>• Collection and transportation</li> <li>• E-waste inventory</li> <li>• Challenges various stakeholders face in e-waste management</li> <li>• Business and finance               <ul style="list-style-type: none"> <li>-Take back scheme</li> <li>-New business models</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>-2 e-waste staff CFSK.</li> <li>-1 Curriculum developer CFSK.</li> <li>-6 computer repair shop technicians</li> </ul>
Collectors	<ul style="list-style-type: none"> <li>• Collection and take-back</li> <li>• Challenges various stakeholders face in e-waste management</li> </ul>	<ul style="list-style-type: none"> <li>- 1 informal collector (Kibera)</li> </ul>

Most of the respondents were experienced and had relevant knowledge to respond to the issues investigated by the study. This was particularly true for the respondents who gave information on e-waste policy issues. Other respondents from various e-waste stakeholders were also able to provide adequate information on the various issues regarding e-waste collection, transportation, disposal, responsibilities and challenges among many others. Many respondents did not want to be identified by their names. Most policy makers preferred

identification by title while other stake holders mostly did not respond to the part for name and contact which was deliberately left optional.

Analysis and presentation of research findings was done in two parts these being qualitative and quantitative in nature.

### **3.4 DATA ANALYSIS AND THEIR JUSTIFICATION**

This section is treated in two parts namely quantitative and qualitative analysis.

#### **3.4.1 Quantitative analysis**

Collected data was entered and analyzed by simple descriptive analysis using Statistical Package for Social Scientists (SPSS) software. The rationale behind choosing the software was because it is the most used package for analyzing survey data. The software has the following advantages: it is user friendly, can easily be used to analyze multi-response questions, cross section and time series analysis and cross tabulation; (i.e. relate two sets of variables) and it can also be used alongside Microsoft excel and word. Descriptive statistics was done on the data. Descriptive statistics including the numbers, tables, charts, and graphs were used to describe, organize, summarize, and present data.

#### **3.4.2 Qualitative analysis**

Keakopa (2006), defined data analysis as the process of bringing order, structure and meaning to the mass of collected data. According to Keakopa (2006), amongst the many publications on analysing qualitative data, Marshall and Rossman describe it as a messy, ambiguous, time-consuming, creative and fascinating process. There are no strict rules to follow in analysing qualitative data (Williamson & Bow 2000, cited in Keakopa 2006). Qualitative assessment focuses on viewing the experiences from the perspective of those involved. It takes into consideration feelings and attitudes of respondents about a problem under investigation.

According to Ambert *et al.* (1995), qualitative research seeks depth rather than breadth. Instead of drawing from a large, representative sample of an entire population of interest,

qualitative researchers seek to acquire in-depth and intimate information about a smaller group of persons. Qualitative research also aims at learning about how and why people behave, think, and make meaning as they do, rather than focusing on what people do or believe on a large scale.

Qualitative data in this study will be manually processed and analysed using broader themes.

Figure 3.1 below presents the process that was followed in data management and analysis.

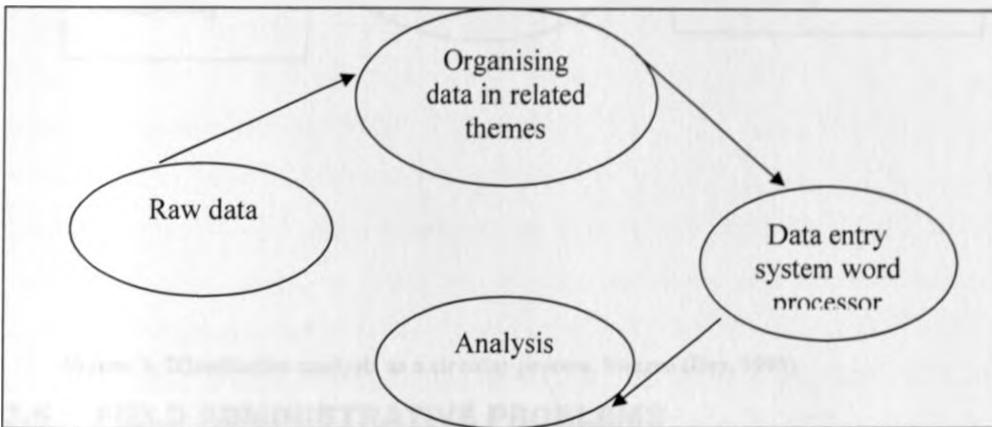


Figure 3. 1 Data management process. Source (Keakopa, 2006)

According to Dey (1993), analysis involves breaking data down into bits, and then ‘beating’ the bits together. Description lays the basis for analysis, but analysis also lays the basis for further description. Qualitative analysis lies on circular related processes of describing phenomena, classifying it, and seeing how concepts interconnect. This is shown in Figure 3.2.

To manage the data collected, raw data was organised under similar themes by e-waste stakeholder category. The completed questionnaires and the transcribed interviews were photocopied and originals kept safely. The answers to each of the corresponding questions from each stakeholder category were then cut and kept together for analysis. This made analysis easier as data under each theme was analysed separately. The data was then typed into a word processor and reorganised as necessary.

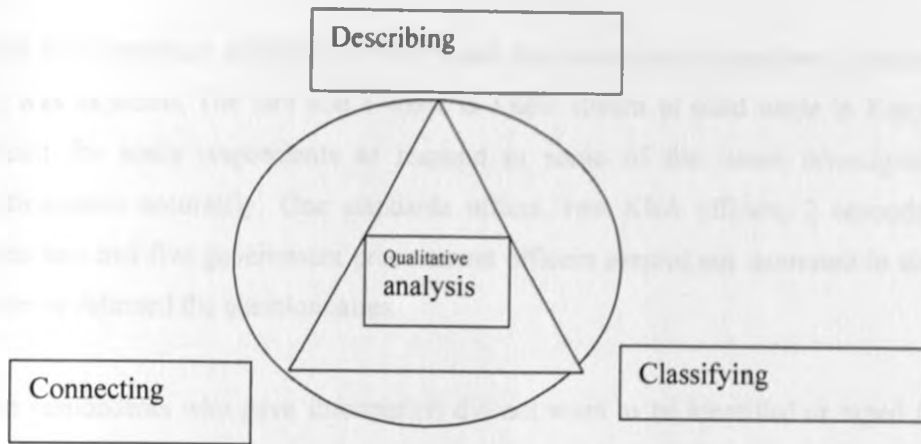


Figure 3. 2Qualitative analysis as a circular process. Source (Dey, 1993)

### 3.5 FIELD ADMINISTRATIVE PROBLEMS

Not all the policy makers approached responded to the questionnaire. This was mainly because most of the times policy makers were locked up in meetings. This led to unnecessary delay in data collection. Bureaucratic problems made it impossible for the researcher to get information from potential government agencies and institutions e.g. Communications Commission of Kenya (CCK) and Ministry of Local government. It was also impossible to access some policy documents.

The producers and generators of e-waste in Kenya especially the distributors of various computer brands such as Dell, Compaq and Toshiba among many others were not willing to participate in the research sitting fear of exposure of their businesses. Their keen interest was on their business rather than the negative environmental or health impacts due to in appropriate disposal practices by the final consumers of the electrical and electronic products. This made it difficult to collect relevant data from producers and generators of e-waste in good time.

Given that there is no proper register of legal recyclers and other e-waste actors in Kenya it was very difficult for the researcher to identify the correct respondents who could give

accurate and relevant information. This made the researcher to interview a smaller number than was expected. The fact that e-waste is a new stream of solid waste in Kenya made it difficult for some respondents to respond to some of the issues investigated by the questionnaires accurately. One standards officer, two KRA officers, 2 secondary school technicians and five government procurement officers seemed not interested in the research and never returned the questionnaires.

Some respondents who gave information did not want to be identified or taped for fear of being victimised by senior management in their organisations. I had to assure the respondents of confidentiality. This put pressure on me during the writing up, as I had to be cautious not to mention any names. Instead, I used their job titles, which they preferred. Most government agencies only allowed some officers to be interviewed or to fill in the questionnaire. Therefore, despite giving out more than one questionnaire in some agencies, only one would be returned, representing the views of that particular agency. Responses from more agencies, recipients of all the questionnaires and interviews with different respondents in one agency would have improved the results.

Some of the respondents, for example from the public sector, were not willing to either fill in the questionnaire or to be interviewed. This could be explained by the fact that in Kenya the establishment of anticorruption authority has left doubts in people's minds; so many people do not trust others especially when seeking information about public service and offices.

### **3.6 CHAPTER SUMMARY**

This chapter has presented the methodology used during the research study and how the data was analysed. Both qualitative and quantitative methods were used in the study. Primary data was collected through questionnaires, interviews, and direct observations during field visits while secondary data was collected from review of documents and literature. The data collected from interviews and questionnaires consisted of direct quotations from respondents about their experiences, opinions, feelings and knowledge on e-waste. The data from observations consisted of detailed descriptions of participants' behaviours, staff actions, and the full range of human interactions. Document analysis yielded excerpts and official reports..

# **4 DATA ANALYSIS, PRESENTATION AND DISCUSSION**

## **4.1 INTRODUCTION**

This chapter presents, analyses and discusses findings from the field research conducted between March 2011 and April 2011 from different e-waste stakeholder categories in Nairobi on various aspects of the study on e-waste management in Kenya. The information gathered through questionnaires, personal observations, discussions, interviews and photographs taken was analyzed thematically, presented and discussed as per research study questions then grouped in accordance with the different e-waste stakeholder categories and aspects of the study as follows:

1. Key issues in e-waste management from Producers perspective.
2. Key issues in e-waste management from Consumers perspective.
3. Key issues in e-waste management from Recyclers perspective.
4. Responsibilities of various e-waste stakeholders and challenges they face.
5. How other countries manage e-waste compared to Kenya and lessons Kenya could learn.
6. E-waste policy issues in Kenya.

## **4.2 KEY ISSUES IN E-WASTE MANAGEMENT FROM PRODUCERS PERSPECTIVE**

On the question why Extended Producer Responsibility in e-waste management had not taken off effectively in Kenya, one respondent reported that the main reason was absence of policy and proper legislation on e-waste. She noted that manufactures and distributors in Kenya were taking advantage of the delay by the government to come up with an e-waste policy and regulatory frame work. She observed that manufactures and distributors ought to be both individually and collectively responsible for the collection and safe disposal of computer related e-waste in Kenya. From the response above it seems therefore that the government should bear the greatest responsibility in providing policy and regulatory frame that would ensure that manufactures, importers and distributors of electronic and electrical equipments take responsibility of the resulting e-waste in Kenya.

Citing two separate take back schemes organized by two mobile phone operators in Kenya, another respondent reacting to the same issue reported that it was difficult to establish producer responsibility organizations in Kenya because individual manufactures had competition amongst themselves. This hindered collective responsibility on e-waste as compared to Switzerland where literature has revealed that collective responsibility is enforced through producer responsibility organizations. Therefore this could suggest that another reason why EPR had not been effective in Kenya was lack of collaborative approach amongst producers.

Reacting to the question on what the e-waste disposal mechanisms of producers in Kenya were, one respondent reported that her company had set up collection centres however it was not successful since consumers wanted to be given incentives in order to take-back their old EEE<sup>1</sup>. Additionally she mentioned that low awareness levels and invisibility of the collection points were some of the reasons why consumers did not return e-waste.

To complement the data collected through questionnaires and interviews, photographs were taken during the field visits to bring out in depth information that could not be revealed by the two. This was done with the permission of persons in charge for ethical reasons. Details of information about the photos are presented in Figures 4.1 and 4.2.

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<sup>1</sup> Response to Questionnaire for e-waste stakeholders on key issues in e-waste management for various stakeholders, completed by ICT officer: Safaricom, ICT department, Nairobi, April 2011.





**Figure 4. 1 Summary of photos taken during Safaricom's e-waste recycling campaign program during public exhibition on "go green" campaign at KICC on 3 April 2011. Source: Researcher.**

Safaricom encourages the return of old mobile phones and computer equipments to designated collection points for recycling and safe disposal. Photo 4 shows sim-cards, photo 5 shows shredded plastics, while photo 7 appears to be a television recycled from a computer monitor. Photo 8 is an object made from recycled e-waste. One respondent confirmed this by reporting that Safaricom Company has established collaboration with CFSK where Safaricom collects e-waste and forwards them to CFSK for safe disposal and recycling<sup>2</sup>.

<sup>2</sup> Interview with Safaricom officer: Corporate Social Responsibility, Safaricom, on 4 April 2011, at KICC, Nairobi.

However 70.00 % of retail shops and distributors of the various computer brands in Kenya interviewed reported that they did not have a lot of e-waste to dispose since they were with the consumers. It was interesting to note that the remaining 30.00% who agreed that they had e-waste were not free and willing to divulge much information on what they did with them or how they disposed them. The silence or reluctance on this issue could suggest that a significant quantity of e-waste is silently being generated in Kenya even by those who ought to lead by example in managing this new stream of solid waste. It therefore appears that very few manufactures could be taking responsibility of resulting e-waste due to their activities in Kenya.

Asked to comment on what financing model would be sustainable in Kenya, 100.00 % of the respondents were convinced that a model that gave consumers incentives would be the most ideal; however they were doubtful about its practicability. According to the respondents interviewed, consumers of electronic and electrical equipments should be paid a fee for any waste equipment returned back. However on financing the model, one respondent felt that the cost should be shared between manufactures, consumers and the government. The government in their view needed to give a conducive and favourable investment environment that would help producers cut on other operational and e-waste management costs. Some respondents felt that an advance recycling fee could be introduced.

In view of the above, the researcher feels that a sustainable e-waste financial management model in Kenya should provide incentives to consumers to promote take back. It is also the understanding of the researcher that the greatest financial responsibility for e-waste management lies with the producers. The government needs to create conducive environment such as reduced tax on imported EEE, reduced bureaucracy during registration of companies and investor organizations. This could protect producers from corrupt government officials who may want bribe in order to register producer responsibility organizations in Kenya. For historic e-waste the government should set aside some money to facilitate their collection and safe disposal, while for new e-waste the government should enforce EPR by making individual manufactures responsible for financing the collection, transportation, treatment, recycling and safe disposal.

Of all those who responded to the issue on the adequacy of their consumer inventory system, 65.00 % reported that they did not have consumer inventory systems while 25.00 % said that

they kept consumer inventory systems of the electronic and electronic equipments sold to consumers however they were neither effective nor adequate. This suggests that the government of Kenya does not have clear mechanisms of control, audit and monitoring e-waste flows hence manufactures and distributors of electrical and electronic equipments feel that they are not obliged to present their inventory to any authority for audit. This could mean that some manufactures and distributors of EEE in Kenya did not support the idea or did not see the need for keeping an inventory probably because they were convinced that nobody would conduct an audit.

### **4.3 KEY ISSUES IN E-WASTE MANAGEMENT FROM CONSUMERS PERSPECTIVE**

This section presents a systematic analysis of data collected after grouping it in accordance with different aspects of the study from the consumers' perspective. It gives data in a descriptive form supported by tables and charts for those questions that required specific answers. It is also treated through qualitative assessment of the research findings.

#### **4.3.1 E-waste separation at source**

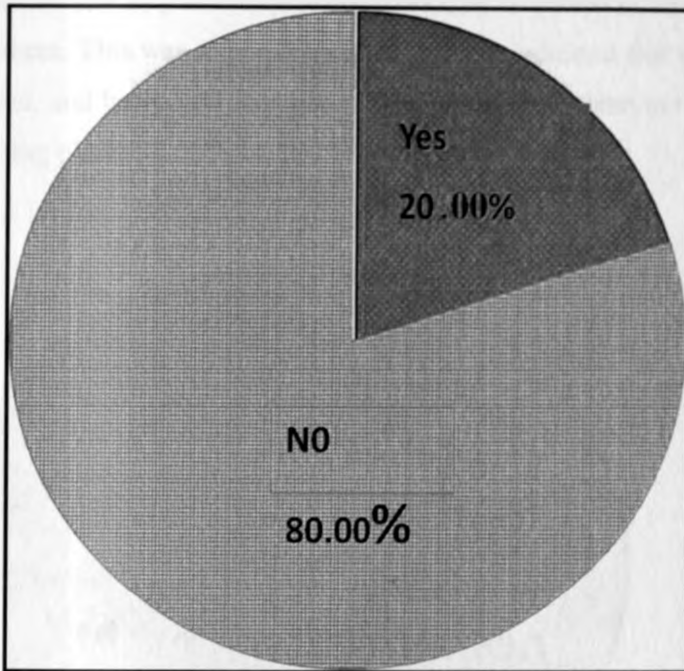
Responses to the question on whether consumers separated e-waste at source revealed that 80.00 % don't. When asked to elaborate why they did not, varied reasons were given including ignorance, cumbersome, lack of awareness, no incentives, no facilities and lack of mechanisms for separation and no policy.

One consumer considered it as a waste of time but was aware that some e-waste could not be recycled hence needed safe disposal. This is what he said,

*"Lack of time and some products are un-reusable"*

In a previous study according to Anahide (2007), lack of time to separate e-waste and driving to a collection site and the fact that consumers have not thought of separation were the reasons given for not separating e-waste at source in South Africa. This is also consistent with findings in yet another study on consumer behaviour in England (Darbly et al. (2005), in Anahide (2007)). This could therefore lead to the conclusion that the main reason why

consumers don't separate e-waste at source seems to be laziness and the perception that it was bothersome and a waste of time. Figure 4.2 below shows distribution of consumers on whether they separate e-waste at source or not.



**Figure 4. 2** Pie chart showing whether consumers separate e-waste at source

Interpreting Table 4.1 below, the majority of consumers (80.00 %) interviewed did not separate e-waste at source while only 20.00 % separated at source. All the consumers (100.00%) responded that lack of policy was the main reason for not separating e-waste at source. This could suggest that consumers get the leeway of not separating e-waste at source since there is no law that forces them to do so.

**Table 4. 1** E-waste separation at source

Response	Frequency	Percent (%)	Valid Percent (%)	Cumulative Percent (%)
Yes	12	20.00	20.00	20.00
No	48	80.00	80.00	100.00
Total	60	100.00	100.00	

### 4.3.2 Consumer disposal practices

Analysis of Figure 4.3 below, indicates that a significant proportion of respondents (52.00 %) mentioned that they stored them due to lack of awareness of where to take them or what to do with them. This was followed by 24.00 % who indicated that they auctioned them, 20.00 % donated, and lastly 4.00 % reported that they returned them to registered collection centers or recycling plant.

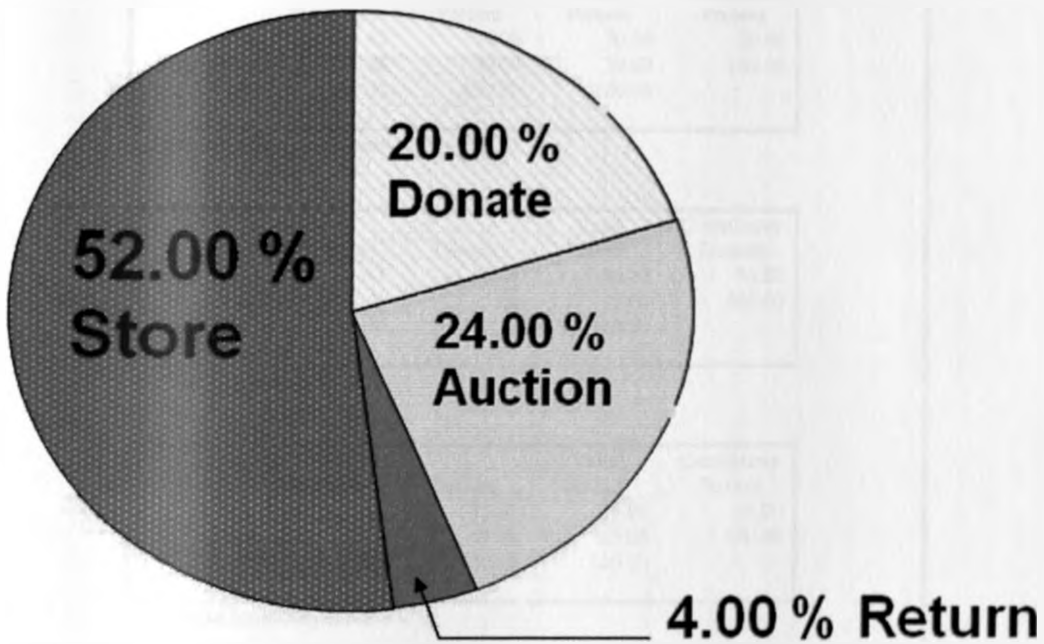


Figure 4. 3 Pie chart showing consumer disposal practices

A similar finding reported in a previous study (Finley (2005), in Anahide (2007)), estimated that “about 70% of South Africa’s e-waste is thought to be in store- most of this held by the government”. In Kenya the researcher through an interview conducted with procurement officers in government institutions showed that most of EEE (98.00%) sold at the auction were inoperative; and that the revenue from the auctions was trivial (nominal). The implication could be made, that government agencies were prone to sell obsolete EEE at auctions trying to escape financial responsibility for historic waste. Hence it can be concluded that the vendee at the auction is illegal recycler and the system of auction stimulates illegal dumping of e-waste in Kenya.

## Frequency Tables

Table 4. 2 Frequency tables for "Donate", "Auction", "Return" and "Store"

	Frequency	Percent	Valid Percent	Cumulative Percent
No	45	75.00	75.00	75.00
Yes	15	25.00	25.00	100.00
Total	60	100.00	100.00	

(a) Donate frequency table

	Frequency	Percent	Valid Percent	Cumulative Percent
No	42	70.00	70.00	70.00
Yes	18	30.00	30.00	100.00
Total	60	100.00	100.00	

(b) Auction frequency table

	Frequency	Percent	Valid Percent	Cumulative Percent
No	57	95.00	95.00	95.00
Yes	3	5.00	5.00	100.00
Total	60	100.00	100.00	

(c) Return frequency table

	Frequency	Percent	Valid Percent	Cumulative Percent
No	21	35.00	35.00	35.00
Yes	39	65.00	65.00	100.00
Total	60	100.00	100.00	

(d) Store frequency table

### 4.3.3 Why consumers do not return e-waste

When asked in their opinion why consumers did not return e-waste to recyclers or e-waste collection points, three key themes came out from respondents: 40.62 % no incentives, 34.38 % low awareness levels of existing collection points, and 25.00 % no policy on e-waste. See the chart that follows. Figure 4.4 below is a pie chart showing why consumers do not return e-waste.

From Figure 4.4 below, it seems a significant proportion of electronic and electrical equipments consumers (40.62 %) in Kenya do not return e-waste to collection points or to recyclers due to lack of incentives. This is a confirmation of an earlier research conducted by Basiye (2007). This was followed by low awareness levels of the consumers (34.38 %) on e-waste issues and the computer recycling plant (CFSK) at Embakasi. A similar finding reported in South Africa reported that 61% of private house-hold consumers store their WEEE at their house for two reasons: first being the potential future use and second being the fact that they don't know what to do with their end-of-life equipment (Anahide, 2007).

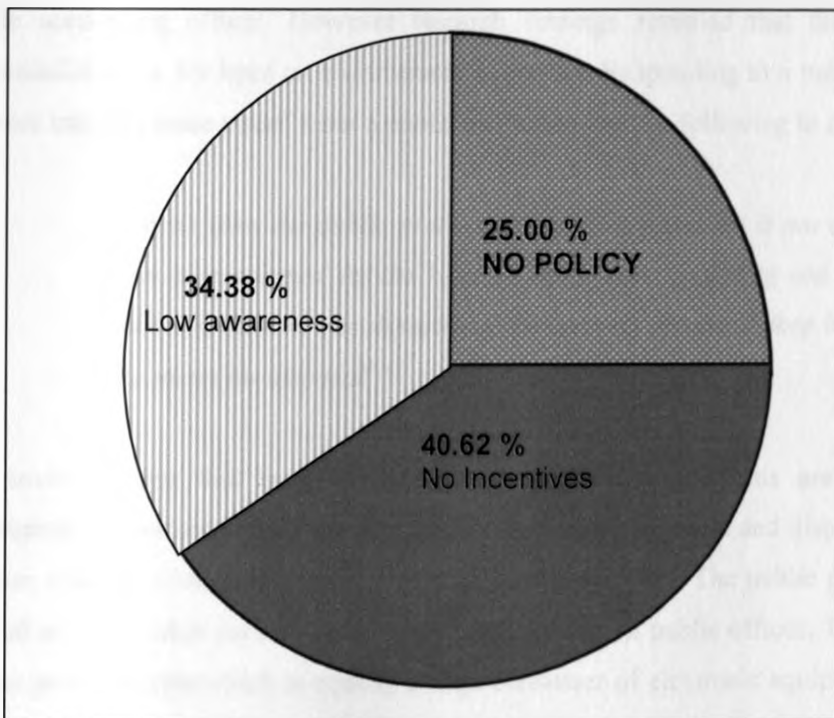


Figure 4. 4 Pie chart showing consumer's return of e-waste

This can be taken to mean that one of the major reasons why most consumers store e-waste is lack of information on how to get rid of it. The findings of this study are therefore consistent with previous findings.

On awareness issue was the revelation that consumers were not aware of the initiatives by Safaricom and Nokia to promote collection of old mobile phones. The study revealed that 25.50 % of consumers don't return e-waste simply because of lack of policy or proper mechanism. The researcher observes that increased awareness on e-waste issues through

training organized by universities, seminars and workshops, as well as public sensitization exhibitions could increase e-waste awareness levels in Kenya.

It emerged that in the public sector and government agencies e-waste was not returned to recyclers or collection points for lack of where to take it or unawareness of what to do with it<sup>3</sup>. This could suggest that most electronic and electrical equipments are lying in government offices confirming the fact that the public procurement and disposal act was not effective coupled with no policy on e-waste.

Part 10 of the public procurement and disposal act on disposal of stores and equipment of a public entity that are unserviceable, obsolete or surplus places responsibility of enforcement on the accounting officer. However research findings revealed that those tasked with responsibilities are not keen on enforcement of the act. Responding to a probing question to dig more into this issue a staff from a public institution had the following to say.

*"In my view the public procurement and disposal act is not effective as can be confirmed by the heap of equipments including old computers which remain in our department for over six months before being taken by stores for disposal"<sup>4</sup>*

This could suggest that most electronic and electrical equipments are lying in most government offices confirming the fact that the public procurement and disposal act was not effective coupled with unclear policy on e-waste management. The public procurement and disposal act only takes care of unserviceable equipments in public offices. This could imply that the private sector which is equally a large consumer of electronic equipments is left out in e-waste management. Consequently it seems that the act is not adequate in tackling the e-waste management problem in Kenya.

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<sup>3</sup> Response to Questionnaire for e-waste stakeholders on key issues in e-waste management for various stakeholders, completed by ICT officer: Ministry of Health, ICT department, Nairobi, April 2011.

<sup>4</sup> Discussion with procurement officer officer, Ministry of Education, April 2011.



### 4.3.4 Computers that have reached EOL

Commenting on whether they had computers they felt had reached EOL, a majority (80.95 %) of the respondents agreed that they had while only 19.05 % indicated they did not have. Figure 4.5 bellow is a pie chart that shows the distribution of consumers who have computers which have reached EOL.

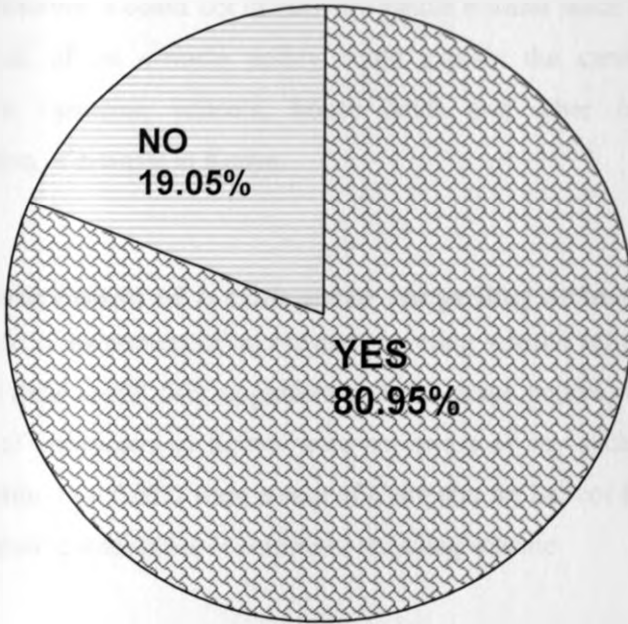


Figure 4. 5 Pie chart showing distribution of consumers with computers that have reached EOL

The researcher feels that the 19.05 % who said that they did not have computers that had reached EOL at least had other forms of e-waste such as mobile phones that had reached end of their useful life.

### 4.3.5 E-waste management policy

The study also sought to investigate whether consumers of electronic and electrical equipments in Kenya had a disposal policy or guideline they were following.

#### Frequency table

Table 4. 3 frequency table for disposal policy

	Frequency	Percent	Valid Percent	Cumulative Percent
YES	6	10.00	10.00	10.00
NO	54	90.00	90.00	100.00
Total	60	100.00	100.00	

Responding to the above issue as presented above, (90.00 %) of consumers said that they did not have any e-waste disposal policy while only 10.00 % indicated that they had one. The respondents who said that they had a policy were from government agencies that followed the government procurement and disposal act. However they were quick to point out that it was not effective. First, because not all government agencies were following it and secondly the few that followed it could not effectively handle e-waste since the act was not specific on e-waste. Lack of an e-waste policy could explain the careless disposal of e-waste in government agencies, schools, house holds and other consumers hence the silent accumulation of e-waste in Kenya.

#### 4.3.6 Awareness of a computer recycling scheme

On the issue of awareness of an e-waste recycling scheme for computers which had reached the end of their useful life, as presented in the graph bellow it was noted that the majority (95.00%) of consumers in Kenya were not aware of any such computer e-waste recycling facility, while only 5.00% were aware of Computer for School Kenya. Figure 4.6 is bellow is a graph showing awareness of computer recycling scheme.

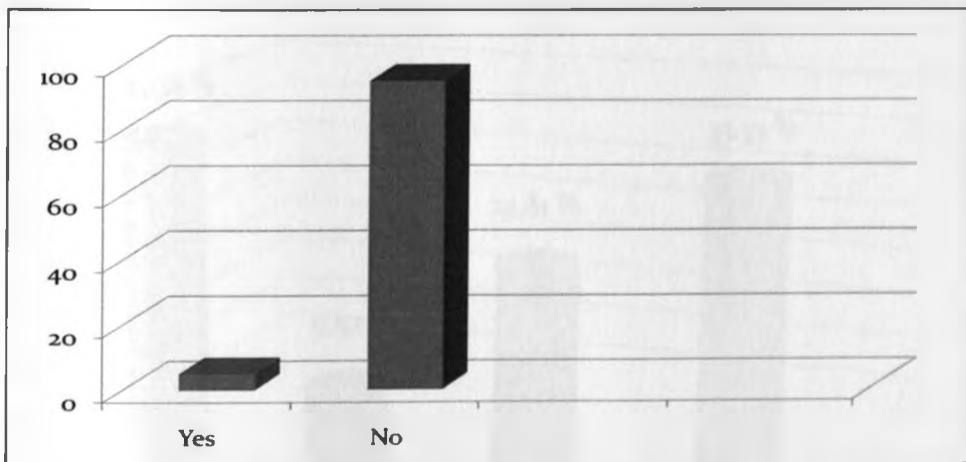


Figure 4. 6 Bar graph showing awareness of a computer recycling scheme

The study revealed that most consumers were not aware of existence of any such initiatives despite their existence for more than 3 years in Kenya. Photo 2 and photo3 show that consumers ought to be returning old mobile phones and electronic equipments the Safaricom's collection box. The researcher observes that an ideal e-waste management framework in Kenya ought to encompass awareness creation as a major component. The

deliverable is a list of how to do it or best practices, applications, infrastructures or content. Other recommendations would be alignment of governments, private sector, donors, civil society, universities etc awareness campaign efforts with sustainable e-waste collection and safe disposal.

#### 4.3.7 Health issues related to e-waste

With regard to health issues and careless disposal or handling of e-waste that consumers had encountered in the recent past that could have a negative impact on the environment or cause a health hazard, the following were revealed: 23.81 % of respondents interviewed had seen carelessly dumped computer components such as Cathode Ray Tubes (CRTs), System units, motherboards, keyboards among many others, 33.33 % had seen open burning of computer parts. Another similar percentage (33.33%) said that they were not aware of any negative health or environmental impacts that result from improper handling of e-waste. It was noted that only a small percentage (9.52 %) of the respondents were aware of health hazards such as cancer, eye sores and breathing complications that may be caused by e-waste. The summary is shown in Figure 4.7 bellow.

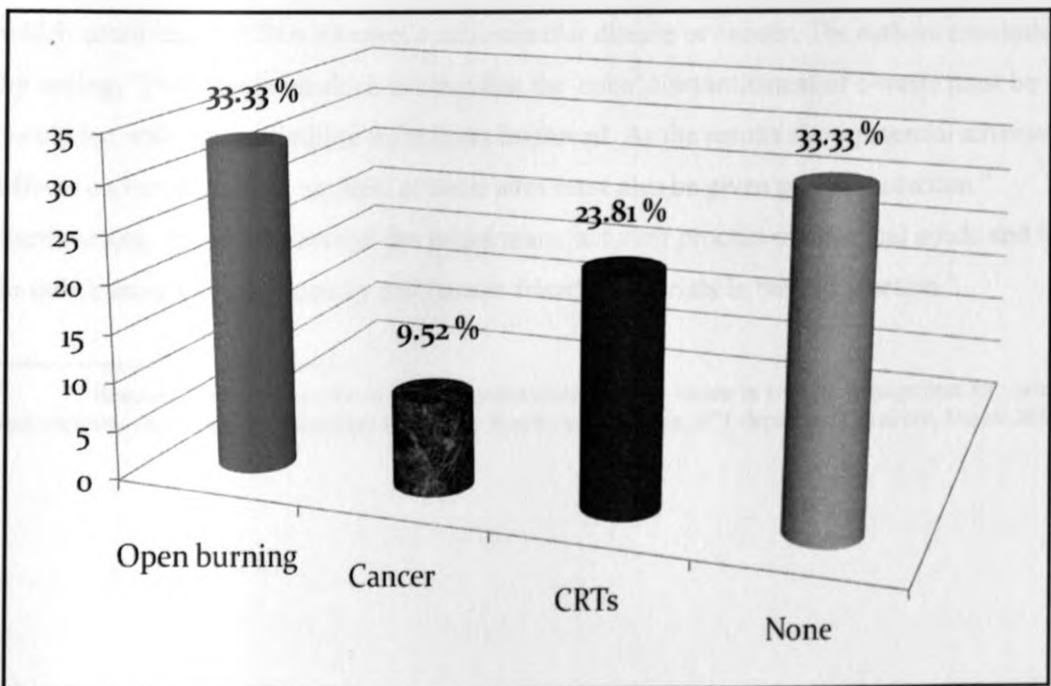


Figure 4. 7 Graph showing health issues related to e-waste

One of the respondents said that,

*"Some don't decompose, some may hurt people, and chemicals from those components are harmful to our health".<sup>5</sup>*

It can be deduced from these findings that a significant percentage of consumers (66.66 %), constituting those who had seen open burning, carelessly dumped computer components such as Cathode Ray Tubes (CRTs), System units, motherboards, keyboards among many others and were aware of cancer as a health hazard due to e-waste, are somehow aware of negative impacts of e-waste yet they are still not safely disposing their e-waste. A section of the consumers reported that they were aware that cadmium can leach into soil, sulphur can cause liver damage, and that mercury causes sensory impairment and memory loss. According to UNEP (2010), hazardous substances such as heavy metals contained in most discarded electronic items pose a serious risk to the environment and human health. Such metals include cadmium, lead, sulphur among others.

According to a recent study (Institute of Physics, 2011), in China samples of pollutants caused significant increases in both IL-8 and ROS levels -- indicators of an inflammatory response and oxidative stress respectively. Both inflammatory response and oxidative stress may lead to DNA damage, which could induce oncogenesis, or even cancer. Tests of local air pollution and its impact on human lung cells revealed inflammatory responses and oxidative stress, which could lead to DNA damage, cardiovascular disease or cancer. The authors concluded by saying, "From these results it is clear that the 'open' dismantlement of e-waste must be forbidden with more primitive techniques improved. As the results show potential adverse effects on human health, workers at these sites must also be given proper protection." Furthermore, one must consider the initial manufacturing process of electrical goods and look to utilise more environmentally and human friendly materials in their production."

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<sup>5</sup> Response to Questionnaire for e-waste stakeholders on key issues in e-waste management for various stakeholders, completed by Secondary Computer Studies teacher: Juja, ICT department, Nairobi, March 2011.

### 4.3.8 Percentage of consumers storing e-waste

36.84% of the consumers interviewed reported that they had between 50-100 computer units in store or at home, 26.32% reported between 20-50 units, 21.05 % over 100 units and lastly 15.75 % had less than 20 computers units in store. Respondents represented by 36.84 %, 26.32 % and 21.05% were mainly drawn from government agencies and secondary schools offering computer studies at KCSE in Nairobi. It therefore seems that learning institutions and government agencies are a major source of e-waste in Kenya. A summary of the above discussion is shown in Figure 4.8.

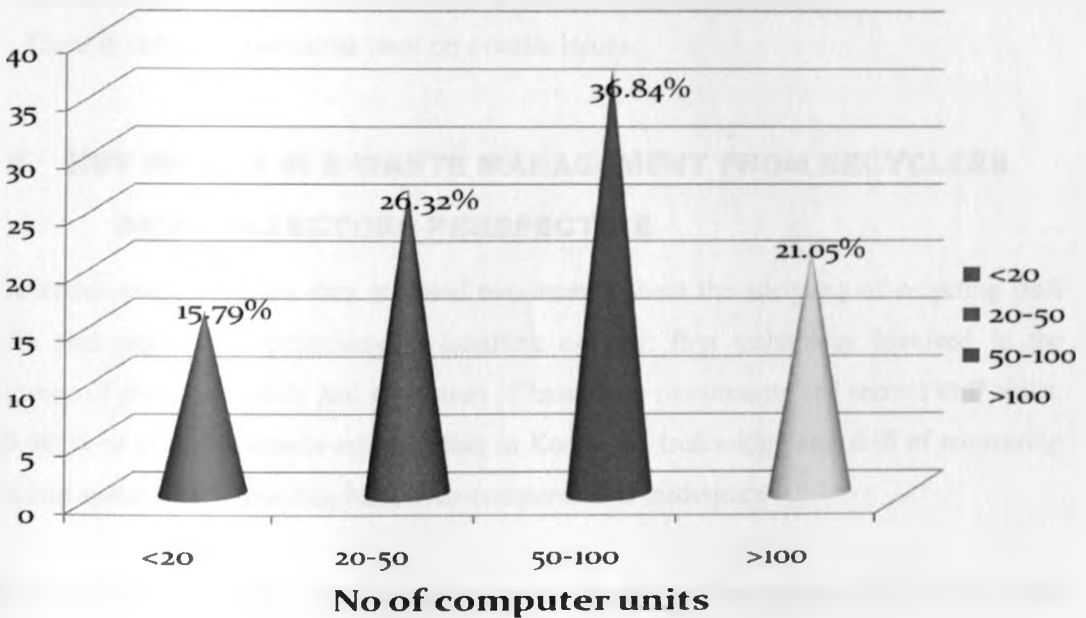


Figure 4. 8 Graph showing percentage of consumers storing e-waste

### 4.3.9 Summary of key issues from the subsections

The key issues from each of the above sub-sections can therefore be summarised as follows:

1. The government bears the greatest responsibility in providing e-waste policy and regulatory frame.
2. EPR has not been effective in Kenya due to lack of collaborative approach amongst producers.
3. Low awareness levels, demand for incentives by consumers and invisibility of collection points are some of the reasons why consumers do not return e-waste.

4. Kenya does not have clear mechanisms of control, audit and monitoring e-waste flows and quantities.
5. Most consumers do not separate e-waste at source in Kenya.
6. A sustainable e-waste financial management model in Kenya should provide incentives to consumers to promote take back.
7. The public procurement and disposal act only takes care of unserviceable equipments in public offices and still is ineffective in public offices since there is no enforcement.
8. A large percentage (95 %) of electrical and electronic consumers in Kenya is not aware of any computer e-waste recycling facility.
9. Some consumers were aware of some negative health and environmental impacts from some e-waste components particularly cadmium, sulphur and mercury.
10. Most consumers (90 %) do not have an e-waste management policy.
11. There is very low awareness level on e-waste issues.

#### **4.4 KEY ISSUES IN E-WASTE MANAGEMENT FROM RECYCLERS AND COLLECTORS PERSPECTIVE**

Qualitative analysis of the data revealed two themes about the adequacy of recycling staff skills and processing technology in handling e-waste: first technology involved in the recovery of precious metals and separation of hazardous components and second staff skills. 100.00 % of the respondents reported that in Kenya the technology and skill of recovering precious metals and separating hazardous components is inadequate<sup>6</sup>.

On the question of keeping an e-waste inventory 100.00 % of respondents from CFSK said that they have a database of all computers donated or collected from schools for recycling, computers distributed to schools and all components exported. However according to an interview with one of the respondents it was noted that most electrical and electronic retail shops, distributors as well as repair shops in Kenya do not bother to keep a record of e-waste<sup>7</sup>. The reason could be due to low profit margins associated with e-waste and lack of e-waste policy and regulatory framework.

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<sup>6</sup> Response to Questionnaire for e-waste stakeholders on key issues in e-waste management for various stakeholders, completed by Recyclers: E-waste officer: CFSK, Nairobi, April 2011; 2 Technicians: CFSK, Nairobi, April 2011.

<sup>7</sup> Kiboi, J. 2011. [Personal communication]. April 3.

In relation to the question on e-waste transportation to the recycling center three patterns of routes emerged from the data: by road, by air, and by water. One respondent said that,

*“Local consumers specifically schools organize their own means of transport through school vans at their cost, however if they can't CFSK transports the e-waste using their own vehicles. Kenya Airways airlifts donated computers to the country for free and transports back e-wastes that cannot be recycled in Kenya to countries such as Norway for further recycling and safe disposal. At times donated computers for recycling in Kenya are shipped by water”<sup>8</sup>.*

One of the respondents felt that registration and formalization of e-waste recycling plants in Kenya ought to be encouraged to ensure control and standardization. However the researcher noted that some of the respondents had no idea of the issue at hand despite clarifications by the researcher. One of the respondents said that,

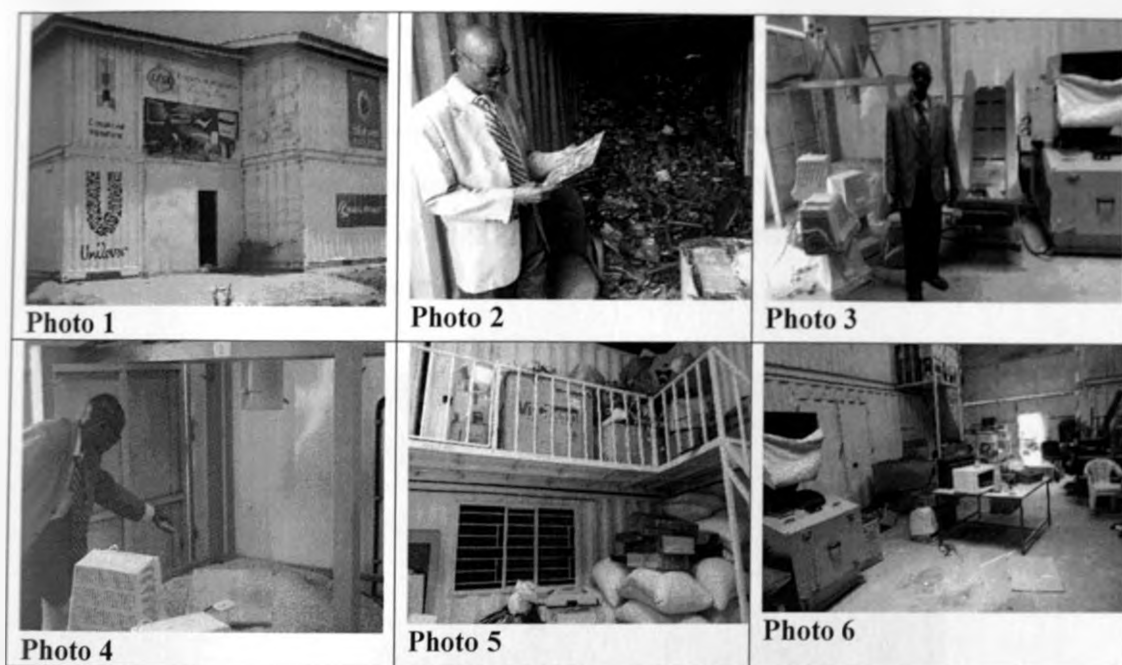
*“the government should enlighten [the public on] the effect of waste material in our environment”<sup>9</sup>.*

This could confirm the low level of awareness on e-waste issues among the public and more worse among the people expected to manage and handle e-waste in Kenya.

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<sup>8</sup> Response to Questionnaire for e-waste stakeholders on key issues in e-waste management for various stakeholders, completed by Recyclers: E-waste officer: CFSK, Nairobi, 3 April 2011.

<sup>9</sup> Responses to Questionnaire for e-waste stakeholders on e-waste issues in Kenya, completed by a computer Technician, Computer For Schools Kenya, Nairobi, Kenya, April 2011.



**Figure 4. 9 Summary of photos taken during the field visit to CFSK recycling plant at Mihango Embakasi on 3 April 2011. Source: Researcher.**

In Figure 4.9 above Photo1 is the e-waste recycling centre established by Computer for Schools Kenya (CFSK) at Mihango in Embakasi Kenya. It has the logo of various companies namely safaricom, CFSK, Kenya Airways, Unilever and Computer Aid International. Safaricom is in the partnership since through its take back scheme CFSK is supposed to get e-waste for recycling. Kenya airways is a partner since it plays a pivot role in air lifting e-waste that CFSK does not have the capacity and technology to safely dispose. Computer Aid International is an NGO that campaigns for re-use of computers before they are disposed. Computer Aid imports computers into Kenya for redistribution to learning institutions, Uniliver assists with recycling and safe disposal of hazardous components. This could suggest that in order to effective manage e-waste in Kenya there is need for collaboration among all the e-waste stakeholders. Perhaps a multi-pronged strategy is required to handle the problem at various levels; individual, institutional, business, government and policy. It was also observed that CFSK attempted to separate e-waste whenever they had the capacity and technology as shown in photo 2 that shows a container of only motherboards.

It was observed that most of the machines were rudimentary and in adequate for recovery of precious metals and separation of hazardous parts. This confirms revelations on lack of well trained e-waste personnel, in adequate technology and machines as some of the challenges



faced by recyclers as reported in an interview by one of the CFSK staff at KICC. Behind the researcher in Photo 3 is one of the machines used by CFSK. Shreds of CRT as seen in photo 4 are put in sacks as seen in photo 5 then exported for safe disposal. Cartons and Containers of donated computers were seen as in photos 5 and 6 respectively. As is discussed in chapter three on methodology the use of photos revealed in depth detail which helped shade more light on e-waste situation in Kenya.



**Figure 4. 10** Open dumping of obsolete computers and fridges in a government office. Photographs taken on Wednesday, April 20, 2011 at 3:40pm. Source: researcher



**Figure 4. 11** Dumped computers in a secondary school computer laboratory; Wednesday, April 20, 2011, 3:40:20 PM .Source: researcher.

It was noted that very few obsolete computers and electronic equipments were collected from Kenyan consumers and collection points. This fact was confirmed during a visit to public government agencies and secondary schools in Nairobi. Two incidences of cases which could be used as examples as observed by the researcher were; one, the open dumping of obsolete

computers and fridges in one of the government ministry offices (see Figure 4.3) and two, the dumping of obsolete computers in a room in a learning institution visited (see Figure 4.4).

These revelations could suggest that most Kenyan consumers, especially large keep their e-waste in offices, labs if learning institutions and homes (if small consumers) among many others instead of safely disposing them. This could explain the reasons given by consumers for not returning e-waste to recyclers or e-waste collection points. The findings of this study on how consumers dispose e-waste are consistent with earlier findings (Osibanjo O., 2009) on Used Electrical and Electronic Equipment management practices in Africa which identified three main practices as disposal at open dumps sites, open burning of selected components, and storage/ hoarding for perceived value.

Findings from this research suggest that an ideal e-waste management framework for Kenya should adequately address the issues raised by consumers that make them not to return e-waste to collection points or a registered recycling center. From analysis of the above photos it can be concluded that Kenya urgently needs an e-waste management policy and legislative framework to handle especially collection and treatment.

Figure 4.1 photo 1 is the Safaricom's e-waste recycling campaign program as part of its Extended Producer Responsibility in Kenya. The study revealed that most consumers were not aware of existence of such initiatives despite their existence for more than 3 years in Kenya. Photo 2 and photo3 show some of returned old mobile phones and electronic equipments in the safaricom's collection box. 34.38 % of consumers felt that these boxes or e-waste collection points were not visible or were in accessible.

During interview with recyclers it was noted that manufacturers and importers do not accomplish their obligations and sign financial agreements regarding e-waste management in Kenya. Under such agreements, e-waste recycling and transportation costs ought to be funded by manufacturers and importers. An interview with a "juakali" e-waste collector from Kibera with a store in the same location revealed that he collects e-wastes especially monitors and system units from institutions through tenders while from house holds by walking from door to door. He then sells them to electronic shops and other scrap dealers and other informal actors in Kibera who make Television sets from the monitors, cooking "jikos" out of the metal casing or recycle them in other ways. He however admitted that he did not know

whether they safely disposed of the resulting e-waste. This could suggest that most of the informal recyclers are more concerned with the economic gain from e-waste other than the environmental impacts. These findings are in tandem with a recent report (Osibanjo, 2009) on e-waste management practices in Africa which reported that “waste management occurs in the informal sector of the economy involving thousands of poor people ignorant of the hazard of exposure to toxins in e-waste”.

The informal recycler from Kibera mentioned that he uses a pick up (Figure 4.12) to transport the collected e-waste to his store in Kibera. This finding on transportation is consistent with similar findings (Schluep (2006), in Anahide(2007)), where it is reported that in South Africa collectors bring scrap metal, paper, glass as well as e-waste to buy back centers by use of various means of transportation including pulling or pushing trolleys. It therefore seems that one of the key issues that the ideal e-waste management framework ought to address is safe e-waste transportation logistics.



**Figure 4. 12 Transportation of e-waste; April 28, 2011, 3:40:20 PM .Source: researcher**

Asked to mention challenges faced by collectors the respondent pointed out four: bureaucracy in government agencies, low level of awareness by consumers on available collection centers, in adequate funds and in adequate storage facility. Asked whether he was a registered e-waste collector he said that he was not yet registered because he did not know the process of

registering. When asked whether he was aware of CFSK he said that he was not aware of it. On the quantities he had collected and the money he had paid for the monitors collected that day from a secondary school he stated that the school had sold to him 23 units of monitors and that he had paid twenty thousand Kenya shillings in turn. He said that he had also collected 35 system units and paid six thousand four hundred and seventy five shillings<sup>10</sup>.

On further prompting he revealed that e-waste collection could be a gainful source of income to the youth in “Kibera” and other informal settlements in Nairobi. It was interesting to note that he makes an income of Kenya shillings 150.00 per piece of system unit metal case sold to “jua kali” artisans who buy them to make “jikos”. He also said that he sells one mother board at Kenya shillings 40.00 to electronic repair shops.

Calculating his profit margin this study estimates that on average he earns Kenya shillings five thousand five hundred (5500.00) on the metal cases and mother boards alone in a month as shown below.

**Table 4. 4 Analysis of profit margins**

<b>PROFIT MARGIN ANALYSIS</b>			
<b>E-WASTE ITEM</b>	<b>QTY</b>	<b>BUYING PRICE</b>	<b>TOTAL</b>
SYSTEM UNIT	35	185.00	<b>6475.00</b>
	<b>QTY</b>	<b>SELLING PRICE</b>	<b>TOTAL</b>
SYSTEM UNIT METAL CASE	35 X 2	150.00	<b>10500.00</b>
MOTHER BOARD	35	40.00	<b>1400.00</b>
<b>TOTAL SALES</b>			<b>11900.00</b>
<b>PROFIT MARGIN (11900 – 6475)</b>			<b>5425.00</b>

From the Table 4.4 above, it can be argued that e-waste could be a source of income to the informal sector in Kenya if well managed. It can further be argued that the profit margin reported above of Kenya shillings five thousand four hundred and twenty five (KShs 5425.00) could easily be doubled to Kenya shillings ten thousand eight hundred and fifty six (KShs10856.00), or even tripled to sixteen thousand two hundred and seventy five (KShs 16275.00) in two weeks implying almost double the amounts in a month given a sound

<sup>10</sup> Ondiege O. [Personal Communication] May 5, 2011.

mechanism for e-waste collection and incentive system. Therefore in a month it is probable that informal e-waste recyclers could earn a minimum of twenty one thousand seven hundred and twelve (KShs 21712.00) Kenya shillings and a maximum of thirty two thousand five hundred and fifty (KShs 32550) or more. This income is definitely comparatively higher than the amount currently earned by informal casual labourers from Kibera working in industrial area whose daily pay rate is Kenya shillings 350.00 aggregating to eight thousand four hundred shillings (KShs 8400) in a month.

Given the above scenario it is the view of the researcher that much as the informal sector is currently playing a key role in solid waste management in Kenya, its full potential in creating gainful employment to the informal sector, and promoting sound environmental management practices especially on e-waste has not been fully explored. Assuming that there is a clear policy on e-waste collection and given the proof of silent e-waste accumulation as documented in this study, the researcher feels that informal sector could play a pivot role in the collection and down stream recycling of e-waste in an environmentally friendly manner while at the same time creation of gainful employment opportunities to thousands of youths.

These revelations confirm one of the significance of this research study which was that its findings would positively impact on the productivity and income levels among the youth; a group considered the productive segment of the society. Consequently, this would indirectly improve security and overall well being of communities especially in the informal settlements in urban centers in Kenya.

#### **4.5 RESPONSIBILITIES OF VARIOUS STAKEHOLDERS AND CHALLENGES THEY FACE**

This information was collected using sections C and E of Questionnaire for e-waste stakeholders (attached as appendix A) and notes taken during field trips. The two questions were open ended and mainly focused on the responsibilities and challenges faced by various stakeholders in e-waste management in Kenya. The questionnaire was circulated to consumers, recyclers and producers. A summary of the findings of this Questionnaire is given in Table 4.5. Subsections 4.6.1 and 4.6.2 give in detail the findings of sections C and E of the questionnaire for e-waste stakeholders.

**Table 4. 5 Summary of findings from questionnaires for e-waste stake holders**

CATEGORY	RESPONSIBILITIES	CHALLENGES
<b>PRODUCERS</b>	<ul style="list-style-type: none"> <li>-Producers ought to have an agreement amongst themselves to organize the take back of e-waste. -Creating awareness among e-waste generators.</li> <li>-Producers ought to ensure that the e-Waste management system is financially viable.</li> <li>-Producers ought to design products with less impact on health and environment.</li> <li>-Producers ought to maintain annual records of the material management in a transparent national register open to auditing and scrutiny by external agency.</li> </ul>	<ul style="list-style-type: none"> <li>-Lack of capital</li> <li>-Low consumer awareness</li> <li>-No e-waste policy</li> </ul>
<b>CONSUMERS</b>	<ul style="list-style-type: none"> <li>-Ought to dispose off e-waste based on a menu of prices which vary depending on the characteristics of the product.</li> <li>- Large consumers ought to have Business to Business arrangements with the e-Waste management system.</li> <li>- Private / household consumers ought to return their end-of-life equipment to dedicated collection points or through authorized pick-up services.</li> <li>- Corporate users ought to maintain records of donations and ensure that the material joins the e-Waste management system at its end-of-life.</li> <li>- Individual companies and public bodies ought to be liable for their disposal practices.</li> </ul>	<ul style="list-style-type: none"> <li>-Low levels of awareness</li> <li>-No incentives</li> <li>-In visible collection points</li> <li>-No policy</li> </ul>
<b>RECYCLERS</b>	<ul style="list-style-type: none"> <li>-Upgrade skills and technologies for best practice in all steps of the recycling.</li> <li>-Respect all national and international environmental legislation</li> <li>-Obtaining all licenses.</li> <li>-Maintaining proper environmental and health standards</li> <li>-Maintaining and producing records for inspection and verification.</li> <li>-Proper processing of their downstream fraction mainly the critical ones (e.g. leaded glass, brominated plastics, etc</li> </ul>	<ul style="list-style-type: none"> <li>-Negative consumer attitude</li> <li>-In adequate technology</li> <li>-Lack of e-waste policy</li> <li>-Bureaucracy during registration and collection of e-waste especially from government agencies</li> <li>-Rapidly increasing e-waste volumes</li> </ul>

**Table 4.6 Summary of findings from questionnaires for e-waste stake holders (Cont.)**

<p><b>POLICY MAKERS</b></p>	<ul style="list-style-type: none"> <li>-Framing appropriate guidelines/legislation to support the e-waste model.</li> <li>-Monitoring the e-waste management processes regularly</li> <li>-Providing incentives to entrepreneurs to set up facilities</li> <li>-Regulating and controlling the number of collection/ recycling facilities in a geographical area.</li> <li>-Approving appropriate technologies</li> <li>-Forming multi-stakeholder monitoring committee</li> <li>-Creating awareness among generators of waste</li> <li>-Authorization of the recyclers involved in handling e-waste</li> </ul>	<ul style="list-style-type: none"> <li>-No collaborative approach to e-waste policy formulation and e-waste management.</li> <li>-Negative consumer attitude</li> <li>-Low level of e-waste awareness among generators</li> <li>-No accurate estimates of the quantity of E-waste generated and recycled</li> </ul>
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### 4.5.1 Responsibilities

These findings are based on Questionnaires C and E, and interview responses as shown in Table 4.5.

According to one respondent from Safaricom, the main duty of producers in Kenya ought to be financing of e-waste management in Kenya. Commenting on producer responsibility in Kenya she had this to say,

*"I strongly feel and believe that it is the responsibility of all electronic and electrical equipments manufactures, distributors and retail shops, ...the so called producers to establish visible collection centers in Kenya and create consumer awareness if we are to solve the e-waste problem in Kenya<sup>11</sup>".*

Agreeing with the position taken by the respondent from Safaricom, three other stakeholders interviewed separately concurred that it was the responsibility of the producers to establish collection centers in Kenya. Additionally they said that the producers were responsible for forming producer responsibility organizations, taking up all returned e-waste and safely disposing them, creating awareness and designing products with minimal negative impact on

<sup>11</sup> Response to Questionnaire for e-waste stakeholders on key issues in e-waste management for various stakeholders, completed by ICT officer: Safaricom, Nairobi, April 2011

health and environment. They were also of the opinion that it was the responsibility of producers to keep an inventory of material flows in Kenya and avail this inventory for audit by an independent body when required to do so<sup>12</sup>.

Reacting to the question on what they believed were the responsibilities of consumers in e-waste management respondents from various stakeholders mentioned the following<sup>13</sup>:

1. Consumers are supposed to dispose off e-waste based on a menu of prices which vary depending on the characteristics of the product.
2. Large consumers ought to have Business to Business arrangements with the e-Waste management system.
3. Private / household consumers ought to return their end-of-life equipment to dedicated collection points or through authorized pick-up services.
4. Corporate users ought to maintain records of donations and ensure that the material joins the e-Waste management system at its end-of-life.
5. Individual companies and public bodies ought to be liable for their disposal practices.

When asked to comment on what they believed were the responsibilities of e-waste recyclers most respondents felt that it was the responsibility of recyclers to; maintain proper environmental and health standards, maintain and produce records for inspection and verification, use proper processing methods of their downstream fractions mainly the critical ones such as leaded glass, ruminated plastics and the rest. On the question of the responsibilities of policy makers respondents reported that they are supposed to frame appropriate guidelines/legislation to support e-waste management, monitor the e-waste management processes regularly, regulate and control the number of collection/ recycling facilities in a geographical area, approve appropriate technologies, create awareness among generators of waste, and authorize recyclers involved in handling e-waste<sup>14</sup>.

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<sup>12</sup> Discussion with standards development officer, KEBS, April 2011; Solid waste management officer, NCC, March 2011, Compliance officer, Waste Management Section, NEMA, April 2011.

<sup>13</sup> Response to Questionnaire for e-waste stakeholders on key issues in e-waste management for various stakeholders, completed consumers, recyclers and producers, April 2011.

<sup>14</sup> Response to Questionnaire for e-waste stakeholders on key issues in e-waste management for various stakeholders, completed by consumers, recyclers and producers, April 2011.



Information from Table 4.1 suggests that for effective and efficient management of e-waste in Kenya all the stakeholders must be ready to take up their responsibilities seriously. It therefore appears to the researcher that the e-waste problem in Kenya can only be tackled effectively if there is collaboration and cooperation amongst the producers, consumers, recyclers, collectors and policy makers each diligently discharging its duties.

#### **4.5.2 Challenges**

These findings are based on Questionnaires C and E, and interview responses as shown in Table 4.5.

Generally the results of this study reveal that each stake holder category has unique challenges with a few cutting a cross. The findings reveal that producers face the challenges of lack of an e-waste management policy, low consumer awareness and lack of capital. Consumers face low levels of awareness, lack of incentives, in visible collection points and absence of e-waste management policy. Recyclers and collectors battle with negative consumer attitude making it difficult to collect e-waste, in adequate technology, lack of e-waste policy, and bureaucracy during registration and collection of e-waste especially from government agencies.

Lastly policy makers have the challenges of absence of collaborative approach to e-waste policy formulation and e-waste management making enforcement impossible, negative consumer attitude, low level of e-waste awareness among generators, lack of accurate estimates of the quantity of e-waste generated / recycled and silently rapidly increasing e-waste volumes<sup>15</sup>. There is very little mention of how to involve the poor in the e-waste policy formulation process. It therefore seems that the need for the process being bottom-up should be acknowledged and addressed in detail.

It has also emerged from the results of this study as confirmed by an interview with one respondent from ministry of public health that top on the list of challenges faced by recyclers in Kenya appears to be the technology to handle e-waste. He said the following with regard to technology,

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<sup>15</sup> Response to Questionnaire for e-waste stakeholders on key issues in e-waste management for various stakeholders, completed by consumers, recyclers, producers, and policy makers, April 2011.

*"In my view the major challenge to recyclers in Kenya is the technology to handle e-waste, you see some of these components are very toxic but we also know that some metals are precious. The question is... do we have the right technology and skill to handle all this [pause] ... "16.*

Clearly, issues of technology and skill remain major problems in Kenya, much as they do in the rest of the region. While it would appear that there is going to be a great deal of reliance on international e-waste experts to help plan systems in Kenya, it is the feeling of the researcher that it is important to note that education and training programmes will have to be developed within the country to meet specific local circumstances and adapt to local needs. Technology transfer will not succeed if local e-waste professionals are ignored. This does not mean that "western" knowledge is to be ignored. It means that African and western systems of e-waste knowledge need to interact, engage with each other and seek insights into each other's weaknesses, limits and strengths.

Institutional and collaborative links with other universities in the region and abroad may be part of the solution to the e-waste problem of training and technology transfer. Exchange of staff and programs, which may require more mechanisms, could help develop the next generation of e-waste professionals. It therefore appears that the universities in Kenya should spear head the development of the professional capacity to impart skills to formal and informal recyclers as well as educate the public. The implication therefore is that Kenya should invest heavily on appropriate technology that can handle toxic as well as precious metals. It can further be concluded that there is need to break dependency by developing own e-waste management models and training programmes that could provide own solutions for addressing the unique e-waste problem in Kenya.

#### **4.6 E-WASTE MANAGEMENT IN SELECTED COUNTRIES**

This section presents an analysis of how other countries manage their e-waste compared to Kenya with an aim of borrowing some lessons. It analyses e-waste management practices in Switzerland, India and South Africa based on various themes. This analysis was crucial since

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<sup>16</sup> Interview with Health Administration Officer: Ministry of Public Health and Sanitation, on 26 March 2011, at the offices of Ministry of Health Upper Hill, Nairobi.

it enabled the researcher to draw a comparison between the selected countries and Kenya on specific aspects of e-waste management practices in line with the last research question. A summary of the findings is presented in Table 4.6 below.

**Table 4. 6 Summary of how other countries manage e-waste compared to Kenya. Source: Researcher.**

THEME	SWITZERLAND	INDIA	SOUTH AFRICA	KENYA
<b>Financing</b>	<ul style="list-style-type: none"> <li>-Secured financing of the collection and recycling.</li> <li>- Advance Recycling Fee (ARF) charged on all new appliances.</li> <li>- Consumers fund collection and recycling through ARF.</li> <li>-ARF used to pay for the collection, the transport and the recycling.</li> </ul>	<ul style="list-style-type: none"> <li>- Consumers take back e-waste to waste collectors who pay them a positive price</li> <li>- Collectors sell to recyclers.</li> <li>- Purchase price offered by recycler drive the WEEE/E-waste collection, transportation and its treatment.</li> <li>- Recyclers sell to raw material producers at a price.</li> </ul>	<ul style="list-style-type: none"> <li>-Producers fund recycling</li> </ul>	<ul style="list-style-type: none"> <li>- No secured financing of the collection and recycling of WEEE.</li> <li>- No Advance Recycling Fee (ARF) charged on all new appliances</li> <li>- Consumers don't fund collection and recycling through ARF</li> <li>- No money set aside to pay for the collection, the transport and the recycling of used WEEE</li> </ul>
<b>E-waste system</b>	<ul style="list-style-type: none"> <li>-based on EPR, both legally and operationally.</li> </ul>	<ul style="list-style-type: none"> <li>- based on a network existing among collectors, traders and recyclers, each adding value, and creating jobs, at every point.</li> <li>-Successful case of industrial symbiosis which is self-organized and market-driven.</li> <li>-Low initial investment required to start a collection, dismantling, sorting or recovery business.</li> </ul>	<ul style="list-style-type: none"> <li>- Centralized national recycling system used.</li> <li>-Modelled on technology transfer</li> </ul>	<ul style="list-style-type: none"> <li>- Not based on EPR, both legally and operationally</li> </ul>
<b>Policies and procedures</b>	<ul style="list-style-type: none"> <li>-have an e-waste management policy.</li> </ul>	<ul style="list-style-type: none"> <li>- No expressed legislation taking care of E-waste.</li> <li>-EMPA developing a national e-waste strategy.</li> <li>- no regulatory mechanism, stipulating the management and handling of post-consumer WEEE/E-waste generated within the country.</li> </ul>	<ul style="list-style-type: none"> <li>-Currently implementing a national e-waste recycling compliance scheme</li> </ul>	<ul style="list-style-type: none"> <li>- No e-waste management policy.</li> <li>-NEMA has come up with e-waste management guidelines.</li> </ul>

**Table 4.6 Summary of how other countries manage e-waste compared to Kenya. Source: Researcher. (Cont.)**

ISSE	SWITZERLAND	INDIA	SOUTH AFRICA	KENYA
<b>Responsibilities</b>	<ul style="list-style-type: none"> <li>-Operative responsibility is shared with the two PROs—SWICO and S.EN.S, who manage and operate the system on behalf of their member producers.</li> <li>-Distributors, Manufactures, and Retailers must take back free of charge (even if no equipment is purchased)</li> <li>-National registry is the responsibility of Environment ministry</li> <li>-End users other than households may be made partly or totally responsible for financing the management of historical products.</li> <li>- Producers have "individual responsibility" for new products put in the market after August 13, 2005.</li> </ul>	<ul style="list-style-type: none"> <li>-Small entrepreneurs responsible for collection, dismantling, sorting or recovery</li> <li>-Producers finance the entire new E-waste management chain by offering a price which is passed down wards to consumers.</li> <li>- Consumers, collectors, traders and recyclers channel e-waste to producers.</li> <li>-Producers safely dispose.</li> </ul>	<ul style="list-style-type: none"> <li>- Consumers, collectors, traders and recyclers channel e-waste to producers.</li> <li>-Producers safely dispose</li> </ul>	<ul style="list-style-type: none"> <li>- Consumers not responsible taking back e-waste.</li> <li>-EPR not operational</li> <li>-dismantling not responsible for safe handling of e-waste</li> <li>-No responsibility on financing e-waste</li> <li>-Producers don't safely dispose</li> </ul>
<b>Collection and Disposal</b>	<ul style="list-style-type: none"> <li>-SWICO and S.EN.S have official collection points around Switzerland in addition to the thousands of retail locations which have to take back old equipment free of charge, irrespective of the brand or year of manufacture.</li> <li>- It is easier for consumers to dispose their WEEE/E-waste at appropriate and visible locations</li> </ul>	<ul style="list-style-type: none"> <li>-Scrap industry accepts scrap including new e-waste.</li> </ul>	<ul style="list-style-type: none"> <li>-Centralized collection points</li> <li>-Organized safe disposal</li> </ul>	<ul style="list-style-type: none"> <li>-No safe disposal except by CFSK.</li> <li>-No visible collection points</li> </ul>
<b>Skill and Technology</b>	<ul style="list-style-type: none"> <li>-Adequate skill and technology to deal with e-waste.</li> <li>-Crushing units, shredders, magnetic and eddy-current- and air-separators exist.</li> </ul>	<ul style="list-style-type: none"> <li>-Technology transfer strategy adopted to develop skill.</li> </ul>	<ul style="list-style-type: none"> <li>-Technology transfer strategy adopted to develop skill.</li> </ul>	<ul style="list-style-type: none"> <li>-In adequate skill and technology to deal with e-waste.</li> </ul>
<b>Main Incentive</b>	<ul style="list-style-type: none"> <li>-Environmental or social benefits</li> </ul>	<ul style="list-style-type: none"> <li>-Financial profit not environmental or social benefits.</li> </ul>		<ul style="list-style-type: none"> <li>-Financial profit seen as main incentive</li> </ul>

**Table 4.6 Summary of how other countries manage e-waste compared to Kenya. Source: Researcher. (Cont.)**

THEME	SWITZERLAND	INDIA	SOUTH AFRICA	KENYA
Challenges/Draw back	-Minimal challenges	-Uncontrolled emission of hazardous toxics -Rapidly increasing E-waste volumes -No accurate estimates of the quantity of E-waste generated and recycled - Low level of awareness amongst manufacturers and consumers of the hazards of incorrect E-waste disposal. -Open air burning using rudimentary techniques -Inefficient recycling processes	-no proper strategies to encourage collection and transportation	-No appropriate and visible collection points -No incentives -Low awareness levels amongst manufacturers and consumers of the hazards of incorrect E-waste disposal  -No policy -In adequate technology -Uncontrolled emission of hazardous toxics -No accurate estimates of the quantity of E-waste generated and recycled

#### 4.6.1 E-waste management

A further research question of this study required an investigation of how other countries manage e-waste and what lessons Kenya could learn. Three countries were studied namely; Switzerland, India and South Africa. It addressed the following themes: (a) E-waste financing; (b) current electronic collection and disposal practices, (c) policies and procedures for the management of electronic waste; (d) skill and technology; (e) Challenges and the responsibilities of various e-waste stakeholders. Review of literature on the last research question as captured in chapter 2 sections 2.3.1, 2.3.2 and 2.3.3 reveal how other comparable countries manage e-waste. Below is an analysis.

##### (a) E-waste financing

As indicated in Chapter 2 section 2.3.1, Switzerland has adopted Advance recycling fee (ARF) where consumers fund collection and recycling through ARF. The ARF is in turn used to pay for the collection, transportation and the recycling. In contrast in South Africa and India producers fund the recycling. In Kenya a totally different scenario from the Switzerland, South Africa and India obtain. There is no secured financing of the collection and recycling of WEEE either by producers or consumers. There is no Advance Recycling Fee (ARF) charged. This suggests that Kenya needs to develop a financing model based on the local circumstances. The researcher feels that the South Africa and India financial models would be practical for Kenya since the study has revealed that lack of economic incentives is

one of the main reasons why consumers do not return e-waste to collection points or recyclers.

### **(b) Current electronic waste collection and disposal practices**

In Switzerland there are official collection points around the country in addition to thousands of retail locations which have to take back old EEE free of charge. In India scrap industry accepts scrap including new e-waste streams while in South Africa EMPA has organized centralized safe collection points. In a sharp contrast to the above, a totally different situation was found in Kenya where there was no safe disposal except by CFSK. There are also no visible collection points. The study revealed that a large percentage (52.00 %) of consumers keep e-waste in offices or at homes, 24.00 % auction, and 20.00 % donate while a mere 4.00 % return them for safe disposal. As pointed out (Huisman 2005, in Anahide B (2007)), "research shows a clear link between number of collection points and kg's collected. Especially in the start-up phase of take back, the availability of collection points is crucial".

The argument here is that the government should do more to ensure that an e-waste management policy and legislative framework is in place. This will promote collection and safe disposal which are some of the main issues in the problem statement of this study.

### **(c) Policies and procedures for the management of electronic waste**

The literature reviewed in Chapter 2 has highlighted the policies and procedures adapted by various countries in guiding the proper management of electronic wastes.

The developments in South Africa and India are more or less comparable. In contrast to Kenya, the study has shown in sections 2.3.2 and 2.3.3, that in India EMPA has come up with a national e-waste strategy that has organically evolved from the informal sector while South Africa is currently implementing a national e-waste recycling compliance scheme. In Kenya there is no e-waste management policy however NEMA has come up with a guideline (see appendix E). As this study has demonstrated (Chapter 2), the development of policies and procedures in Kenya needs urgent and immediate attention.

It therefore seems that Kenya is lagging behind on e-waste policy issues compared to the two. Switzerland has a sustainable e-waste management policy. It can therefore be concluded from

the study that similar policy and management approaches as the ones in Switzerland, South Africa and India are necessary for Kenya to address the e-waste problem.

**(f) Skill and technology**

The results of this study as presented in Table 4.7 and analyzed in section 4.5.2 strongly indicate that there is inadequate technology and skill to manage e-waste in Kenya. In Switzerland there is adequate skill and technology to deal with e-waste. In South Africa and India Technology transfer strategy has been adopted to develop skill. As argued in section 4.5.2, integrated and collaborative programmes should be put in place to ensure technology transfer in e-waste technology and skills in Kenya. I therefore suggest that university lectures and researchers be incorporated in the education programmes and development of e-waste management curriculum during the technology transfer.

**(g) The responsibilities of various e-waste stakeholders**

On responsibilities of various stakeholders as presented in Table 4.7 there is an indication that in Switzerland, India and South Africa there are clear responsibility allocations and each of the actors is taking up their responsibilities. This probably could be because of clear e-waste policy and management procedures in the three countries compared to Kenya. This study advocates immediate amendment of current solid waste management legislation more so the introduction of a section specifically for e-waste and speedy operationalization of the e-waste management guidelines developed by NEMA. It is the view of the researcher that the guidelines are a good start and that their immediate adoption would be a step in the right direction in tackling the e-waste problem, This will make clear provisions for the management of electronic waste, so that various stakeholders understand their duties and the consequences of non-compliance.

**(b) Challenges**

It has been observed that Switzerland face the most minimal challenges while Kenya and India have the most challenges. South Africa faced the challenge of lack of proper strategies to encourage collection and transportation. However the study also found out that some of the challenges were unique to each country while others were replicated across. It could therefore be concluded that Kenya and India needed to do a lot if they have to contain the growth in quantities of e-wastes generated. The analysis of the results in Table 4.7 indicates that the

the interview questions administered to policy makers, standards officers, and policy enforcers. The questions asked mainly focused on the current e-waste disposal practices in Kenya, policies and procedures for management of e-waste, responsibilities of the various stakeholders, technology and availability of professional staff training as well as challenges various stakeholders face.

Kenya has developed a strategic plan (2006-2010) that aims at creating "an enabling environment through policy, legal and regulatory reforms" (Waema & Mureithi, 2008). Implemented by Ministry of Environment and Natural Resources (MENR), the plan describes hazardous waste and pollutants. The environment awareness is high although sensitization is not specifically done on e-waste; one of the respondents stated that the government has developed guidelines for e-waste.

Respondents revealed that the country lacks a regulatory framework for e-waste management stressing that in the past; Kenya has not had a recycling policy on electronics. According to a recent study (Waema et al., 2008) there is mention of the fact that in Kenya, "there is currently no legislation governing e-waste". Public Procurement Oversight Authority (PPOA) which oversees the procurement process in public sector is said to have not seriously considered end-of-life effects of products procured.

In an attempt to fight against hazardous waste, Kenya is a signatory to numerous multilateral environmental agreements. Respondents mentioned some of these agreements as: (1) Basel convention on the control of trans-boundary movements of hazardous wastes and their disposal; (2) Bamako convention on the Ban of the imports into Africa and the control of trans-boundary movement of hazardous wastes into Africa; (3) Nairobi convention which provides a mechanism for regional (East Africa) cooperation, coordination and collaborative actions on solving pollution problems of the coastal and marine environment; (4) Stockholm convention on Persistent Organic Pollutants (POPs) and (5) Rotterdam convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade. Respondents also highlighted the usefulness of such agreements i.e.,



development and implementation of e-waste management policies should be priorities for Kenya, South Africa and India to overcome the challenges.

#### **4.6.2 Lessons Kenya can learn**

As presented in section 4.6.1 the researcher feels that Kenya could learn a lot of lessons from Switzerland, South Africa and India. Some of these are listed below:

1. Kenya could have a model where consumers take back e-waste to waste collectors who pay them in turn. The Collectors could sell to recyclers who could in turn sell to producers. This could drive the e-waste collection, transportation and its treatment as practiced in India.
2. Kenya could come up with Advance Recycling Fee (ARF) charged on all new appliances coming into the market after the new e-waste policy. The ADF could be used to finance the collection, transportation, storage, recycling and safe disposal of e-waste generated as done in Switzerland.
3. The e-waste system in Kenya could make producers both legally and operationally responsible.
4. The existing informal waste management sector consisting of collectors, traders and recyclers could be incorporated in the formal e-waste management system. This could create jobs to thousands of jobless Kenyans.
5. On e-waste management policy, Kenya could have one similar to Switzerland.
6. All e-waste stakeholders ought to take their responsibilities with regard to e-waste management.
7. Organized visible collection points could be established in Kenya as happens in Switzerland, India and South Africa.
8. Technology transfer strategy could be adopted to develop e-waste management skill in Kenya.

#### **4.7 E-WASTE POLICY ISSUES IN KENYA**

This section presents an analysis of data on e-waste policy and legislation in Kenya from the perspective of policy makers. This information was collected from policy makers using Questionnaire for policy makers (attached as appendix B) supplemented by interviews (attached as appendix C). The questionnaire was personally circulated by the researcher and

the interview questions administered to policy makers, standards officers, and policy enforcers. The questions asked mainly focused on the current e-waste disposal practices in Kenya, policies and procedures for management of e-waste, responsibilities of the various stakeholders, technology and availability of professional staff training as well as challenges various stakeholders face.

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promotion of mechanisms and infrastructure needs for greener environments, controlling and providing guidelines for cross boarder movements of hazardous components<sup>17</sup>.

Despite the fact that Kenya is a signatory to numerous multilateral environmental agreements as revealed by the respondents, the problem statement section of this study states that there is no policy framework to address the collection, transportation, treatment, safe disposal and monitoring of e-waste flows in Kenya. It seems therefore that though there is intention to manage e-waste and hazardous wastes there is no enforcement mechanism of such agreements or the agreements are not binding on all countries. Africa suffers imports of hazardous wastes and all forms of e-wastes in the name of donations from Europe and America. This study advocates for an urgent review of the agreements.

While it cannot be disputed that the quantity of electronic wastes will continue to grow with increased computerization in government agencies, evidence clearly shows that currently there are no clear policies on e-waste management in Kenya. A discussion with some of the respondents revealed that the use of computers in government offices had brought many challenges with regard to disposal of electronic wastes deemed to have reached their EOL? The respondents indicated that while there was a need to manage electronic wastes, there was a lack of relevant policies and procedures to support the management of such equipments throughout their life-cycle. It was reported that government policies and strategies for managing solid wastes were inadequate in addressing the e-waste problem<sup>18</sup>.

An interview conducted in March with a solid waste management officer and two other separate interviews conducted in early April with an ICT officer and a health and administrative officer on the progress made so far in terms of policies and procedures for the management of electronic wastes in different ministries and departments revealed that most agencies had not made any significant progress. From the responses, it was found that other agencies were convinced of the need to have policies and procedures specifically for the

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<sup>17</sup> Responses to Questionnaire for policy makers on e-waste policy issues in Kenya, completed by compliance and enforcement officers NEMA, ICT standards and development officers KEBs, Health Administration officer Ministry of public health and sanitation, ICT officers, Nairobi, Kenya, April 2011.

<sup>18</sup> Responses to Questionnaire for policy makers on e-waste policy issues in Kenya, completed by compliance and enforcement officers NEMA, ICT standards and development officers KEBs, Health Administration officer Ministry of public health and sanitation, ICT officers, Nairobi, Kenya, April 2011.

management of electronic waste but were waiting for guidelines from the national environmental management authority.

A follow-up interview in late April with a compliance and enforcement officer from NEMA established that an e-waste guideline document had been developed by NEMA/MEMR and was at the government printers<sup>19</sup>. The respondent stated that the guidelines would cover issues such as legal admissibility of electronic wastes, their management throughout their life-cycle and EPR issues. The officer reported that there would be a review of Environmental Management and Coordination Act (EMCA) to include e-waste component into the waste management regulations starting July 2011. It was reported that the legal interventions and provisions (attached as appendix C) of waste management regulations (2006) did not adequately respond to the e-waste problem<sup>20</sup>. As part of future government plans, it had become clear from the responses that preparations to set the stage for jump starting a national e-waste policy were at an advanced stage.

Guidelines for e-waste management in Kenya (NEMA, 2010) present global and local context on e-waste, legal and institutional framework, e-waste categories and guidelines for target groups in e-waste management. These guidelines compares with those of an earlier publication, an e-waste guideline manual (UNEP, 2007). According to (NEMA,2010) producers need to establish channels to collect e-waste, implement individual take back or get organized into PROs and build in the cost of product take back and disposal into the purchase product price. Importers need to notify NEMA for consent to transport e-waste through Kenya subject to stated conditions. They are also needed to specify standards for products on the expected remaining lifespan of the equipments and electrical appliances. It therefore seems that KEBs and KRA will have to play a lead role in enforcement of importation. Refurbisers need to ensure that unusable material goes to a licensed disposer, waste plucked out of the equipment go to the recycler, and provide incentives to the consumer to donate used devices.

Recyclers need to establish recycling infrastructure and environmentally sound technologies to manage electrical and electronic waste and ensure that dismantling is done in an environmentally safe manner. According to (NEMA, 2010) recycling processes should be

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<sup>19</sup> Simiyu, I. 2011. [Personal communication]. April 26.

<sup>20</sup> Simiyu, I. 2011. [Personal communication]. April 26.

approved and licensed by NEMA. Transporters need to ensure that e-waste is properly stored and disposed in licensed dumping sites and that vehicles transporting e-waste obtain e-waste transport license from NEMA. Therefore it can be concluded that NEMA will have to play a great role on enforcement.

The guidelines stipulate that consumers need to dispose e-waste generated to the e-waste collection centres, sell or donate e-waste to licensed refurbishers, take back equipment to the manufacturer, importer or assembler or dump e-waste at the licensed dumping site. It is my feeling that Municipal council and NEMA should ensure enforcement of these guidelines.

According to (NEMA,2010) government organizations such as MEMR, Ministry of Local Government, KEBS, NEMA, KRA and CCK need to prepare a framework with appropriate legislation to support e-waste management, monitor the processes of e-waste handling regularly, create a management plan with responsibilities for different target groups, provide incentives to entrepreneurs to set up e-waste collection and treatment facilities, regulate / control the number of e-waste facilities within a geographical area, approve innovative e-waste management technologies that are environmentally sound and form multi-stakeholder monitoring committees to oversee the implementation of the e-waste management guidelines. On collection systems it is indicated in the guideline that collectors shall seek approval from NEMA and Local Authorities and their details be publicised for public use. Informal sector e-waste collectors will only need to acquire a license if they collect e-waste from various sources. The guidelines seek to use Reduce, Repair, Reuse, and Recycle strategy to minimize e-waste. Disposers should keep a record of the amounts and categories of waste. NEMA in this guideline is tasked with inspection of e-waste handling facilities.

On recycling and recovery of e-waste NEMA in collaboration with relevant lead agencies shall register and recognise collection schemes as well as recycling centres for regulation through licensing. NEMA in collaboration with the Kenya Revenue Authority (KRA) may have to introduce an Advanced Recycling Fee (ARF) for products which will eventually become part of the e-waste stream as part of import levy. It therefore appears that NEMA and KRA bear greatest responsibility towards ensuring enforcement of these guidelines.

When asked to comment on why generators of e-waste in Kenya could not be held accountable for their deeds in Kenya the respondents said that lack of proper legal framework to prosecute and enforce were the main reasons. Responding to the question on whether Kenya should have an e-waste policy or whether it needed to develop an e-waste bill and why one respondent from NEMA said that,

*"I strongly feel that in order to immediately start addressing the silent accumulation of e-waste in Kenya a bill would be most appropriate because a policy takes too long"<sup>21</sup>.*

Concurring with her sentiments, an ICT standards officer from Kenya bureau of standards noted that a bill would be faster in reversing the current e-waste situation<sup>22</sup>. These two revelations could mean that Kenya ought to act immediately on the e-waste problem as soon as the e-waste guidelines are published and EMCA revised. This would be a short term remedy as the country works on a long term e-waste policy and regulatory framework which is equally important and urgent.

When asked about the adequacy of the current monitoring and evaluation system, the respondents reported that they were not adequate and that their impact had not yet been felt. And on what suggestions they had to ensure effective independent audits and material flow monitoring, they suggested establishment of an e-waste section in every organization, training, awareness creation, and finally KRA and KEBs discharging their mandate with the newly developed structures<sup>23</sup>. Responding to a question on the reasons as to why the Basel convention could not make the manufactures responsible for hazardous wastes as opposed to countries, a compliance officer from NEMA said that,

*"even though NEMA represents the government of Kenya through Designated National Authority on Basel issues, there are no structures in place to enforce the BASEL convention but they are being established"<sup>24</sup>.*

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<sup>21</sup> Simiyu, I. 2011. [Personal communication]. April 26.

<sup>22</sup> Response to Questionnaire for policy makers on e-waste policy issues in Kenya, completed by an ICT standards and development officer, Kenya Bureau of Standards, Nairobi, Kenya, April 2011.

<sup>23</sup> Responses to Questionnaire for policy makers on e-waste policy issues in Kenya, completed by compliance and enforcement officers, ICT standards and development officers KEBs, Health administration officer Ministry of public health and sanitation, ICT officers, Nairobi, Kenya, April 2011.

<sup>24</sup> Simiyu, I. 2011. [Personal communication]. April 26.

Policy makers were also asked about the potential challenges they foresaw during the implementation of an e-waste management policy in Kenya. One policy maker from NEMA, stated that her major fear was lack of cooperation from manufactures to set up Producer Responsibility Organizations (PROs) in Kenya<sup>25</sup>. Another respondent from the ministry of public health particularly singled out lack of technical capacity to deal with e-waste in Kenya<sup>26</sup>.

Responding to the same question another policy maker from the ministry of ICT stated that:

*"inclusion of stakeholders [has] not [been] adequately addressed e.g. streetboys who survive on the business, low awareness levels and lack of funds to compensate [consumers and collectors were major challenges]"<sup>27</sup> .*

The above statement shows that an ideal e-waste management framework ought to take cognisance of the role played by the informal sector, tackle the low awareness levels as well as look into the economic benefits consumers and e-waste collectors attach to e-waste in Kenya. Raising the same concern a solid waste management officer from NCC confirmed that street boys and other informal waste management sectors played a great role in solid waste separation in Kenya and as such ought not to be ignored<sup>28</sup>. The respondents, however, felt that an e-waste management system would only be effective in Kenya after a policy framework was in place as this would ensure that various stakeholders took their responsibilities seriously.

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<sup>25</sup> Response to Questionnaire for policy makers on e-waste policy issues in Kenya, completed by a compliance and enforcement officer, NEMA, Nairobi, Kenya, April 2011.

<sup>26</sup> Interview with Health Administration Officer: Ministry of Public Health and Sanitation, on 26 March 2011, at the offices of Ministry of Health Upper Hill, Nairobi.

<sup>27</sup> Interview with ICT Officer: Ministry of Information and Communication Technology, on 23 March 2011, at the offices of Ministry of ICT, Nairobi.

<sup>28</sup> Interview with the solid waste management officer: Municipal Solid Waste Management, NCC, on 15 March 2011, at the offices of Nairobi City Council, Nairobi.

While responding to the question on what kind of e-waste training capacity was available in Kenya for the e-waste handlers and recyclers and what plans were there to incorporate universities in capacity building one respondent said that,

*"None currently however an e-waste management awareness strategy is being developed with members from higher institutions and will be rolled out in due course"*<sup>29</sup>.

Additional findings from two other responses on the same question revealed that they were not aware of any plans on capacity building by the government<sup>30</sup>. An interview with a compliance and enforcement officer revealed that there was a plan to launch an e-waste research program in Kenya spearheaded by Masinde Muliro University of Science and Technology in collaboration with other public and private universities. The program would be funded by UNEP and would involve all relevant researchers from universities<sup>31</sup>. A separate interview suggested that the e-waste technology used in Kenya was rudimentary and needed to be upgraded<sup>32</sup>. On the issue of retaining e-waste professionals; respondents felt that it was the duty of the government to give incentives and remunerate them well.

The above revelations could suggest that Kenya needs a technology transfer strategy like the one implemented by EMPA in South Africa, however the trained e-waste handlers and other professionals ought to be well remunerated and given incentives by the government to ensure retention in employment. This would avert "brain drain" of those already trained. This was because they could easily command jobs in the private sector with salaries many times more than earned in the public service. University lecturers, researchers and other trained e-waste professionals would go into highly paid jobs in international agencies either operating locally or elsewhere, a trend that would be fatal. It could also mean that the government of Kenya

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<sup>29</sup> Simiyu, I. 2011. [Personal communication]. April 26.

<sup>30</sup> Responses to Questionnaire for policy makers on e-waste policy issues in Kenya completed by ICT standards and development officer: KEBs and Health Administrative officer: Ministry of Public Health and sanitation, Nairobi, Kenya, April 2011.

<sup>31</sup> Simiyu, I. 2011. [Personal communication]. April 26.

<sup>32</sup> Interview with Health Administration Officer: Ministry of Public Health and Sanitation, on 26 March 2011, at the offices of Ministry of Health Upper Hill, Nairobi.



ought to be alert on other countries which could have immigration-friendly policies that could allow easy movement of skilled e-waste professionals.

On what policy makers believed the mechanisms of e-waste disposal in Kenya were similar sentiments were expressed by all the respondents interviewed. One of the respondents had this to say,

*"of course there are no established disposal mechanisms, people just throw away in dump sites, sell them to scrap dealers, or store them in offices or homes, what I also know is that some government institutions auction computers deemed to have reached end of their use full life"<sup>33</sup>.*

Commenting on the recommendations, suggestions on improvements and way forward on e-waste disposal in Kenya interviewed policy makers pointed out the following: setting up collection centers, burn on manufactures who do not comply and improving technical skills. One of the respondents suggested adjusting procurement policies by formulating environmental sound policies.

## **4.8 THE IDEAL E-WASTE MANAGEMENT FRAMEWORK**

The purpose of this study was to develop an ideal e-waste management framework to handle the collection, transportation, processing, recycling, disposal and monitoring of e-waste material flows in Kenya. This section presents the desired end result. In other words how the ideal situation would be in the long term, informed by gathered knowledge and findings from this study. The proposal is that the desired long term situation be achieved through the ideal e-waste management framework whose components are discussed below.

### **4.8.1 Stake-holders**

This sub-section identifies stakeholders who ought to be part of the proposed framework as:

(a) Consumers (b) Collectors, and collection points, (c) refurbishers, (d) processors or dismantlers, and (e) final disposers, (f) the government, (g) academicians and NGOs, (h) Producer Responsibility Organizations.

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<sup>33</sup> Interview with Health Administration Officer: Ministry of Public Health and Sanitation, on 26 March 2011, at the offices of Ministry of Health Upper Hill, Nairobi.

### **(a) Consumers**

E-waste needs to be brought from consumers to a collection point and from a collection point to the refurbisher or processor. The role of private consumers in the proposed framework is to take back e-waste to convenient collection points or retail shops. Private consumers should be paid some money at a determined rate since this study has revealed that 40.62 % of consumers in Kenya do not return e-waste to collection points or to recyclers due to lack of incentives. Corporate companies and government institutions should transport their e-waste directly to a registered refurbisher or processor. This could save storage space in collection points.

### **(b) Collectors and collection points.**

According to Anahide (2007), to have appropriate collection site is important in order to change consumer behaviour regarding the discharging of e-waste. This study has revealed that 40.62 % of consumers don't return e-waste because there are no incentives followed by 34.38 % who mentioned low awareness levels of existing collection points. This constitutes 75 % of consumers. This framework proposes that collection points provide a place to communicate e-waste information to the consumer. Information sheets on containers and leaflets could explain why it is important to safely dispose e-waste. Additionally a list of collection points and of types of equipment collected could be given.

Retailers and traders in the current system in Kenya do not play any role in e-waste collection as compared to developed countries such as Switzerland. When selling new items retailers and traders should encourage customers to return them at EOL and explain how this could be done. Consumers could be given discounts when purchasing new EEE if they return back the old ones.

Buy-back centres would probably be one of the viable avenues for collecting e-waste in Kenya. These could be set up by entrepreneurs who must be registered and trained in e-waste handling. Given that these entrepreneurs could be downstream dismantlers it is not advisable to set them up near dump sites as this could encourage dumping of scrap. Consumers should be paid whenever they return e-waste. To have proper records of volumes collected there must be a weighing bridge at every collection point. This data should be given to a national e-waste registry office for e-waste quantity generation monitoring.

Municipal collection sites shall receive WEEE/ e-waste and take responsibility for delivery to regional sorting stations operated by the municipalities. This shall be practiced across the country. Each county shall come up with and enforce strategies of streamlining e-waste collection. Informal scrap dealers could also be incorporated in collection of e-waste. The producers will be finally responsible for collection and funding of e-waste management system in the country. It puts the responsibility on them for setting up collection centres or take-back system either individually or collectively for all EEE at their end of life. They are also made responsible for financing and organizing a system to meet the costs involved for current as well as historical waste.

### **(c) Government**

The government plays the role of coordination by providing e-waste rules (legal enforcement). The government of Kenya at national level in the proposed framework formulates e-waste management policies and frameworks. Such e-waste legislation should address the roles of producers, consumers, recyclers and consumers. For instance legislation should make take-back of EOL equipment mandatory for consumers in Kenya and also establish legal policy framework for EPR which is the basis of PRO. It is also the duty of the government to implement the policies and guidelines formulated through enforcement, monitoring and evaluation. The government of Kenya should make sure that all electrical and electronic manufactures in Kenya are registered with a producer responsibility organization. The manufactures should be made to take responsibility of final disposal of e-waste. Learning institutions and the private e-waste investors will operate under the government. To the investors the government bears the responsibility of creating a favourable environment for investment. It is only through this that Kenya can realize the positive fringe benefit of e-waste of job creation to the youth and informal entrepreneurs as mentioned in the significance section of the study and confirmed in section 4.4 of the analysis.

### **(d) Producer Responsibility organizations (PROs)**

Producer Responsibility Organizations would provide managerial component of the framework logistics and e-waste processing. In the proposed framework it should be the duty of EEE manufactures to form PROs and ensure that they are operational in Kenya. The framework proposes official collection points around Kenya in addition to creation of thousands of retail locations which have to take back old equipment free of charge, irrespective of the brand or year of manufacture. It becomes easier for consumers to dispose

their WEEE/E-waste at appropriate locations. In the framework EEE manufactures and importers through PROs are solely responsible for treatment and final safe disposal of WEEE/E-waste or its fractions. Common collection points will enable the PROs to better manage the logistics, gain from the benefit from economies of scale and provide a consumer friendly and all inclusive system.

#### **(e) Investors and Universities.**

Universities have a great role to play in e-waste research and technology transfer. The research findings have shown that the technology and skill to handle e-waste is inadequate in Kenya. It can therefore be argued that any framework that does not address technology and skill cannot equally adequately address the e-waste problem in Kenya. Learning institutions especially the universities should be charged in collaboration with other academic bodies, donors, and government institutions with the responsibility of spearheading development of e-waste curriculum and implementing the same in institutions of higher learning, tertiary colleges, secondary and primary schools. When doing so comparative analysis should be done with success stories and best practices from other countries be borrowed. However as Kenya borrows technology caution should be taken to marry foreign knowledge with the local context. The frame work takes cognizance of the urgent need of training and education of the Kenyan public especially consumers and the informal actors as away of e-waste awareness creation. Further still on the informal actors the framework proposes funding of e-waste entrepreneurs in Kenya hence inclusion of investors in the framework. Foreign investors such as NGOs should be encouraged to take an active role in the recycling industry in order to create employment and entrepreneur based opportunities to the youth. NGOs could also establish contact between refurbishers and disadvantaged people for second hand computer donations.

### **4.8.2 Other framework supportive conditions**

#### **(a) Integrating the informal sector**

The informal sector has played a very significant role in solid waste management, especially in e-waste recycling. This strength is required to be harnessed and channelised. As this study has revealed street boys have not been adequately considered. The e-waste rules must find mechanism to integrate and control the activities of the informal sector by creating

opportunities for its participation. The sector is already established and plays an active role in solid waste management in Kenya. Perhaps what is lacking is an organized infrastructure of how to co-opt the informal players into the e-waste management mainstream. Informal collectors, traders and recyclers in Kenya are already doing a lot in trying to reverse the e-waste menace. However there is lack of policy and a legal framework to coordinate their activities. An enabling regulatory framework should be developed as described in the final draft guidelines for e-waste management in Kenya (NEMA/MEMR, 2010) and speedily implemented if economic benefits for example job creation is to be realized from this new stream of solid waste

**(b) Collaboration**

The proposed framework as a matter of principle recognizes that national systems should be run and managed by industry/ recyclers/ producers within a sound legislative framework established in collaborative and consultative process with all e-waste stakeholders. As was revealed by the study and discussed in section 4.7 one of the challenges faced by e-waste policy makers in Kenya is lack of collaborative approach to the development of e-waste policy. Consultation and collaboration amongst the producers, recyclers, collectors, universities, UNEP, NGOs, Investors, and consumers is the only sure way of constructively responding the e-waste problem in Kenya.

**(c) Illegal imports and dumping monitoring**

An ideal e-waste management framework needs a section that deals with control of importation of electrical and electronic products into Kenya. The framework proposes inclusion of a clause that empowers Kenya Revenue Authority and Kenya Bureau of Standards to come up with and enforce minimum requirements for the importation of EEE into Kenya.

### **4.8.3 The ideal e-waste framework and EMPA framework**

While it remains true that the proposed framework shares some components with the EMPA framework, it remains different from EMPA's. It is believed that it provides an e-waste management system unique to Kenya based on the local context and findings from this study by including the following components:

- Clearly defined e-waste collection system
- Universities, NGOs and Investors
- Clearly defined transport logistics
- Producers and manufacturers of Electrical and Electronic Equipments
- Informal sectors
- Collaboration
- Illegal imports and dumping monitoring

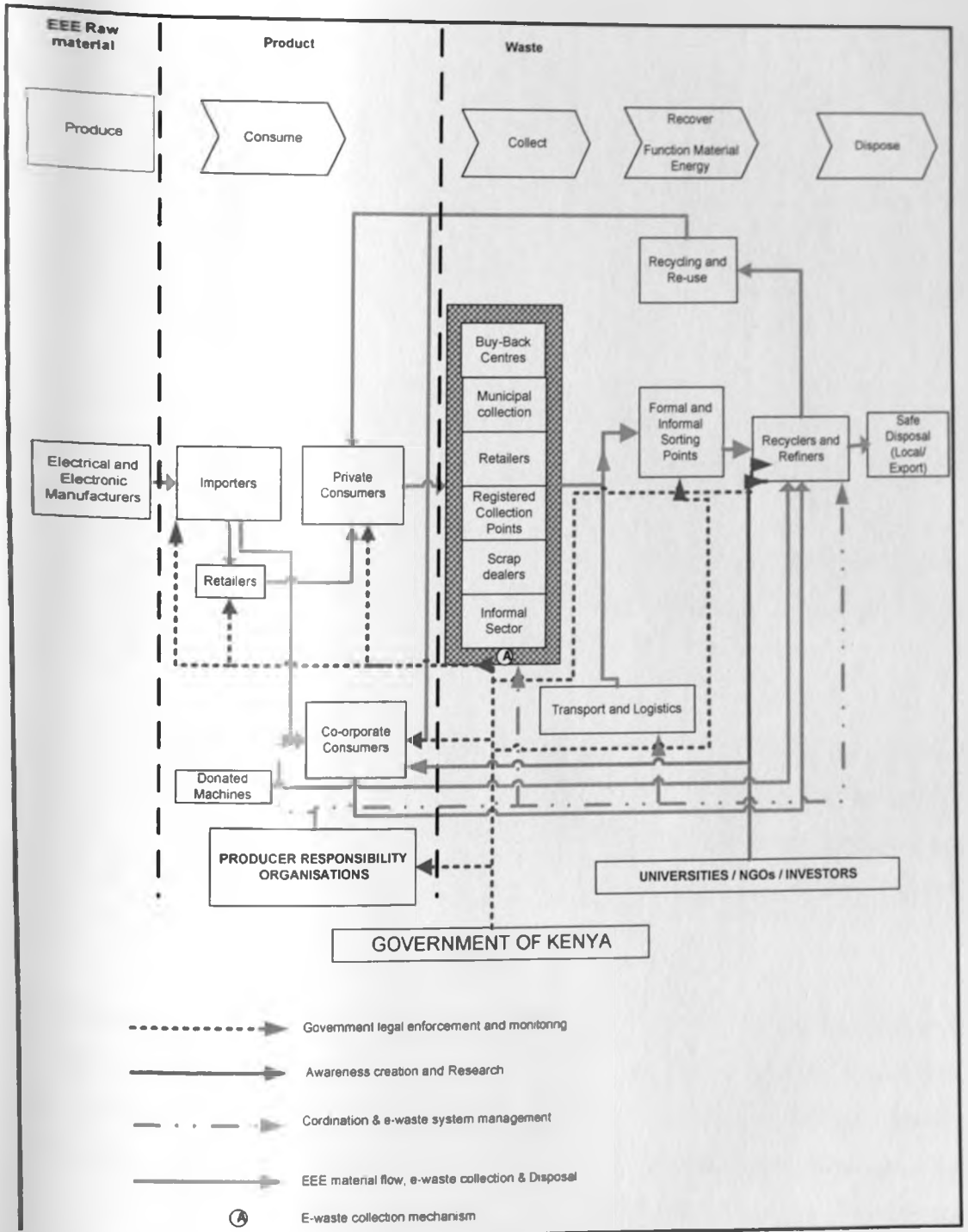


Figure 4. 13 The ideal e-waste management framework for Kenya.

## 4.9 CHAPTER SUMMARY

This chapter has presented findings, analysis and discussion from data collected during the research study. The data presented and discussed in this chapter has suggested that there are low levels of awareness on e-waste in Kenya while there are no safe disposal practices. It has also emerged that producers do not carry out their responsibility in e-waste management in Kenya due to lack of an e-waste policy. Other countries such as Switzerland, South Africa and India have been shown to be doing better in e-waste management and that Kenya could learn a lot from them.

It has also emerged that Safaricom and Nokia had piloted on take-back initiatives but they failed due to consumers wanting to be given incentives. The research findings indicate that a framework that gives consumers incentives would be ideal. In Kenya most consumers do not return their e-waste to collection centers or retail points for safe disposal. Both public and private consumers keep their e-waste. The technology needed for safe processing of e-waste in Kenya according to the research findings are inadequate.

Switzerland utilizes Advance Recycling Fee model in their e-waste management framework where consumers are charged an advance recycling fee whenever they buy a new electronic item. In India the price paid by the producer runs the whole e-waste management chain since refurbishers and recyclers who are mostly informal actors in India are paid by the consumer. They in-turn pay the collectors who sell e-waste to them.

Findings from this study have also revealed that e-waste presents great opportunity for employment while at the same time poses serious health and environmental impacts. Care therefore ought to be taken especially when recovering precious metals and separating hazardous material from e-waste. While NEMA/ MEMR have developed a national e-waste management guideline it is another issue to implement the recommendations in the guidelines so as to start reversing the negative impacts of e-waste. It is my feeling that multidisciplinary approach should be adopted when coming up with the final e-waste management policy framework for Kenya. Findings of this study show that there is a problem with all



stakeholders working together in trying to develop an e-waste policy framework for Kenya.

Most policy makers still operate in isolation.

The chapter concludes with a proposal of an ideal e-waste management framework for Kenya taking into consideration most of the research findings.

## **5 CONCLUSIONS AND RECOMMENDATIONS**

### **5.1 INTRODUCTION**

This chapter concludes the research study undertaken based on key findings. It is presented in five sub sections. Section one is the introduction, section two presents the conclusion of the research study against the research objectives, section three presents limitations of research, finally section four presents recommendations and direction for future research. Where photographs were used in this study permission was sought from relevant authorities for ethical considerations.

### **5.2 CONCLUSION OF RESEARCH STUDY AGAINST OBJECTIVES**

This study had three objectives. This section will discuss the findings of the research study in relation to the objectives.

#### **5.2.1 Responsibilities of various e-waste stakeholders**

According to the findings in this research various e-waste stakeholders have a role to play in e-waste management in Kenya. Producers have the responsibility of financing e-waste management system, designing products with less negative impact on health and environment, create e-waste awareness, establish e-waste collection centers and form PROs.

Consumers have the responsibility of disposing e-waste based on a menu of prices which vary depending on the characteristics of the product. Private / household consumers ought to return their end-of-life equipment to dedicated collection points or through authorized pick-up services. Corporate consumers ought to maintain records of donations and ensure that the material joins the e-Waste management system at its end-of-life.

Recyclers have the responsibility of upgrading their skills and technologies for best practice in all steps of recycling, registering firms, obtaining all licenses and ensuring safe e-waste recycling procedures. Policy makers are tasked with the responsibility of framing appropriate guidelines/legislation ensuring safe e-waste disposal and recycling of precious metals, monitoring the e-waste management system regularly, regulating and controlling the number

of collection/ recycling facilities in a geographical area, approving appropriate technologies and creating e-waste awareness.

### **5.2.2 E-waste disposal practices of stakeholders and challenges they face**

The findings of this research indicate that various stakeholders have different ways of disposing e-waste in Kenya. Research findings show that 52.00 % of consumers store e-waste due to lack of awareness of where to take them or what to do with them. Another 24.00 % auctioned them, 20.00 % donate, while mere 4.00 % return e-waste to registered collection centers or recycling plant. The main challenge for consumers were awareness, lack of incentives and no visible collection points.

Two groups of recyclers identified in this study are formal and informal recyclers. Computer for Schools Kenya is a registered (formal) recycling company that recycles donated computers and distributes them to schools. Most computers recycled by CFSK are imported since most Kenyan consumers do not return e-waste. CFSK also make Television sets with e-waste. Informal recyclers sale collected e-waste to “jua kali artisans who make “jikos” out of them and to metal scrap dealers. This study established that it was not clear how scrap dealers and other downstream vendors finally disposed of their e-waste. The main challenges facing recyclers were in adequate technology, bureaucracy, and increasing e-waste volumes.

Producers don't take their responsibility of safe disposal in Kenya for lack of an e-waste management framework. Challenges faced by producers were lack of collaborative approach to e-waste policy formulation, low level of e-waste awareness, and no accurate estimates of the quantity of E-waste generated and recycled.

### **5.2.3 Framework for e-waste management in Kenya**

The framework presented in fig 4.13 has been developed from findings in this research study. The framework can be used by policy makers to monitor flow of EEE and the resulting e-waste in Kenya. It provides a mechanism for safe collection, transportation, recovery of precious metals and final safe disposal of electronic waste.

The framework has seven distinct components namely; Government, Producer Responsibility Organizations, Universities & Investors, Consumers, Collectors, Recyclers and Final

disposal. These components were validated by the findings of this study. The proposed framework is generic and can be adopted in developing countries. A summary of the cost implication of implementing the framework is presented in Table 4.7 below.

**Table 4. 7 Cost of framework implementation**

Framework Element	Cost Implication
e-waste collection system	-Incentives for collection -Storage costs
Universities, NGOs and Investors	-Trainers -Training tools -Training venue -Trainee costs( allowances, cover at work place) - Technology transfer
Transport logistics	-Transportation from retail points, scrap dealers, informal collectors. -Municipal collection
Producers and manufacturers	-Collection points set up costs. -Incentives for collection costs.
Informal sector	-Incentives for collection
Illegal imports and dumping monitoring	-Monitoring and enforcement overhead costs

The framework implementation costs identified above provide the key elements to be considered in working out the financial implications of implementing the proposed framework.

### **5.3 Contribution of research to practice and theory**

According to Osibanjo O. (2009), “in many developing countries and countries with economies in transition, e-waste is both an emerging problem and an economic opportunity due to the growth of disposal of electronic devices that contain materials that are both toxic and valuable”. This study adds value to each and every player included either directly or indirectly in e-waste management. For instance to the informal actors such as “street boys”, recyclers, scrap dealers among many others, it creates job opportunities and means of

livelihood. The revelation of e-waste recycling in “Kibera” opens great opportunities for further research in the informal settlements so as to map e-waste management practices and impacts on job creation and health. To the importers, distributors and retailers it adds value to their business function through Extended Producer Responsibility which gives them a positive image in the public eye as they are seen to be undertaking their corporate social responsibilities. To the government it makes it easy to manage e-waste and create awareness on general environmental issues. To the consumers it offers a convenient mechanism for safe disposal of EOL equipments thereby avoiding negative environmental and health impacts. Processors, refurbishers and investors easily get material for their processing plants increasing their profit margins enabling them to get value for their investments.

The study has positive academic contribution. It confirms and validates salient components of an e-waste management system namely consumers, collection, recycling and final disposal as proposed by Waema (2008). The components Government, Investors & Universities, Producer Responsibility Organizations, Municipal collections, scrap dealers, informal collectors and donated machines have been included in the proposed e-waste management framework. These new concepts are believed to extend research in e-waste management. Findings of this study have also added to the body of knowledge in e-waste management in Kenya.

#### **5.4 Limitations of the research**

There are two noteworthy limitations of this research study: one, generalization effect. These research findings are limited because they were generated in an exploratory qualitative inquiry. The research design was not intended to produce results that account for or predict e-waste disposal practices and behaviour of a wide classification of people. However, because the survey generated a relatively clear e-waste management framework that can be applied to practical e-waste management challenges and experiences, it should be relatively easier to design a series of focussed hypothesis- testing studies to experimentally verify and expand on the framework developed in this study. Secondly the study was limited to e-waste from computers leaving out other forms of e-waste from fridges, Television sets, mobile phones etc. making it impractical to generalise its findings to other forms of e-waste.

## **5.5 Recommendations and direction for future research**

While it might appear at the early stages of implementation of this framework that few materials may end up in the desired recycling and processing centers, it is recommended that registered recyclers and processors be patient as the collection system picks up. The reason is that it may take a little more time before the informal actors and consumers are convinced that they need to collect their waste using the proposed framework especially if incentives are not given. There is an urgent need to communicate the aim of the proposed framework, the roles, and challenges of different stakeholders. For instance it should be explained that the system manager i.e. the PRO is independent and must be left to operate as such without political or any such kind of influence which is a common practice in Kenya. Finally practicing recyclers might consider how effective and instrumental they could be in promoting safe e-waste collection, transportation and disposal using the proposed framework.

Although it is hoped that this study will have contributed to the management of electronic waste in Kenya by identifying the need for policies, procedures, e-waste awareness creation, collection, recycling, safe disposal and technical capacity development among others, there is a need for further research to be carried out in the future in the following aspects:

1. For a more thorough examination of e-waste management practices in Kenya, a future study should include more agencies and more respondents as well as classification of people in each of the agencies.
2. The economic viability of each step of the process, including logistics, could be studied further to know exactly where a financial help is needed and how profitable e-waste recycling could be.
3. A future study should look at the issue of technology transfer, training and e-waste education in detail, covering both e-waste handlers and the public and provide a comprehensive model of training programmes designed after intensive discussions with relevant stakeholders including universities and professional associations.
4. A study of the consumer behaviour to determine the best option for e-waste collection points such as retailer take back, collection centre or municipal collection centre or any other that may be appropriate for Kenya could be investigated in a future survey.

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# APPENDICIES

## APPENDIX A

### QUESTIONNAIRE FOR E-WASTE STAKEHOLDERS

#### SECTION A: GENERAL INFORMATION

The information provided in this questionnaire will be confidential and strictly used **ONLY** for my University thesis research on e-waste management in Kenya.

Stakeholder Category	
Location	
Respondent name and contact (Optional)	

#### SECTION B: KEY ISSUES IN E-WASTE MANAGEMENT FOR VARIOUS STAKEHOLDERS

Please answer appropriately to the following issues in e-waste management in Kenya:

##### **B1: PRODUCERS (To be answered by Producers only)**

1. Why has Extended Producer Responsibility in e-waste management **not** taken off effectively in Kenya? \_\_\_\_\_

2. In your opinion what financing model would be sustainable in Kenya? \_\_\_\_\_

3. How adequate is your consumer inventory system if any? \_\_\_\_\_

4. What are your mechanisms for e-waste disposal? \_\_\_\_\_

##### **B 2: CONSUMERS (To be answered by Consumers only)**

5. Do you separate e-waste at source?  Yes  No

6. Why do you separate e-waste at source or not? \_\_\_\_\_

7. In your opinion what are the **two** key reasons why consumers in Kenya don't return e-waste to retail shops, recyclers or collection centres? \_\_\_\_\_

i) \_\_\_\_\_

ii) \_\_\_\_\_

8. Which recycling scheme for obsolete computers are you aware of in Kenya?

\_\_\_\_\_

9. Mention any negative environmental or health impact you have encountered in the recent past due to improper e-waste handling.

\_\_\_\_\_

**B3: REFURBISHERS/ COLLECTORS / RECYCLERS/ DISMANTLERS (To be answered by Refurbishes/ Collectors /Recyclers)**

10. How adequate are your staff skills and processing technology in handling e-waste?

\_\_\_\_\_

11. Mention any negative environmental or health impact you have encountered in the recent past due to improper e-waste handling.

\_\_\_\_\_

12. Do you keep an inventory of your e-waste? If yes how effective is the system?

\_\_\_\_\_

13. How do you collect, and transport computer e-waste from consumers to your recycling plant? Please describe the route.

\_\_\_\_\_

14. What is your opinion on the registration and formalization of e-waste recycling plants in Kenya?

\_\_\_\_\_

15. Do you have any disposal policy?

Yes  No

16. How do you dispose of computer components which you cannot recycle?

Landfill  Sell locally  Export  Other

(specify) \_\_\_\_\_

**SECTION C: RESPONSIBILITIES OF VARIOUS STAKEHOLDERS.**

In this section, please mention what ought to be the two key responsibilities of the various stakeholders in the categories provided for sustainable management of e-waste in Kenya?

	STAKEHOLDERS	RESPONSIBILITY
1	<u>Producers</u>	1..... 2.....
2	<u>Consumers</u>	1..... 2.....
3	<u>Recyclers</u>	1..... 2.....
4	<u>Collection centers</u>	1..... 2.....
5	<u>Retail shops/ Distributors</u>	1..... 2.....

**SECTION D: E-WASTE DISPOSAL (This section is to be filled by Consumers)**

- Do you currently have computers you feel have reached end of their useful life? Yes  No
- If yes to 1 above please give an estimate of the number of units.  
 <20     20-50     50-100     >50
- Do you have any disposal policy?  Yes     No
- How do you dispose of your obsolete computers?  
 Donate     Auction     Take to collection point     Keep in store due to unawareness of what to do.

**SECTION E: CHALLENGES FACED BY VARIOUS STAKEHOLDERS**

In this section, please mention challenges faced by the various stakeholders under the categories provided below for sustainable management of e-waste in Kenya?

	STAKEHOLDERS	CHALLENGES
1	<u>Producers</u>	1..... ..... 2..... .....
2	<u>Consumers</u>	1..... 2..... 3.....
3	<u>Recyclers</u>	1..... 2..... 3.....
4	<u>Collection centers</u>	1..... 2.....
5	<u>Retail shops/ Distributors</u>	1..... 2.....

THANK YOU FOR YOUR TIME AND PARTICIPATION IN THE RESEARCH.

# APPENDIX B

## QUESTIONNAIRE FOR POLICY MAKERS

### SECTION A: GENERAL INFORMATION

The information provided in this questionnaire will be confidential and strictly used **ONLY** for my University thesis research on e-waste management in Kenya.

Personal details

<b>Government body/agency:</b>	
<b>Occupation and years of experience</b>	
<b>Respondent name and contact (Optional)</b>	

### SECTION B: ROLE OF POLICY MAKERS

#### *Policies and legislation*

1. How adequate are government policies and strategies to address e-waste in Kenya?  
\_\_\_\_\_
2. Why can't the Basel Convention make the manufacturers responsible for hazardous wastes as opposed to countries?  
\_\_\_\_\_  
\_\_\_\_\_
3. Why can't producers of e-waste be held accountable for their deeds in Kenya?  
\_\_\_\_\_  
\_\_\_\_\_
4. In your opinion should we have e-waste policy or do we need to develop an e-waste bill and why?  
\_\_\_\_\_  
\_\_\_\_\_
5. How adequate is the current e-waste monitoring and evaluation system?  
\_\_\_\_\_
6. What suggestions do you have to ensure effective independent audits and material flow monitoring?  
\_\_\_\_\_

b) *Technology transfer and competencies*

7. What kind of training capacity is available for the e-waste handlers and recyclers in Kenya? What plans are there to incorporate institutions of higher learning in capacity building for e-waste management?

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8. What plans does the government have to ensure that professionally trained e-waste handlers are retained in employment?

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9. What potential challenges do you foresee during the implementation of an e-waste management policy in Kenya?

---

**THANK YOU FOR YOUR TIME AND PARTICIPATION IN THE RESEARCH.**

## APPENDIX C

### INTERVIEW GUIDE FOR POLICY MAKERS

#### 1. E-waste issues & e-waste policy.

- a) How effective do you think the government long term "Vision 2030" has been so far with regard to solid waste management in Kenya?
- b) In your opinion how adequate is CFSK e-waste recycling centre in e-waste management in the Kenya?
- c) What are the guidelines and procedures for e-waste management in Kenya and how adequate are they?
- d) How do you keep up-to-date with developments in e-waste management practices in other parts of the world? In coming up with an e-waste management policy framework for Kenya, are you drawing any lessons on experiences from elsewhere? If yes where?
- e) What do believe are the mechanisms of e-waste disposal in Kenya and what are your recommendations on improvements or way forward?

#### 2. Challenges to e-waste management

- a) Give at least 6 (six) conditions envisaged by government to foster Extended Producer Responsibility in Kenya?
- b) In your view what do you attribute to the poor response by Kenya public to sustainable solid waste management practices?
- c) What do you believe are the challenges to e-waste management in Kenya?



## APPENDIX D

### Waste Management Regulations (1999)

Part 11 Section 10(1-2) of Waste Management Regulations states that:

10(1) any person granted a licence under the Act and any other licence required by law

#### **Legal Interventions**

1. Part 12(a) of the second schedule of Environmental Management and Coordination Act (EMCA, 1999) states that Environmental Impact Assessment (EIA) and Environmental Audits (EA) shall be carried out for waste disposal including work involving sites for solid waste disposal.
2. Part VIII Section 87(1) EMCA, 1999 states that no person shall discharge or dispose of any wastes whether generated within or outside Kenya, in such a manner as to cause pollution to the environment or ill health to any person.

Part VIII Section 89 EMCA, 1999 states that any person who at the commencement of this Act owns or operates a waste disposal site or plant or generated hazardous wastes shall apply to the Authority for licence under this part within six months after the commencement of this Act.

## **APPENDIX E**

### **List of respondents to Questionnaires for policy makers, discussions and interviews.**

ICT Standards and development officers, Kenya Bureau of Standards, April 2011.

Health Administrative officers, Ministry of Public Health and sanitation, April 2011.

Solid waste management officers, Municipal Solid Waste Management Nairobi City Council  
March 2011.

Senior ICT Officers, Ministry of Information and Communication Technology, March 2011.

Compliance and enforcement officers, Waste unit, NEMA, April 2011.