

**AN ASSESSMENT OF EXISTING E-WASTE MANAGEMENT SYSTEMS IN  
INSTITUTIONS OF LEARNING IN RUIRU SUBCOUNTY, KIAMBU COUNTY**

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N50/14077/2009

A research project submitted in partial fulfillment of the requirements for the award of degree of Master of Environmental Planning and Management in the school of environmental studies of Kenyatta University.

May 2014

## **Declaration**

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

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I thank you all

Kaloki Nicholus

## **Dedication**

I dedicate this work to my wonderful brother Kelvin for being with me every step of the way. You are all I would want in a brother. To my mum Ann, thank you for your unconditional love guidance and support, you molded me to the man I am today. My sisters Salome, Agatha, Esther thank you for instilling confidence in me and believing in me.

This project is also dedicated to my late Brother David, to you I say, I made it, your inspiration lives on.

Finally, this is to Late prof Wangari Mathai my heroine, all environmentalists who believe in a better, cleaner, and safer world for all, and those who believe in mutual love.

## Abstract

The usefulness of ICT has led to an overwhelming elastic demand for electronics most computing devices such as mobile phones and computers. Individuals, learning institutions and government institutions worldwide are adopting ICTs at a fast pace. Widespread consumption has resulted into huge amounts of Waste of Electrical and Electronic Equipment (WEEE) or e-waste generated from non-usable or old electronics. E-waste management in developing countries is one of the least revised environmental topics. In recent times however the subject is getting research limelight from scholars. This study aimed at enhancing the existing e-waste management practice in institutions of learning in Kenya through systematic investigation of the current circulation, usage, handling and management of WEEE. This study evaluated the existing policy, institutional and regulatory framework on E-waste, the type and quantity of e-waste generated by institutions of learning in Ruiru sub county, the methods currently employed in e-waste disposal and recommend strategies that may be used to improve management of e-waste by the institutions. It explored the background to e-waste, and disposal practices in institutions of learning as key producers of e-waste and challenges they face. The study investigated the role of institutions of learning and Kenyan Authorities in combating electronic waste menace. It further looked at the Government's lack of enforcement of existing laws dealing with e-waste management, the legislative bodies that are concerned in management of e-waste and furthermore account for the chemicals and hazardous substances in e-waste and the impacts they can have on the environment and human health. The Data for this study was collected using questionnaires, interviews, and discussions with key policy officers in government agencies, institutions of learning and collectors in Ruiru sub county. Secondary data was collected from review of literature. Data acquired was analyzed using SPSS and excel programs and illustrated where possible to draw conclusions. A Framework of integrated waste management was used to ensure e-waste is managed in a strategic way that leads to an e-waste management approach that could exist in a sustainable society. Data analysis revealed that institutions of learning are among the largest producers of e-waste such as Computers, typewriters, printers, Power cables, photocopier, Tv sets, radios, projectors ,desk phone, audio mixers , binding machines, microphones, UPS, video switcher, video cameras, still cameras, CCTVs; however none of the sampled institutions had an e-waste management policy or a defined method of e-waste management. 40% of them disposed of their waste with general waste without prior separation while 40% simply stored it and 18% gave it to scrap dealers. The level of awareness on e-waste was low especially it's environmental and health effects at 25 % and 23% respectively. 68% of institutions were willing to give out their e-waste for free. 32% percent who were willing to sell or give it out but with conditions of free pick up at 60%, guarantee of proper disposal at 3% ,28% if the law required them to and 10% would give it out if they were sure it was of no value to them. This revealed a high investment potential in E-waste recycling sector. The highly anticipated Governments free laptop program is likely to compound the e-waste steam management in primary schools spread all over Kenya if proper mechanisms of handling the resultant stream of waste are not put in place. Kenya lacks an e-waste specific policies but the government recognizes the challenges posed by e-waste and has already come up with draft regulations on E-waste due for adoption. The study recommends that e-waste specific policies and regulations be developed to govern e-waste from the production, importation, collection, transport, recycling and disposal. A proper National and institutional collection system needs to be developed and consumer sensitization and awareness increased.

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## Abbreviation and Acronyms

CCK	Communications Commission of Kenya
EE	Electronic Equipment
EEE	Electrical and Electronic Equipment
EMCA	Environmental Management and Coordination Act
EoL	End of Life
EPR	Extended Producer Responsibility
E-waste	Electronic waste
GDP	Gross Domestic Product
ICT	Information and Communication Technology
KEBS	Kenya Bureau of Standards
KPA	Kenya ports Authority
KRA	Kenya Revenue Authority
LDPE/LLDPE	Low Density Polyethylene/Linear Low Density Polyethylene
NEMA	National Environmental Management Authority
NGOs	Non-Governmental Organizations
PET	Polyethylene Terephthalate
RoHS	Restriction on Hazardous Substances
SVTC	Silicon Valley Toxic Coalition
UNEP	United Nations Environmental Program
WEEE	Waste Electrical and Electronic Equipment
WMA	Waste Management Act
WMPC	Waste Management and Pollution Control

## CHAPTER ONE

### INTRODUCTION

#### 1.1 Background

Electronic waste (E-waste) can be defined as various forms of electrical and electronic equipment (EEE) that are old, end of life electronic appliances that have ceased to be of any value to their owners (UNEP 2010). E-waste is composed of various materials, including bulk materials, hazardous, and valuable substances. In general, almost 80% of the weight of electrical and electronic equipment is made of glass, iron, aluminum, and plastic (Deathe et al., 2008). Some of the substances that are used in the electrical and electronic equipment are non-hazardous in nature; however, they become hazardous after they end up in a toxic compound when used in manufacturing of electrical and electronic equipment (UNEP, 2007; Robinson, 2009). E-waste accounts for 8% of municipal solid waste worldwide (Babu et al., 2007).

Over the last decades, the electronics industry has revolutionized the world. Electrical and electronic products have become ubiquitous of today's life around the planet. Without these products, modern life would almost be impossible in (post-)industrialized and industrializing countries. Electrical products serve in diverse disciplines such as medicine, mobility, education, health, food-supply, communication, security, environmental protection, and culture. Like all products in the market, at the end of their useful stage electrical products are potential wastes.

According to SVTC, (1999), E-waste is growing three times faster than any other waste stream, at the same time, the usable lifespan of electronic products has kept shrinking (average electronic lifespan used to be eight years, now it is down to two). It is estimated that e-waste grows 3-5% each year in advanced countries (Whitney and Webb, 2008; Hischier et al., 2005). United Nations University's estimations indicate that current e-waste arising across the twenty-seven members of the European Union amount to around 8.3 – 9.1 million tons per year; global arising are estimated to be around 40 million tons per year. The European Environment Agency and United Nations Environment Program estimate that 40-50 million tons

of electrical equipment waste is produced each year globally. It's increasing three times faster than all other types of domestic waste. The problem is that only around 10% of all this e-waste is collected and taken care of in adequate recycling facilities (La Dou & Lovegrove 2007, Cobbing 2008), "Across Africa, the technology market is predicted to grow by over 8% a year for the next three years. The problem is that only around 10% of all this e-waste is collected and taken care of in adequate recycling facilities (La Dou & Lovegrove 2007, Cobbing 2008).

Africa as a continent is not spared and though it does not handle as much e-waste as in developed countries, it is in bad shape since no formal systems exist for recycling of e-waste. In most of sub-Saharan African countries, E- Waste has in the recent past been a big problem. The lack of a sustainable e-waste management infrastructure means that e-waste is collected and recycled in crude methods, causing the release of toxic chemicals to the environment and putting those refurbishing and dismantling e-waste at risk. This is aggravated by the fact these countries usually have little e-waste legislation and no regulations to protect the health of e-waste workers. Kenya, like most Africa countries lacks effective polices and strategies to dealing with e-waste. This spells a perilous lack of effective guidelines to deal with trade and disposal of e-waste in many African countries hence exposing the continent to vulnerabilities associated with e waste.

Across Africa, the technology market is predicted to grow by over 8% a year in the next years. This is great news for the region, but comes at a cost (UNEP 2009). E-waste in Africa is growing 20% each year due to rising sales of electronic goods and legal and illegal imports of second hand and surplus equipment" ( HP Environmental Compliance 2009). In Africa, the exportation of electronics wastes by developed countries to poor developing countries like Kenya, presents the main culprit of all. Electronic equipment and devices are becoming widely used in offices and by students due to the necessity to communicate and do research in emerging countries. The rapid economic growth has led to a rise in the generation of electrical and electronic waste (e-waste), coming both from local consumers and recycling of second-hand equipment imported for re-use. Therefore, Solid waste creation and disposal is a distinctly human phenomenon that is placing increasing pressure on both the environment and modern infrastructure in developing countries, one of the biggest challenges facing human beings is the unhealthy disposal of solid waste resulting from activities of development (Joseph, 2006). Increased electronic equipment use has led to increased electronic waste. Poor management of the resultant waste will lead to

increased pollution, potential problems in public health, ecological as well as socioeconomic impacts.

Among other regulations, International conventions such as Basel convention, Bamako etc., have been key to e-waste management however the menace continues. The continued generation of electronic waste and the unclear responsibility for the disposed electronic products in Kenya is posing a great challenge to the Kenyan government due to increased usage and importation of second hand electronic equipment such as computers in the recent past.

## **1.2 Problem statement**

The disposal of wastes in or on land without careful planning and management can present a danger to health and the environment and is a serious problem in many societies (Ehrampoush&Moghadam, 2005). Increased use of technology especially ICT in institutions of learning and offices, low initial cost, unplanned obsolescence of electrical and electronic equipment has led to an e-waste generation problem for Kenya. New and improved electronics and advanced models e.g. cellular phone and personal computers) are coming out in the market everyday making the older models technically and technologically obsolete and less satisfying to consumers thereby contributing to potential electronic waste stream. A recent baseline study done in 2008 showed that Kenya generates 3,000 tons of electronic waste per year (NEMA 2009). The study predicts that the quantity is expected to increase as usage increases and as Kenya positions itself as the Silicon Savannah in Africa. The current e-waste generated in Kenya is at 11,400 tons from refrigerators, 2,800 tons from TV`s, 2,500 tons from personal computers, 500 tones from printers and 150 tons from mobile phones (press release UNEP,2010).

Kenya is a favorite destination for second hand computers which are affordable and mostly cost on average \$100. These are used in institutions of learning and cyber cafes. The downside of such computers is that they have a shorter shelve life and break down faster than new computers. This is expected to worsen as Kenya positions itself to become an ICT hub. Institutions of learning among them schools and colleges use a high number of electronic equipment. This means that they are key contributors to electronic waste; however they don't have elaborate mechanisms of managing the resultant electronic waste at the end of their useful life. The e-

waste problem is likely to be compounded by the expected stream of electronic waste that will be occasioned by the free government laptops project expected to benefit thousands of primary school pupils spread all over Kenya. This Electronic waste will pose a great challenge to the Kenyan government and threatens the health of the people and the environment as 2% of e-waste is toxic. Ruiru subcounty being mostly urban has had an increasing number of colleges, high enrolment in both primary and secondary schools brought about by urbanization. These learning institutions have embraced ICT in learning teaching and research and more EEE is likely to be occasioned by the free laptop government project therefore necessitating a keen investigation of existing policies on E-waste management towards its effective management before it becomes a bigger problem.

### **1.3 Research questions**

1. What policy and institutional framework govern e-waste management in Kenya?
2. What type and quantity of electronic waste is generated in institutions of learning in Ruiru sub county, Kiambu County?
3. What are the environmental and health impacts of e-waste?
4. What are the disposal mechanisms of electronic waste materials in institutions of learning in Ruiru subcounty, Kiambu County?
5. How can electronic waste management be improved in institutions of learning in Ruiru subcounty?

### **1.4 Objectives**

1. To analyze Policies and institutional framework that governs electronic waste management in Kenya.
2. To assess types and quantity of E-waste generated in institutions of learning in Ruiru sub county, Kiambu County over the years.
3. To examine the environmental and health impacts of e-waste.
4. To examine disposal mechanisms of electronic waste materials in institutions of learning in Ruiru sub County and their effectiveness.
5. To prepare a planning model for the management of electronic waste in institutions of learning.

## **1.5 Premises**

- (a) Kenya's policies and institutional framework governing the management of electronic waste are not effective and their review is vital towards better e-waste management.
- (b) Institutions of learning have integrated the use of electronic equipment in teaching and learning however their mechanisms of disposing the resultant electronic waste are not elaborate or well structured.

## **1.6 Justification**

Technology has become a part of every aspect of modern life in everything we do including education. Managing the resultant e-waste at the end of useful life is challenging not only due to its increasing volume but also because of its hazardous nature as 9% of electronic waste is hazardous. E-waste is increasing exponentially due to the penetration of electrical and electronic devices in any aspect of modern day life.

E-waste is the fastest growing waste stream ( Nuoron and Osibanjo 2008) with the growth rate of 3to 5% per year which is 3 times faster than the general waste (Pucket et al 2002) , which is equivalent to 20-50 million tons a year worldwide (UNEP 2005), This has been brought about your constant desire for newer and more efficient technology, combined with the aggressive marketing by the producers, making the consumers replace their electronic devices more and more frequently. For instance, cell phones have now an average life span of less than two years in the industrial world, and computers two to four years (BAN & SVTC 2002, UNEP 2005). thus creating great management challenges to the government`s free laptop project expected to generate a further stream of electronic waste across Kenya in local public schools.

The usefulness of Information and Communications Technologies (ICTs) in learning has led to an overwhelming elastic demand for electronics most especially computing devices such as mobile phones and computers. As population increases, more institutions of learning are coming up and the demand for school education related equipment as well. Individuals and government institutions worldwide are adopting ICTs at a fast pace making E- waste in the recent past a head-ache to African countries with Africa estimated to generate a higher volume of e-

waste than Europe by 2017 ( UNEP 2009). Ruiru sub County has a high number of such learning institutions.

### **1.7 Significance of the study**

This study will play a significant role in creating awareness of the uniqueness of e-waste problem in Kenya in that E-Waste is relatively new and its quantities are rapidly growing as technology becomes more common. It is hoped that the results from this study form a base for decision makers in formulating strategies towards improving electronic waste management in institutions of learning.

The research will explore the government's readiness to manage the expected extra stream of electronic waste from laptops to be occasioned by the free pupil laptop project initiated by Jubilee government, to understand how various factors such as legal requirements, awareness, convenience and financial incentives, government, consumers, cost, manufacturers can impact on collection and the proper management of used and EoL of EEE. It is expected that the findings of this study will contribute to policy formulation among decision makers on sustainable e-waste management and contribute to knowledge pool and information pool within which future research can be carried out.

### **1.8 Theoretical framework**

The study adopts an integrated solid waste management framework that has underlying concepts that include; the life cycle based concept, generation based concept and management based concept (UNEP 2007). Its premise is that, no one approach is superior in waste management but their integration yields improved solid waste management.

It also advocates for suitable environmentally reuse and recycling to conserve natural resources and energy through systematic segregation, collection and reprocessing (UNEP, 2007). Integration entails different aspects such as integration of scales from household, institutions, neighborhood, city, region, country urban systems, and different actors (Baritone, 2000). It looks at roles, interest and powers structures prevalent in waste management.

Awareness of environmental problems has led to the development of new efficient technologies to minimize the environmental impacts associated with waste. It has shifted the main concern of waste management from disposal to waste prevention, minimization, and recycling. Nowadays, waste management involves considering an interrelated series of options aiming at waste source reduction, recycling, treatment, and finally disposal. If properly managed, intergraded solid waste management (ISWM) can ensure the efficient management of waste through re-use or recovery (Bazzani 1998).

Agenda 21 (UNEP, 1992) also proposes the use of integrated life cycle management concept which presents a unique opportunity to reconcile development with environmental protection. The objectives of such a framework would focus on four waste related program areas: minimizing waste; maximizing environmentally sound waste re-use and recycling; promoting environmentally sound waste disposal and treatment; and expanding waste service coverage. The four program areas are interrelated and mutually supportive and must therefore be integrated in order to provide a comprehensive and environmentally responsive framework for managing waste. The mix and emphasis given to each of the four program areas will vary according to the local socio-economic and physical conditions, rates of waste generation and composition. All sectors of the society should participate in all program areas. ISWM systems thus combine: waste streams, waste collection, and waste treatment and disposal methods with the aim of achieving environmental benefits, economic, optimization, and societal acceptability (Bortoleto, 2007).

According to Boll (2006), waste hierarchy which was effectively promoted internationally at the conferences such as the United Nations Conference on Environmental Development and habitat II is now accepted as universal guideline in national policy making for solid waste management. This hierarchy is based on environmental maxims and upholds the fundamental principle of -`prevention is better than cure`. Prevention of waste is the most preferred option for solid waste management. Further down the hierarchy, re-use and recycling of waste according to its perspective characteristics is preferred to disposal in landfill sites, dumping or open dumping.

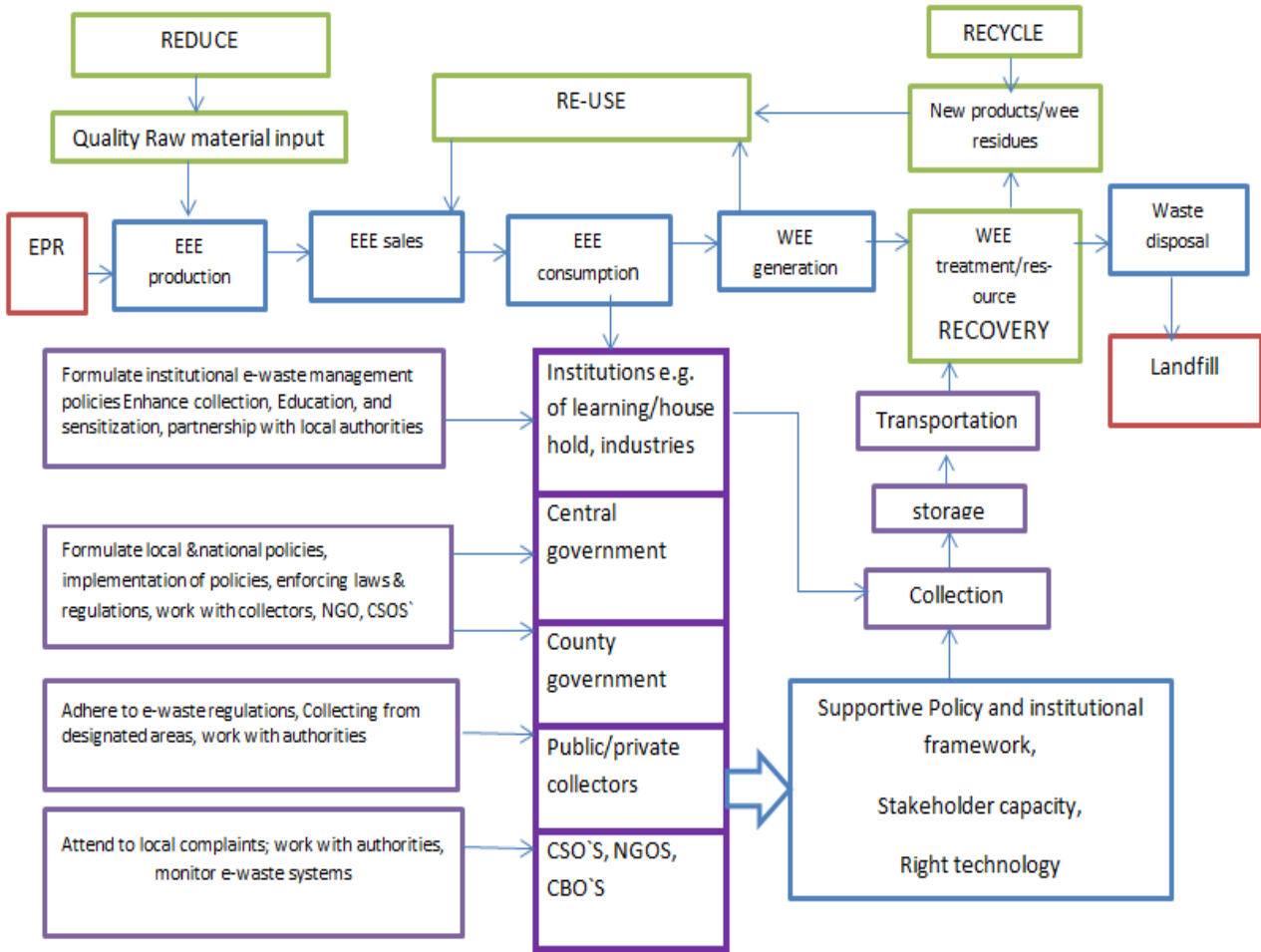
The modern concept of integrated solid waste management is very complex comprising of not only the environmental aspects of waste hierarchy or the technical aspects of the conventional approach but also incorporating economic, legal, institutional, political and cultural as well as

social issues. Environmental protection and economic feasibility of the system are the first priorities of this approach. The implementation of this modern concept demands effective institutional arrangements with rules and regulatory instruments which define the obligatory administrative, technical, logistic, and hygienic know-how to operate an effective waste collection and disposal system. The basic premise is that solid waste need not be considered as merely as menace but rather as a resource or even a livelihood (Boll, 2006). The basic goal of integrated solid waste management is to manage society`s waste in a manner that meets public health and environmental concerns and the public`s desire to re-use and recycle waste materials.

### **1.9 Conceptual framework**

The conceptual framework is informed by integrated solid waste management system that promotes reduction, re-use, and recycle of solid waste at all levels of management hierarchy i.e from when waste is generated until its disposal. There are many sources of electronic waste: households, industries, institutions and other sources. For the purpose of this study, the researcher concentrated on electronic waste generated by institutions of learning in Ruiru Sub County. The study sought to establish the amount, composition, and mechanisms of disposal of the generated electronic waste. The study assessed whether the institutions have an established e-waste disposal system and if they practice the 3Rs in order to minimize the waste generated as well as benefit from recycling and re-use.

The following flow diagram demonstrates the conceptual framework that informed the study carried out in learning institutions in Ruiru Sub County. The waste management hierarchy is a nationally and internationally accepted guide for prioritizing waste management practices with the objective of achieving the optimal environmental outcome. It sets out preferred order of waste management from the most preferred to the least preferred (zero waste 2008). The e-waste generated at the institutional level can be minimized, re-used, and/or recycled. These are the topmost preferred ways of managing wastes whereas incinerating, land filling, open burning and open dumping are least preferred in waste management. The researcher`s conceptual framework has re-modified the 3R strategy to a 4R one to include recovery as illustrated below.



**Figure 1: conceptual framework**  
**Source: Author, 2014**

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1 Introduction

There has been little academic research carried out on electronic waste. The few that exist include the work of Grossman, (2006); Saphores, et al, (2006); Wynne, (1989); Brass, (2006). Research on waste more generally has focused on issues of rubbish and disposal Chappells and Shove, (1999a, 1999b); Douglas, (1984); Hawkins, (2000); Hetherington, (2002); Munro, (1998); Strathern, (1999); Strasser, (2000); Thompson,(1979). Research raises questions of: what counts as rubbish; Thompson, (1979); how the history of disposal has developed (Chappells and Shove, 1999a; 1999b); how we come to terms with throwing things away (Hetherington, 2002; Gregson, 2005); how we understand re-use (Strathern 1999); attitudes towards composting (Tucker, 1999); and the role of community waste projects in influencing household behavior (Sharp, 2005). This research will provide a background to issues of e-waste. E-waste management in developing countries is one of the least revised environmental topics. In recent times however the subject is getting research limelight from scholars.

#### 2.2 History of E-waste

The e-waste concept came to light as far back as in 1970s and 1980s following environmental degradation that resulted from hazardous waste imported to developing countries (Shinkuma&Huong, 2009). In reaction to hazardous waste importation, the Basel Convention on the control of trans boundary movements of hazardous wastes and their disposal was instituted in 1992 to control the situation. Since then many countries have become members of the convention. Although “the Basel Convention does not regulate secondhand items and some e-waste scrap” (Shinkuma&Huong, 2009), it has played a role in banning exportation of obsolete products and engineering waste solutions. For example its theme in 2006 was: “creating innovative solutions for the environmentally sound management of electronic waste” (Buenker, 2007).

E-waste phenomenon continues to flourish due to rapid adoption and use of ICTs which has contributed to increase in e-waste stream. E-waste is said to be one of the fastest growing waste streams (Cairns, 2005); growing at a rate of 3–5% per annum i.e., approximately three times faster than an ordinary municipal solid waste (Davis & Heart, 2008). Increase in e-waste stream has attracted the attention of many governments, individuals, and researchers due to its impact on the environment and human health. In Europe, the EU implemented two directives i.e., Directive 2002/96/EC on WEEE and Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS 2005). The directives enforce an extended producer responsibility system and encourage reuse, recycling and recovery, and minimizing the environmental impact of E-waste (Schmidt, 2005; Wen et al., 2006; Dwivedy & Mittal, 2009). In addition, EU uses the concept of QWERTY/EE (Quotes for environmentally Weighted Recyclability and Eco-Efficiency) to improve or enable environmental performance of end-of-life products (Huisman & Stevels, 2004). The QWERTY/EE strategies include determining: Weight based recycling and recovery targets, restriction on hazardous substances, treatment rules for recyclers, minimum collection amounts, and outlet rules for recyclers. Other countries such as USA, Japan and china have also amended laws for e-waste management.

In China, regulations that specifically deal with e-waste are in implementation. For example, the Management Measures for the Prevention of Pollution from Electronic Products regulation that aims at prohibiting the environmentally adverse processing of E-waste and reducing utilization of hazardous and toxic substances in electronic appliances (Xianbing et al., 2006). Besides regulations, researchers have suggested various strategies of mitigating E-waste problems and solutions that lead to DfE (Design for Environment) or Green IT. Some of the suggested strategies include methods and models for predicting the flow of e-waste and assessing environmental impact of ICTs. It is argued in Shinkuma & Huong (2009) that a traceability system for tracking/tracing E-waste information is required. Therefore models like Material Flow Analysis (MFA); a method applied to support the material and substance flow management in the waste (Streicher-porte et al., 2005) is required for e-waste mitigation. Wang & Chou (2009) has also studied user behavior and willingness to recycle. All these developments have emerged drastically due to urgent needs for green environment and Green IT.

### **2.3.1 ICT growth**

Having received a grant from Rockefeller Foundation and Ford Foundation, KENET conducted a research project on E-Readiness In 2005-2008 in Kenya. This is the ability to use Information and Communication Technologies (ICT) towards development. KENET specifically examined the use of ICT to develop research and learn. KENET has since then been able to conduct two e-readiness projects namely E-readiness in Kenya (in 2006) and EA accession project Phase I (2008) and the third, e-readiness project called EA accession project Phase II (2010).

### **2.3.2 Strategic ICT sub-indicators**

This study calculated the values of 60 sub-indicators (e.g. personal computers (PCs) per 100 students, Internet bandwidth per 1000 students). The values were then converted to stages using the staging framework developed by the researchers. The survey selected a subset of only 15 sub-indicators that were considered strategic. These strategic sub-indicators could, for example, be incorporated in the performance targets of the institutions and therefore monitored on an annual basis. The figure below shows the overall performance in the 15 sub-indicators for the 25 institutions. In order to be ready to use ICT to enhance learning, it will be necessary for the institutions to move to at least stage 3 in all the strategic indicators. It is clear that learning institutions have continued to embrace ICT in teaching, learning, and research therefore heightening the need for more advanced electronic equipment. This equipment however sophisticated are being faced out by more advanced ones emerging in the market. They too have an end of life therefore resulting to e-waste that needs to be managed.

### Strategic sub-indicator stages for all institutions

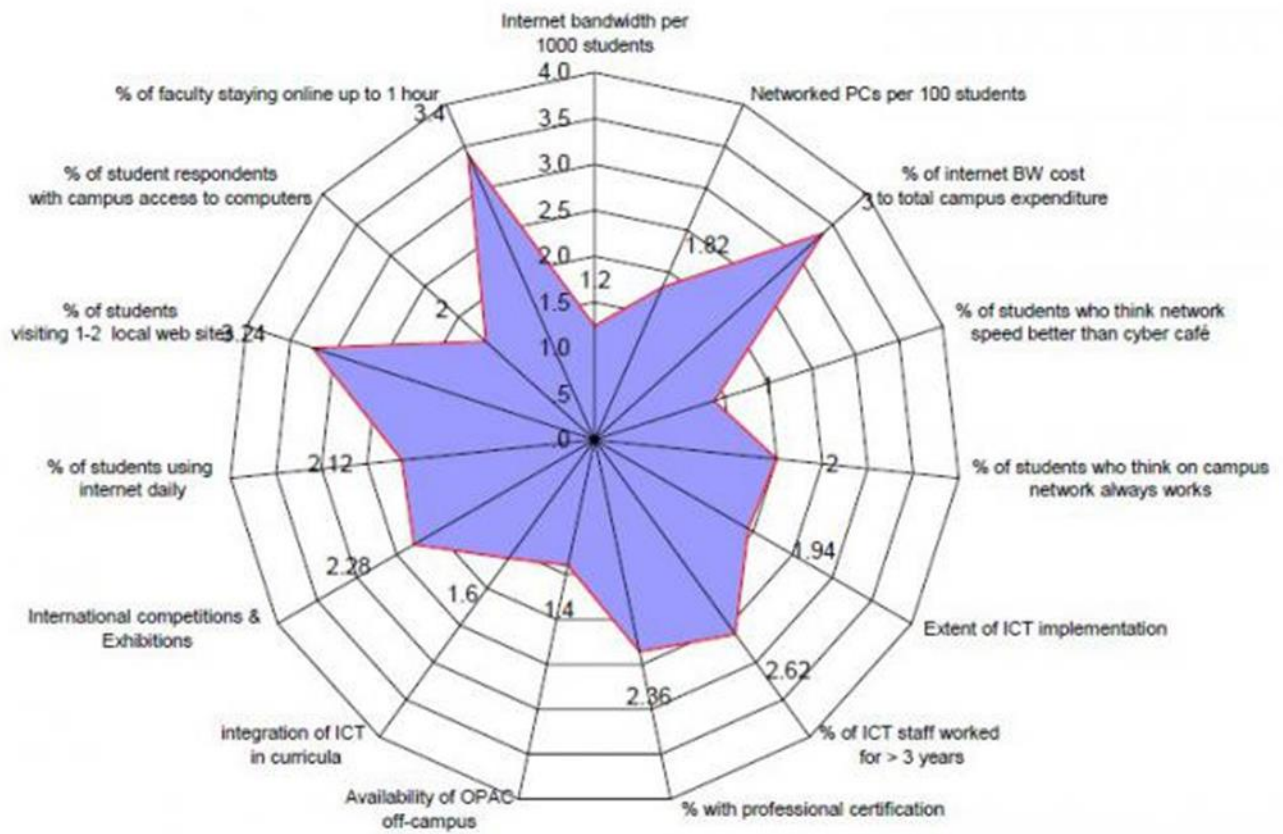
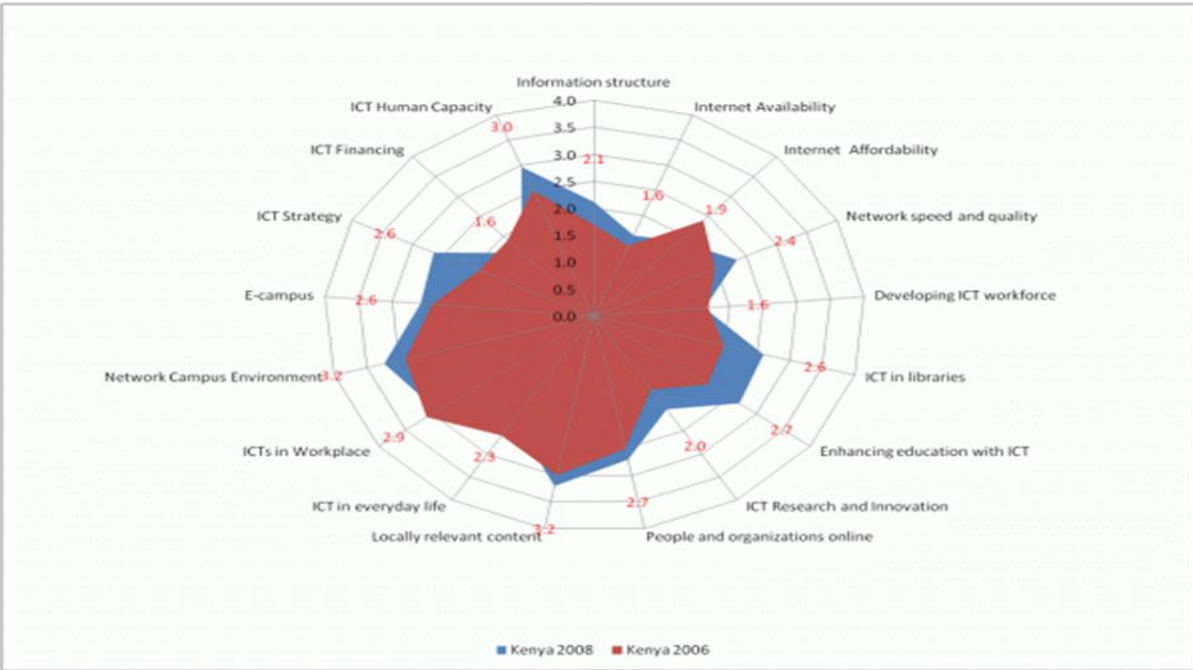


Figure 2: ICT use Kenya

Source, Kennet (2008)



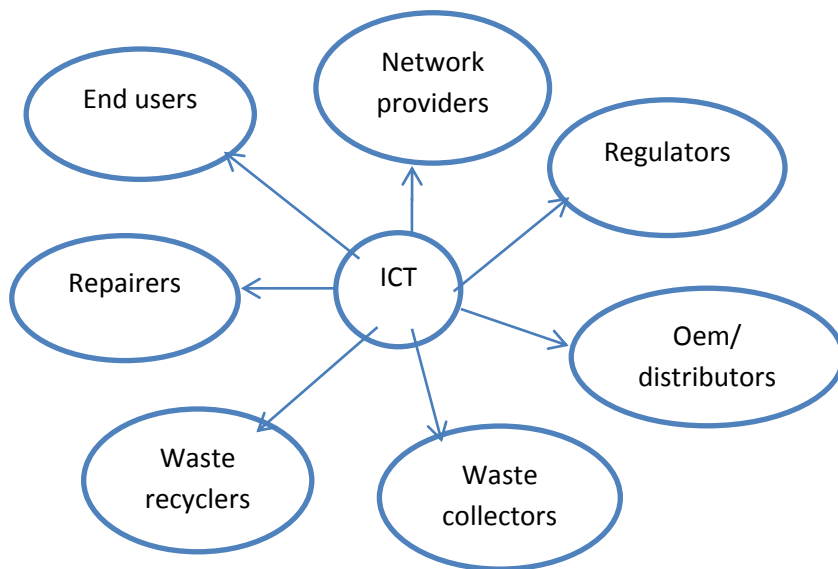
**Figure 3: ICT use Kenya**

Source, Kennet (2008)

**2.4 Institutional framework**

**2.4.1 ICT sector stake holders**

Network providers, regulators, OEM/distributers, end users, repairers/refurbishers, waste collectors, NGOs, waste recyclers, this is shown in figure 4.



#### **Figure 4: ICT sector main component regulators**

**Source: author 2014.**

##### **Kenya bureau of standards (KEBS)**

The role of KEBS include pre-export verification of products and the development of e-product standards with relevant government agencies

##### **National Environmental Management Authority NEMA**

EMCA 1999 (9) a mandates NEMA to co- ordinate the various environmental management activities being undertaken by the lead agencies and promote the integration of environmental considerations into development policies, plans, programs and projects with a view to ensuring the proper management and rational utilization of environmental resources on a sustainable yield basis for the improvement of the quality of human life in Kenya. National Environmental Management Authority deals with the development of e-waste regulations and management in consultation with other relevant agencies and stakeholders. It also does the approval of environmental impact assessment (EIA) in line with the telecommunications transmission stations in conjunction with the relevant ministries. The National Environmental Management Authority signed a memorandum of understanding with CFSK which set up a recycling plant. This was one of the government's efforts manage e-waste. NEMA also supports other non-Governmental and private sector organizations that deal with waste management such as Practical Action, and Kenya National Cleaner Production Centre<sup>38</sup> (KNCPC).

According to the county NEMA office, the general environmental status of the sub county was wanting, it prioritized general waste management however, and there were no measures or special mechanisms of handling e-waste since it was disposed with the general waste. The office was faced with challenges such as lack of resources to facilitate awareness creation and sensitization. Its main activities involved enforcement and compliance, licensing and EIA approval.

## **County Authorities**

County authorities have taken over the role of waste management i.e. collection, transportation and disposal. The office admits that the general environment of the sub county needs improvement. The environment office was working in conjunction with the sub county NEMA and public offices to develop a waste management Authority to specifically take over the waste management function. Some of the strategies in place to deal with waste management involved zoning so as to establish the types of waste generated in different areas of the county, its analysis, and quantity. It has also budgeted for more trucks for waste collection and personnel training. It is further advocating for the identification of a landfill to aid in waste disposal .The county has partnered with UN habitat and World Bank on some issues such as awareness campaigns and communal clean ups done every month. Some of the challenges the sub county faces are shortage of personnel, insufficient resources to carry out its functions, political interference on its affairs and corruption. The high population of the sub country also poses a challenge in waste management. The county suffers a backlog of work inherited through devolution.

## **Local authorities**

Local authorities role included general waste management i.e. collection, transportation and disposal

## **Kenya Revenue Authority KRA**

Import verification of products at point of entry is done by KRA, It is also done by KPA/KEBS

## **Communications commission of Kenya (CCK)**

CCK types approval of telecommunication EEE in consultation with KEBS

## **The ministry of environment,Water, and natural resources**

The ministry of environment and natural resources recognizes the environmental challenges and issues brought about by the current ICT revolution in Kenya today and mainly the resultant e-waste. According to the ministry, their main concerns are; determination of Kenya`s amount and composition of e-waste, extent of collaboration in waste management with key stakeholders,

accessibility to waste during collection from the generator; institutions involvement and development of legal, policy and regulatory framework, comprising of ministry of environment and NEMA, public health, Kenya bureau of standards and CCK; management, regulation and control of influx of e-waste in Kenya through trade and institutional donations; disposal mechanisms and specifics of e-waste that could be contributing to climate change.

This study established that even though the government continues to show its interest in proper e-waste management, there is need for a multi-sectoral approach and involvement of all stakeholders if at all thee-waste management is to be successful. Further urgency will be necessitated by the governments free laptop program to standard 1 pupils, a project that will benefit all standard 1 public school pupils across the country. This project is bound to create yearly stream of e-waste whose management will be made harder by its spread in recurrence at the end of life of these laptops.

### **Kenya bureau of standards**

Kenya bureau of standards was brought into existence in 1974 by an act of parliament with the aim of acting as a trade facilitator. Concerning ICT, KEBS prepares ICT product standards. It also does testing and quality management as well as verification of conformity prior export. These standards also apply to some electrical and electronic equipment. Among the challenges facing KEBS is the lack of capacity and infrastructure for safe disposal of rejected or hazardous goods although it should be upon the importer to bear the disposal.

### **Computer for schools Kenya (CFSK)**

Computer for schools Kenya, (CFSK) is a non-governmental organization whose mission is “to empower young Kenyans for life in a knowledge based society by facilitating the development of ICT infrastructure and capacity.” CFSK does this through distribution of high-end reconditioned computers to learning institutions as well as to community information access and resource access centers. Computer for schools Kenya, (CFSK) has for the eleven years that it has been in existence sourced over 120,000 personal computers that have been deployed in over 8,500 Public Secondary and Primary Schools, Medical Training Centers, Technical Training Institutes, Teacher Training Colleges, and several Universities. They also operate a comprehensive preventive and curative maintenance program for the computers to make sure of their full

operation. CFSK has also in a number of institutions, placed Internet access, electricity generators, and the World Space Direct Media Service. Within the eleven years that CFSK has been in operation, it has also carried out training to over 20,000 Education Officers and heads of schools, teachers, and tutors, members of Schools' Board of Governors and Teachers /Associations Parents. It has further successfully developed digital multimedia teaching/learning resources specifically intended for Kenya's national Secondary School curriculum – providing both teachers and students with an invaluable modern tool in an attempt to make learning fun and more stimulating. CFSK has also developed software tools to aid school management.

Computers for Schools Kenya is a partnership of communities, civil society organizations, private sector corporations, , international charities and development partners working together for the long term good of the nation. Much of CFSK's success can be directly attributed to close partnership, making it possible for 3,000,000 young Kenyans to now have access to information and communication technologies that they would have otherwise not accessed. Their exemplar work has enabled them to win the African ICT Achievers Award for Top Civil Society Organization to Bridge the Digital Divide in Africa In 2007 and 2008.

### **WEEE Centre**

Waste Electrical and Electronic (WEEE) Centre is an off-shoot of Computers for Schools Kenya (CFSK). CFSK took responsibility to dispose of this stream of e-Waste occasioned by the distributed electronic equipment therefore, in 2006 formed a e-Waste Management department. As time went by, CFSK ventured further into the government, NGOs, Corporate organizations, Small Medium Enterprises, as well as households. WEEE Centre was the first ever large scale organization to carry out this line of work in Kenya and registered as a separate entity from CFSK in the year 2012. With e-Waste becoming a reality in Kenya, WEEE center realized the need for recycling activities towards efficient and environmentally sound management of the country's e-Waste. WEEE Centre has partnered with National Environmental Management Authority (NEMA) with whom they have a Memorandum of Co-operation and work closely to develop sustainable models for electronic waste handling.

WEEE Center commits itself to running an environmentally friendly operation, environment conservation through the efficient, safe and conservative disposal of e-Waste. In order to

achieve this, the Centre developed an in-house e-Waste management protocol guided by three criteria, these are: - healthy, environmental friendly, and sustainable. Peripheral devices, Electrical and electronic equipment, parts and accessories that are no longer usable are disposed of in a process that ensures zero dumping by the center.

### **2.5.1 E-Waste growth**

With 50 million metric tons of E-waste disposed worldwide each year, e-waste recycling has become an increasingly important issue globally. China alone adds 2 million tons of e-waste and the number increases at a rate of more than 10% each year (Ni, 2007). American consumers replace their mobile phones every one and half years on average (Grow, 2008), producing 130 million discarded cell phones annually nationwide (Hanselman, 2007). In China, 70 million mobile phones and 10 million PCs are being discarded each year (NDRC1, 2006). Likewise, more than 50 million PCs are disposed in the U.S. each year (Hung, 2007), with this number accounting for only 10% of the disposable computers. The majorities of defunct computers are not being used and simply collect dust (Zhong, 2009).

E-waste is growing three times faster than any other waste stream at the same time, the usable lifespan of electronic products has kept shrinking (average electronic lifespan used to be eight years, now it is down to two. This is according to SVTC (1999). It is estimated that by 2010 there will be a further 716 million computers in use; China will have 178 million new users and 80 million new users in India (Greenpeace, 2008). However, although much of the broader debate centers on the bulk or weight of waste (for example, how much households throw away, the apparent lack of space for landfill, the need to recycle or reuse to limit waste bulk and save space), e-waste does not occupy a large proportion of waste weight (perhaps around 1% of waste, (CEI, 2005). This has led some to argue that e-waste is a small problem, on which we should not pass legislation which may in any case restrict economic growth (CEI, 2005). Size in this case may not appear to matter. In place of a focus on size, much of the discussion on e-waste is focused on toxicity – the concentration of metals and plastics in electronic goods which can become harmful when attempts are made at disposal through burying e-waste (landfill), burning it (incineration, sometimes for energy generation) or dismantling it and re-using component parts or raw materials (recycling). An average PC contains over 1000 components, generating a potential array of environmental problems (SVTC, 1999). This debate on disposal toxicity forms

one of three areas of e-waste concern, the others being the production of electronic goods (the materials used, the energy used in production) and energy consumption in usage of electronic products (and how this might be reduced). The debate on e-waste has led to the development of the Waste Electrical and Electronic Equipment (WEEE) directive and Restriction on Hazardous Substances (RoHS) directive. These directives aimed to introduce a system which would manage, regulate, count, and assess – in short, hold to account – electrical and electronic equipment.

In the European Union (EU) the total weight of electronic appliances put on the market in 2005 ranged up to more than 9.3 million tons with a sensible growing rate, particularly in Eastern Europe. Electronic appliances put on the market included 44+ million large household appliances in EU15, 48 million desktops and laptops, In the United States of America (USA), in 2006, more than 34 million TVs and displays have been placed on the market, while more than 24 million PCs and roughly 139 million portable communication devices such as cell phones, pagers or smart-phones have been manufactured. India had an installed base of about 5 million PCs in 2006, which is contributing to the 25% compounded annual growth rate in the Indian PC industry. In China, roughly 14 million PCs were sold in 2005, Currently, the available data on e-waste arising is poor and insufficient and estimation techniques are required for extension of known data to regional-global coverage. United Nations University's estimations indicate that current e-waste arising across the twenty-seven members of the European Union amount to around 8.3 – 9.1 million tons per year; global arising are estimated to be around 40 million tons per year. It is estimated that e-waste grows 3-5% each year in advanced countries (Whitney and Webb, 2008; Hischer et al., 2005). More than 20 million personal computers became obsolete in the United States in 1998 and 75% of e-waste remain in storage simply because the owners are not aware of possible options to manage them properly (Pichtel, 2005). The European Environment Agency and United Nations Environment Program estimate that 40-50 million tons of electrical equipment waste is produced each year globally. Although the proportion of e-waste in respect to the total waste quantity is still lower than in industrialized countries, the lack of regulations in the disposal sector is a cause for concern. E-waste is not recycled properly or is dumped or burned in an uncontrolled manner, thus having predictably negative consequences for the environment and human health.

**Table 1: Categories of E-waste**

Source: AU WEE directive.

<b>Categories of E-Waste Covered by the EU WEEE Directive</b>
1. Large household appliances
2. Small household appliances
3. IT and telecommunications equipment
4. Consumer equipment
5. Lighting equipment
6. Electrical and electronic tools (with the exception of large-scale stationary industrial tools)
7. Toys, leisure and sports equipment
8. Medical devices (with the exception of all implanted and infected products)
9. Monitoring and control instruments
10. Automatic dispensers

**Table 2: Electronic product weight estimations**

source; Saples inc (2005)

	lbs/unit	kg/unit
CPUs	23	10.44
Monitors	38	17.24
Large Peripherals (Printers, Fax, etc)	8	3.68
Laptops	15	6.81
Small Peripherals(Keyboards, Mice, Speakers)	15	6.81
Other	10	4.72

**Table 3: Electronic product weight estimations**

Source: US environmental protection Agency (US EPA 2007a)

	Average Product Mass (kg)
CRT Monitors	18.14
CRT TVs	31.75
CPUs	9.98
LCD Monitors	7.26
LCD TVs	13.15
Laptops	3.63
Peripherals	6.80

## 2.5.2 E-waste management

E-waste Management encompasses more than just the disposal or recycling, but also the re-disposal logistics involved in the collection and transporting the waste. It also includes the strategies for the reduction of the total waste generated, in line with the 4R principle - 'Reduce, Recover, Reuse, and Recycle'.

## 2.5.3 Need for e-waste management

There are four main reasons which make e-waste management imperative, these are;

### 2.5.3.1 The growing volume of e-waste

ICT and the electronics industry is rapidly growing, the quantities of discarded electronics have also increased. Secondly, the rising incomes complemented by falling prices of electronic products have made it possible for more people to afford electronics. Rapid technological growth and progress has resulted not only in large number of new electronic products but also reduced their lifespan therefore making products go obsolete faster. The average life cycle of EEM is shown in table 4.

**Table 4: Average life cycle of EEM**

Source CEM

No.	EEE Product	Use Period (Year)	Scenario 1: Lower Period (Year)	Scenario 2: Upper Period (Year)
1	TV	10	9	13
2	PC	9	8	13
3	Mobile Phone	7	7	10
4	Refrigerator	12	11	13
5	Air Conditioner	12	11	13
6	Washing Machine	12	11	13

**Plate 1: Images of e-waste**  
**Source: Elretur (2004).**



### **2.5.3.2 Resource depletion:**

According to Lindhqvist, (2000), Waste is regarded as a resource which should and could be reclaimed. Though disparate in their composition; EEE products contain valuable metals among them gold and silver. They also contain hundreds of other materials broadly categorized as non-ferrous metals, plastic, precious metals and ferrous metal, and glass. SENS report (2003) found out that, in Switzerland more than 50% various metals, plastics and plastic metal mixtures of 20%, CRT glass of 9% and the rest consisting of various other substances.

In 1998, EU estimated e-waste generation in was 4% of the waste stream, and increase by at least 3-5% a year (EEB 2001). For instance, the average life span of a PC central processing unit declined from 4.5 years in 1992 to years in 1999 and is projected to level off at 2 years by 2005 (Lin, 2002). With more advanced recycling technology, it is possible to recycle high quantities of metals at almost 95-99%., reducing e-waste should also be a priority due to:

### **2.5.3.3 EEE manufacture is extremely resource intensive.**

EEE manufacture is expensive. One desktop computer requires 240 kilograms of fossil fuels, 22 kilograms of chemicals and at least 1,500 litres of water (Williams, 2003).

### **2.5.3.4 Health and environment hazard:**

The main environmental issue concerning of electronic waste management is the uncontrolled release of hazardous substances into the environment as well as sub-optimal use of recyclable materials. Improper disposal can be extremely hazardous to the environment and health. Some of the health hazards include a number of ailments as a result of contact with toxins such as dioxin, cadmium, mercury, furans, and lead among others, emitted in landfills or incineration processes. E-waste Recycling process can also result to Emission and effluents therefore care should be taken during the process.

### **Plate 2: Unsafe burning of toxic E-waste**

**Source; Field survey 2014**



### **2.5.3.5 Trans- boundary movements of e-waste:**

Trans- boundary movement of e-waste mainly from developed countries to still takes place. Both exporting and importing of e-waste is illegal in many countries –goes against the principal of environmental justice. Trans- boundary movement of e-waste especially to developing countries like Kenya is particularly dangerous because such countries often may not have the capacity to recycle and dispose the waste in an environmentally sound manner

### **2.5.3.6 Toxicity of e-waste**

Toxic elements account for about 2% of the total weight of E-waste; Secondly, the majorities of materials have an economic value and therefore a considerable recycling or reuse potential (i.e. copper, aluminum, gold, nickel). While the toxic elements are of low risk during the use phase of equipment; these substances can become harmful in the end-of-life phase. Different toxic chemicals are used in the manufacturing of electrical and electronic equipment such as plastics, , gallium, nickel, mercury, aluminum, vanadium, beryllium, lead, chromium, cadmium, and arsenic (Robinson, 2009; Van de Merwe, 2009). If these products are not disposed of properly and are landfilled, toxic components can leach into soil, and ground water (Rushton, 2003).

A computer monitor contains 6.3% lead, which if not well contained and recovered, infiltrates the water, soil, and/or air system as a result of burning of wastes. The amount of pollutants in a computer is much higher in than in other EEE such as washing machines and refrigerators (Barba-Gutierrez et al., 2007). Poor conventional methods of disposing e-waste, which are mainly open dumping and open burning results in to oxidation of plastics made of plastics of BFR, this releases dioxins, furans and toxic Respiratory Suspended Particles that cause risks to human health upon exposure and alters environmental systems. Most risks arise during the uncontrolled e-waste recycling activities that occur in developing countries, and are results of the rudimentary methods used. These include manual disassembly and sorting; heating and acid leaching of printed circuit boards (PC-boards); shredding, melting and extrusion of plastics; open burning of plastic coated wires and other components; and sweeping and collection of toners from toner cartridges.

**Table 5: Hazardous compounds that may be present in (EEE) and e-waste, as well as those that may be formed during end-of-life treatment of the e-waste. The primary locations of the compounds in the EEE are also shown.**

**Source: Swedish environmental protection agency (2011)**

<b>Hazardous compound</b>	<b>In electrical and electronic equipment (EEE) and e-waste</b>
<i>Metals</i>	
Antimony (Sb)	Semiconductors (SbH <sub>3</sub> ), flame retarded plastic (Sb <sub>2</sub> O <sub>3</sub> ), solders, CRT-glass, Pb-acid batteries
Arsenic (As)	As GaAs in MMICs, LEDs, laser diodes and solar cells
Asbestos	In some old items that have to resist heat (coffe pots, heaters etc.)
Barium (Ba)	Sparkplugs, fluorescent lamps, getter plates in vaccum tubes
Beryllium (Be)	Cu-Be alloy in springs, relays and solders. Power supply boxes and x-ray lenses
Cadmium, (Cd)	Contacts, switches, solder joints, Ni-Cd batteries (CdO), stabilizers in PVC, CRT phosphors
Chromium (Cr[VI])	Coating on metal surfaces, steel alloys
Copper (Cu)	Wires, cables, PC-boards, relays, switches, electromagnetic motors, lead free solders
Lead, (Pb)	Solders, CRT glass (PbO), stabilizers in PVC, lead-acid batteries
Mercury, (Hg)	Hg-batteries, cold cathode lamps, switches, relays, thermostats, sensors, medical equipment, telecom equipment.
Nickel (Ni)	Ni-Cd batteries, electron guns of CRTs
Selenium (Se)	Photocopying machines, photocells, light meters, solar cells, rectifiers and x-ray cameras
Tin and organo-tin	Stabilizers in PVC, glass coatings
Yttrium	Phosphors in CRTs and LEDs. Also in lasers, superconductors etc
Zinc (Zn)	ZnS in luminiscent pigments of CRTs

Brominated flame retardants (BFRs)	Plastic details, e.g. TBBPA in PC-boards, and PBDEs and HBCD in casings etc.
Dioxins (PCDD/Fs, PBDD/Fs, PBCDD/Fs)	Formation during thermal processes PBDD/F as an impurity in BFR-treated materials.
Various Br-compounds (benzenes and phenols)	Formation during thermal processes, some are also used as flame retardants
Polychlorinated biphenyls (PCBs)	Old capacitors and transformers. Formation during thermal processes.
Polychlorinated naphthalenes (PCNs)	Old capacitors and insulated wires. Formation during thermal processes.
Chlorinated paraffins (CPs)	Plasticizer and flame retardant in PVC and other plastics.
Chlorinated benzenes (e.g. hexachlorobenzene, HCB)	Formation during thermal processes
Polycyclic aromatic hydrocarbons (PAHs)	Formation during thermal processes.
Freons (CFCs, HCFCs, HFCs)	Cooling units of refrigerators and freezers
Nonylphenol (NP) and nonylphenol ethoxylate (NPE)	Antioxidant in plastics
Organophosphorus flame retardants (e.g. TPP)	Plastic details, e.g. casings of computer monitors
Phthalates (e.g. DEHP, DBP)	Plasticizers in PVC wires, cables etc.
Fluorinated comp. from Teflon	Formation during thermal decomposition of Teflon (PTFE)
Liquid crystals	LCDs
Toner dust	Toner cartridges of photocopiers, laser printers and faxes
Nanoparticles	Nanotubes in semiconductor chips, quantum dots in lasers, Ag-nanoparticles as surface coatings

### 2.5.3.8 Health impacts of e-waste

Upon incineration of e-waste, toxic chemicals such as dioxins and polycyclic aromatic hydrocarbons can be produced (Rushton, 2003). These hazardous materials may cause a wide range of negative health impacts including brain damage, kidney problems, lung cancer, skin ulcers, birth defects, and death (Babu et al., (2007); Brenniman and Hallenbeck, (2002).The categories of E-waste according to AU WEE directive are;

**Table 6: Some of hazardous materials found in E-waste  
Source (Van de Merwe, 2009)**

<b>Material</b>	<b>Location</b>	<b>Health impacts</b>	<b>Source</b>
Aluminum	CRT, used in printed wiring board as conductors and connectors	Skin rash, skeletal and respiratory problems, associated with Alzheimer's disease	Grossman (2006) Schmidt (2002)
Arsenic	Printed wiring board	Allergic reactions, vomiting, abnormal heart rhythm, increase risk of cancer	Schmidt (2002)
Beryllium	Used in circuit boards as conductors and connectors	Long disease, allergic reactions, increase risk of cancer	Grossman (2006) Five Winds International (2001) Schmidt (2002)
Brominated flame retardants: PBB and PBDE	Plastics, printed circuit boards, components, cables	Increase risk of cancer in the digestive and lymph systems	Brenniman and Hallenbeck (2002) Five Winds International (2001)
Brominated flame retardants: PBB and PBDE	Plastics, printed circuit boards, components, cables	Increase risk of cancer in the digestive and lymph systems	Brenniman and Hallenbeck (2002) Five Winds International (2001)
Cadmium	Plastics	Affects the kidneys	Babu et al. (2007) Brenniman and Hallenbeck (2002) Five Winds International (2001)
Chromium IV	Decorative, housing of the computer	Strong allergic reactions , ulcer, liver and kidney damage, DNA damage, increase risk of cancer	Babu, et al. (2007) Brenniman and Hallenbeck (2002) Schmidt (2002)
Gallium	Semiconductors, printed wiring board	Increase risk of cancer	Schmidt (2002)

Mercury	Printed circuit boards, batteries, CRT, printed wiring	Chronic brain, kidney, lung and fetal damage, allergic reaction, increase risk of cancer,	Babu et al. (2007) Brenniman and Hallenbeck (2002) Five Winds International (2001) Grossman (2006) Schmidt (2002)
Nickel	Printed wiring board, CRT	Reparatory problems, increase risk of cancer	Grossman (2006) Schmidt (2002)
Silica	glass, CRT, printed wiring board	Reparatory problems, increase risk of cancer	Grossman (2006) Schmidt (2002)
Vanadium	CRT	Lung and throat irritations	Schmidt (2002)

### 2.6.1 Key planning issues in Key-waste management

The key planning issues in e-waste management concerning the stakeholders and the challenges they face concerning e-waste are;

### 2.6.2 Government

- Environmental pollution
- Lack of management regulations and formal collection system
- How to regulate waste electronic products

### 2.6.3 Sellers, manufacturers, and importers

- Fears of increase of production costs by adding recycle and disposal fee.
- Lack of knowledge of proper treatment technologies
- Problems in collection, storage, transportation, and treatment process.
- Stakeholder analysis and Challenge
- Lack of knowledge on how to select treatment facilities and pollutants discharge standards
- Unfair competition

- Poor management and control on recycle process and causing secondary pollution

#### **2.6.4 General public**

- Residential environment deteriorates
- Compensation mechanism.
- Collection system of wastes

### **2.7 Waste disposal techniques**

There are various methods of waste disposal which mostly depend on technology, socio-economic and cultural factors. These methods range from simple to open dumping to complex methods such as pyrolysis and deep well injections. E-waste disposal should be done in a careful manner as most materials in it are harmful to human health and the general environment.

#### **2.8.1 Compositing**

Compost is a material that can be used as a soil fertilizer or conditioner after the addition of necessary chemical supplements. It is the conversion of organic components of solid waste through bio-degradation under controlled conditions. This converts waste to a usable resource mechanically or manually. However, compositing is limited as its inappropriate for non-compostable materials like e-waste.

#### **2.8.2 Landfilling**

Landfilling can be said to be the cheapest, simplest, and better method of solid waste disposal method where land is sufficient, and geological formation suitable. It involves a solid waste disposal site carefully selected and prepared for use. To reduce its volume, waste is compacted and covered with soil. However, toxic compounds found in e-waste can leach in to the soil and contaminate soil water. The formation of climate relevant trace gases and the generation of hazardous mycotoxin are some of the Impacts of landfilling of organic wastes in an anaerobic area, (Werlan 1992)

#### **2.8.3 Incineration**

Incineration is a disposal method used mostly where land is expensive, moisture content of wastes is low, and the caloric value is high. It involves the reduction of combustible wastes to an inert residue through burning at high temperatures of about 1,700-1,800 degrees Celsius. At these temperatures, any combustible material is reduced into ash leaving a volume of about 5-25% of the original volume including the non-combustible materials, (petty John, 1972). However, incineration may be expensive especially when the caloric value of waste is low and the moisture high supplementary fuel. This method is necessitating synonymous with air pollution problems through vaporized metals and dioxins, dust and smoke.

#### **2.8.4Waste Management Strategies**

There are various strategies that can be employed to manage e-waste. These strategies can be combined through integrated e-waste management to provide maximum effectiveness (Goosey, 2009). These strategies include reuse, service, or refurbish, remanufacturing, recycling, and final disposal (Goosey, 2009; Envirosris, 2000). Reuse means trade of the electrical and electronic equipment or its components in the way that they were originally designed (Jofre and Morioka, 2005). Service or refurbish means repair or maintenance, which leads to the extension of functional lifespan of the electrical and electronic equipment (Jofre and Morioka, 2005).

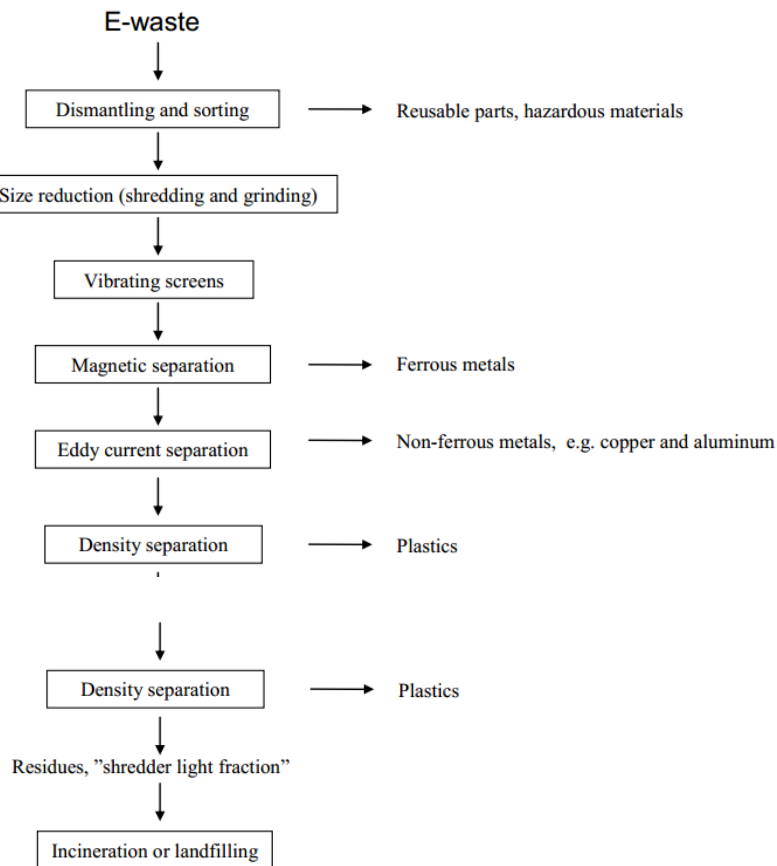
Reuse and refurbishing provide many environmental and social advantages such as saving materials and energy by decreasing the use of raw materials in order to manufacture electrical and electronic equipment, which can lead to less required packaging; less waste production; and more importantly, diversion of e-waste from the solid waste stream (EPA, 211; Jofre and Morioka, 2005). Reuse also enables low-income individuals to have access to electrical and electronic equipment at cheaper costs (EPA, 2011; Goosey, 2009). Remanufacturing is an e-waste management strategy and consists of removing some parts of e-waste in order to utilize them in the manufacturing of new electrical and electronic equipment (Goosey, 2009).

Recycling (with or without disassembly) includes substituting virgin materials by recycled components and includes recovery of raw materials, and reprocessing (Bilitewski et al., 1997; Jofre and Morioka, 2005). Recovery of raw materials is considered an important concept in application of e-waste management strategies due to the fact that it leads to conservation of valuable resources (Goosey, 2009). One of the key elements in implementing successful

recycling management is to keep e-waste clean and uncontaminated, which will facilitate and enhance disassembly, and recovery processes (Goosey, 2009).

### 2.8.5 Recycling and resource recovery

Resource recovery and recycling is one of the best strategies in waste management. It has been necessitated by the overwhelming increase of both domestic and municipal solid waste. Most e-waste has recoverable and valuable metals. Other benefits of recycling involve saving on the costs of waste disposal, and the substitution of secondary materials for virgin ones. According to Gachamba (1993), the major form of recycling in Kenya is done through scavenging. This is for metals, plastics, paper, and bottles. Recycling business has a high potential however, a strong legislation is necessary to guide on e-waste recycling as well as favorable market conditions.



**Figure 5: E-waste recycling process:**

**Source: Swedish environmental protection agency (2011)**

**2.9 E-waste management in developing countries**

Waste Electrical and Electronic Equipment (WEEE) or E-waste is one of the fastest growing waste streams in the world. In developed countries, it equals 1% of total solid waste on an average. The increasing “market penetration” in developing countries, “replacement market” in developed countries and “high obsolescence rate” make WEEE/E-waste one of the fastest waste streams. There is a pressing need to address e-waste management particularly in developing countries. The presence of valuable recyclable components attracts informal and unorganized sector. The unsafe and environmentally risky practices adopted by them pose great risks to health and environment.

For effective WEEE/E-waste management, we need to quantify and characterize this waste stream, identify major waste generators such as learning institutions, and assess their role in its management and the risks involved. A scientific, safe, and environmentally sound management system, including policies and technologies, needs to be developed and implemented. The electrical and electronics industry is one of the world’s largest and fastest growing manufacturing industries. Rapid growth, and rapid product obsolescence through short innovation cycles turns e-waste into the fastest growing waste stream worldwide. E-waste is characterized by two main attributes: It is hazardous, due to its content of toxic substances such as lead, cadmium, mercury, PCBs (polychlorinated biphenyls) etc., but at the same time it is valuable.

Most developing countries fall short of a solid waste management system that minds the challenges and hazards of poor e-waste handling. According to Mundada, Kumar, &Shekdar, (2004) cited in Nnorom&Osibanjo, (2007), most developing countries do not have both the necessary infrastructures and effective legislation to avert the hazards that emerge from poor e-waste management. Rather, the prominent method of e-waste handling in developing countries involve low-end treatment methods such as backyard recycling, open dump disposal, disposal in water bodies and open burning (Furter, 2004) cited in (Nnorom&Osibanjo, 2007). These in many instances stem from the lack of recycling and recovery infrastructures or, as witnessed in some cases, a weak environmental policy among

many other varying in-situ conditions. The general level of research work and scientific understandings about e-waste handling and management is low in developing countries. Nnorom&Osibanjo, (2007) indicated that South Africa is the only country to have a well-established e-waste recycling data registration system in Africa and the availability of such data in all the rest countries is scarce. As limited the understanding in these countries as it is, the main problem remain a less progressive action to implement the available research outputs. Basically, the E-waste stream in developing countries originate from two distinct sources; local generation and importation of second hand electronic materials from the developed nations in the name of 'bridging the digital divide'. Particularly the latter is adding much to the existing challenge of E-waste management developing nations since much of this imported second hand electronic materials soon reach the height of their designed service life and get discarded. In some cases, these imported second hand electronics are totally dysfunctional. For example BAN 2005 noticed that about 25-75% of the imported second hand computers to Nigeria are unusable junk. The setting up an effective and sustainable e-waste management systems in developing countries yet seem far-flung.

### **2.9.2 E-waste in Kenya**

Kenya's ICT industry is growing fast. The rate of ICT acquisition specifically computers and mobiles is increasing. Most ICT products come from EU countries such as Britain, Asian countries such as China and Malaysia and USA. Generally ICT imports are new and old products are discouraged. However, there is a considerable portion of refurbished and old products brought in country through various channels such as NGO donations to institutions like schools. The primary reason for importing refurbished and old products is that people prefer cheap goods. It is not until September 2006 when that Kenya held the Eighth Conference Of Parties (COP 8) in Nairobi that e-waste management problem was perceived urgent. The low consumption of EEE and the general trend by households to dispose them with the general solid waste made it seem less urgent.

A lot of e-waste has been dumped in Kenya in the disguise of donations (Musili 2008). The unusable computers are shipped back to donor countries by Non-governmental organizations, up to a quarter of the computer donations to recipient countries such as Kenya are unusable. 10 to 20 per cent of the computers of the computers donated to Kenya by the United Kingdom and the

United States are unusable (make it fair, 2008). Kenya`s susceptibility to more E-waste is due to the availability of huge market for second hand computers as well as the affordability compared to the price of new computers (Waema, 2008).there is an influx of cheaper computers both new and old among other EEES from Asia. Now more and more people can afford these cheaper products but the contentious issue is the end of life disposal of these EEES as they have a short life span.

### **2.9.3 E-waste management facts in Kenya**

UNEP estimates the current e-waste generated annually in Kenya at;

- 11,400 tonnes from refrigerators,
- 2,800 tonnes from TVs,
- 2,500 tonnes from personal computers,
- 500 tonnes from printers and
- 150 tonnes from mobile phones (Press Release UNEP, 2010).

#### **2.9.3.1 WEE Mass flow**

The mass flow study carried out in 2007 by Kenya ICT Action Network showed that:

- 1,513 tonnes of electronics entered the market.
- The consumer in addition to receiving 1,489.4 tonnes also received 151.3 tonnes from the second hand market.

The consumers are likely to dispose

- 1,210.4 tonnes in the second-hand market,
- 18.6 tonnes to collectors or as general waste which is sent to refurbishers.
- 18.6 tonnes directly to recyclers.
- Refurbishers and recyclers then send 605.2 tonnes for disposal.

### **2.9.3.2 Key challenges facing Kenya**

- i. Significant amount of second-hand equipment in the market with short remaining lifespan.
- ii. Dumping of e-waste by developed nations.
- iii. Inadequate regulatory and policy structures to safeguard health, environment, and social consequences of e-waste.

### **2.9.3.3 E-waste management in the formal sector**

Computer for Schools Kenya (CFSK) distributes refurbished computers to schools, takes after 5 years. The Collected computers are refurbished, some to TV monitors, recycled Monitors and boards are exported for disposal. Nokia has a recycling scheme while HP is setting up take back and disposal facility. The government agencies seem to have a limited capacity and facilities to deal with e-waste.

### **2.9.3.4 E-waste management by the informal sector**

E waste management mostly by informal sector Most of whom have inadequate skills, are neither registered nor authorized. They dismantle discarded WEE items to recover usable parts, mainly, electronics, and scrap metal such as copper. The remainder is disposed with other domestic waste to dumpsite.

Kenya lacks clear data on the availability of various EEE in the country or the available one is contradictory. According to Omosa and McCormick, (2004), it was estimated that in the year 2004 only 17% of Kenyans owned a personal computer while Intermedia (2004) stated that in 2005, 32% of Kenyan owned a computer. Waema, (2008) indicated in his study that approximately 1 million out of 33billion Kenyans own a computer. Evidently there are discrepancies in the figures and it necessitates a clear study to establish and validate the right number and data on the available EEE in Kenya. This would facilitate informed planning for the control and management of the resultant e-waste.

Generally, little has been done in management of e-waste in Kenya; however, there have been some initiatives of E-waste management in Kenya after the eighth COP to the Basel convention. The forum for the Future and Practical Action Aid in collaboration with Vodafone conducted an E-waste pilot project primarily focusing on cell the phones waste with the aim of determining the volume of the waste and possible collection methods. Nokia then set up a take- back scheme for the EoL mobile phones. Several NGOs have developed project proposals on E-waste management with special focus on ICT equipment. Currently, computer for schools Kenya (CFSK) program has a functioning computer repair and refurbishing centre and intends to expand the program into a fully-fledged e-waste management centre.

#### **2.9.4 Policy framework**

Mureithi et al., ( 2008) asserts that the country lacks a regulatory framework for e-waste management and that in the past; Kenya has not had a recycling policy on electronics. Mureithi further mentions that, in Kenya, "There are 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. There is need to adjust procurement policies by formulating environmental sound policies. There are environmental regulations which are not specifically designed for E-waste. These include the waste management regulations of 2006 enforced by NEMA-the institution that implements all policies relating to the environment . These laws help in controlling generation, handling, transportation, storage, or disposal of waste that threatens public health, the environment or natural resources. There is also an ICT policy instituted by Ministry of Information and Communications (MoIC) in 2006. The policy demands electronics dealers to demonstrate their readiness to minimize the effects of their infrastructure on the environment in order to get their licenses renewed.

In addition, Kenya has 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; The government is planning to have guidelines for e-waste.

Kenya's basic policy regulations and legislations include the Basel convention on the control of trans-boundary movements of hazardous waste and their disposal adopted in 1989 and came to force on 5<sup>th</sup> may 1992. The 162 party countries committed to reduce the generation of hazardous waste to a minimum and ensure that it is managed in a manner that will protect human health and environment from its adverse effects and reduce the Trans boundary movement of such wastes therefore making it illegal to traffic them.

### **2.9.5. Legal framework**

The international community and some National governments have realized the importance and the urgency to adopt frameworks to regulate, monitor and control the disposal of e-waste. Several efforts, on international as well as national levels are underway to manage e-waste. In a course to fight against hazardous waste, Kenya is became a signatory to numerous multilateral environmental agreements. Some of these agreements are:

Basel convention on the control of Trans boundary movements of hazardous wastes and their disposal ; Bamako convention on the Ban of the imports into Africa and the control of trans-boundary movement of hazardous wastes into Africa; 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 ; Stockholm convention on Persistent Organic Pollutants (POPs) and Rotterdam convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade. Such agreements have been key in, promotion of mechanisms and infrastructure needs for greener environments, controlling and providing guidelines for cross boarder movements of hazardous components. On the question of public-private sector partnerships, the government has to engage in the business. However much there is a need to have facilities for recycling and re-use, such facilities have to be run by the private sector organizations. For example in 2008, the National Environmental Management Authority signed a memorandum of understanding with an NGO i.e., CFSK (Computer for Schools Kenya) which set up a recycling plant. The move was one of the government's deliberate efforts to work on e-waste. NEMA also supports other nongovernmental and private sector organizations that deal with waste management such as Practical Action, and Kenya National Cleaner Production Centre<sup>38</sup> (KNCPC). It is clear that the government is willing to collaborate with

private sector investors to control e-waste. Their contribution is to setup regulations, sensitize citizens, and give economic incentives such as tax rebates if need be. International agreements such as the Bamako convention have been key in, promotion of mechanisms and infrastructure needs for greener environments, controlling and providing guidelines for cross boarder movements of hazardous components. However, the enforcement of these regulations has been poor. The passing of the draft e-waste regulations would be imperative in dealing with e-waste menace.

#### **2.9.5.1 Basel convention**

The Basel Convention on the Control of Trans-boundary Movements of Hazardous Waste and their Disposal was adopted in 1989 and coming into force on 5th May 1992. A total of 162 countries party to the Convention committed to reduce the generation of hazardous waste to a minimum, and ensure that it is managed in a manner that will protect human health and the environment from its adverse impacts and reduce the trans-boundary movement of such wastes, making their illegal traffic a criminal offence. Some of the hazardous substances under the jurisdiction of The Basel convention, as characterized in list A of Annex VII I(A1180) are *waste electrical and electronic assemblies or scrap containing components such as accumulators and other batteries, mercury switches, glass from cathode ray tubes, PCB capacitors, or contained with constituents (for instance polychlorinated biphenyl, compounds of cadmium, mercury, lead, beryllium, hexavalent chromium, arsenic)* unfortunately, Basel convention does not address the loophole of second hand electronic equipment in a working condition that might be sent to other countries.

*Electrical and electronic assemblies among them (printed circuit boards, electronic components, and wires) destined for direct reuse and not for recycling or final disposal* are among those in the de controlled list in Annex IX (B110) if they are not flammable or toxic or do not contain the hazardous substances listed in Annex 1. An amendment to the Basel convention otherwise known as the Basel ban whose aim was to prevent the export of e-waste has not been fully effective as many party countries did not ratify it. Despite Kenya ratifying the two international conventions on the ban of exportation of hazardous waste, she continues to receive second hand ICT equipment due to poor implementation of these regulations.

### **2.9.5.2 Bamako convention**

The main aim of the Bamako convention was to criminalize the importation of hazardous waste into the African region, its dumping, and incineration. Despite Kenya ratifying the two international conventions on the ban of exportation of hazardous waste, she continues to receive second hand ICT equipment due to poor implementation of these regulations.

The local government act (cap 256) and public health act (cap 242) formerly gave the local authorities control over solid waste management and sanitation. They would establish and maintain municipal solid waste management services. This was before the creation of Environmental Management and Coordination Act (EMCA 1999). The two acts however did not give clear guidelines on sound waste management including solid waste, standards of the services, recycling or waste reduction therefore in effective. They did not provide for the classification of waste into municipal, industrial, or other hazardous type, to enable assigning of responsibilities over each type. Local Government Act has however been repealed by the County Government act, the counties have a responsibility on general waste management though there are no specifications on e-waste management. Ruiru sub county Government was found not to have any specific e-waste management regulations. However, the environment ministry was advocating for an environmental management Authority within the county to handle environmental matters. It had also partnered with UN habitat on various initiatives such as communal clean up and environmental awareness.

### **2.9.5.3 EMCA (1999)**

Environmental Management and Coordination Act (EMCA 1999), is the main act that addresses waste management in the country. This act was created in 1999 and outlines specifically how e-waste should be handled. The act states *` no person shall discharge or dispose of any wastes in a manner that would cause pollution, to the environment or ill health to any person; no person shall transport wastes except to a licensed waste disposal site established and in accordance with a valid license issued under the Act` (EMCA 1999).*

In addition, in its fifth schedule, EMCA 1999 describes e-waste better giving it five characteristics which are, toxicity, explosivity, flammability, oxidizivity and corrositivity. E-waste contains compounds of metals classified as hazardous wastes by virtue of its constituents. According to

section 5 of EMCA`s E-waste management guidelines, requires the waste generator to minimize waste and eliminate waste altogether as well as identify and eliminate potential negative impacts of the product, enabling the recovery and reuse of the product, reclamation and recycling and incorporating environmental concerns in the design and disposal of the product. Sections 17-23 require hazardous waste generators to conduct an EIA and label clearly the hazardous waste. NEMA is mandated to oversee the transport of such materials.

*The science and technology act, cap 250 of 1977, the Kenya communications act 1998, and the Kenya broadcasting act of 1988* are the main statutes that deal with end of life management of ICT equipment. The three acts basically address the licensing and frequency distribution therefore inadequate in addressing the e-waste problem.

In addition to the three statutes, the National ICT policy (2006) in endeavor to address e-waste issue states that “ *as a prerequisite for grant or renewal of licenses, applicants must demonstrate their readiness to minimize the effects of their infrastructure on the environment. This should include provision of appropriate recycling, disposal facilities for toxic waste.* The policy aims at promoting an environmentally friendly ICT sector by incorporating environmental considerations in IT products however the many good proposals for the development of recycling and disposal facilities and regulations have not been implemented. The lack of clear e-waste specific regulations, poor enforcement, and implementation except EMCA1999 stifles the efforts on proper e-waste management.

#### **2.9.5.4 Draft E-waste regulations 2013**

The draft e-waste regulation define e-waste as ‘electrical and electronic equipment’ as equipment which is dependent on electric currents or electromagnetic fields in order to work properly and equipment for the generation, transfer and measurement of such currents and fields falling under the categories set out in schedule 5 of these regulation; even though the regulations have not been passed yet, they play a crucial role in helping manage e-waste in Kenya. Below is a short overview of what the document proposes;

#### **Registration of Producers**

On the registration of producers in schedule 4 of the draft regulations states:

4. (1) A Producer who intends to introduce new or used electrical and electronic equipment into Kenya shall apply for registration from the Authority.

(3) Every Producer operating in Kenya must register with the Authority within sixty (60) days of the coming into force of this regulation as per sub regulation (2).

The above would help regulate the number of producers and therefore ease follow up and enforcement of compliance.

### **Annual compliance certificate of Producers**

Schedule 5 on compliance states,

5. Every producer shall obtain an annual compliance certificate upon-(a) declaring the previous year's weight of electrical and electronic equipment introduced in the market by product type;

(b) Production of an evidence note with a licensed treatment facility;

© Production of a valid contractual agreement with a licensed treatment facility; and

(d) Payment of the prescribed fee.

### **Producer Responsibility**

The regulations also have advocated producer responsibility, it states on schedule 6;

6. (1) every producer shall, declare to the Authority-

(a) The previous year's electrical and electronic equipment products introduced into the market; and

(b) Provide to the Authority subsequent year's projected imports of any electrical and electronic equipment products.

(2) The declaration referred to in Regulation 6 (1) shall be in the format stipulated in schedule 11;

(3) Every producer shall provide information to recyclers on how to dismantle their product at the end of life and the location of any hazardous substances or items within the product;

(4) Every producer shall, within their relevant product category and on the basis of their market share, support the financing of collection and treatment for problematic fractions by the licensed treatment facility to ensure effective take back and treatment of e-waste;

(5) (a) Every producer shall pay upon receipt of the evidence note from the license treatment facility the treatment fee determined by the Authority based on the market share of the producer.

(b) In determining the market share of the producer the authority shall be guided by the formula as indicated in schedule 11.

(6) Any producer or a third party acting on behalf of the producer and intending to establish an e-waste collection center shall notify the Authority of the location and physical address of the center indicating the Global Positioning System coordinates;

(7) (a) Every producer shall ensure that e-waste returned under individual take-back schemes, is not disposed of at municipal disposal site/facility,

On the establishment of an E-waste recycling facility, it further states in schedule 9 that;

9. (1) Any person intending to establish an E-waste recycling facility shall obtain an EIA license in accordance with the Environmental (Impact Assessment and Audit) Regulations of 2003;

(2) Every owner/operator of a recycling facility shall obtain an operating license from the Authority in accordance with the Environmental Management and Coordination (Waste Management) Regulations of 2006.

The above is a way of ensuring producers responsibility is incorporated in e-waste management prior manufacture. This is because producers understand their products better and would be better placed in tracking and determining the disposal of their products at the end of their useful life.

## **Responsibilities of Recyclers**

Schedule 10 on responsibilities, the regulations state that,

10. (1) Recyclers shall;

(i) Receive and dismantle the Waste electrical and electronic equipment into hazardous and non-hazardous components in an environmentally sound manner;

(ii) Ensure that the components which cannot be recycled locally are exported as specified in this regulation.

(2) The licensed recycler shall collect and treat e-waste in accordance with the Guidelines published by the Authority;

(a) the standards set out in this regulation,

Setting of the above standards for recycling would ensure that e-waste is recycled in an environmentally sound manner.

## **Responsibilities of Generators**

11. The generator shall ensure e-waste is segregated from other forms of waste and is taken to licensed refurbishers, collection centres or recyclers.

## **Responsibilities of Refurbishers**

12. (1) Refurbishers shall ensure that the resultant e-waste is transferred to a collection center or to licensed recyclers;

(2) Every person involved in the repair or refurbishment of electrical and electronic equipment shall ensure that the e-waste is recycled in a facility licensed by the Authority.

## **Transportation of E-Waste**

13. All transporters of e-waste shall;

(1) Obtain necessary licenses from the Authority upon application in a prescribed form and payment of the prescribed fee;

(2) maintain tracking documents at all times which shall be made available on request by environmental inspector; and

(3) Ensure that the mode of transport used complies with Regulation 8 of the Environmental Management and Coordination (Waste Management) Regulations of 2006.

### **Responsibilities of Collection Centers**

14. Any person intending to establish a collection center shall notify the authority in the form prescribed in schedule.

### **E-Waste- Control and handling**

Schedule 15 addresses E-waste control and handling especially importation and exportation and states;

15. (1) The Authority may establish a mechanism to ensure collaboration within African States on importation of e-waste;

(2) Any e-waste imported into Kenya from within Africa shall be for the purpose of recycling, refurbishment, and material recovery;

(3) Any person importing e-waste referred to under these regulations from within Africa into Kenya shall apply to the Authority for a permit in accordance with the prescribed format upon payment of the prescribed fee set out in schedule 10; Importation of Electrical and Electronic Equipment

16. (1) The importation of electrical and electronic equipment containing Cathode Ray Tubes into the country are restricted except for essential services such as medical equipment;

(2) The importers of all electrical and electronic equipment donated to individuals, educational institutions, religious organizations, communities, or body corporate by whatever means, shall obtain the necessary approvals from the Authority in accordance with the prescribed form and fee.

(3) Every electrical and electronic equipment imported into the country shall bear a label indicating the year and country of manufacture Prohibitions

Schedule 17 addresses E-waste disposal methods. It states;

17. (1) No person shall dispose e-waste;

(a) By burning;

(b) In non-designated waste receptacles; or

(c) By burial or at a dump site.

(2) No person shall;

(a) Treat Cathode Ray Tubes in an unsound environmental manner;

(b) Cause leaching of precious metals with acids and other hazardous waste from printed wire boards or Printed Circuit Board in an uncontrolled manner;

(c) Carry out open burning of electrical and electronic equipment /e-waste at the recycling facilities;

(d) Abandon e-waste anywhere other than in the collection centres and/or in the licensed recycling facilities.

Any person who contravenes this regulation commits an offence and liable on conviction to a fine not exceeding one hundred thousand shillings or to imprisonment for a term not exceeding six months or to both.

### **Environmentally Sound Management**

18. Every person dealing in e-waste shall practice principles and standards of Environmentally Sound Management of e-waste.

### **Reporting**

On reporting, the regulations state;

19. (1) Every Refurbisher of electrical and electronic equipment shall keep records of quantities of e-waste transferred to the collection centers;

(2) Every recycler of e-waste shall submit to the Authority every six months records of;

- (a) Quantities of e-waste received of each category for recycling;
- (b) Quantities and types of recovered materials including precious metals;
- (c) Recycling technologies applied;
- (d) Quantities exported for further recycling; and
- (e) Certificate of disposer recovery;

### **Minimum collection incentives/values**

20. The Authority shall establish a framework through which to provide incentives to actors in the e-waste value chain.

The minimum collection value is the value that will be paid by the recycler to collectors ensuring that all e-waste is collected. Some e-waste does not have a positive recovery value due to the cost to process being more than the revenue recovered

22. No person shall import any near end-of-life and e-waste from outside Africa into Kenya;

### **Disposal of e waste by County governments**

Concerning county governments, the regulation states that;

25. (1) No County Government shall allow disposal of e-waste in their waste facilities save for in the manner prescribed by these regulations;

(2) It shall be an offence for any county government to allow disposal of e waste in their waste facilities save for in the manner prescribed by these regulations.

### **Handling unauthorized e-waste consignments**

On handling e-waste consignments;

28.(1) Any person who exports e-waste either by ship, railway, air or road without an export permit issued by the Authority, shall commit an offence.

## **General penalty**

29. Any person who violates any of the provisions of these Regulations commits an offence and is liable upon conviction to imprisonment of not less than 36 months and a fine of not less than two million Kenya shillings or both such imprisonment and fine.

## **Operation of Regulations**

30. These Regulations shall operate in addition to other relevant Regulations and Standards made under any other law.

### **2.9.6 Road map for a better e-waste management**

Regardless of the variation in volume and extent of scholarly understandings about E-waste in the global spectrum, the need to advance existing handling and management methods is evidently emphasized by most researchers. Apparently, the developing nations have to build their capacities on subjects like e-waste management and at least follow the footsteps of the developed world as part of their effort to achieve sustainability. Countries with a good track of e-waste management needs to continually improve their existing systems and methods towards perfection. The Basel Convention and SteP (Stopping the e-waste Problem), initiated by the United Nations, are among the global efforts intended to tackle e-waste problems worldwide. These schemes utilizes mechanisms such as banning the trans-boundary movement of hazardous materials and creating knowledge and information exchanging platform on waste electronic and electrical equipment among others.

At national level, several researchers are devising sophisticated approaches distinctly designed to suit the challenges and cultures of e-waste handling in their countries. Kahhat et al, ( 2008) propose E-waste management system for the United States which ensures proper end-of-life treatment while establishing a competitive market for reuse and recycle at the same time. The proposed framework is termed ‘e-Market for Returned Deposit’ and integrates the utilization of RFID (Radio-Frequency Identification Device) technology implanted in new electr(on)ic products and the existing cyber infrastructure to reclaim used/obsolete electr(on)ic materials back to recycling centers. Similarly, other research efforts in developing countries suggest a different approach to beef up the existing e-waste management practice in

these countries. Nnorom&Osibanjo, (2007) emphasizes on a need to take lesson from Thailand, which has enacted a restriction on the importation of used electronic appliances, to lessen the existing challenges of e-waste in developing countries. The authors also suggest establishing extensive recovery systems, which includes value-added, material and energy recovery, and imposing economic policies such as Advanced Recycling Fee (ARF) on both new and used electronic appliances. While, provided the current state of used electronic materials movement particularly from developed to the developing world, Gwebu&Batsumi, (2006) underscore the need to implement EPR system to tackle the challenges of e-waste in developing countries. However, Kojima (2005) questions the practicality of implementing EPR systems in developing countries for reasons such as difficulty in collection of waste equipment from rural communities that have low rate of appliance penetration and also the very existence of informal recycling activities that snatch a share of the e-waste.

## CHAPTER THREE

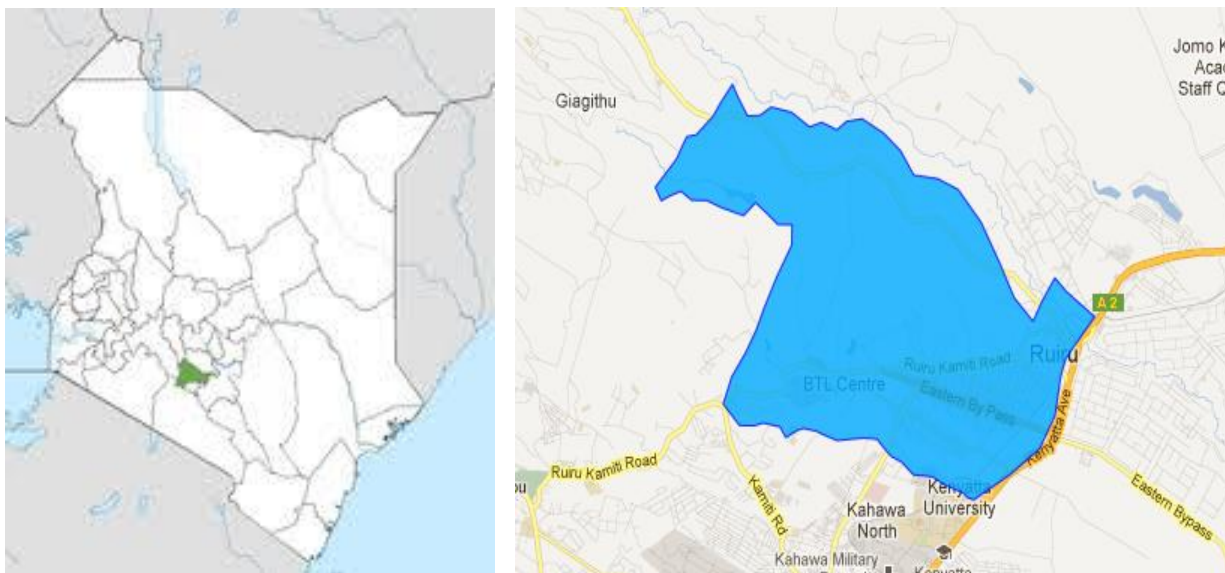
### STUDY AREA

This chapter looks at Ruiru Sub County in Kiambu County. It describes the physical setup, economy, education, and population of the County and Sub County

#### 3.1 Physical set-up

This study is limited to Ruiru Subcounty, Kiambu County which has been chosen since it has various learning institutions from primary, secondary to tertiary which have embraced ICT in teaching learning and research among other electronic equipment. It is found in Kiambu County which is located in central Kenya. Kiambu County covers an area of 2,543 sq km with average temperatures of 18.7°C and 989mm of rainfall per annum. Its population is 1,623,282 and a population density of 632 people per km square. The county has 8 (Municipal councils of Kiambu, Limuru, Thika, and Ruiru, County Councils of Kiambu and Thika, Town Councils of Kikuyu and Karuri). Kiambu town is the administrative capital.

**Plate 3: Kiambu county; source; google maps. Plate 4: Ruiru sub county; source google maps**



### **3.2 Population**

In 1991, Ruiru sub county then a district had a population of over 100,000 people while in the year 2005 it grew to a population of over 200,000. Currently, the population stands at over 234,000 signifying an increase in population growth mainly attributed to migration of people from Nairobi as a result of housing shortage. Kiambu County is a county in the former Central Province of Kenya. The capital of Kiambu County is Kiambu and its largest town is Ruiru. Ruiru, a town emerging in terms of population and economic growth as witnessed in recent years will benefit immensely from the construction of Thika Highway and other projects that are Underway. The County is adjacent to the northern border of Nairobi County.

### **3.3 Economy**

Kiambu economy prides in rich highland soils coupled with very favorable climatic conditions, agriculture plays a very important role in the county's economy. However with its proximity to Nairobi and limited land resources, the services sector is slowly replacing agriculture as a major economic activity. The county is undergoing rapid urbanization as a result. The county is predominantly rural, but its urban population is increasing as Nairobi is growing rapidly. Among the top ten cities and towns in the country, Ruiru is ranked as the sixth most populated region, housing more than 100,000 people. The first five are Nairobi, Kisumu, Nakuru and Eldoret.

### **3.4 Education**

The sub county has a high number of learning institutions as stipulated in the tables below. Its registered middle-level colleges registered with the Ministry of Higher Education are: Compuera College, Royal College of Science and Technology and Nairobi Institute of Business Studies Branch, Zetech College among others. The sub county's current number of institutions are;

**Table 7: Public primary schools, source**  
**Source: Field survey, 2014**

YEAR	DISTRICT	No. OF SCHOOLS	BOYS	GIRLS	TOTAL ENROLMENT
2012	RUIRU	30	8473	8231	16704
2013	RUIRU	30	8759	8995	17754

**Table 8: Private primary schools**  
**Source: Field survey, 2014**

YEAR	DISTRICT		No. OF SCHOOLS	BOYS	GIRLS	TOTAL ENROLMENT
2012	RUIRU	108	8473		8231	16704
2013	RUIRU	108	9253		9153	18385

**Table 9: Public secondary schools**  
**Source: Field survey, 2014**

YEAR	DISTRICT	No. OF SCHOOLS	BOYS	GIRLS	TOTAL ENROLMENT
2012	RUIRU	12	1465	1124	2589
2013	RUIRU	12	1629	695	2324

**Table 10: Private secondary schools**  
**Source: Field survey, 2014**

YEAR	DISTRICT	No. OF SCHOOLS	BOYS	GIRLS	TOTAL ENROLMENT
2012	RUIRU	14	599	1036	1635
2013	RUIRU	16	1262	1882	3144

**Table 11: number of colleges**  
**Source:Source: Field survey, 2014**

No of colleges	Year
8	2013

## **CHAPTER FOUR:**

### **METHODOLOGY**

#### **4.1 Introduction**

Methodology is more than just a guideline for solving a problem with specific components such as tasks, methods, phases, techniques, and tools. It encompasses procedures followed to collect, analyze and interpret data in any study research objectives.

#### **4.2 Research Design**

The study employed an explanatory and descriptive research design. The strength of an exploratory design is based in its flexibility, which easily allows different aspects of the problem to be considered (Kothari, 2009). On the other hand the descriptive design was favoured because of its rigidity as a protection against bias and on the need to maximize reliability.

The instruments for data collection were pre-tested (piloting) and readjusted to ensure accurate capturing of the required data for writing the final report. This design was also boosted by the combination of sampling types for complete coverage of the desired data.

#### **4.3 Target Population**

The study targeted the general population of Ruiru sub county represented by institutions of learning (Primary schools, secondary schools, and tertiary institutions), and government institutions for example, Municipal Council of Ruiru, District Commissioner's Office, National Environment Management Authority, Nongovernmental Organizations, Computer For Schools Kenya and KNBS

## **4.4 Nature and Sources of Data**

### **4.4.1 Types of data**

Two types of data were collected. These were primary and secondary data. The primary data which was collected from the field gave the first hand information about the extent of e-waste management issues experienced in Ruiru sub County. Secondary data was acquired from archived in documented information such as technical reports and archival retrieval.

### **4.4.2 Sources of Primary Data**

Primary data sources include institutions, and resource persons such as the District Commissioner, County Education Officer, Physical Planner, Public Health Officer, Municipal Environment Officer, among others. The above provided the baseline data for the research study in the field.

- **Participant Observation**

During participant observations, observations were made and information captured using cameras useful in capturing information such as activities in the study area, topography, structures, waste collection and disposal activities among others. Field notes were taken during the course of this study on e-waste management issues as per the objectives. Oral interviews were an important source of data especially in gathering information from various institutions as well as institutions. These include government offices and other sectors involved in waste management.

### **4.4.3 Sources of Secondary data**

Secondary data was obtained from various sources which include reference books (published), information from government bodies such as from relevant line ministries charged with responsibilities of executing various government policies necessary in waste management in Kenya, relevant reference publications, maps, national waste management plans, policies and data from websites in the internet will also be used.

## **4.5 Sampling Procedures**

The study integrated both probability and non-probability sampling techniques:

### **4.5.1 Probability Sampling Technique**

Probability sampling is one in which every unit in the population has a chance of being selected in the sample, and this probability can be accurately determined. The combination of these traits makes it possible to produce unbiased estimates of population totals; by weighting sampled units according to their probability of selection. These methods rely on random selection in a variety of ways from the sample frame of the population. They permit the use of higher level statistical techniques which require random selection, and allow you to calculate the difference between your sample results and the population equivalent values so that you can confidently state that you know the population values.

- **Stratified Random Sampling**

The Study area was stratified into the following levels; Primary schools, secondary schools, and tertiary institutions. Simple random sampling techniques were employed on the primary and secondary stratas. However, it was a case study for the 8 Colleges.

- **Systematic Simple Random Sampling**

During the administration of institutional questionnaires, Transects were identified in each strata of which questionnaires were administered.

### **4.5.2 Non Probability Sampling Technique**

Nonprobability sampling is any sampling method where some elements of the population don't have a chance of selection otherwise referred to as 'out of coverage or under covered, or where the probability of selection can't be accurately determined. It involves the selection of elements based on assumptions regarding the population of interest, which forms the criteria for selection. Hence, because the selection of elements is non-random, non-probability sampling does not allow the estimation of sampling errors. The study utilized purposive/judgemental and convenience non random sampling methods. These will be used particularly when administering questionnaires to businesses and choosing institutions to be interviewed.

- **Convenient Sampling**

This method involved the selection of cases and or units of observation as they became available. During the field study, this method came into play at various stages whereby the researcher was directed to other places within the sub county where he got further information.

### **Purposive Judgmental Sampling**

This technique was used to investigate cases that have the required information as per the objectives of the study .This method was employed in the identification of the various interest groups for instance relevant institutions such as NEMA and CCK.

#### **4.6.1 Sample Size**

Given that 30 is a statistically accepted number that can be used to represent a given population, the researcher gathered field data from institutions 59 learning institutions. (30% of the total number of the sub county's institutions) 42 primary schools, 9 secondary schools and 8 tertiary institutions.

#### **4.6.2 Instruments of Data Collection**

##### **Questionnaires**

Questionnaires (both open and closed ended) were designed, pre-tested and later administered to the sampled institutions and relevant offices. The procurement officer, the ICT department head, or head of the institution was the most preferred respondent to whom the questionnaire was administered. This was done in a bid to collect information as per the objectives of the study. These are found in appendix 111.

##### **Interview Schedules**

This method involved collection of data through face to face interaction with officers from various institutions. A lot of information was obtained using these instruments since they allowed for clarifications on unclear views and interrogation of ambiguous information. This can be found in appendices.

## **Observation Guide**

Observation was used for basically collecting data and in verifying information (ground-truthing) from data collected using the questionnaires. Observation guides as instruments of data collection also served to increase the range of relevance and reliability of data on the various issues, parameters, resources, and activities under investigation in the sub county.

## **Photography**

This comprised capturing of data using digital cameras .It helped in classification of data and acted as evidence of actual practices that took place in the study area .Photography captured spatial temporal data and it involved transferring the real situation on the ground and masking it on paper for easier understanding .

## **4.7 Methods of Data Analysis and Presentation**

Qualitative description and quantitative methods was used to analyze the information collected from the respondents. The quantitative techniques was achieved through coding the data from the questionnaires based on broad thematic areas then undertaking analysis using Statistical Package for Social Scientists (SPSS) version 16 .The analysis was descriptive in nature and proportions, graphs, percentages and averages used to draw up conclusions. Data presentation was done by use of pie charts, graphs, and maps.

To select an appropriate statistical technique, a two set criterion was considered which included;

- i. The appropriateness of the technique to the research question,
- ii. The characteristics of data.

**Table 12: research matrix**  
**Source: Field survey, 2014**

Objectives	Type of data	Sources of data	Research tool
1.To analyze Policies and institutional framework that governs electronic waste management in Kenya.	Primary Secondary	Literature review, institutional interviews, Resource persons	Books, Journals, Internet Research papers Questionnaires, Interview guides
2.To assess types of electronic waste generated in institutions of learning in Ruiru subcounty, Kiambu County over the years.	Primary	institutional interviews, Resource persons	Questionnaires, Interview guides Observation guides
3.To examine the environmental and health impacts of e-waste.	Primary Secondary	Interviews Literature review	Questionnaires Interview guides Books, journals
3.What are the environmental and health impacts of e-waste	Primary secondary	Interviews Resource persons Literature review	Questionnaires Books Journals

4.To examine disposal mechanisms of electronic waste materials in institutions of learning inRuiru sub county and their effectiveness.	Primary	institutional interviews,  Resource persons  group discussions  literature review	Questionnaires,  Interview guides
5. To develop and recommend models of better electronic waste management in institutions of learning.	Primary  Secondary	Data analysis	SPSS,  Discussions  Recommendations

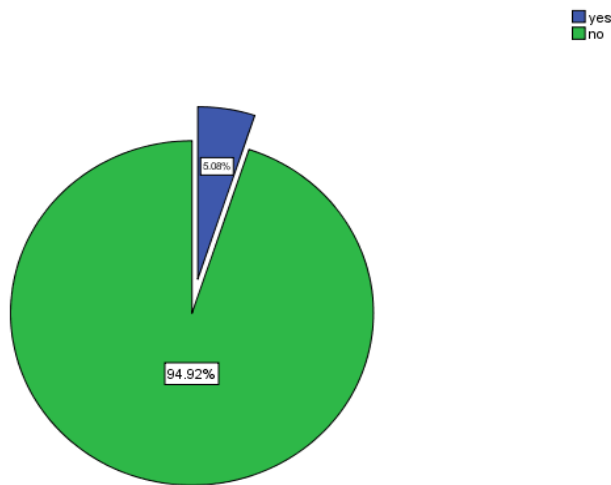
## CHAPTER FIVE

### RESULTS AND DISCUSSION

This chapter shows the analysis and results acquired from the data collected and analyzed. It displays the results and reflects the real situation on the ground. The results are discussed and displayed with the aid of graphs, photos, and chats. The respondents were mainly the head of institutions, procurement officers and heads of ICT from the sampled institutions.

#### 5.1 E-waste generator responsibility

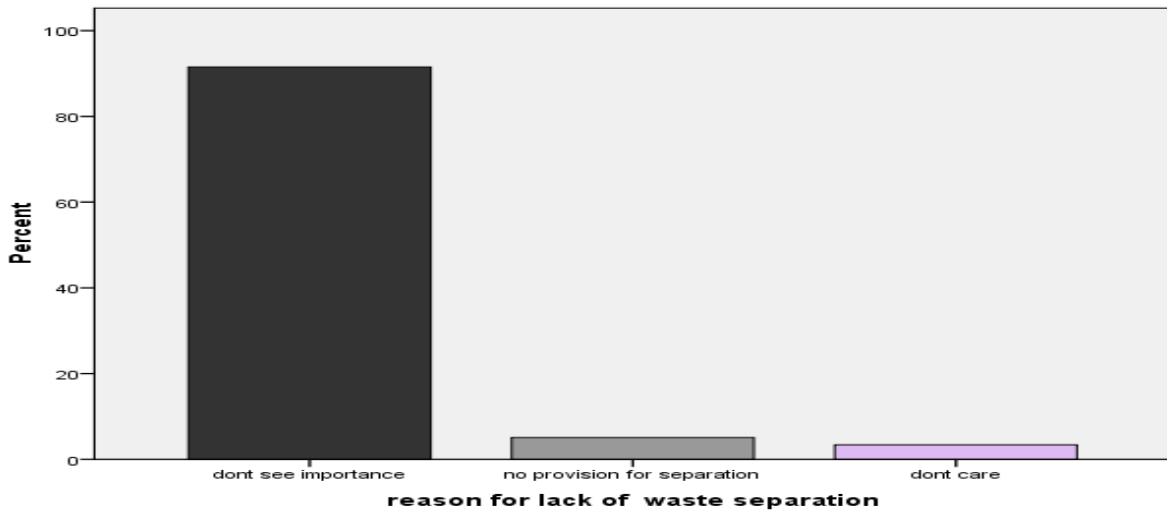
Although the draft e-waste regulations have not been passed yet, it states that the generator shall ensure e-waste is segregated from other forms of waste and is taken to licensed refurbishers, collection centers, or recyclers. However, as shown in figure 6, the study established that 95% of the institutions do not separate their wastes before disposal. This means that their e-waste is normally disposed with the general waste.



**Figure 6: waste separation**

**Source: Field survey, 2014**

The learning institutions gave varied reasons as to why they did not separate e-waste before disposal. 93% of the respondents did not find it important to separate e-waste from general waste before disposal, 5% claimed there was no provision for separation as the institution did not provide separate litter bins. 3% of the respondents generally didn't care how the waste was disposed as shown in figure 7.



**Figure 7: reason for not separating waste**

**Source: Field survey, 2014**

Concerning the recycling of e-waste, none of the institutions recycled its WEEE as shown in figure 8. This shows that recycling has not been adopted by most institution. There is great potential in the recycling industry and its adoption would not only help handle the e-waste management problem, but can also be a source of income.



**Figure 8: number of institutions that recycle e-waste**

**Source: Field survey, 2014**

The draft e-waste regulations requires any person intending to establish a collection center to notify the authority in the form prescribed in schedule. Ruiru Sub County however had no e-

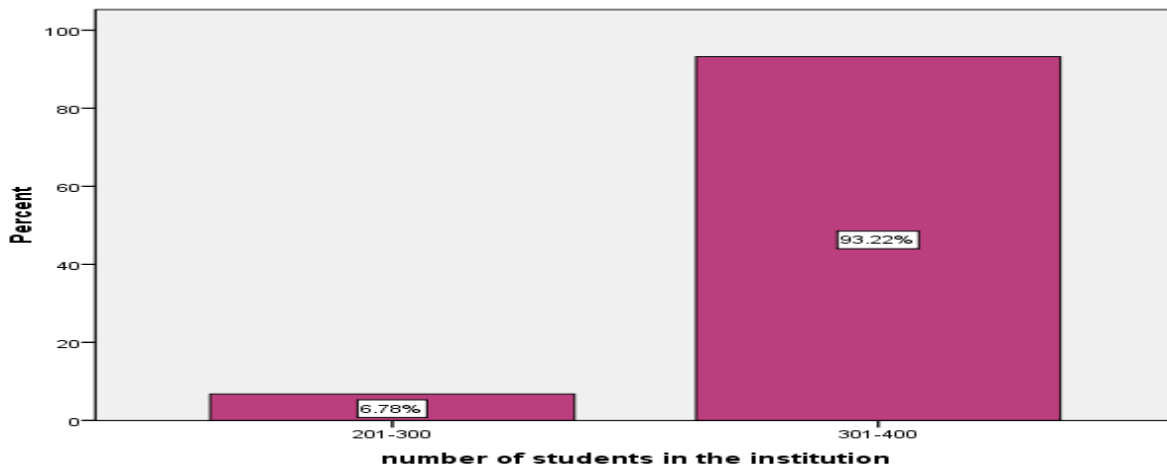
waste collection centers and e-waste was disposed with the general waste. The country however has WEEE center, a branch of CFSK which receives and recycles E-waste. Its capacity however not enough to handle all e-waste generated. Its location in Nairobi only makes it possible to serve a small geographical area too.

### 5.1.2 Disposal of e waste by County governments

Concerning county governments, the regulation states that; No County Government shall allow disposal of e-waste in their waste facilities save for in the manner prescribed by these regulations. However, the study established that Ruiru sub county had not paid any attention on e-waste management. There were no special mechanisms of handling e-waste as it was being disposed of with general waste and scavenged by scrap dealers.

## 5.2 E-WASTE TYPE AND AMOUNT

To understand EEE usage within the sampled institutions, the study sought to find out the number of students within the learning institutions. it was established that 6% of the sampled institutions had students ranging from 200 to 300 while those with students between 301 to 400 were 94%. This shows high enrolment of students in primary, secondary and colleges within the sub county. The high enrollment can be attributed to the fact that a larger part of the sub county is found in an urban area. This is well illustrated in figure 9.

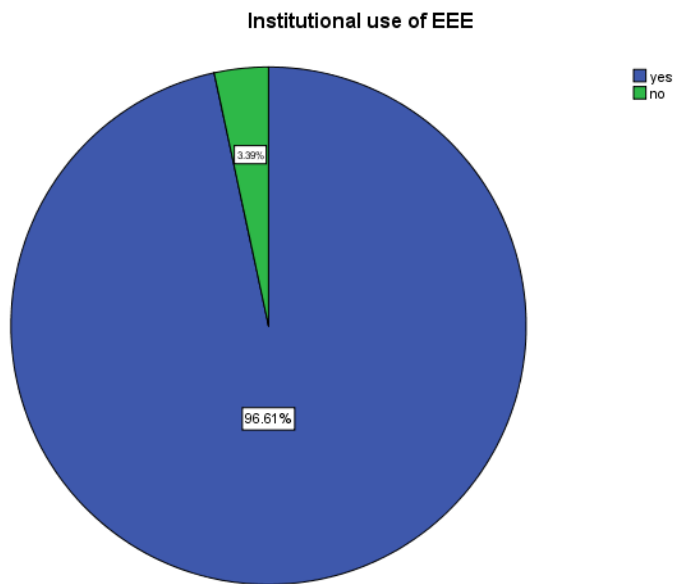


**Figure 9: number of students in the institutions**

**Source: Field survey, 2014**

The study established that 96.61% of all sampled institutions use EEE in teaching and learning as shown in figure 9. The most common EEE was desktop computers. The high usage can be attributed the fact that the sub county is found in an urban area therefore a high number of

schools and colleges. An example of some of EEEs used in the learning institutions is shown in plate 5 and 6.



**Figure 10: use of EEE**  
source: Field survey, 2014

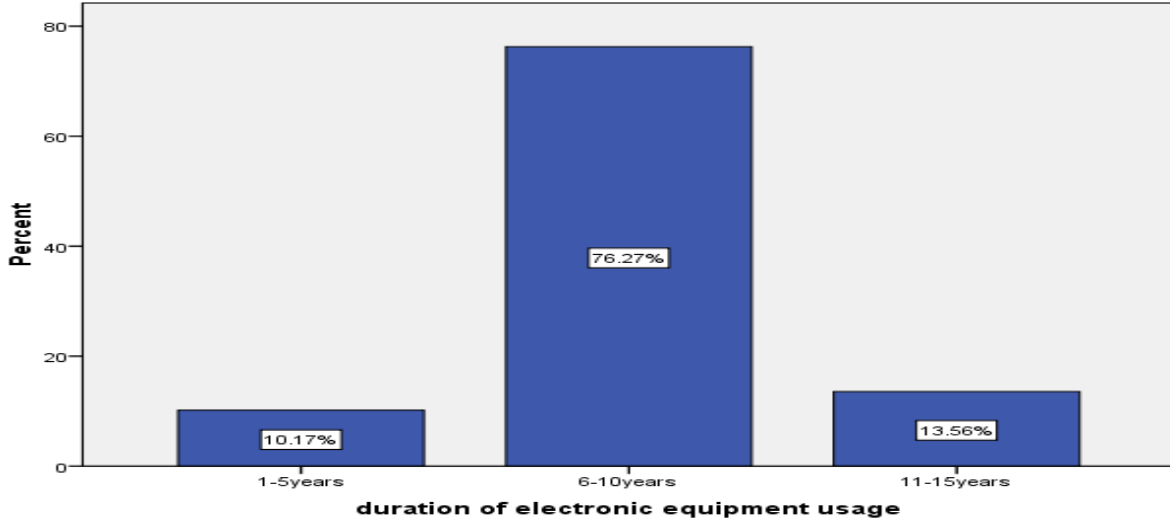
**Plate 5: A radio studio with EEE in one of the institutions**  
**Source: Field survey, 2014**



**Plate 6: A computer lab in one of the secondary schools**  
**Source: Field survey, 2014**



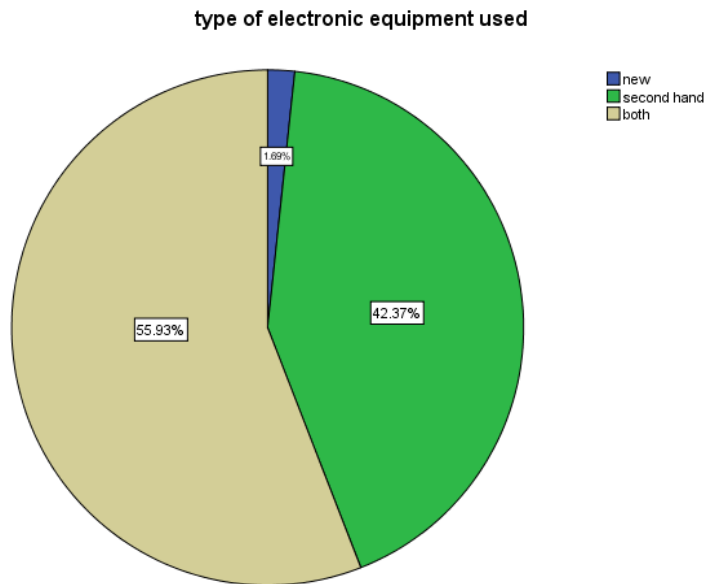
Among the institutions sampled, 10% of them had been using EEE in teaching and learning in the last 5 years. 77 % had used EEE for the last 6 to 10 years while 14 % had employed the use of EEE for the last 11-15 years as shown in figure 11.



**Figure 11: duration of EEE usage**

**Source: Field survey, 2014**

55.93% of the sampled institutions used both new and second hand EEE which were mostly computers as compared to 42.37% which used second hand EEE only. 1.69% of the institutions however preferred purchase and use of only new EEE. This is illustrated in figure 12 and plates 7 and 8.



**Figure 12: type of EEE used**  
**source: Field survey, 2014**

**Plate 7: newly procured**  
**Source: Field survey, 2014**

**plate 8: unpacking of new EEEs**  
**source: Field survey, 2014**



The EEE used range from less sophisticated one such as typewriters as shown in plates 9 and 10, to more modern ones such as computers, printers, desk phones, cameras, television sets, radios, microphones, typewriters, audio and video mixers as shown in plate 11 and 12

**Plate 9: a class room with typewriters**  
**Source: Field survey, 2014**



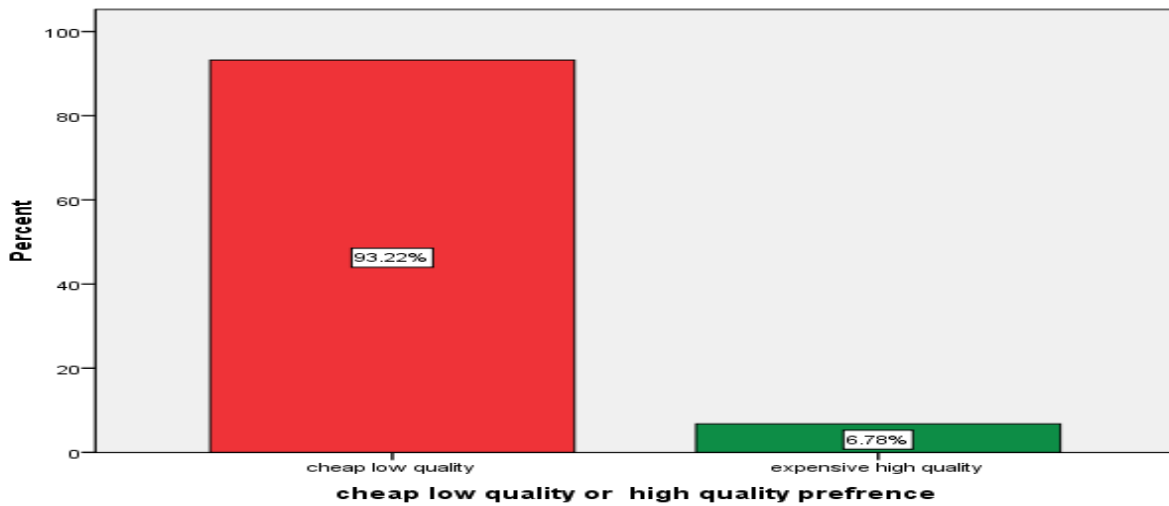
**plate 10: a typewriter in use,**  
**source: Field survey, 2014**



**Plate 11: a video switcher in one of the colleges** **Plate 12: modern devices in a studio class**  
**source: Field survey, 2014** **source: Field survey, 2014**



Concerning the quality and standards of the EEE procured for use in the institutions, 94 % went for cheaper low or medium quality EEE as opposed to 5% of the sampled institutions who bought new high quality EEE. Among the 5% were the well-established institutions that can afford to import and procure the equipment. This is illustrated in figure 13.

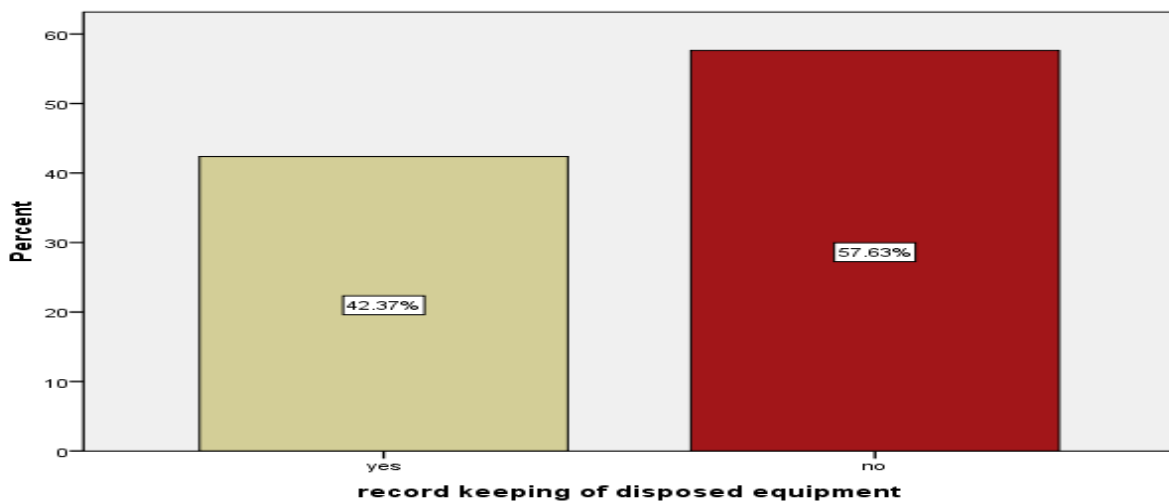


**Figure 13: low to high quality preference**

**source:Field survey, 2014**

The type of waste generated in the learning institutions in Ruiru sub county range from ; computers and computer accessories, mixers, cameras, typewriters, printers, photocopiers, television sets, radios, desk phones, power cables, uninterruptible power supplies, microphones, projectors, biometric logging systems, switch router modems, binding machines, video switchers, CCTV and cameras. However the highest number of WEEE produced came from computers and computer accessories.

As illustrated in figure 14, it was found that 42 % of the sampled institutions kept records of the WEEE stored or disposed of. This facilitated easy compiling of data on WEEE within the institutions.



## Figure 14: keeping of E-waste records

Source:Field survey, 2014

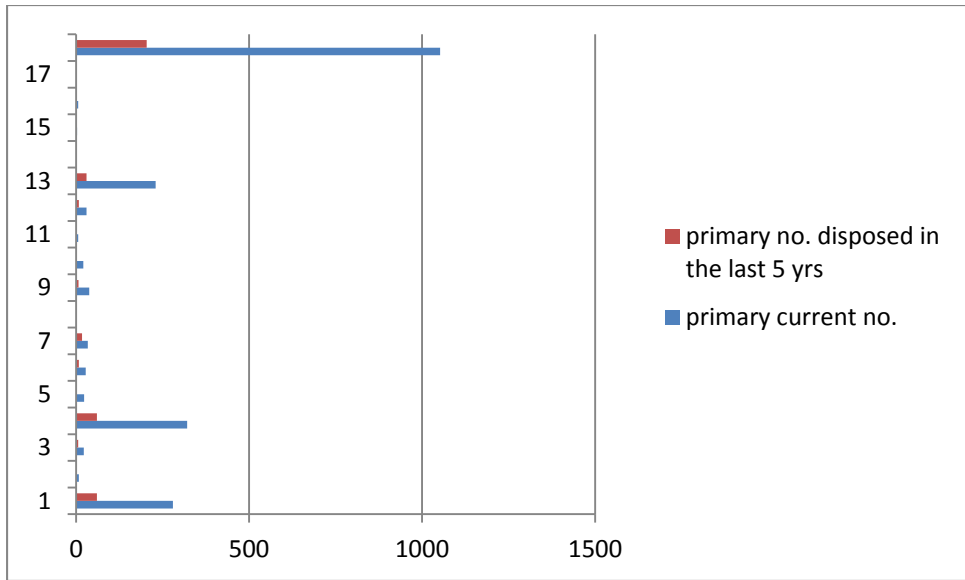
### 5.3 AMOUNT OF E-WASTE GENERATED

The study undertook to find out the current number of various EEE in the sampled institutions. The number of WEEE generated and either stored, or disposed within the last five years. There was a total of 1,052 EEE in primary schools, 560 in secondary schools and 2,840 in the 8 colleges in the sub county. The institutions had in the last five years disposed of a total of 204 WEEE in primary schools, 118 in 6secondary schools, and 449 in colleges. The data is summarized in table 12 and figures 15, 16 and 17.

**Table 13: Number of EEE in institutions of learning**

Source:Field survey, 2014

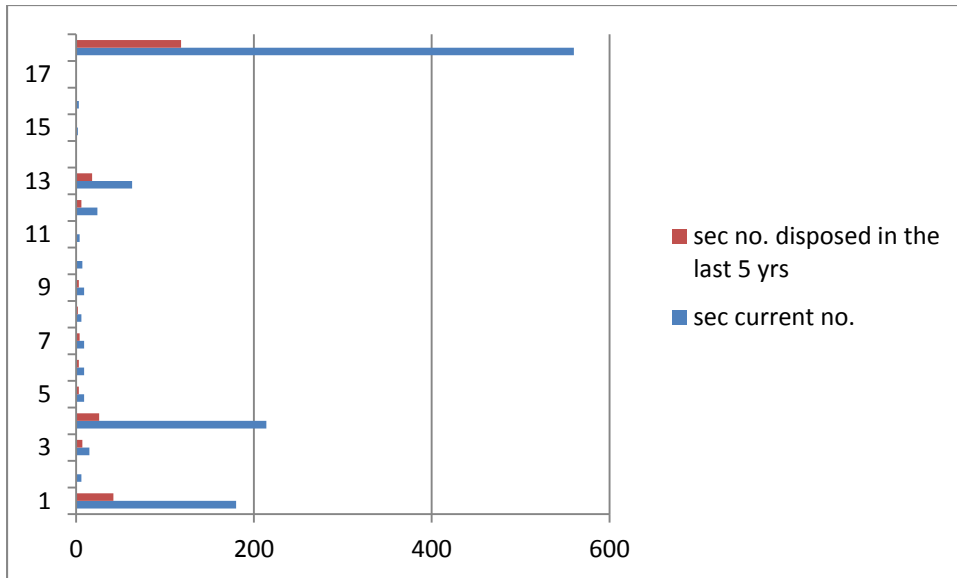
	primary		sec		college		
	current no.	no. disposed in the last 5 yrs	current no.	no. disposed in the last 5 yrs	current no.	no. disposed in the last 5 yrs	
computers	280	60	180	42	723	282	
typewriters	8	2	6	1	85	16	
printers	22	6	15	7	26	8	
powercables	321	60	214	26	1211	83	
photocopiers	23	2	9	3	8	7	
tv	28	8	9	3	8	2	
radio	34	17	9	4	8	3	
projector	2	0	6	2	8	2	
desk phones	38	7	9	3	8	3	
binding machines	21	2	7	1	8	2	
audio mixers	6	1	4	1	6	1	
microphones	30	8	24	6	40	12	
UPS	230	30	63	18	653	22	
video switcher	0	0	0	0	3	0	
video cameras	3	0	2	0	8	2	
still cameras	6	1	3	1	3	1	
CCTV	0	0	0	0	34	3	
TOTAL	1052	204	560	118	2840	449	



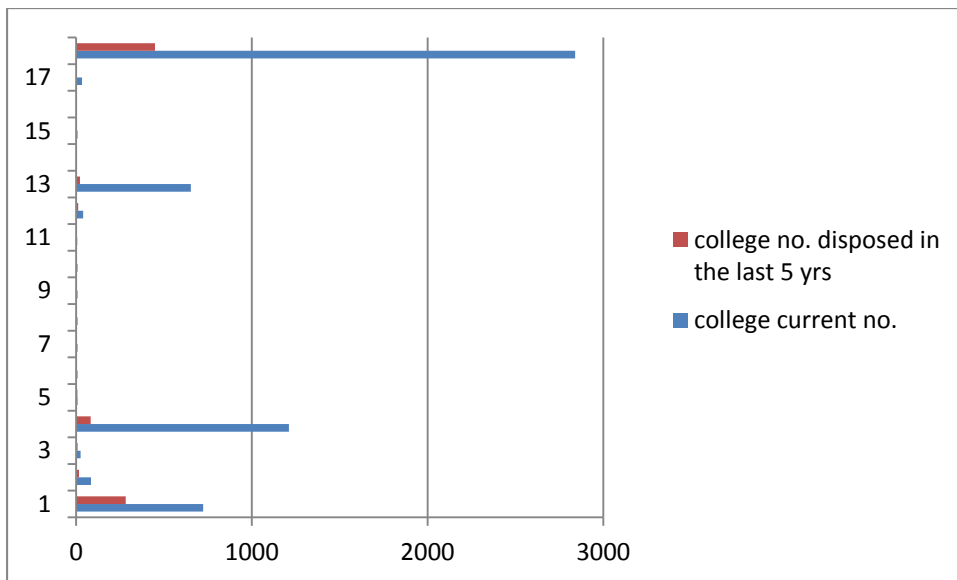
**Figure 15: Number of current and disposed EEE in the last 5 years in primary schools, source: Field survey, 2014**

Key:

1	Computers	11	audio mixers
2	Typewriters	12	binding machines
3	Printers	13	Microphones
4	Power cables	14	UPS
5	Photocopiers	15	video switcher
6	Tv sets	16	video cameras
7	Radio	17	still cameras
8	Projector	18	CCTVs
9	desk phones		
10			



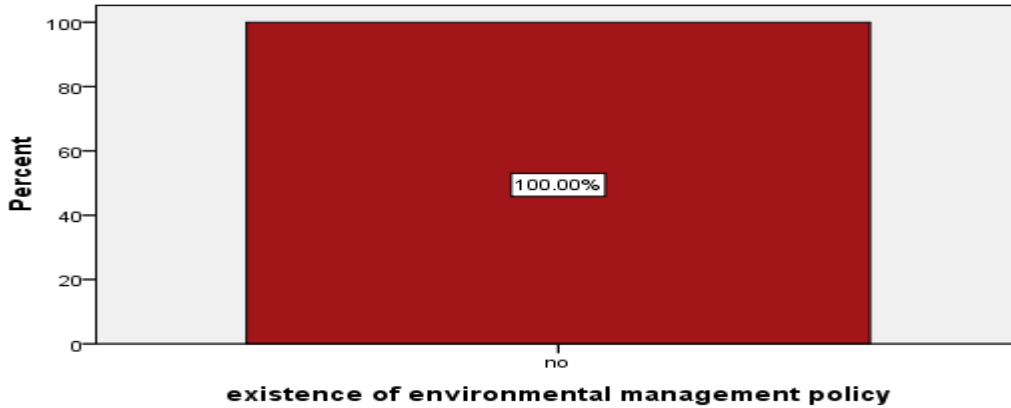
**Figure 16: Number of current and disposed EEE in the last 5years in secondary schools, source:Field survey, 2014**



**Figure 17: Number of current and disposed EEE in the last 5years in colleges, source: Field survey, 2014**

## 5.4 DISPOSAL MECHANISM

The study established that all the sampled institutions of learning did not have any environmental policy nor e-waste policy as shown in figures 18 and 19.

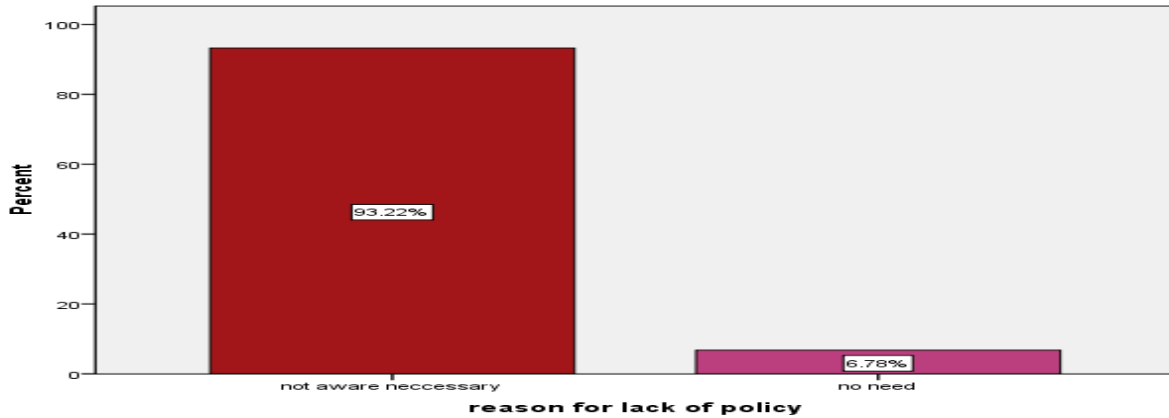


**Figure 18: existence of institutional environmental policy, source: Field survey, 2014**



**Figure 19: existence of e-waste management policy in institutions source:Field survey, 2014**

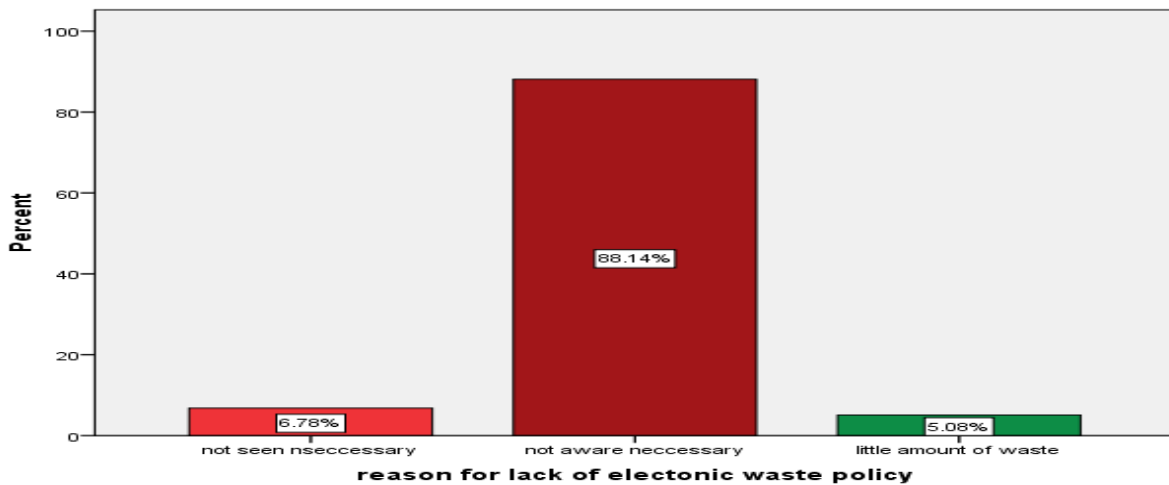
The institutions gave a number of reasons for the lack of an environmental policy.7% of the respondents felt there was no need for it while 93% were not aware it was necessary to have an environmental policy. This is shown in figure 20.



**Figure 20: reason for lack of institutional policy**

**Source:Field survey,2014**

Most of the institutions lacked an environmental policy for the reasons. 6% of the respondents did not find an e-waste policy necessary, 6% felt the little e-waste they produced was too little to pose any environmental hazard, and 88% were not aware of the necessity for an e-waste policy. These results are shown in figure 21.

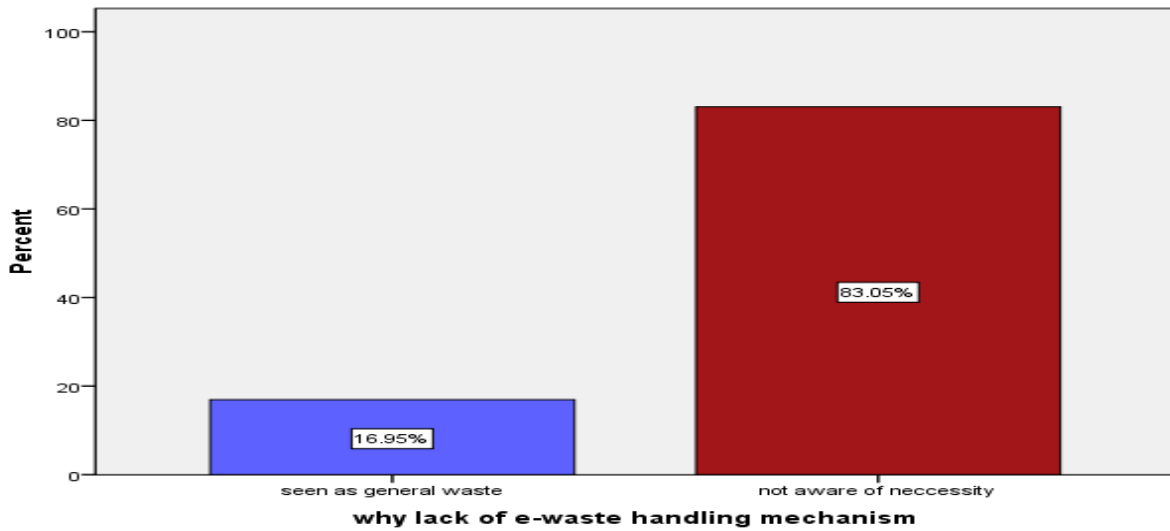


**Figure 21: Reason for lack of e-waste policy in institutions**

**Source:Field survey, 2014**

The study sought to establish what e-waste disposal mechanisms the institutions in Ruiru Sub County have in e-waste management. However, not a single institution had a well-defined mechanism of dealing with e-waste.

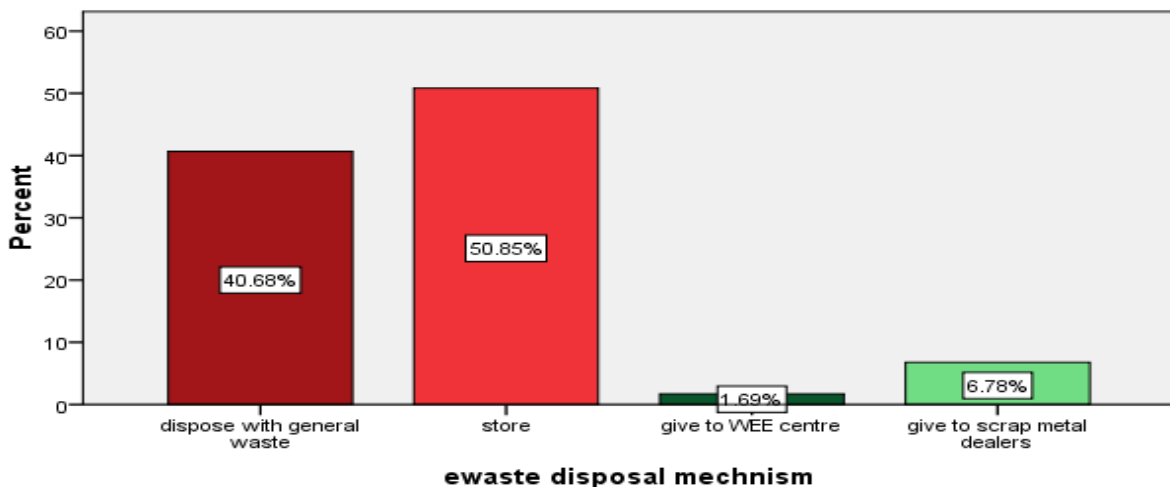
The reasons cited for the lack of a proper e-waste disposal mechanism were two. First, 26% saw e-waste as general waste with no need for special attention. Secondly 14% were not aware that E-waste is different from general waste. This is shown in figure 22.



**Figure 22: reason for lack of e-waste handling mechanism**

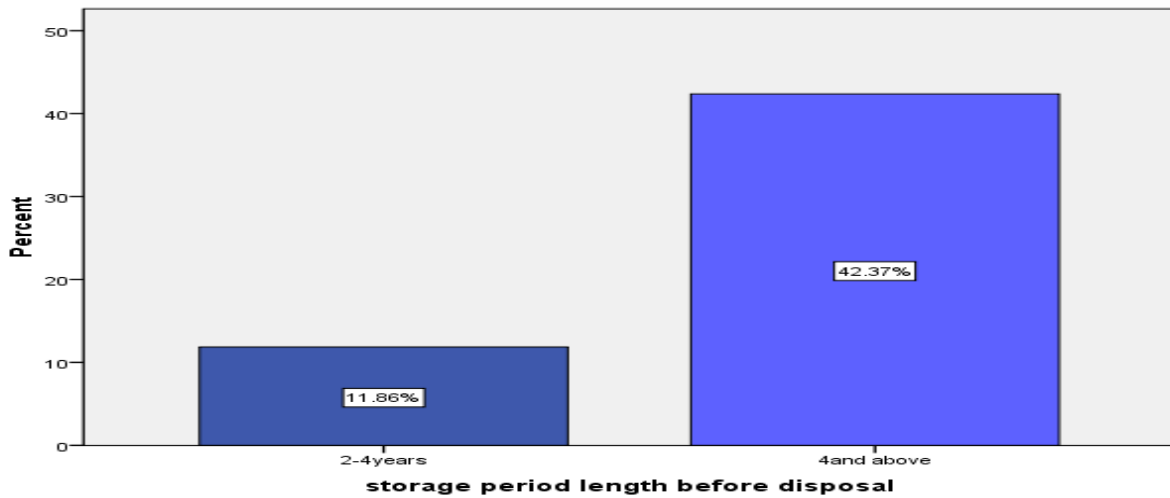
**Source: Field survey, 2014**

The study found out that most learning institutions do not have an elaborate e-waste disposal mechanism. Most of the WEEE is stored for years awaiting disposal and as a source of spare parts. The results are similar to a study carried out by BAN. It established that about 75% of old electronics are stored as consumers feel that they have some value but are unsure on how to dispose them (BAN, 2007). According to HP (2009), nearly a third of the households stored their unwanted computers at home in Morocco. In India further, only an estimated 10% of the e-waste finds its way to recyclers due to inefficient take back scheme. The disposal mechanisms employed by the learning institutions were mainly three. 1% of the institutions was aware of the WEEE center and engaged them in the collection of their E-waste. 40% of the sampled institutions disposed e-waste with general waste without separation. 50% of the institutions simply store E-waste that could be recycled. The storage period before disposal ranged from at least 2 years. This is shown in figure 23 and 24 plates 9 and 10 respectively.



**Figure 23: institutional e-waste disposal mechanisms**

Source: Field survey, 2014



**Figure 24: storage duration**

Source: Field survey, 2014

**Plates 13 and 14: old computers in a store in one of the colleges** Source: Field survey, 2014



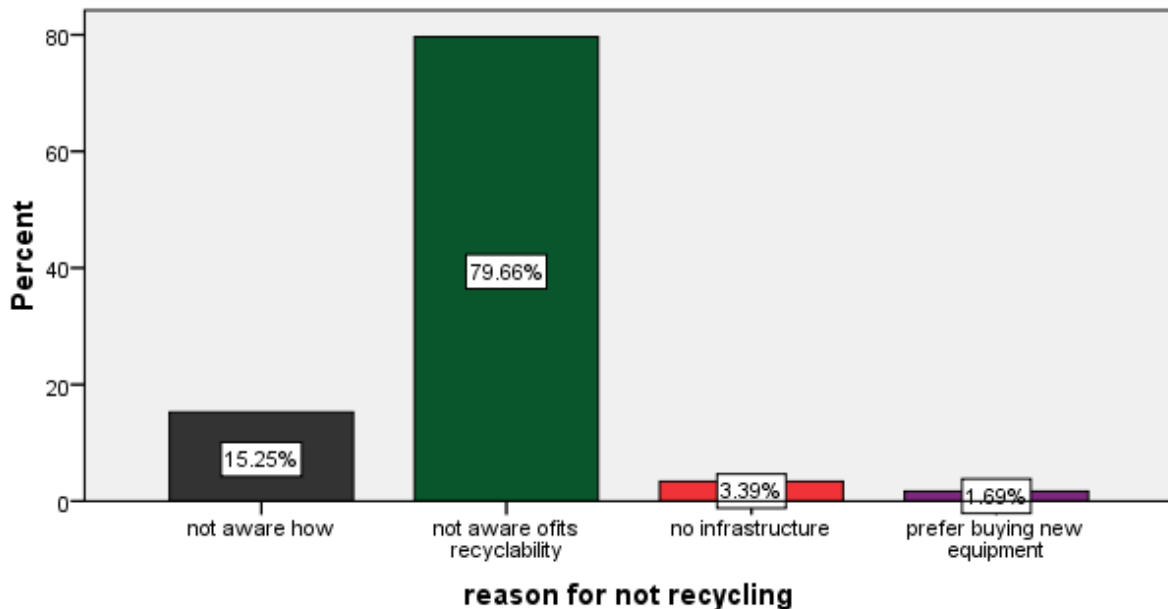
Further, the research found out that the E-waste that cannot be stored is easily disposed of in a pit with general waste within the institutions. Some was also thrown away haphazardly as shown in figure 21 and plates 15 and 16.

### Plates 15 and 16: Improperly disposed e-waste

Source: Field survey, 2014



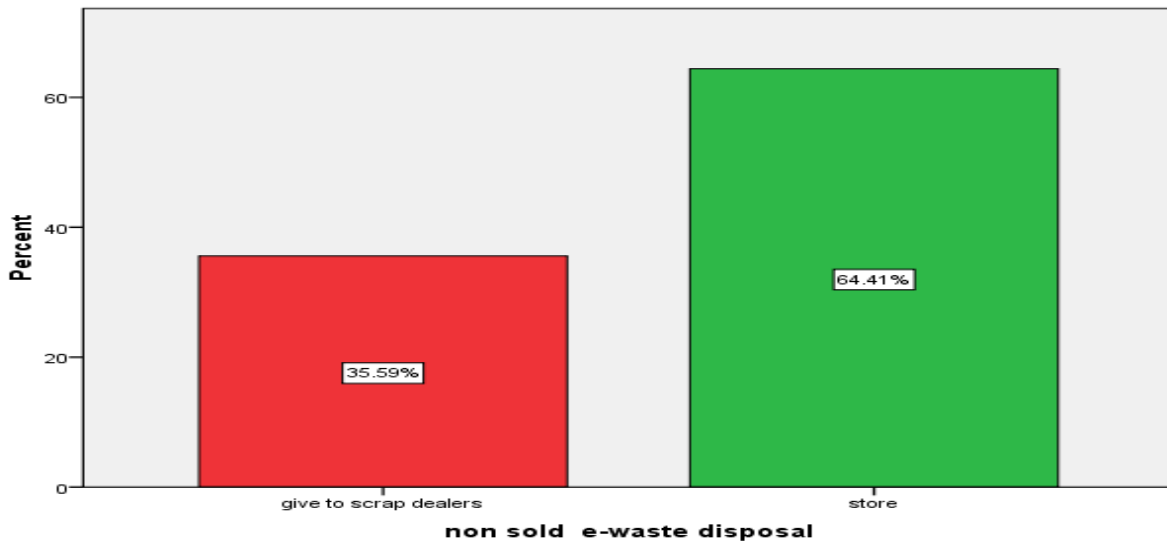
Recycling of e-waste was nonexistent within all the sampled institutions of learning. Among the reasons they gave as to why they did not recycle their e-waste was as follows; 80% were not aware that e-waste could be recycled, 16% were aware that e-waste can be recycled but were not aware how. 3% felt there was no infrastructure to facilitate recycling of e-waste while 1% of the institutions sampled preferred buying new EEE. This is shown in figure 25.



**Figure 25: Reason for not recycling**

**Source: Field survey, 2014**

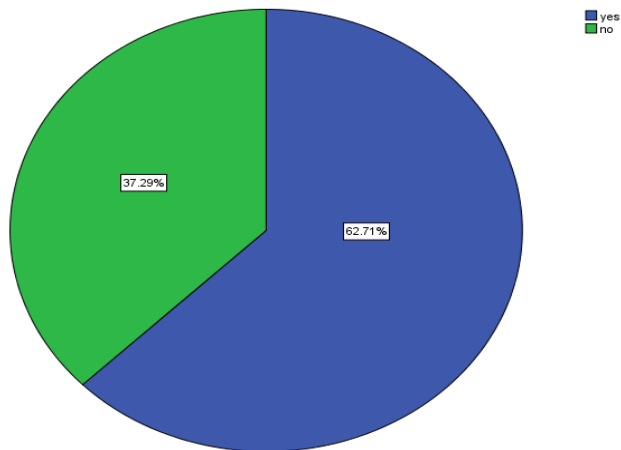
This indicates that there is a high potential for business in the recycling industry if structures and collection mechanism were put in place. At 65%, storage of WEEE was most practiced by the learning institution compared to 35% of the institutions that gave it away to scrap metal dealers as shown in figure 23. The lack of recycling infrastructure and investment in the recycling industry can be attributed to the reason why most consumers don't recycle their WEEE.



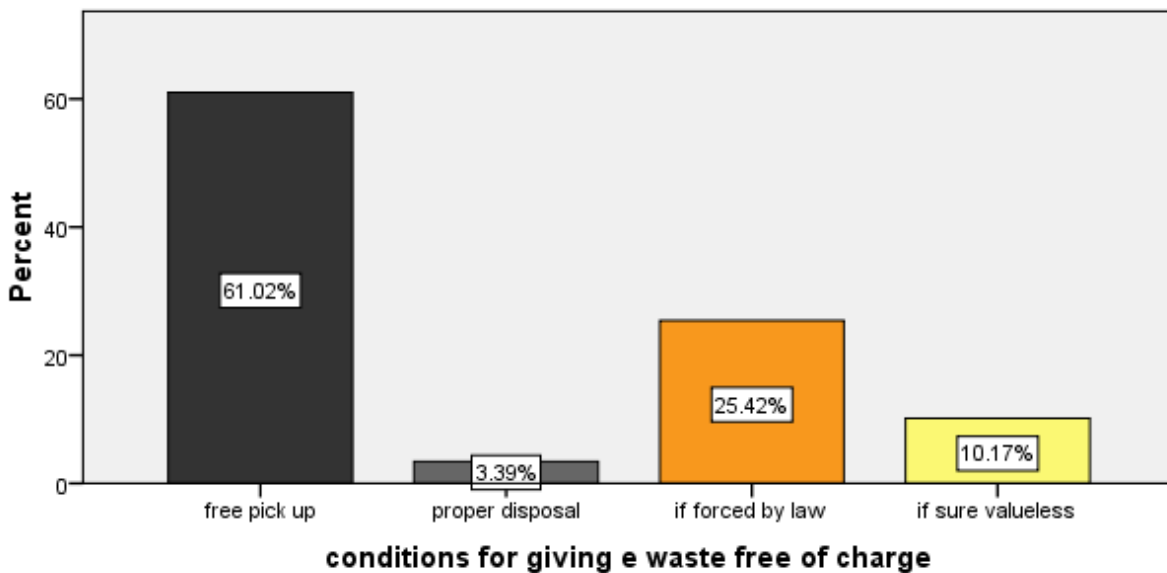
**Figure 26: e-waste disposal mechanism**

**Source: Field survey, 2014**

It was established that 62% were willing to give out their e-waste for free. This further shows that it would be possible to manage e-waste as many of the institutions were willing to give it out for free. The 38% percent who were willing to sell would help in making sure that some income comes from the waste that would have otherwise been improperly disposed. The remaining 38% were willing to give it out but with conditions of free pick up at 61%, guarantee of proper disposal at 3%. 25% would give it out if the law required them to and 10% would give it out if they were sure it was of no value to them. This is shown in figures 27 and 28.

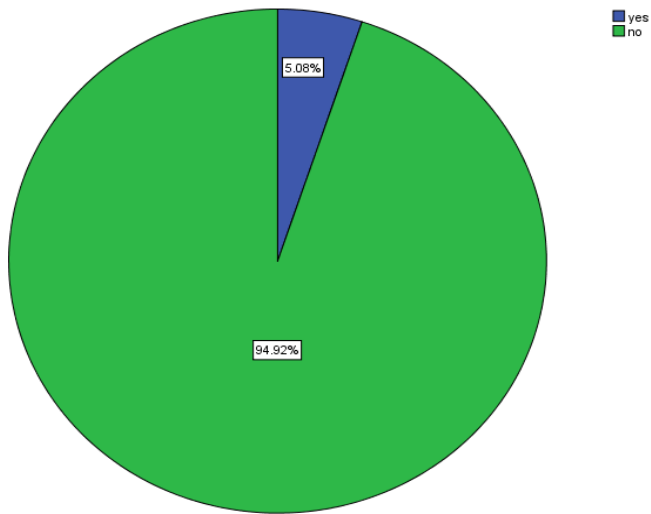


**Figure 27: willingness to sell e-waste**  
**Source: Field survey, 2014**



**Figure 28: conditions for free giving of e-waste**  
**Source: Field survey, 2014**

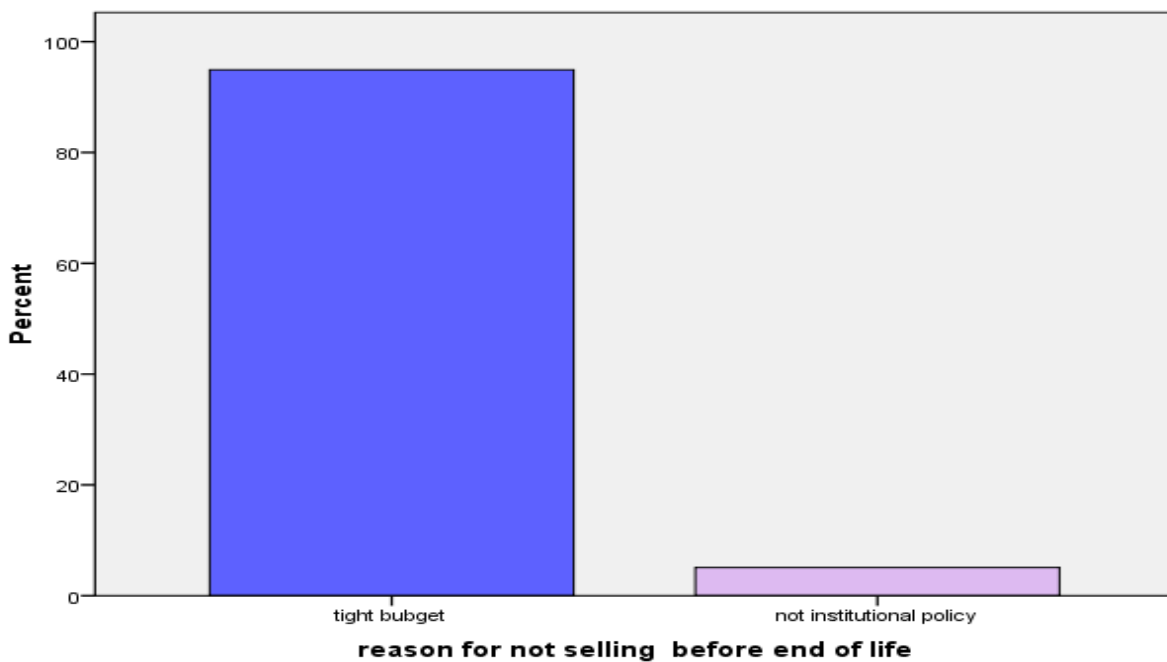
In an attempt to avoid e-waste, only 5% were willing to sell their EEE before their end of life so as to acquire new ones with 95% willing to use their EEE until their end of useful life. This would ensure refurbishing to increase the usable life of the EEE consequently reducing the number of EEE in circulation as procurement of more computers is avoided. This is illustrated in figure 29.



**Figure 29: willingness to sell EEE before end of life**

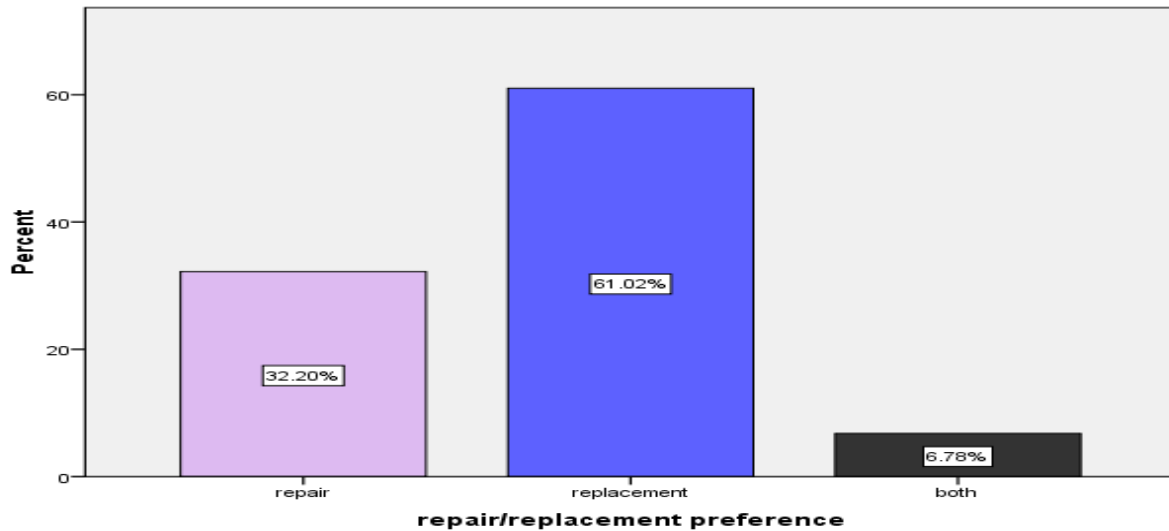
**Source: Field survey, 2014**

At 97% were the institutions citing tight budget as the main reason why they would not sell their EEE before their end of life compared to 3% who claimed that it would be against the institutions policy as illustrated in figure 30.



**Figure 30: reason for not selling EEE before end of life**  
**Source: Field survey, 2014**

60% of the learning institutions sampled preferred replacement of EEE nearing end of life as compared to 36% who preferred repair. 4% however preferred both repair and replacement of their EEEs as shown in figures 31 and plate 13.

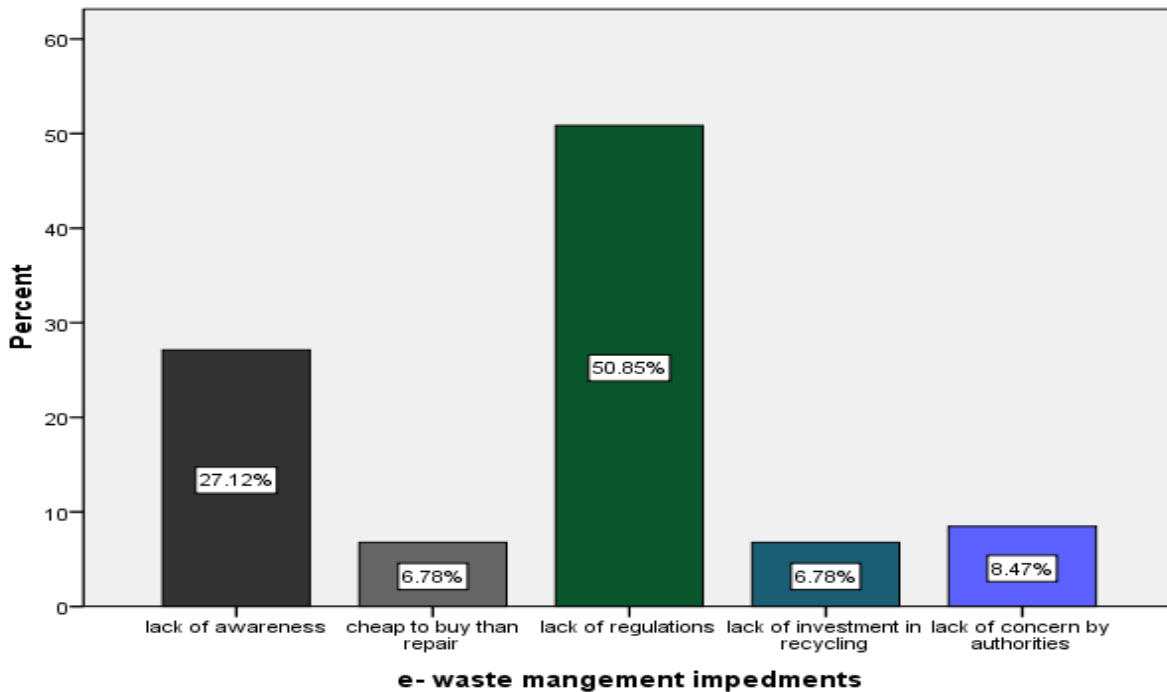


**Figure 31: repair/replacement preference**  
**Source: Field survey, 2014**

**Plate 17: A computer under repair in one of the institutions**  
**Source: Field survey, 2014**



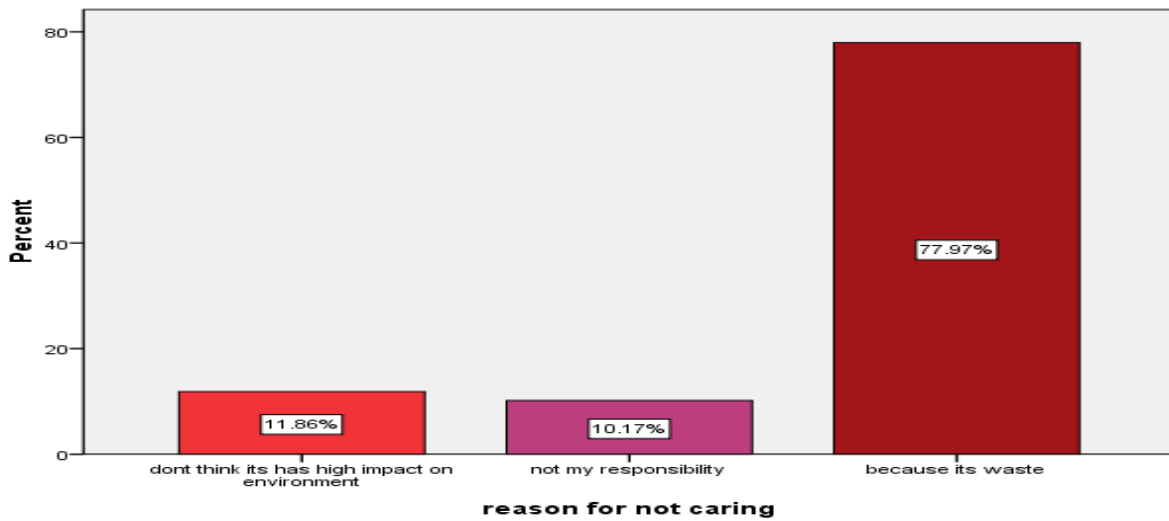
The study established a number of impediments of e-waste management according to the respondents. 27% felt that lack of awareness is to blame for improper e-waste management, 7% felt that availability of cheap EEE is to blame for high number of improperly disposed e-waste. 50% of the respondents believe that lack of regulations on e-waste has greatly contributed to its improper management. 6% blamed lack of investment in recycling while 10% blamed the concerned authorities for not playing their role in waste management. This is shown in figure 32.



**Figure 32: reasons for poor e-waste management**  
**Source: Field survey, 2014**

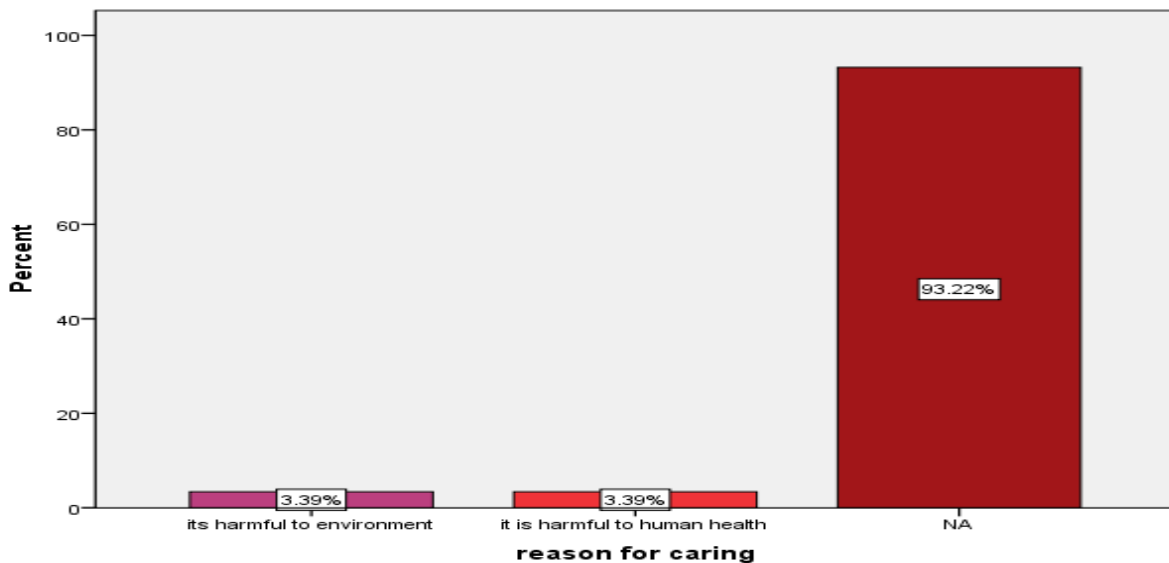
### 5.5 ENVIRONMENTAL AND HEALTH IMPACTS OF E-WASTE

E-waste has a number of both environmental and health impacts negative health impacts including brain damage, kidney problems, lung cancer, skin ulcers, birth defects, and death soil contamination, and water contamination. It was however alarming that only 25% of the respondents could highlight the effects. This could be explained the fact that only 10% of them could tell what happens to the e-waste they dispose away and only 14% cared what happens to the e-waste discarded. Of those who did not care what happens to the discarded e-waste, 16% felt that it had no serious health or environmental effects, 8% felt that it was not their responsibility while 76% of the respondents did not care since e-waste just like general e-waste is of no value to them as shown in figure 33.



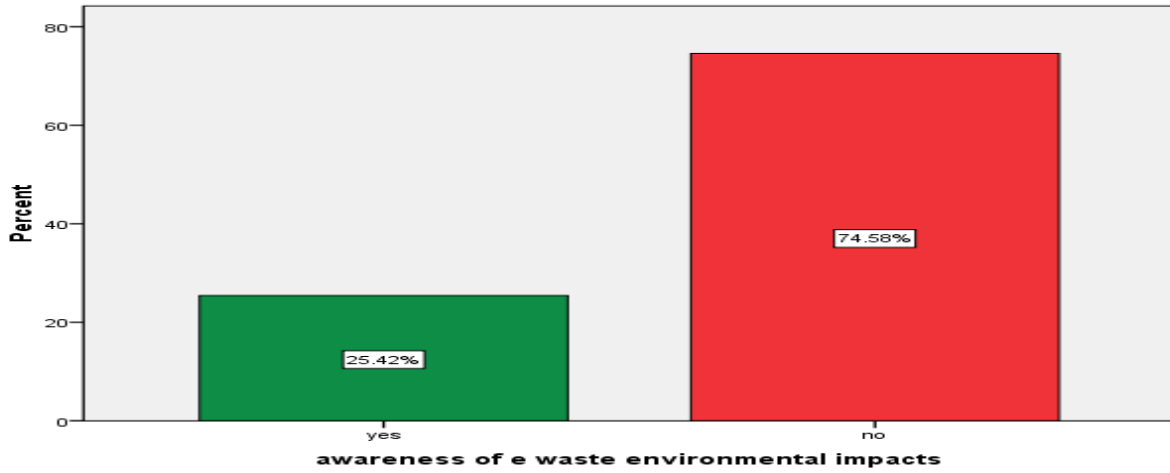
**Figure 33: Reason for not caring**  
**Source: Field survey, 2014**

Of those who cared what happens to the e-waste they dispose, 3% percent cared since they knew it was harmful to the environment and 3% felt it was harmful to human health as shown in figure 34.



**Figure 34: Reason for caring**  
**Source: Field survey, 2014**

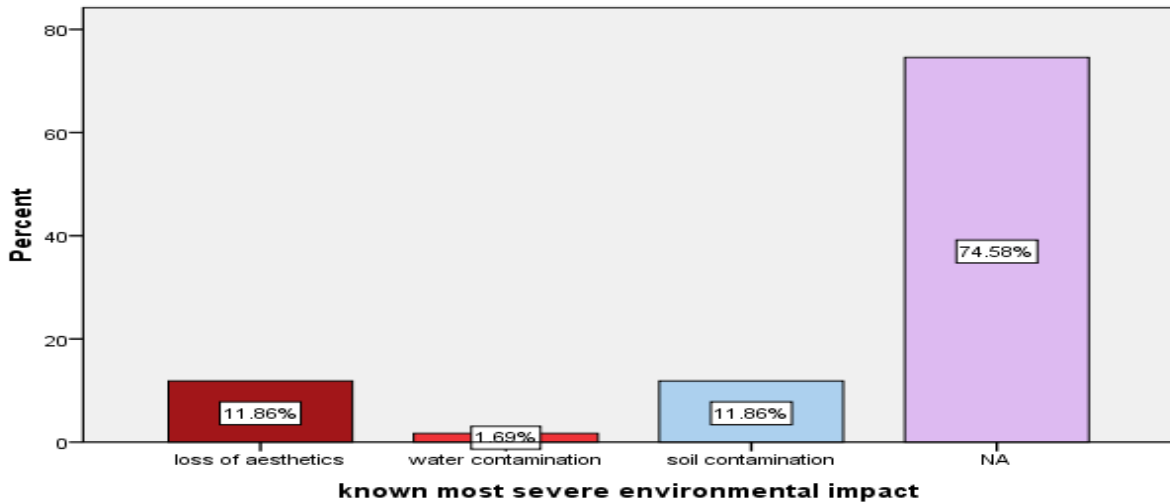
25% of the respondents claimed to be aware of the environmental impacts posed by e-waste while 75% of the respondents had no idea. This is shown in figure 35.



**Figure 35: e-waste awareness**

**Source: Field survey, 2014**

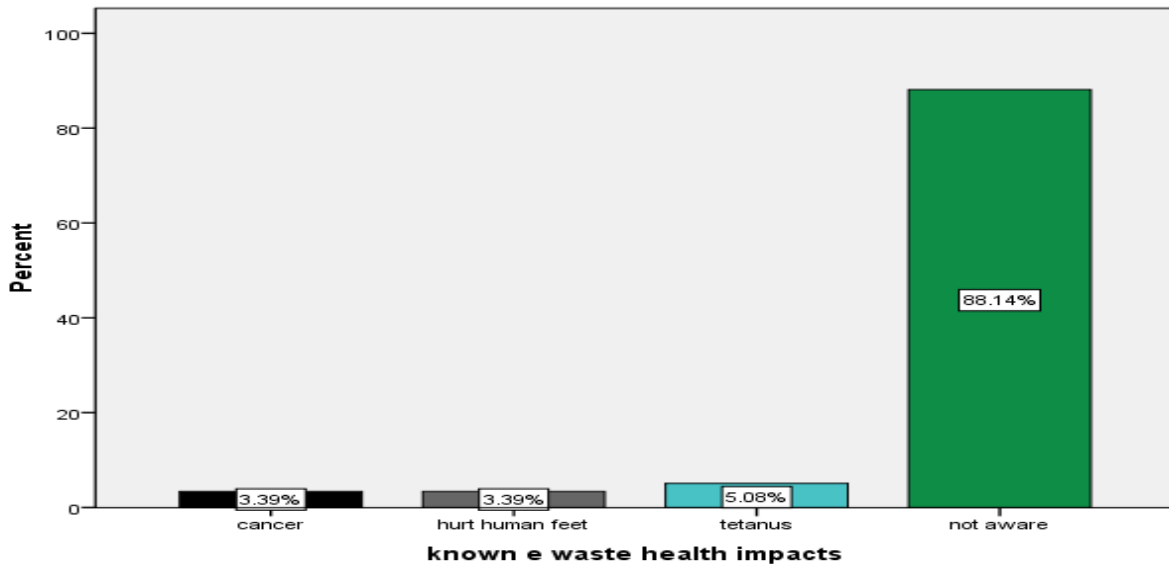
It is worrying that only 25% of the respondents were aware of the environmental implications of improper e-waste disposal. The cited environmental impacts by the respondents include; loss of aesthetics, soil contamination, and water contamination. This is shown in figure 36.



**Figure 36: known environmental impact**

**Source: Field survey, 2014**

Concerning the health implications of improper e-waste disposal, the 18 percent of those aware of them were concerned that it causes cancer, hurts human feet, and causes tetanus. This is shown in figure 37. It is evident that the respondents have little knowledge on the myriad of hazards e-waste possess to their health.

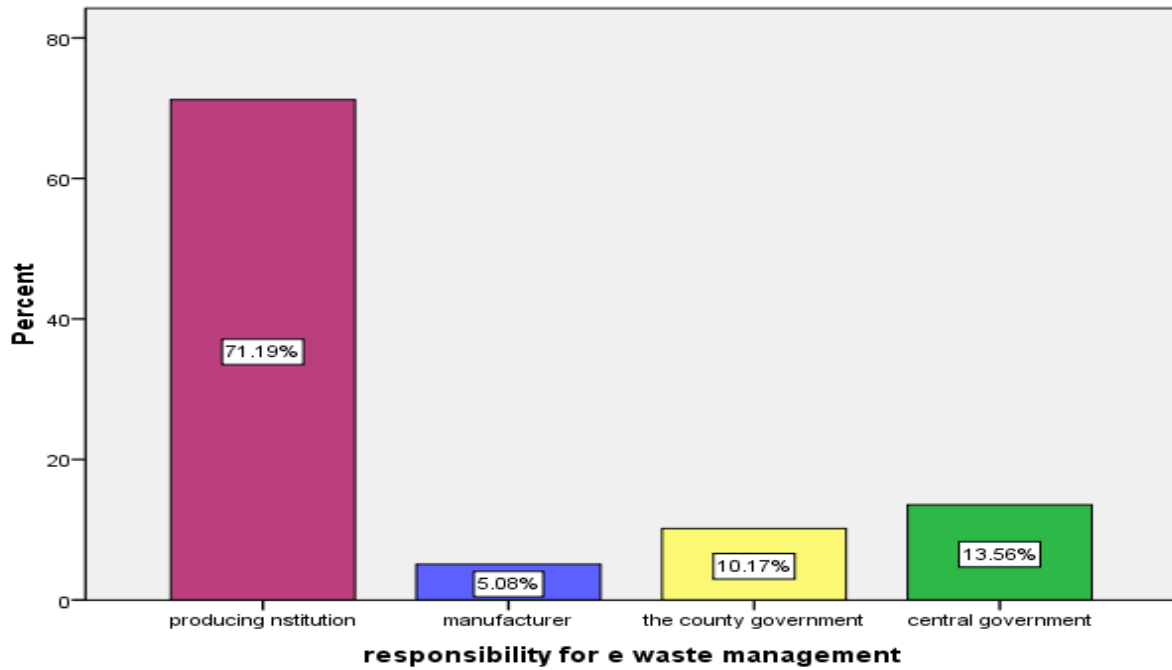


**Figure 37: known health impacts**

**Source: Field survey, 2014**

## 5.6 METHODS OF IMPROVING E-WASTE MANAGEMENT

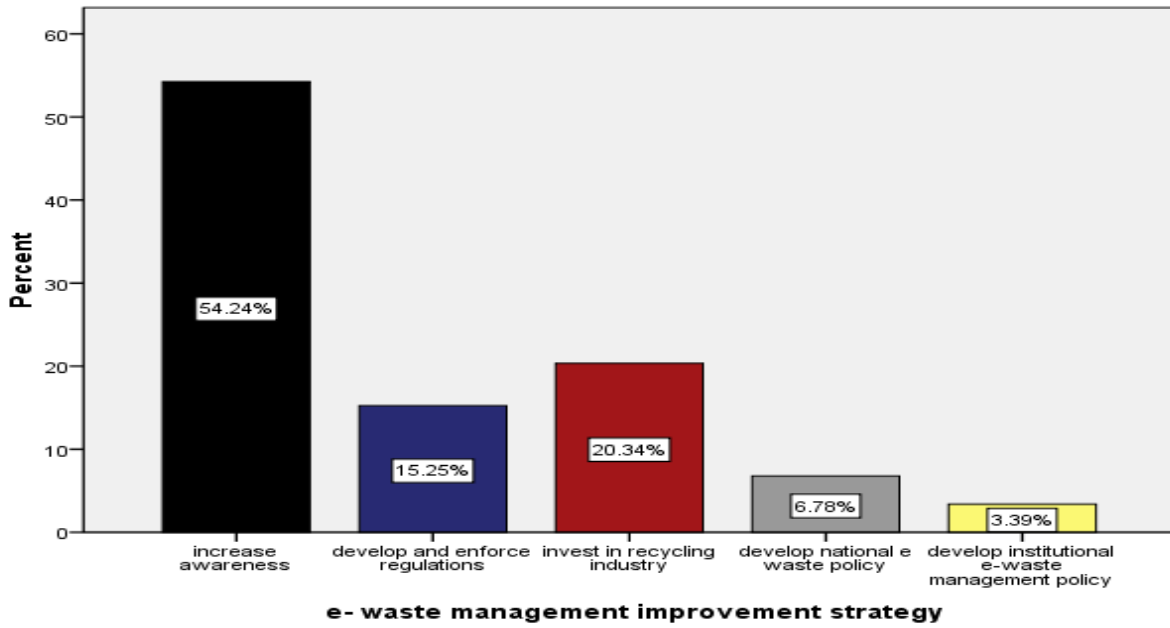
It is evident that e-waste management should be a joint effort by various stake holders. The study established that all the learning institutions within Ruiru sub county do not have a special mechanism of handling e-waste. Most of the e-waste was dumped with general waste without prior separation and mostly ends up in burned in a compost pit. There were little efforts on recycling as only one college was working with WEEE center to which it sells its e-waste. On e-waste management responsibility however, 75% of the respondents felt that e-waste management should be the responsibility of the producing institution. 5% said that the manufacturer of the EEE should be the one to take care of the resultant e-waste at the end of life. 10% of the respondents wanted the county government to handle e-waste while 15% said it should be the central government’s responsibility as shown in figure 38.



**Figure 38: e-waste management responsibility**

**Source: Field survey, 2014**

E-waste management as already established needs a better more inclusive approach in management. All the stakeholders need to play their part if the menace is to be dealt with. The respondents proposed a number of ways that they felt useful in e-waste management these are; increase awareness on e-waste, develop and enforce e-waste regulations, invest in the recycling industry, the development of a national e-waste policy, development of individual institutional e-waste management policy. This is illustrated in figure 39.



**Figure 39: how to improve e-waste management**  
Source: Field survey, 2014

## **CHAPTER SIX**

### **CONCLUSION AND RECOMMENDATIONS**

#### **6.1 CONCLUSION**

The study shows that there are a myriad of issues that surround e-waste management that have not been considered or effectively done towards its proper management. Technological advancement in a rapidly modernizing world, e-waste is increasing rapidly. E-waste is also imported into Kenya in form of second hand computes and finds its way mostly in cyber cafes and learning institutions. Despite its fast growth, there are no clear mechanisms put in place by the Kenyan government to handle it. The level of awareness among the general public on e-waste as well as its implications on the environment and human health is low. There is therefore the need for awareness creation, sensitization, and education for the general public. Despite the high value of some of the metals found in WEEE, Recycling has been minimal in Kenya. There is need for more investment in the business and support of such initiatives.

All the institutions involved in the study were found not to have special disposal mechanisms to handle their e-waste properly. E-waste awareness was low... there is a necessity for joint effort in e-waste management throughout the chain. E-waste generating institutions such as learning institutions need to develop their individual e-waste policies. Furthermore, special mechanisms should be put in place to handle e-waste from separation, collection, and transport to recycling by these institutions. Efforts by the generating institutions should be complimented by government's good policy implementation and effective enforcement of e-waste regulations. However there is a high chance of higher volumes of e-waste finding their way in dumpsites.

#### **6.2 RECOMMENDATIONS**

##### **6.2.1 Better Methods and opportunities in handling waste**

###### **6.2.1.1 Promotion of recycling**

There is need to adopt and promote the 3R system in handling EEE in Kenya. This system has been successfully adopted in Asian countries and proved effective; this will enhance waste recycle and treatment as shown in figure 40. From the proposed cycle, producers sell e-wastes to small peddlers (informal sectors) and Second hand products are then resold to the market for reuse. E-waste generating Institutions can be encourage to store their waste for some time and have scheduled pick -ups by a recycling agency such as the WEEE center. The government through the ministry of environment and education should support and increase the number and capacity of WEEE centers in every county in order to cope with the expected stream of e-waste before the implementation of the free laptop project. It should further establish a take back mechanisms with all the benefiting schools of the computers after a defined period of time. This

will ensure all the generated waste therefore finds its way into a recycling center. Recovery of valuable items and metals, such as steel and iron, waste plastics, waste metal will also be done.

### **6.2.2 Options / opportunities to strengthen E-waste management**

The development, gazetment and promotion of regulations requiring more producers to contribute to e-waste management would greatly help in waste management. Secondly, there should be up scaling of current and establishment of new take back schemes by manufacturers, suppliers, and service providers. Employment opportunities should be created through the entire chain of e-waste recycling. Lastly, informal businesses should be assisted in recycling to become sustainable by capacity building and easy access to funding.

### **6.2.3 E-waste collection**

Mechanisms should be put in place to facilitate the collection of all e-waste from the producer therefore ensuring that all e-waste finds its way to a recycling center. These can be;

- Permanent drop offs sites
- Special collections events
- Retail stores
- As needed scheduled pick-up in e-waste generating institutions

## **6.3 Possible E-waste financial structures**

There are a number of financial structures that have been in use to handle general waste. The structures concerned with e-waste include; End of life (EOL) fees, (pay as you throw), Advanced fee recovery (ARF), Extended producer responsibility (EPR), Collective producer responsibility (CPR), and Individual producer responsibility (IPR). These structures have not been fully embraced in Kenya. They have therefore not been effective in e-waste management. The enforcement of these financial structures across all the stakeholders in WEEE chain would significantly improve-waste management, curb its effects, and tap on its opportunities.

## **6.4 E-waste management**

E-waste management can be done by; the waste generating institutions, Government Entity, Third party E-waste, Association of Electronics manufacturers, or Association of processors/Recyclers.as established; learning institutions are among the top generators of e-waste. These institutions ought to take responsibility in managing their waste. Procurement procedures of EEE should be well laid out and emphasize on quality. Proper storage, collection, record keeping, and transportation of the generated WEEE should be well stipulated.

## **6.5 Policies and strategies**

### **1. Key policy tools for e-wastes management**

The draft e-waste regulations should be gazette and enacted to aid in e-waste management. EPR should be enforced and national directories of product for EPR. Formal collection system of e-wastes; should be encouraged, there further should be allocation for funding support for e-wastes sectors with good environmental performances and other economic instrument;

### **2. Imported e-wastes management**

Kenya should curb illegal movement of hazardous e-wastes; it should further strengthen the environmental enforcement for e-wastes recycle and disposal firms. Training and education, raising awareness of e-waste issues to the public should be done.

## **6.5.1 Proposed strategies**

### **Strategy 1**

- i. Kenya should learn good practices of international experience on recycle and reuse of electronic products
- ii. Turning from emphasis on end of pipe treatment to priority given to pollution prevention and control in the whole process of production and consumption.
- iii. System should be formulated and implemented beforehand.
- iv. Policies and measures should be comprehensive and diversified, and give emphasis on economic incentive means and market instrument.
- v. Promoting public participation and setting up partnerships among government, enterprises, and the public.
- vi. Establishment of e-waste management policies in institutions generating E-waste (including learning institutions)
- vii. Device a viable way of collecting and transporting e-waste from generating institutions.
- viii. More investment in e-waste recycling should be done

### **Strategy 2**

- i. Improvement of the legal system for recycle and reuse of electronic products
- ii. Relative balance of social subjects embodied in the life cycle of products under the rules of responsibilities, obligations and interests

- iii. Recycle and reuse of electronic wastes should accord with 3R principle
- iv. System planning and design must follow life attributes of products in different phases of life cycle
- v. National law, regulations, and standards, technical guidelines need to establish targeting e-wastes management and coordination of regulations are needed.

**Strategy 3**

- i. Setting up legal system for recycle and reuse of electronic products in Kenya
- ii. Definition and scope of electronic products
- iii. Responsibilities of governments and stakeholders (including manufacturer, importer, seller, consumer, persons in charge of reuse and final disposal of wastes) during life cycle of products Policies and measures to promote recycle and reuse of wastes
- iv. Supervision, management, legal liability and etc.

**Strategy 4:**

- i. Promotion 3R strategy and international cooperation
- ii. Preventing illegal movement, joint efforts by export and import countries are needed;
- iii. Border control and cargo inspection;
- iv. Monitoring and keeping track of recyclables movement
- v. Capacity building for e-wastes recycle and disposal in a proper ways in developing countries in terms of monitoring, enforcement, technology and policymaking;
- vi. Education and public participation, the role of NGOs

**PLANNING MATRIX FOR BETTER E-WASTE MANAGEMENT IN INSTITUTIONS OF LEARNING IN RUIRU SUB COUNTY**

objectives	Planning issues	Strategies	activities	Time frame			Who is responsible
				Short	Medium	long	
<b>1. To analyze Policies and institutional framework that governs electronic waste management in Kenya.</b>	<ul style="list-style-type: none"> <li>•Fragmented and inefficient regulatory framework</li> <li>•Lack of specific policies, Acts of Parliament and E-waste management plans integrated in the CIDP</li> <li>•Lack of institutional e-waste management policies</li> </ul>	<ul style="list-style-type: none"> <li>•To design and Formulate specific e-waste management policy.</li> <li>• Enactment of e-waste management re-gulations</li> <li>•To design institutional e-waste management policies.</li> <li>•integration of e-waste management in CIDP</li> <li>•Improving products responsibility system, Implementing EPR (Extended Producer Responsibility) system and charging system for</li> </ul>	<ul style="list-style-type: none"> <li>•Drawing successful approaches on E-waste management from other countries</li> <li>•Engaging technocrats and stakeholders</li> <li>•Lobbying and advocacy to compel Parliament to enact a bill on e-waste management</li> <li>•pass the draft e-waste regulations</li> <li>•Implementing EPR</li> <li>•Border control and cargo inspection</li> </ul>		✓	✓	Consumers, suppliers, manufacturers, NGO's, KEBS, CCK, NEMA, MoEW& NR  Central government, county government, NEMA,
				✓	✓	✓	

		<p>electronic</p> <ul style="list-style-type: none"> <li>• Preventing illegal movement, joint efforts by export and import countries</li> </ul>					
	<ul style="list-style-type: none"> <li>•Lack of awareness e-waste management at different levels in the society</li> <li>•Lack of coordination between national government, county government and various stakeholders in e-waste management</li> </ul>	<ul style="list-style-type: none"> <li>•To design an academic curriculum which integrates studies in e-waste management</li> <li>•To train technocrats in the area of e-waste management</li> <li>•To design a framework at national and county levels on how to engage various stakeholders at different levels</li> <li>•To streamline channeling of funding from donors, national and county government on e-waste</li> </ul>	<ul style="list-style-type: none"> <li>•Training teachers in e-waste management</li> <li>•Teaching the new curriculum to children from upper primary to tertiary levels</li> <li>•Availing scholarships in e-waste management as incentives</li> <li>•Organizing seminars and workshops</li> <li>•Engaging stakeholders in forums</li> <li>•Establishing single line funding at both national and county levels</li> <li>•Supervision, management,</li> </ul>		<ul style="list-style-type: none"> <li>✓</li> <li>✓</li> <li>✓</li> </ul>	<ul style="list-style-type: none"> <li>✓</li> <li>✓</li> </ul>	<p>KIE, government, county government</p>

		<p>management</p> <ul style="list-style-type: none"> <li>•National law, regulations, and standards, technical guidelines need to be established targeting e-wastes management and coordination of regulations are needed.</li> </ul>	<p>legal liability</p> <ul style="list-style-type: none"> <li>•Setting up legal system for recycle and reuse of electronic products in Kenya</li> <li>• ensure Recycle and reuse of electronic wastes is done in accordance with 3R principle</li> </ul>				
<p><b>2. To assess types and quantity of E-waste generated in institutions of learning in Ruiru sub county, Kiambu County over the years.</b></p>	<ul style="list-style-type: none"> <li>•poor regulation on importation of second hand EEE</li> <li>•Low quality and counterfeit EEE in the market.</li> <li>•Low Short life span</li> <li>• insufficient data on EEE and WEEE</li> </ul>	<ul style="list-style-type: none"> <li>•ban on importation of second hand EEEs</li> <li>•quality guarantee on EEE</li> <li>•procurement and manufacture of quality EEE</li> </ul>	<ul style="list-style-type: none"> <li>•enforcement of regulations on e-waste</li> <li>• ensure quality of EEE by KEBS</li> <li>• strict adherence to procurement laws</li> <li>•Quality inspection of EEE before importation</li> <li>•involving manufacturers and consumers</li> <li>• ensure inventory and</li> </ul>	<p>✓</p>	<p>✓</p>	<p>✓</p>	<p>KEBS, PPOA, KRA, CCK, MoEW&amp; NR, Procurement officers, PPOA</p>

			record keeping of EEE and WEEE				
<b>3.To examine the environmental and health impacts of e-waste</b>	<ul style="list-style-type: none"> <li>•respiratory problems,</li> <li>•increased risk of cancer, fetal damage, kidney lung damage, allergies, long disease, abnormal heart rhythm.</li> <li>•soil contamination</li> <li>•water contamination</li> </ul>	<ul style="list-style-type: none"> <li>• proper e-waste disposal</li> <li>• enforcement of e-waste regulations</li> <li>• increase awareness and sensitization</li> <li>•Device a viable way of collecting and transporting e-waste from generating institutions.</li> </ul>	<ul style="list-style-type: none"> <li>•Awareness campaigns</li> <li>•incorporating e-waste education in the curriculum</li> <li>•training teachers on waste and e-waste management</li> <li>•holding workshops on E-waste management and effects</li> <li>•Engaging stakeholders in forums</li> </ul>	✓		✓	<ul style="list-style-type: none"> <li>✓ government, county government,</li> <li>✓ NEMA, MOH, MoEW&amp;NR</li> </ul>
<b>4.To examine disposal mechanisms of electronic waste materials in institutions of learning in Ruiru sub County and their effectiveness</b>	<ul style="list-style-type: none"> <li>•poor disposal mechanism</li> <li>•lack of responsibility and accountability in disposal</li> <li>•lack of infrastructure</li> <li>•lack of awareness in proper e- waste management</li> </ul>	<ul style="list-style-type: none"> <li>• Education on proper e-waste management.</li> <li>•foster accountability in e-waste management</li> <li>•To increase capacity for e-waste management</li> </ul>	<ul style="list-style-type: none"> <li>•hold work - shops and seminars on e-waste management and its accountability</li> <li>•To train technocrats in the area of e-waste management</li> <li>•invest in</li> </ul>	✓		✓	<ul style="list-style-type: none"> <li>National government,</li> <li>County government, local community, NGOs, CBOs and FBOs , learning institutio</li> </ul>

		<ul style="list-style-type: none"> <li>•avail infrastructure for e-waste management</li> <li>•sensitize the stakeholders and general public on need for proper waste management</li> </ul>	<p>recycling and provide necessary infrastructure</p> <ul style="list-style-type: none"> <li>•provide funds on e-waste management</li> <li>• avail scholarships on e-waste management courses as incentives</li> <li>• introducing curriculum and teaching students and pupils in from upper primary to tertiary levels on e-waste management</li> <li>•Engaging stakeholders in forums</li> </ul>		<p>✓</p> <p>✓</p>	<p>✓</p> <p>✓</p> <p>✓</p>	ns
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**Kenyatta University**

**Department of Environmental Planning and management**

**Interview schedule for Public Health**

**The information given here under will be used for the academic purpose, should be given voluntarily, and will be treated with the confidentiality it warrants.**

### **Questions**

Q1.What is your mandate in relation health in learning institutions

Q2.What are the main issues and challenges that you face in the public health sector

Q3.what is the trend of the most prevalent disease and emergency responses in place

Q4.What are the main flagship projects that you have in line with vision 2030

Q5.How effective are the policy legislation in the governance of the public health in relation to E-waste

Q6..what are the health safety standards enforced in the development of learning innstitutions, to ensure enforcement of health regulations

Q7.how many health facilities are in the municipality and their management (public/private).

Q8.What are the community driven waste management projects that are being supported by your office

Q9.what are disaster preparedness measures put in place in the municipality

Q 10.How does the sanitation in the Sub county affect the health of the people

Q11.Has there been any cases of diseases resulting from E-waste



**Kenyatta University**

**Department of Environmental Planning & management**

**Interview schedule for Education officer**

**The information given here under will be used for the academic purpose, should be given voluntarily, and will be treated with the confidentiality it warrants.**

**Name of interviewer----- date-----**

**Institution-----**

Q1. What is your mandate with regard to education in the sub county?

Q2.what is your role in managing Electronic equipment usage and e-waste management in Institutions of learning?

Q3.Are there any mechanisms put in place to regulate ICT usage in institutions of learning?

Q4. Do you undertake any sensitization or awareness creation on e-waste?

Q3.Do you have any policies concerning procurement of ICT in institutions of learning?

Q4.Who are your partners in e-waste management?

Q5.What measures have been put in place to cater for the expected stream of e-waste from the government free laptop project?

Q.6 how many pupils are expected to benefit from the program each year?

Q7. Have you put in place any take back, recycle system for the laptops?

Q8. What is the life expectancy for the laptops?



**Kenyatta University**

**Department of environmental planning & management**

**Institutional questionnaire**

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Name of interviewer----- date-----

Institution-----

Questions

A1. when was your institution started?

2. How many students does the institution have?

3. Does the institution use any electronic equipment?

a) Yes      b) no

i) If so what kind of electronic equipment do you use?

Type of electronic equipment	Number	Estimated life span/turnover	Source( new/secondhand)	Usage %

--	--	--	--	--

3. Since when did it embrace the use of electronic equipment?

4. Where do you source your electronic equipment?

a) Donations    b) government    c) institutional funds    d) personal student procurement

5. Who is in charge of electronic equipment procurement?

6. How many class 1 pupils do you have? (for pri school only)

**B1.** Does the institution have any Environmental management policy?

a) Yes     b) no

ii). If so has the policy been effective in environmental management

a) Yes     b) no

iii) Does the institution have any E-waste management policy?

b) Yes     b) no

iv) If so has the policy been effective in environmental management

a) Yes     b) no

v) Who is charged with E-waste management in the institution?

**B.1)** Are there any mechanisms of handling e-waste?

a) Yes     b) no

2) How do you dispose your E-waste?

a) landfill    (b) dispose with general waste    (c) store    (d) repair    (e) donation    (f) incineration

3) Do you separate waste before disposal?

a) Yes  b) no

4) Do you do recycle your electronic waste?

a) Yes  b) no

C1. Are you aware of the effects of e-waste?

a) Yes  b) no

2. I. Does the institution create any awareness/sensitization to the employees and students on environmental management?

a) Yes  b) no

ii) If yes how?

iii) How can e-waste management be improved?

5. Who is in charge of electronic equipment procurement?

**B1.ii) Does the institution has any Environmental management policy?**

b) Yes  b) no

ii).If so has the policy been effective in environmental management

c) Yes  b) no

iii) Does the institution have any E-waste management policy?

d) Yes  b) no

iv) If so has the policy been effective in environmental management

b) Yes  b) no

v) Who is charged with E-waste management in the institution?

**B.2) i) Are there any mechanisms of handling e-waste?**

b) Yes  b) no

ii) How do you dispose your E-waste?

b) (landfill b) dispose with general waste (c) store b) repair d) donation e) incineration

iii) Do you separate waste before disposal?

b) Yes  b) no

iv) Do you do recycle your electronic waste?

b) Yes  b) no

C.i). Are you aware of the effects of e-waste?

b) Yes  b) no

ii). Does the institution create any awareness/sensitization to the employees and students on environmental management?

a) Yes  b) no

ii.a) If yes how?

iii) How can e-waste management be improved?

B3. In the last five years, have you discarded any of the following equipment (yes/no) if so how many and in what condition? (tick appropriately)

EQUIPMENT	YES	NO	NUMBER	REPAIRABLE	NON REPAIRABLE
Photocopiers					
Printers					

Fax machines					
Laptops					
Desktops					
Computer accessories (cables, cartridges, mouse key board)					
Television/radio					
Modems					

a) How long did you keep the broken equipment disposal?

a) 1 month-1 yr b) 1-2 yrs c) 2-3 yrs d) 3-4 yrs e) 4 and above

b) Do you keep records of the equipment you discard?

c) Do you prefer repair of equipment or purchase of new one?

d) Are you aware that some electronic parts can be profitably recycled?

a) e) Are you aware of what happens to the equipment you discard?

b) YES  b) NO

d(2) if yes what?

f) Are you aware of social and environmental impacts of electronic and electrical waste? c)

YES  b) NO

g) Are you aware of any equipment recycling company?

c) YES  b)NO

h) Do you sell the electronic your electronic equipment for recycling?

d) YES  b)NO

i) If yes, who do you sell it to?

a) Scrap metal dealer b).2<sup>nd</sup> hand market c). any other (specify)

j) At what percentage of the cost price would/ you sell the equipment?

k) Does the collector come to pick the equipment?

l) Would you be ready to pay for your discarded equipment to be picked for recycle?

m) Would you be willing to give out your e-waste for free?

a) yes b) no

n) if yes, with what conditions? (Specify e.g. free pick up)

o) If you don't sell your obsolete equipment, how do you discard it?

a) Auction b) take back c) donation d) give to scrap dealers for free

p) In your opinion,

a) What impedes proper e-waste management?

b) Whose responsibility should it be to manage e-waste

c) What should be done to improve e-waste management

q) Do you have separate litter bins for different waste categories?



**Kenyatta University**

**Department of environmental planning & management**

**Computer for schools Kenya**

**The information given here under will be used for the academic purpose, should be given voluntarily, and will be treated with the confidentiality it warrants**

Q2. What is your General Mandate?

Q3. What is your role with regard to computer procurement to schools?

Q4. What is your policy on E-waste?

Q5. What are your mechanisms in handling E-waste from the computers you procure?

Q6. Who are your partners in carrying out your mandate?

Q7. What are the challenges you experience in your mandate?

Q8. Where do you procure your computers?

Q9. How can E-waste management be improved?

Q10. Are there any e-waste recycling process industries in operation?

a) Yes

b) no

Q11. Is the county involved in any recycling industry?



**Kenyatta University**

**Department of Environmental Planning &management**

**Interview schedule for NEMA officer**

**The information given here under will be used for the academic purpose, should be given voluntarily, and will be treated with the confidentiality it warrants.**

**Name of interviewer----- date-----**

**Questions**

- Q1.What is the environmental status of Ruiru sub county?
- Q2.What are the priority areas in environmental planning and management
- Q3.what measures are put in place to deal with pollution?
- Q4.How are you managing the pollution levels in Ruiru sub county?
- Q5.What are issues that you face in the enforcement of waste management the sub county?
- Q6.Does the sub county have any e-waste management policies?
- Q7.Who are the partners in e-waste management?
- Q8.Are there any mechanisms of e-waste management?
- Q9.How is e-waste disposed in the sub county?
- Q10.Are there any efforts in sensitization, awareness creation?
- Q11.Is there a general national policy and regulatory framework in E-waste management?
- Q12.Is there a required e-waste disposal mechanism and who enforces it?
- Q13.How would you quantify electronic waste in the sub county?

## Work plan

ACTIVITY	sept /Oct 2013	Dec 2013	Jan/ Feb. 2014	March 2014	April 2014
Proposal writing and Presentation					
Field work and Piloting					
Correction of instruments					
Data collection					
Report writing					
Presentation of final draft					

## Budget

ITEM	AMOUNT
Printing	25,000
Transport&accommodation	35,000
research materials	20,000
Stationery	5,000
miscellaneous	15,000
<b>TOTAL</b>	<b>100, 000.00</b>