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ELECRONIC WASTE DISPOSAL IN THE UNIVERISTY OF NAIROBI PREMISES : A CASE STUDY OF COMPUTER E-WASTE IN FOUR SELECTED CAMPUSES (MAIN, CHIROMO, LOWER KABETE AND UPPER KABETE)

BY

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DECLARATION

Declaration by the student

This research project is my original work and has not been presented for masters in any other university.

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Deceleration by the Supervisors

This research project has been submitted for examination with my approval as the University supervisor.

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DEDICATION

To my late Parents, **Mr. Joseph Saye Foday** and **Mrs. Annie Geh Foday** and all my lovely siblings most especially **Ms. Ruth Wonyen** who have worked tremendously hard to ensure that I reach this far in my academic sojourn.

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LIST OF ABBREVIATIONS

CAK:	Communication Authority of Kenya
CCK:	Communication Commission of Kenya
CED:	Consumers of Electronic Devices
CFCs:	Chlorofluorocarbons
COP:	Conference of Parties
CRT:	Cathode Ray Tube
EACR:	East Africa Compliant Recycling
EEE:	Electrical and Electronic Equipment
EMCA:	Environmental Management Co-ordination Act
EoL:	End-of-Life
EPA:	Environmental Protection Agency
EPR:	Extended Producer Responsibility
ERP:	European Recycling Platform
EU:	European Union
GDP:	Gross Domestic Product
GIS:	Geographic Information System
GoK:	Government of Kenya
ICT:	Information and Communications Technologies
ICTUoN:	Information Communication Technology Department, UoN
KEBS:	Kenya Bureau of Standards
MoLG:	Ministry of Local Government
MPP	Maintenance, Procurement and Partners of ICT in UoN
MT:	Metric Tons
NCC:	Nairobi City County
NEMA:	National Environment Management Authority
NGOs:	Non-Governmental Organizations
OEM:	Original Electronics Manufacturers
PCB:	Printed Circuit Boards
POPs:	Persistent Organic Pollutants

StEP:	Solving the E-waste Problem
WEEE:	Waste Electrical and Electronic Equipment
WMT:	Waste Management Theory
WMT:	Waste Management Theory
UoN:	University of Nairobi
USD:	United States Dollar
UoNEP:	University of Nairobi Environmental Policy

ABSTRACT

This study sought to understand the disposal methods of electronic waste at the University of Nairobi in various departments amongst academic staff, students, computer lab managers, procurement and maintenance officers. This study help to enlighten the University of Nairobi on the health and hazardous nature of electronic waste, and also provide public awareness in the area of e-waste management at the University level. It also discusses maintaining clean environment as stipulated in the Bamako Convention which talked about the handling of hazardous substances in an environmental sound manner within Africa. The targeted respondents from the four selected campuses in University of Nairobi included students, academic staffs, computer lab manager, ICT staffs, and procurement and maintenance staffs. The main objective was to ascertain the management of electronic waste at the university. The study uses Waste Management Theory (WMT) to describe a targeted prescribe action upon which implies that sustainable waste management depends greatly upon how waste is defined. The study used of both primary and secondary data. The primary data was collected by administering of questionnaires to respondents and key informant discussion while the secondary data was collected from journals, articles, books, past researches and other online resources. The sampling procedure was multi stage purposive sampling techniques since researcher has to take into consideration smaller sample size since the total population of students in the University of Nairobi is quite large. The sample size was 83 respondents and two key informant interview from the Ministry of Environmental and Natural Resources and the National Environmental Management Authority (NEMA) to provide insight on the topic under discussion. The data was analyzed using the SPSS version 22 based on the data analyzed, the majority of the respondent were unaware of the hazardous substances found in e-waste. Most of the direct users direct users (76.6%) stated that there are no e-waste collection mechanism through which to dispose of their e-waste and this was validated by the 61.7% direct users indicating none applicability of e-waste separation system, since there is no e-waste collector. Among those (23.4%) that identified the presence of e-waste collector, only 14.9% stated that there is separation of e-waste from other wastes. Therefore, there is a need to have an separate receptacle/centres for e-waste collection and programmes especially in lower Kabete campus and also in the remaining three campuses; and a mass e-waste disposal and hazard education and sensitization especially in the Main campus. The assumption of the study was confirmed that there is significant relationship between the increased use of computer devices and the challenges of the effective E-waste management methods at the University of Nairobi. Based on the findings and recommendations from this study, the following areas are recommended for further studies: Implications of informal e-waste disposal mechanism on public health in Kenya; and Health effects and environmental contamination of stored e-waste in University of Nairobi.

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CHAPTER ONE
INTRODUCTION

1.1 Background of the Study

The production and constant use of Electrical and Electronic Equipment (EEE) continues to rise globally most especially in the developing countries, and thus aggregating the number of Waste Electrical and Electronic Equipment (WEEE) as its reaches its total End-of-Life (EoL). The fast growing and development in the Information and Communications Technology(ICT) industry has worsened the situation with increase of computers and mobile devices to satisfy the increasing human-satisfactory request. (Osibanjo & Nnorom 2015) contend that owing to the vibrant manner of the Information Communication Technology (ICT) industry, the size and computational capacity of ICT devices has been experiencing fantastic enhancement, but has therefore decreased the lifespan of these products and which has led to their rapid undesirability. This process of development has brought with it number of challenges including handling of e-waste subsequently produced and which has negative impact on both the health of humans and the environment as well as pollution.

In 2006, the global E-waste, however poorly recorded or underreported, stood at 36.3 million metric tons (Mt), of which the European Union accounted almost 8.3m (Mt). (Huisman J. *et al*. 2008). The global production of second-hand electronics as at 2013 stood at 48.9m Mt i.e. an average of 20kg per 7 billion world population. The waste generated from this figure is expected to increase by almost one-third i.e. 65.3m Mt by the year 2017 with U.S and China taking the lead. In 2012 alone, China produced over 10.8m Mt of electronics, while U.S produced about 9.9m Mt, however in same year, the U.S generated over 9m Mt of e-waste while China generated about 7.2m Mt. This is due to the previously produced electronic in circulation within the U.S market. (Lewis & Writer, 2013).

In 2010, the United States of America (U.S) produced close to 258.2 million units of second-handed electronics, out of which 171.4 million were recycled and 14.4 million exported to another country; the deficit of 72.4 million which were neither recycled nor

dumped in second-country constitutes e-waste magnitude in the US as at 2010 alone. The top five (5) destination of those exported electronics includes: Mexico, Hong Kong, Chile, Canada, and Bolivia. While those exported products are used in the second country as new electronics, such electronics comes with its own hazards (Toro, 2013).

In India, there is an expected 500% increase in the number of computer E-waste between 2007 and 2020 while 400% is expected in China and 200% in South Africa. Mobile phones E-waste is expected to increase by 1800% in India and 700% in China. (Pappas, 2010).

In 2014 (Baldé, *et al*. 2015), the global electronic waste recorded was 41.8m Mt of which only less than 16.6% was properly recycled. 60% of the 2013 electronics waste consist of home and business equipment while 7% consists of computers, printers, mobile phones, calculators and other small information technology (ICT) devices. The E-waste contained approximately 16.5 Mt iron, 1.9 Mt copper, 0.3 Mt gold (which is an equivalent of 11% of the world gold production in 2013) and other resources all estimated to be valued at as well as silver, aluminum, palladium plastic and other resources with a combined estimated value of around 41.6 billion United States Dollar (USD). Also the toxins includes but not limited to about 2.2 Mt lead glass; 0.3 Mt batteries containing mercury, cadmium, chromium; and 4.4 Mt of ozone-depleting chlorofluorocarbon (CFCs).

Out of the 41.8m Mt E-waste in 2014, Africa accounted for 1.9m Mt with countries like Egypt –0.37 Mt, South Africa –0.35 Mt and Nigeria –0.22 Mt making the top list of absolute E-waste generation in Africa while Equatorial Guinea and Mauritius tops the relative E-waste generation. However, reports of E-waste in Africa is highly under reported and unaccounted due to poor waste management and institutionalized systems. (Baldé, *et al*. 2015).

Kenya has not been left behind in the rapid in ICT industry simply because of the huge demand for electronics equipment such as desktops and laptops computes which has acted as a stimulant for growth in the other sectors of the economy (Communication Commission of Kenya (KCC) 2008). This is because computers have been used in every sectors of work environment as an easy means of performing daily tasks. Another service offered through the computers in offices and homes includes but not limited to the following: internet

accessibility, games, movies, entertainments (access to radio via internet etc). All these usage of desktop and laptop has led to the increased in the use of computers over fixed lines.

The Information and Communication Technology industry in Kenya has been increasing at a rapid speed as compared to other countries in the East African region. Due to the removal of the tax levies on computers devices; promotion of e-learning in primary schools and institutions of higher learning; and the launch of the e-government strategy (2004) with the aim of mainstreaming ICT in Kenya have created a huge request for computers and other related accessories (Communication Commission of Kenya (CCK), 2009). The situation has been complicated by the rapid expansion of the telecommunication industry with high proliferation of electronics devices. In 2014, Kenya had a total of 32 million electronics gadgets users as per the statistics provided by Communications Authority Kenya, 2004. The increased number of Internet users has also augmented tremendously in Kenya according to the report of the Kenya Communications Authority.

A report in 2010 indicated that high E-waste generating countries are less likely to embrace green products as compared to high percentage of people in lower E-waste production that are willing to pay more to buy green products. (Lemon, 2010) Thus creating an increasing generation of E-waste. Electronic waste contains chemical substances that have adverse effects on the environment and human health. Subsequently, the management of e-waste needs to be structured in ways that curtail the adverse effect (Adamu, 2014).

According to Hageluken (2007), open burning of desktops, laptops and others electronic devices discharge furans and dioxins. If the computers or the ICT devices end up in dumpsites or landfills, as in many African countries case, they can pose long-term pollution of the environment including ground water catchment areas and soil; and they could have serious effects on human health. It is consequently prudent to address the EoL managing of these equipment so as to guarantee that these products do not end up in dumpsites and landfills. All electronic products on the market at the end of life are considered possible unwanted.

Therefore, it is imperative that there is an understanding of the process of production of waste from computers and their accessories. Suffice to note that consumers play a crucial part in waste generation as they are the users of these computers and so are the computers technicians and/or repairers who may produce these waste in their work places and homes. This study however, focused on the consumers and their patterns in the electronic waste management in the University of Nairobi based on the selected campuses. It seek to know how these wastes are disposed of and their rate of disposal.

Due to the remarkable nature of e-waste or unwanted electronic equipment, it has developed a crisis borne because of substances such as lead, beryllium, flame retardants found in e-waste which pose both occupational and environmental health threats(Puckett *et al*, 2002). According to Babu *et al* (2006), noted that some of these components mentioned above if ingested or gain entry to human body can bioaccumulate and pose a risk of irreversible effect on human health such as the lead which is mainly used in circuit boards may lead to the nervous system damage while the mercury contributes to damage of the brain. Other health complications related with toxins from E-waste includes cancer, liver and kidney damage and impaired mental development.

The best practice of desktop, laptop and accessories e-waste management in order to avoid the health risk involves the handling of proper management practices, legislation and education or public awareness of its harm to human health. Proper management practice includes: inventory, collection and segregation, rethink, product reuse, recycling and disposal methods. Legal framework provides execution and managing of model ideal for e-waste handling and minimization, disposal, setting up of goals and standards, allocation of responsibilities and identification of penalties. E-waste management practices entails research and development, awareness and education.

Despite of Kenya being signatory to numerous multilateral environmental agreements such as: (1) 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; (2) Bamako conversion on the Ban of the imports into

Africa and the control of trans-boundary movement of hazardous wastes into Africa; (3) Basel convention on the control of Trans boundary movements of hazardous wastes and their disposal; (4) Rotterdam convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and (5) Stockholm convention on Persistent Organic Pollutants (POPs) and Pesticides in International Trade. Nothing much had been done in curtailing the issue of e-waste. As such, there should be strong mandate on the disposing of e-waste from Central Government headed by the Ministry of Environment and Natural Resources and National Environmental Management Agency(NEMA) in fostering mechanisms for greener environments, controlling and providing guidelines for cross boundary movements of precarious substances.

1.2 Statement of the Research Problem

The phenomenal growth and development in the Information and Communications Technology industry has exacerbated the situation with proliferation of computers and electronic devices to address the rising demand. Osibanjo and Nnorom (2015) contend that owing to the dynamic nature of the ICT industry, the size and computational capacity of ICT products has been going through tremendous improvement, but has consequently decreased the lifespan of these products and led to their quick obsolescence. This growth has brought with its number of challenges including management of e-waste subsequently produced and which has negative impact on human health and the environment as a result of pollution.

As such, the University of Nairobi is a public university that received many computers as donations from friendly governments, and Non-Governmental Organizations (NGOs); after the usage of said donation, will generate into e-waste. It is noted that e-waste constitutes hazardous substances that may adversely affect the environment and human health if not accurately handled. Obsolescence of electronic equipment has been observed at University premises, evidently within the Department of Geography and Environmental Studies GIS computer Lab, in particular, desktops, Laptops computers and its accessories. While it is apparent that e-waste is a matter of great concern for government, environmentalist, and researchers as well as the citizens in any particular country; there is

scanty evidence that indicates the attempt to address the issue of waste disposal, as well as the understanding of the intricacies related to laptops and desktops computers e-waste disposing method within the University of Nairobi.

It is therefore based on the problems identified above, that this study examines the magnitude and challenges of E-waste disposal within the Main campus, upper & Lower Kabetes, and Chiromo campuses of the University of Nairobi with a specific focus on desktops, Laptops and palmtop computers with its associated office hardware like printers, scanners, mouse, Keyboard and other portable handheld ICT devices.

1.3 Research Questions

1. How does the increase in the use of electronic devices affect e-waste management at the University of Nairobi?
2. What are the e-waste disposal methods among the campuses in the University of Nairobi.
3. What are the regulatory roles of relevant stakeholder in e-waste management within the University of Nairobi?
4. What are the challenges faced by the University of Nairobi in disposing e-waste?

1.4 Objectives of the study

The overall objective of this study examines e-waste disposal methods of laptops and desktops computers and computer accessories at the University. Moreover, the study attempts to achieve the following objectives:

1. To establish the influence of increased use of technological devices on management of electronic waste within University of Nairobi.
2. To evaluate the methods of e-waste disposal among the University of Nairobi Campuses (Main campus, Chiomo and Kabetes)
3. To evaluate the extent to which existing regulatory roles of e-waste relevant stakeholders influences the effective management of e-waste disposal within the University of Nairobi

4. To understand the current challenges facing University of Nairobi in disposing end of life computer devices.

1.5 Assumption

The research derives an assumption that there is correlation between the trend in the increasing availability of the waste materials and the ease of managing these e-waste products. The increased abundance of technological devices have negatively influence e-waste management. Landfill disposal as scraps and dumpsites are the main methods of e-waste disposals among the University of Nairobi authorities in Kenya, poor e-waste regulatory mechanisms by the relevant stakeholder leads to increased e-waste production with less disposal mechanisms within the University of Nairobi in Kenya. Non-fixed method of e-waste disposal; lack of communication and participatory mechanisms that involves the collection of End of Life (EoL) devices from electronic end-users are major challenges in disposing e-waste at the University of Nairobi in Kenya. Hence, this study assumes that:

There is significant relationship between the increased use of computer devices and the challenges of the effective E-waste management methods at the university of Nairobi.

1.6 Justification of the study

This study focuses on e-waste disposal regarding computers and accessories at four selected campuses at the University of Nairobi. The study informed that computers industries are the fastest growing sector in the Kenyan economy. In 2011 the contribution of the computer sectors in Kenyan economy represented over 5.6% of gross domestic product (GDP), and up to a further a 1.9% from intangibles (social benefits) (Deloitte LLP, 2011).

Kenya has become the hub of ICT evolution which has led to increased growth rate in the mobile phones, computer and electronics gadgets and subsequent increase in the number of computers and electronic equipment in the market. However, Kenya has not yet created a policy framework nor has it established environmentally safe disposal methods to keep pace with the ever changing technology. The innovation in most cases is changing much

faster than the rate at which regulations are drawn. Subsequently, large amount of computers e-wastes are generated and their negative environmental impacts may undermine any attendant gains if these e-waste are not well sustained.

This study mainly focused on computers e-waste generated at the University of Nairobi since statistics have shown that computers and other electronic gadgets are the most widely used in Kenya and at the university level. The reason for this is that computers have easy to use features and the cost is much reasonable (Ogembo, 2010). This means therefore that computers e-waste and electronic gadgets has a similar percentage of e-waste in the Kenyan market. The rationale for focusing on computer e-waste is also because of the computer labs at almost every department within the University; as such e-waste will be generated.

The findings gathered from this study will be useful to the University of Nairobi and policy makers such as NEMA and the County government as they budge toward policy measures on the e-waste in the country. They would also provide useful information to future researchers in the area of e-waste management.

1.7 Scope and Limitation of the Study

The scope of this study is limited to computers e-waste at the university of Nairobi specifically main campus, chiromo and upper & Lower kabete campuses. This is despite the fact that e-waste includes a broad range of others electronic equipment's. The choice of the computers e-waste was based on the fact that the laptops, tablets desktop computers and other computer accessories that are being donated to the University to enhance the learning processes has therefore generated e-waste and also the computer industries are one of the fastest growing industries in Kenya. The study sought to examine the e-waste from some types of electronic equipment in Kenya if financial and time resource is possible. The study's geographical boundary was limited to Nairobi City, specifically University of Nairobi campuses: Chiromo, Kabete and main campus.

The study also looks at the problem of e-waste generation concentrated amongst those campuses. In order to make general assumptions about e-waste, the study focuses on laptops, and desktop computers and accessories being used by various departments within the University of Nairobi that has generated into e-waste.

1.8 Chapters Outline

This study is organized into five chapters; Chapter One is the introduction and gives the background of the study. Chapter Two reviews the literature on electronic waste and electronic waste management. It contains the following sub-topics: global concept of e-waste, methods, stakeholder's involvement in e-waste management, and challenges of e-waste disposal among students and the factors influencing effective disposal of electronic waste, while Chapter Three describes the research methodology used in the study. The Chapter four give the data presentation and analysis; while the chapter five presents the summary, conclusion and recommendation.

1.9 Operational Definition of Terms/Concepts

E- waste: E-waste is a term used to cover all types of electrical and electronic equipment (EEE) nearing the end of their "useful life" (source: solving e-waste problem (StEP)

EEE: Electrical and Electronic Equipment is defined as equipment which is dependent on electrical currents or electromagnetic fields in order to perform properly and the equipment for the generation, transfer and measurement of such current and field falling under the categories set out in Annex IA to Directive 2002/96/EC (WEEE) and designed for use with a voltage rating not exceeding 1000 volts for alternating current and 1500 volts for direct current.(Source: Directive 2002/96/EC (WEEE))

End-of-Life: Is when a desktop or Laptop computers has reached its lifespan or no longer usable. (StEP).

E-waste management: refers to the organization and coordination of collections, transportations, storage, dismantling and recycling of disposable of obsolete, end-of- life or discarded computer e-waste.

Waste: any substance or object which require disposing of and provisions of pursuant the of national law in force. (Source: Directive 75/442/EEC, Article 1(a).

WEEE: Waste Electrical or Electronic Equipment is waste including all components, sub-assemblies and consumables, which are part of the product at the time of disposing (Source: Directive (EU, 2002a).

CHAPTER TWO
LITERATURE REVIEW

2.0. Introduction

The all over idea of this segment is to search relevant information from past researches with a view to identifying gaps which this study attempts to fill. It presents past studies on literature on electronic waste and electronic waste management. It contains the following sub-topics: concept of e-waste, methods, stakeholder's involvement in the management of e-waste, and e-waste challenges in disposal among students and the factors influencing effective disposal of electronic waste. It also shows the research gaps that this study seeks to bridge together with the contributions to this research.

2.1 Electronic device usage and the concept of E-waste

Electronic waste is growing faster in the waste stream. This is due to the purchasing of new electronic gadgets at an alarming rate and whereby throwing the old one away. New ideas in the technological world is always coming out and making the old electronics less desirable. As a result some electronic gadgets don't last as a supposed to last, and seen cheaper to buy new ones than to repair. For thinner and much smaller designs (like smart phones, and tablets) are making it really difficult for electronic gadget users to repair and make the use of the devices to prolong (Dump, D., & Obsolete, Q. 2015).

2.1.1 Global E-waste

The idea of e-waste started way back in 1976 in the United States when the illicit discharge of e-waste were in under developed countries which continues to emerge as serious challenge as well as business opportunities for the large amount of generated e-waste both toxic and valued substances found in those. The properties includes iron, copper, aluminum, gold and other metals in e-waste which is estimated over 60%, while hazardous component comprises 2.70%. Due the great deal of poisonousness of these contaminants when it is most especially being burned or recycled in environments that are unrestrained, according to the Basel Convention which has recognized e-waste as hazardous elements, and developed a regulatory framework for the management of transboundary movement

of such waste. The Basel Ban, is yet to implement the amendment to the Basel Convention, we would move a one step closer by forbidding the exportation of electronics-waste products from countries are developed to industrializing. (Widmer, R., *et al* 2005).

Herat, S. (2009).conducted a research on e-waste in Australia describing it as multiplying at an alarming rate due to desire for Information technology products/electronic gadgets. His study was mainly focused on computers products. The management e-waste is typically considered as the solid waste sleeping giant in this area, Australia's e-waste rate is set to climb to even higher levels compared to most other countries around the world as the country is experiencing a steady and growing information technology dependent economy. However, the government of Australian lags behind schedule in many countries around the world in formulating appropriate policies and regulations to deal with the e-waste problem. Even though there is little progress made in this concern, numerous external factors distinct to Australia are impeding the progress. Due to the uniqueness, the way to go maybe to carryout thorough research in the area of policy formation taking into account social, environmental, technical and economic aspects of solid waste management related to e-waste. According to Herat, S. (2009) it will be very prudent to conduct proper research in the topic under discussion to avoid the mistakes carryout by countries around the globe where policies and regulations were done without any proper study associated to the homegrown problems.

Waste production per capita in some countries, like India and China, is fairly actually little (projected<1 kg per capita per year), but these countries also tend to have some of the rapid rising markets for electrical and electronic devices/equipment because they are far from saturation (Streicher-Portea *et al*. 2005). From 1993 to 2000, in China, the number of Personal Computers(PCs) users increased by 1052% while the normal world growth rate of electronic waste was a bit lower at 181%. In the same era, 604% growth was presented by India. the number of mobile phone users in China From 1996 to 2002 has rose to about 200 million which have created alarming rate of e-waste in the global market (LRD, 2005). It is projected that about 66% of various harmful elements in e-waste are of WEEE by weight consists of metals such as aluminium, iron, copper, and gold and non-metallic, with

34% of other contaminants make up about the waste pollutants. Ferrous metal is one of the most common metal found in electronics and its components (Morf *et al*. 2006) Statistics found in Ireland demonstrate that iron and steel comprise almost half of the total national WEEE waste, which is estimated to be between 25 000 and 30 000 tonnes year–1 (WEEE 2001) while nonferrous metals such as aluminium, copper and some precious metals make up about 13% of their WEEE waste stream (ETC/ RWM 2003). About 5.4% constitute glass of the total weight of waste from electric and electronic equipment annually (Theisen 2002). The second largest component were plastics, by weight approximately 21% of WEEE in 2001 in Ireland(Wilkinson *et al.* 2001). There is an additional risk that some of this plastic is blaze retardant and can be harmful to the environment if not throw away accordingly.

Africa is being continually known as a suitable e-waste dumping site for the rest of the world due to the continent's inability to produce her own first-hand (new) electronic devices. At the greater risk is the West Africa nations, while the East and Southern Africa nations have an established measures to prevent massive and highly degenerated e-waste dumping, the West Africa nations have done little effort in this regards. Majority of electronic importation to Ghana and Nigeria is constituted by illegal import of used electronic that are or near what can be referred as E-waste. This is factored by the quest for cheaper EEE as opposed to strict standard and price regulatory EEE market in those export countries. (Baldé, *et al.* 2015).

Electronic waste recycling is usually informal in Africa, often comprising of unmonitored open-air burning in landfills and/or dumpsites. Thus causing damage to physical and environmental health issues. The weak cooperation, strict legislation, adoption and compliance of those rules between the developing nations –where E-waste are dumped and the developed nations –where E-wastes are exported have exacerbated poor socioeconomic development and poverty. This is because the socioeconomic gains of e-waste recycling have not been fully harnessed in Africa and the usage of E-waste itself further constitutes poor performance, efficiency and ultimately low economic productivity that would have otherwise improved the national development. (Baldé, *et al*. 2015).

In 2014, Mauritius generated and e-waste of 9.3 kilograms per inhabitant (kg/inh). As at 2011, the country suffers mechanism that separates the collection of E-waste from other wastes resulting to about 1.5 kg/inh of mixed e-waste materials along with others, while large e-waste are usually stored within the premises of households. About 42 kg of e-waste was believed to have been stored per household in the country. (Africa Institute, 2012).

In Ethiopia, the flooded market and use of cheap EEE is confined to the urban areas due to unavailability of electricity and increased poverty in the rural areas. However while there are large volume of e-waste from those urban areas, the rural parts also accounts for small proportion of the national e-waste due to the use of devices powered by battery. The effects of E-waste within Ethiopia have not been greatly established as compared to those in countries like Nigeria and Ghana due to the moderation in the volume of e-waste in Ethiopia. Ghana and Nigeria has very high volume of e-waste and an indicated practice of unsound recycling and disposal methods in various households and predominantly within buildings, and offices of both governmental, private and non-governmental entities. (Manhart *et al*. 2013).

2.1.2 Kenya and E-waste

The problem of electronic-waste in Kenya was brought to the spotlight through the Basel convention on Trans-boundary waste management, which took place in September of 2006 in Nairobi and the Eighth Conference of Parties (COP 8). Beforehand, E-waste was not considered vital due to the small consumption of electrical and electrical equipment (EEE) and the overall movement by Homes to stockpile EEE, use it again or waste it along with other solid waste after their end of life (EoL). Research conducted by Mureithi and Waema (2008) suggests that the amount 3,000 tonnes of E-waste created each year in Kenya approximately. This total E-waste volume is expected to rise due to the importation and usage of EEE which might increases in future. The study found out that there is a high buildup of obsolete ICT gadgets in households, workplaces and repairing shops since the holders are unaware of safe dumping options and that information on how to dispose E-waste is missing t from the consumers right to the final handlers of E-waste.

Kenya has an approximately 5.4 K tonnes of EEE including of mobile phones, printers, PCs and other electronic gadgets was in 2007 placed on the Kenya market. In comparison, 7.4 K tonnes of WEEE were produced in the similar time consisting of computers, printers, mobile phones , refrigerators and Televisions (Schluep *et al*., 2009). By the importation and usage of computers likely to rise in pending years, the sum of WEEE made is likely to escalate. Compared to past years for example, a 200% rise in the imports of IT devices in 2007 which was documented (Mureithi and Waema, 2008). In spite of being an under-developed country, partially because of a lack of decent standard, the market for used computers and clones is still high due to profitability. It is recorded that an estimated 60% of the computers donated to schools and others are beyond refurbishing, and is appropriate for the reconditioning marketplace (Mureithi and Waema, 2008).

There are challenges on policies formulations on E-waste management and there is no legislation to appropriately deal with the challenge pose. Mureithi and Waema's study also found out that the following have undermined the quest for a policy and legislation framework in Kenya: lack of mechanism to implement the policy interventions by the government; inadequate capacity key government agencies dealing with E-waste; coordinated approach is lacking across for government agencies that are in charge of e-waste management; absence of regulatory-arm and policy formation to safeguard health, environmental and the social E-waste consequences have Mureithi and Waema's study scope was limited to IT equipment/devices; precisely personal Computers, laptops, cathode ray tube (CRT) and printers, flat screen monitors, and associated PCs devices. This study therefore focused on laptops and desktops E-wastes.

Estimates from UNEP and UNU (2009), puts the amount of computers E-waste produced annually in Kenya at 150 tonnes. This is bound to increase as the number of mobile phone, laptops and desktop computers users' increases. Kenya considered in this study as a country with a small scale formal and informal E-waste reprocessing area. It stated that the key barrier to sustainable recycling E-waste technologies and managing is lacking of a policy framework that this study seeks to examine.

2.2 E-waste management

There are various ways of e-waste collection methods that occur in different countries on the disposing method. Municipal depots in many cases are responsible for collection which is accomplished via local support of the original electronics manufacturers (OEMs), which are charged with responsible of collecting of WEEE in many countries.

According to study carryout by Babu *et al* (2007), noted that in order for recycling of electronic waste method to be fruitful, labour cost, the economy structure (including the informal sectors that are important), the regulatory framework currently available, possibilities and limits of law enforcement must be taken into account in order to find solutions that can improve the situation with regard to environmental impacts, occupational hazards and economic revenue. In order for a recycling system to be sustainable, it must also have the ability to adhere to near future changes in the quantity and quality of the waste movements.

Presently, burden for regulatory framework is the key factor for the recycling of e-waste. The absence of regulatory arm at a national level in most nations has been proving to significantly impede recycling rates (Solving the E-waste Problem (StEP), 2009). At the moment, there is no law in the United States on recycling of electronic waste nevertheless, twenty five states have passed laws to require statewide e-waste recycling which the uppermost per capital collection volumes are Minnesota 6.37, Oregon 6.31, and Washington5.92 pounds (1 lb=0.45 kg) per person, respectively (Electronics Take Back Coalition). Some of the major lessons learn during the collection period as follows: (a) states with high collection volumes have laws covering collection costs, encouraging a variety of collector types, including government, private and non-profit; (b) high collection volumes are seen when laws make the collection suitable, or when they start collection goals; and (c) recycling was enhance by banning landfill.

Usually, U.S. e-waste produced is being pre-processed domestically and before being exported abroad for end-processing, with the retrieval of metals that are special and precious. It is being recorded that 50 to 80 percentage of the e-waste collected in the United States are shipped to countries that developing such as China, Pakistan and India, because

of low-cost of labour and lesser tough measures on environmental guidelines (StEP), 2009). Pyrometallurgical processing methods at copper smelters in Canada and Western Europe are the methods in which remaining e-waste collected in the U.S. are being processed. The U.S. doesn't have smelting capacity that is integrated, and so the e-waste it generates does not processed them. Due to the advancement of pyrometallurgical processes, these integrated smelters are used to process e-waste and their capacity for fairly low price metallic retrieval from e-waste. Nevertheless, sufficient capacity is not at these smelters processing to process huge volumes of global e-waste, and it is not monetarily possible for the building capital-intensive smelters in each state. There exist a small scale plant in the U.S. to recycle precious metals recovery from industrial catalysts and spent automotive and whilst the knowhow may not be the same, these small-scale pyrometallurgical processing plants could be an alternative for e-waste recycling in the United States. Hydrometallurgical processes is also used to recycle e-waste at a much smaller scale, which acidic leaching agents is utilize to recover metals. Nevertheless, there is also traditional leaching means, cyanide and aqua regia are such methods, result in hazardous emissions which must be handled and dispose accordingly.

Three studies by Dr. P Shah on environmental and biodiversity waste and conservation in 2013 have not identified e-waste management rather those studies focused on the general environmental waste management. Also, Susan (2016) conducted a study on waste management within the University of Nairobi without direct focus to e-waste rather the study recognized that the normal wastes are usually disposed together with e-waste.

The university environmental management policy requires a policy consideration on e-waste. The university of Carleton in Canada have since 2013, adopted e-waste recycling program across its campuses and was able to recycle about 13,000 Kg of e-waste in 2013. The program allows for free of charge, direct and indirect e-device users to drop their end-of-life e-device at designated points across the campus. The program cleans up the data on the device before recycling and in cases where data cannot be destroyed, the device is destroyed so as to abide by the information protection and privacy Act. The policy also accommodates the guidelines at both the provincial and national level so as to have a

synergetic e-waste management policy. This policy in Carleton is not peculiar to only universities in Canada but across the North America region. (Carleton University, 2017).
In Europe, like the North American region, the University of Gasglow among other universities have adopted e-waste management policy for the school environment. The WEEE regulations of university of Gasglow dates to year 2006. The regulation requires users to procure use, dispose, recycle and reuse electronic devices responsibly. The regulation further outlines the roles of partners and the university management in WEEE management. Thus, avoiding the conflict of what roles should be acted upon and who should act. Lastly the regulation policy clearly states the implications in cases where those delegated or whose responsibility to act have failed to act. (University of Glasgow, 2017)

2.2.1 Kenya method of e-waste

A study conducted by Otieno, I., & Omwenga, E. (2015) on E- waste management in Kenya assume that most of the generated e-waste in developing countries around the world is being managed through crude means by the informal sector such as product reuse, dispose in open field by burning or end up in landfills. It is obvious that some of the EEE produce extremely poisonous materials that requires being disposed in an environmentally sound manner to avoid it harmful effects to human life and the environment. Study has proved that mobile devices, computers, and TVs sets will contribute roughly 9.8 million tons in e-waste stream by 2015. Governments, environmental institutions and individual researchers has been concern due to increase in e-waste stream which has hazardous effect on human health and degrade the environmental significantly.

Kenya e-waste recyclers market is growing and becoming so equipped with vendors disassemble old electronics equipment and re-selling or reused portions for overhaul. The foremost source of elements is refurbishes, followed by WEEE collectors and recyclers. Additionally, recycling set-ups are being established around some informal businesses previously (Mureithi and Waema, 2008).

Material WEEE elements as follows: plastics, ferrous metals and aluminum are liquefied and used in the production of agricultural equipment in the informal marketplace. Nevertheless, specialized equipment for treatment of material fractions like copper, printed circuit boards (PCBs), CRT and other hazardous fractions such as lead, mercury and lithium do not exist in the country. Recyclers are mostly responsible for final disposal with unwanted fractions taken to landfills (Mureithi and Waema, 2008). WEEE is anticipated to be a massive difficulty in the near future. From the consumer to the final disposer, knowledge on where to discard WEEE is lacking with a high growth of old ICT equipment in homes, offices and repair shops since the owners are not aware of disposal options and whether it has any outstanding valuables (Mureithi and Waema, 2008).

The Ban of the importations into Africa and the control of transboundary movement and management of hazardous wastes within Africa called the Bamako Convention which is a pact for African nations that forbids the import of hazardous wastes into member countries (BAN, 1991). Kenya is a member of the both (Basel and Bamako Conventions). However, there is no arranged system of WEEE collection and thus collected as part of the normal waste (Mureithi and Waema, 2008). While government policies and regulations have not kept up with the speed of the challenge posed by WEEE, a concept paper to address what it termed 'the new phenomenon' of WEEE has been developed. Precisely, the government was reported to be considering recycling and technology transfer (Mureithi and Waema, 2008). It is postulated that due to lack of policy and legislative framework coupled with the lack of a practical WEEE managing structure, much of WEEE remains in storage (Mureithi and Waema, 2008). The WEEE regulations in the University environment in Kenya have not been fully explored as many of the Universities still dispose e-waste using the normative waste disposal methods. (MoENR, 2017)

2.2.2. E-waste policy framework in Kenya

According to the Ministry of Environmental and Natural Resources 2010, In Kenya, waste management is under the control of the local county authorities within the city council of Nairobi as mandated under the Local Government Act (CAP 265) and Public Health Act (CAP 242). These fragments of legislation make the local authorities responsible for the

running of municipal waste. The key limitation of the Local Government Act and Public Health Act is that they are silent on the handling of e-waste. To address such challenges, the Local Government is formulating a solid waste management policy while the City Council of Nairobi is also developing an integrated solid waste management strategy in conjunction with UNEP.

The Environmental Management Coordination Act amended (2015) enactment provides a channel to address the waste management issues in Kenya as to how the waste should be handled. The Acts sets out the institutional framework on environmental management in Kenya. The National Environmental Management Authority is charged with the authority to exercise general overseer and coordination over all matters relating to the environment and the principal Government agency that deals with the implementation of policies.(NEMA, 2010). The Acts also charged with the development of regulation on waste management including hazardous waste.

In 2006, NEMA developed the waste management regulation which applies to all categories of wastes as provided in the regulation. These includes hazardous and toxic wastes, industrial wastes, pesticides, radioactive substances and biomedical wastes. Hazardous wastes in the regulation is defined as having five distinct characteristics, for example: explosive, flammable, toxic oxidative and corrosive, but deals with hazardous waste in totality; provides the activities, administrative and operational procedures that are used in handling, packaging, treatment, conditioning, reduce, reuse, recycle, storage and waste disposal. The regulation applies to e-waste waste by the virtue of its composition, which includes several of the substances listed as hazardous waste. Some subsidiary of the legislation of EMCA includes: the Environment Management and Coordination (Substance Controlled) Regulations 2007,which deals with the management and control of substances that deplete the ozone layers.

NEMA in 2010 came up with the E-waste Management guidelines which aim at the establishment of E-waste regulations in Kenya NEMA introduced the guideline because it realized that Kenya has not anticipated the problem e-waste and also influenced by the proliferation of technology advancement which making some of the electronic products like televisions, fridges, computers and mobile phones obsolete very fast. Nevertheless, NEMA believes that computers and mobile phones e-wastes will form a larger percentage

2.2.3. E-waste policy framework in UoN Kenya

The University of Nairobi Environmental Policy 2015 (UoNEP) is a good policy document that cut across environmental issues within and outside the university but lacks the full implementation. According to the guiding principles of the Policy, "the Article 42 of the Constitution of Kenya, 2010, provides that every person has the right to a clean and healthy environment which includes the right to have the environment protected for the benefit of present and future generations through legislative and related measures". It is on this fundamental national policy framework that the UoNEP was formulated. To implement the environmental policy, staff and students will was guided by these principles: (1) continuous improvement, (2) reduce, reuse, recycle, (3) environmental compliance, (4) stewardship, and (5) training and education, but such guiding principles has been lacking since the inception this policy. On Section 7.9 of the UoNEP, the university will adopt cost-effective measures to ensure that all electronic waste is disposed of in an environmentally sustainable manner that is in line with the Environmental Management and Coordination Act.

The UoNEP outlined that WEEE needs to be managed but failed to specifically highlight the disposal method i.e. incineration or other sustainable disposal means. While the policy created a forum for WEEE management committee and tasked the general members of the University on WEEE management, it did not specifically delegate on the downstream, a specified waste disposal agent to clean-up WEEE within the University. Also the UoNEP had little consideration for training UoN waste disposal department on WEEE management, and lacks private partnership with WEEE management organizations.

2.3 Stakeholder involvement

In order to have a clean environment for healthy life on earth such as the proper disposing of e-waste, the most be stakeholders' involvement. E-waste policies require in Japan, mandate manufacturers and shippers to take-back electronics for end of-life management. Japan's "Home Appliance Recycling Law" (1998) orders that household e-wastes in four categories be collected such as computers, televisions, refrigerators, washing machines and air conditioners. Consumers are mandated to pay an end-of-life fee that covers a percentage of the recycling and transport costs. Depending on the type of appliance, the total fees vary between US$27 and US$65 (Kahhat *et al*.). Customers are required to bring e-waste to the place they bought the product. Vendors then transport the products to specific collection sites, and manufacturers are to ensure the e-scrap is recycled. Manufactures can also sell the e-scrap for reuse or hire another company to recycle the waste. Recycling of e-waste in Japan is at rate about 75% for products covered under the Home Appliances Recycling law, due to the fact that greater financial responsibility is retained on the consumers (CRU) (Namias, 2013).

Presently, there is no U.S. Federal order to recycle electronic waste; nevertheless, twenty five states have enacted legislation requiring state wide e-waste recycling. Despite state-wide recycling efforts, it is estimated that 13.6%9 to 26.6%10 to e-waste is recycled in the U.S. According to the Environmental Protection Agency (EPA) of the U.S. Office of Resource Conservation and Recovery report "Electronics Waste Management in the United States through 2009," 2.44 million short tons were prepared for end-of-life management in 2010. Due to this estimated generation and the abovementioned U.S. e-waste recycling rates, roughly 332,000 to 649,000 short tons of e-waste was recycled in the U.S. in 2010.

In India, like in other developing countries, waste management is a multifaceted issue due to the existence of the host of stakeholders, some of whom are outside the ambit of the law. The strategies for waste management adopted thus far have been, the legislating of norms and policies, generation of awareness, incentives and taxation and setting up institutional infrastructure for recycling and disposing. Electronic waste is a quite new waste stream with multifaceted managerial issues owing to difference in generation with valuables and

unknown toxics. The collection of such a waste which has recoverable metals with high reuse and refurbishable value is a challenge due to thriving informal sector market. In this paper, we analyze the building blocks of an E-waste Management Policy cycle.

The Berlin Conference backed by an UN-led initiative started in 2004 at the Electronic Goes Green in to build an international platform to exchange and develop knowledge on WEEE systems among countries to enhance and coordinate various efforts around the world on the reverse supply chain (StEP 2005). European Recycling Platform (ERP) set up at the end of 2002 by Hewlett Packard, Sony, Braun and Electrolux to enable the producers to comply with the WEEE directive. Its goals is to assess, plan and operate a pan-European platform for recycling and waste handling services (Widmer *et al* 2005).

The stakeholders engaged in creation, and enforcement of regulations on generation, management and disposal of e-waste in Kenya are: Ministry of Local Government (MoLG), National Environment Management Authority (NEMA), Kenya Revenue Authority (KRA), Communication Commission of Kenya (CCK) and Kenya Bureau of Standards (KEBS). They prepare a framework with suitable legislation to support e-waste management, monitor the processes of e-waste handling regularly, create a management plan with responsibilities for different target groups, provide incentives to entrepreneurs to set up e-waste collection and treatment facilities, regulate / control the number of e-waste facilities within a geographical area, approve innovative e-waste management technologies that are environmentally sound, form multi-stakeholder monitoring committees to oversee the implementation of the e-waste handling guidelines, create awareness among all the stakeholders through the legislative frame work of e-waste management, develop standards to avoid the importation and donations of unusable or unsafe e-waste, and decide the impact of and come up with strategies for managing technology changes such as analogue-to-digital television devices and deciding the method for Strategic Environmental Assessments (NEMA, 2010).

The Authority responsible for the environment at policy level is known as National Environment Management(NEMA) in Kenya. With one of the key responsibility being full implementation of the Environmental Management ordination Act (EMCA) mandate which defines hazardous waste, pollutants and pollution. To achieve this objective, the Ministry's role is to create an enabling environment through policy, legal and regulatory reforms for environmental and natural resources management (NEMA, 2010).

The major instrument of Government in the implementation of all policies relating to the environment is The National Environment Management Authority (NEMA). In the NEMA strategic plan 2010-12, key objectives include universal compliance and enforcement of environmental regulations, developing guidelines and standards and the prosecution of offenders failing to meet the provisions of the Environmental Management Co-ordination Act (EMCA) 1999. The principal agencies that are also relevant to e-waste management include the Ministry of Information and Communication, Communication Commission of Kenya (CCK), Kenya Bureau of Standards (KEBS), Kenya Revenue Authority (KRA), Ministry of Education, Ministry of Local Government (MoLG) and Nairobi City County (NCC).

2.4 Challenges of e-waste disposal

Electronic waste is defined as end-of-use or end-life of electronic products, components and peripherals such as: computers, fax machines, phones, Personal Digital Assistant (PDA), radios and TVs E-Waste recycling sites: This refers to the space allocated specifically for recycling e-waste or end-of-used of ICT assets.

Information and telecommunications technology (ICT) and computer Internet networking has infiltrated almost all facet of contemporary lifecycle, and is absolutely impacting human life even in the most remote areas of the developing countries. The fast development in ICT has led to an enhancement in the capacity of computers but simultaneously to a lessened the products lifetime as a result of which increasingly large quantities of waste electrical and electronic equipment (e-waste) are being produced yearly. ICT growth in most developing countries, mainly in Africa, depends more on used or refurbished EEEs

most of which are imported without confirmatory testing for functionality. Therefore, a huge quantities of e-waste are currently being managed in these countries. Some of the problems confronting emerging countries in e-waste management include: the lack of organization for proper management of e- waste, lack of regulation dealing precisely with the handling of e-waste, an absence of any agenda for end-of-life (EoL) product take-back or execution of extended producer responsibility (EPR). This research surveys these problems as they relate to practices in emerging countries with importance on the prevailing situation in Kenya. Effective handling of e-waste in the developing countries stresses the execution of EPR, the establishment of product reuse through remanufacturing and the introduction of competent recycling facilities to handle the waste. The operation of a global set-up for the standardization and certification/labelling of used appliances intended for export to developing countries could be acquired to regulate the export of electronic devices that are recyclables (e-scrap) in term of used devices/equipment.

2.5 Theoretical framework

2.5.1 The theory of Waste Management

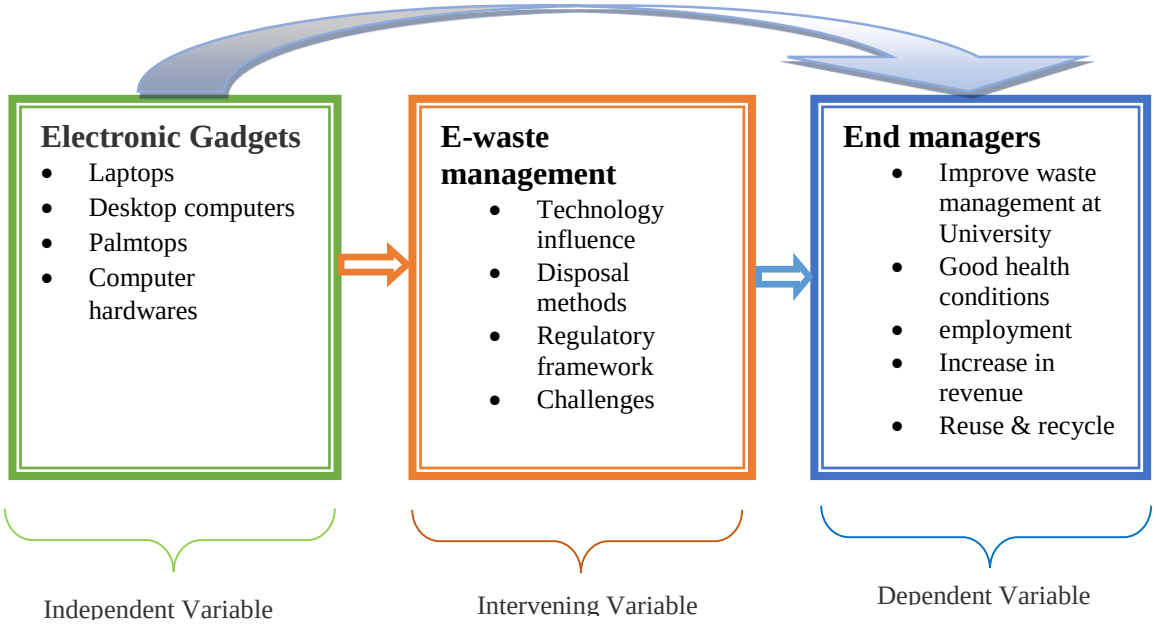
Waste Management Theory (WMT) was developed by (Pongrácz *et al* 2004) it was used in this study; it is based on the theory that the way we define a target proposes action upon it, which implies that sustainable waste management depends greatly upon how wastes are defined. Every term used in a scientific theory or in a given branch of science ought to be precisely defined. Definition is the most descriptive form which gives the exact meaning as defines. Definition is always vital in the field of law, but it is particularly important in a system of regulatory control, as it is necessary to define what can and cannot be controlled (Pongrácz, *et al* 2004). Effective definition of core concepts is an epistemologically well-bounded theoretical construct. It follows that a prerequisite of the scientification of waste management, and the evolution of WMT, is offering scientifically adequate definitions of the key concepts of waste management, starting with the descriptive definition of waste. Obvious and adequate method of characterizing a scientific concept. Definitions are offered to state or describe the accepted meaning, or meanings, of a term already in use which are called descriptive definitions. (Pongrácz, *et al* 2004).

2.5.2 Theoretical framework

The Waste Management Theory (WMT) was used in this research, describe a targeted prescribes action upon which implicates that sustainable waste management depends greatly upon how waste is defined. Each term used in a scientific theory or in a given branch of science must be well-defined. The chart below identifies the key variables of this study; the three variables (Independent, intervening and dependent) are based on identification and relationship among and between variables.

The prepositions here are taken from empirical observation, based on the travel chain of computers from electronic gadgets(which may be considered the starting point of the problem), and the case of e-waste management more specifically from technology influence, disposal methods, regulatory framework, and challenges, as well as the environmental protection from end managers; such as improve waste management at the University, good health conditions , employment, revenue and reuse and recycle, to the end of life of electronic wastes.

Figure 2.1 Theoretical Framework



Source: Pongrácz, *et al* 2004

2.6 Summary Literature Review and Research Gaps

2.6.1 Summary

This chapter has provided the literature review and scholarly work on the factors influencing e waste management of the electronics at various levels. It has also offered both theoretical and conceptual framework.

Electronic waste production has continued to grow in both developed and emerging countries. Humans are struggling with the management of the continued generation of wastes and how to limit these as well as handle the wastes resulting from different human activities, particularly in the discharge of wastes into the environment. The impact of the waste disposal is manifested in the negative effects it has on the flora and fauna; impinging on the health of the environment, its ecosystems, loss of biodiversity as well as on human health. It is therefore prudent to understand such relationship in an attempt to waste management and generation.

The unprecedented increased in the usage of electronic equipment globally, combined with rapid obsolescence, development of new product, or desire for new gadgets creates actual substantial volumes of wastes, creating very serious global pollutions problems from the standpoint of disposing and recycling and the likelihood of across bounders movement of such wastes. Challenges in the management of e-wastes including those from laptops, desktops and computers accessories which include development and implementation of legal framework, financial flow and materials of e-waste, the stake of informal recycling and the reluctance of peoples to pay fees for recycling among others have led to stockpile of e-waste materials(StEP , 2004).

2.6.2 Research Gaps

The researcher has reviewed relevant literature and discovered that while Africa is positioned to continually experience high density of cheap EEE, there have been no concerted effort to properly recycle and dispose those EEE considered as e-waste after its short-lived life. Additionally, there are under-reported empirical evidence of the magnitude and the challenges of e-waste generally in Africa. Over and above, while there have been

researches and propositions by scholars and intellectuals from institutions of higher learning, the institutions from which those academics represents still face the challenges of an effective disposal of e-waste; this include University of Nairobi. Thus the researcher find answers to the factors that poses challenge to an effective E-waste management within the University of Nairobi.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1. Introduction

The chapter gives an summary of the methodology of research; it includes research design, study area, data collection source and method, data collection tools, target population, sampling techniques and size, data analysis and research ethics. The purpose of the study is to assess effect of increasing e-waste materials in institutions precisely The University of Nairobi.

3.1.1. Study Area and Nairobi University Overview.

The University of Nairobi is situated in Nairobi county Central Business District (CBD), a rapid developing city with a inhabitants estimated over 3.5 million. The city centre has an estimated 700 square kilometres with the altitude of 1,675 metres above sea level. It is 480 kilometres west of the Indian Ocean. Underneath the University of Nairobi 1985 Act, the University established six Colleges. The colleges are as follows: College of Humanities and Social Sciences (CHSS), College of Health Sciences (CHS) ,College of Architecture and Engineering (CAE) ,College of Agriculture and Veterinary Sciences (CAVS), College of Biological and Physical Sciences (CBPS), and College of Education and External Studies (CEES).

This research was conducted in University of Nairobi premises in four selected campuses: Main campus, Chiromo, Lower Kabete Campus and Upper Kabete Campus. As shown in figure 3.2; the main campus is situated in Nairobi central business district on latitude and longitude $36^0$48’58.5”E and $1^0$16’48.432”S respectively. The Chiromo campus is situated along Groganville Estate, which host the college of physical and biological sciences, with latitude and longitude $36^0$48’27.936”E and $1^0$16’24.492”S respectively. The lower Kabete is the school of Business located on latitude and longitude $36^0$44’16.548”E and $1^0$14’15.576”S respectively. The upper Kabete is the College of Agriculture & Veterinary Sciences, located on latitude and longitude $36^0$44’5.424”E and $1^0$15’4.248”S respectively. The University has the total enrolment of about 98,713 in 2015 (Kofa, 2016).

Figure 3.1 Views of the Four UoN campuses

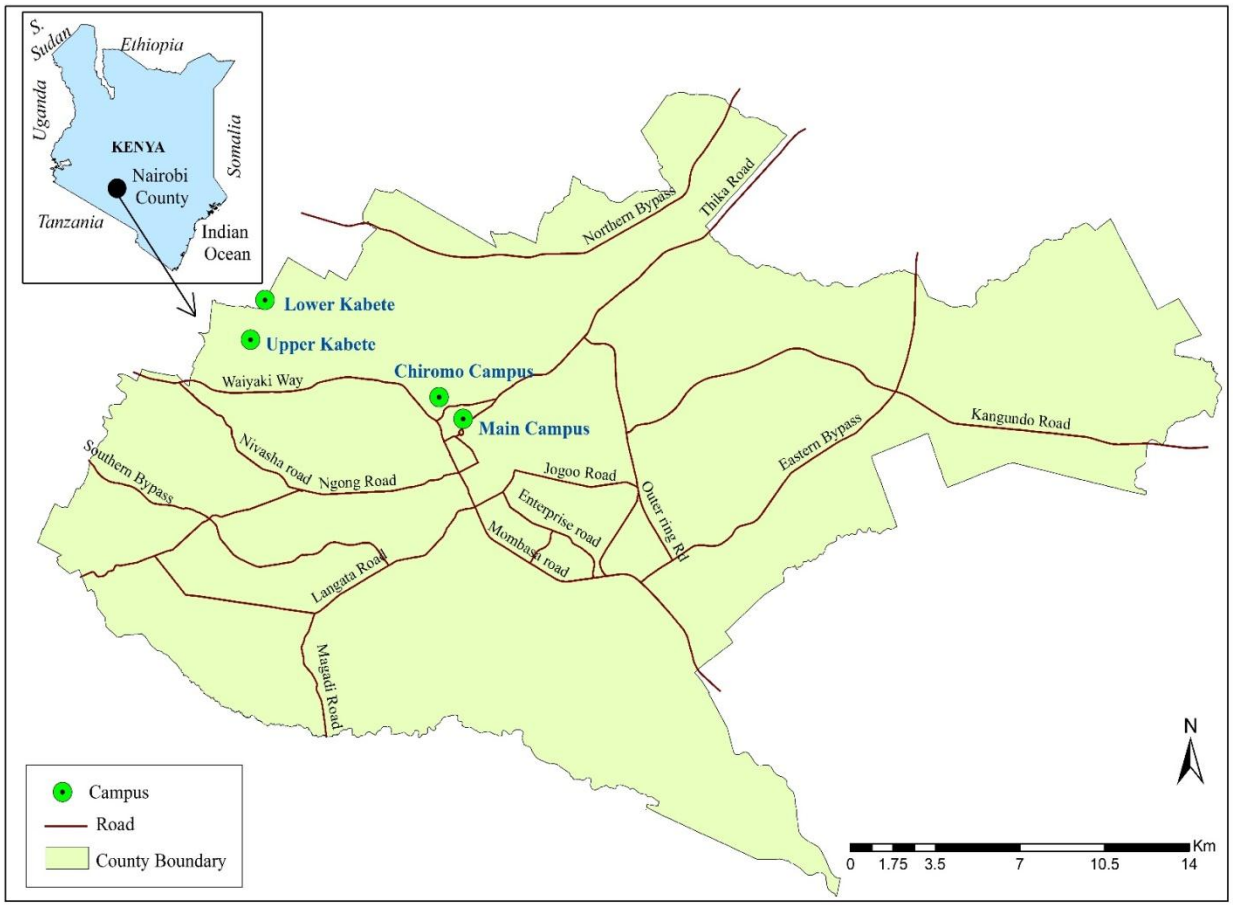
Main Campus

Chiromo Campus

Upper Kabete Campus

Lower Kabete Campus

Figure 3.2 Location of the four UoN campuses



Source: Survey of Kenya (2011) and Author (2016)

3.2.1. Justification for choosing to study at the University of Nairobi

University of Nairobi was selected based on the fact that the institution produces the highest number of graduates in Kenya and as well as the highest number enrollment according to Kenya Universities and Colleges Central Placement Services (KUCCPS, 2015). This means that the number of computer users (Students, Lecturers and staffs) will be higher as compare to other universities with lower number of enrollments within Kenya. Therefore, there will be generation of e-waste which requires a research to ascertain the disposal method of the said e-waste.

Within the University of Nairobi(UoN), the number of courses offered and enrollment into main campus, chiromo, upper and Lower Kabetes campuses are much higher than the rest of the campuses (Amain, 2015). As the results, there will be higher number of computers users as compared to the rest of the campuses and such e-waste will be generated. Based on these factors, the University of Nairobi was selected for this research.

3.3. Research Design

The study examines e-waste disposal in the University of Nairobi computer labs and offices using number of techniques and approaches which includes explanatory survey, descriptive analysis, case study and statistical analysis. Explanatory survey take into account the detailed respondent view and explanations with reference to situation -analysis as regards to the research, there will be usage tables and figures to explain the outcome investigation. It also allows the assemblage of large amount of data from a substantial inhabitants in a highly economical way. It allows one to collect quantitative and qualitative data which can be analyzed quantitatively and qualitatively correspondingly using descriptive analysis with statistical inferences (Saunders *et al.* 2007). Hence, descriptive and quantitative surveys are both deem the best strategies to fulfill the objectives of the research.

3.4. Targeted Population and Sample frame

A study population is a precisely known by gathering of people or items recognized to carry alike features. Research population usually carries individuals or objects that has common, binding characteristic or trait. In this study, the researcher focuses on population

consisting to university of Nairobi computer device users among the students, academic staff, procurement and maintenance staff and ICT staff within the Main campus, Chiromo and upper & Lower Kabetes.

3.4.1. Targeted population, Sample frame and Sample size

According to Explorable.com (Nov 15, 2009), the population of the research is generally a large collection of individuals or objects that is in the main focus of a scientific query. It is due to the benefits of the population that researches are done. Nevertheless, due to the large sizes of populations, researchers often cannot test every individual in the population because it is too expensive and time-consuming. This is due to reason why the researchers depend on smaller sample size and multi stage purposive sampling techniques since the total population of students in University of Nairobi is 98,713 (Kofa, 2016) and the population of staff is about 250 (UoN handbook, 2009).

According to Given (2008), in order to get valid and reliable data, it is important for the researcher at his justifiable discretion, to focus specifically and select a sizeable sample that best inform the research. Therefore, the researcher adopts multi stage purposive sampling technique in three stages. As show in Table 3.1: the 1st stage is to be the purposeful selection of University of Nairobi computer device users. The 2nd stage is the purposeful selection of four campuses within the university of Nairobi as the sample frame, namely: main campus, upper Kabete campus, lower Kabete campus and Chiromo campus. The 3rd stage involves the purposeful selection in "Multi stage sampling" to select Students and Academic Staffs as direct users; and service providers/facilitators like the Computer Lab Manager (Senior Staff), ICT staffs (Junior Staff), and Maintenance and procurement Partners each from the respective four campuses.

Table 3.1 Multi stage purposive sampling

1st Stage	2nd Stage	3rd stage	Targeted Number
University of Nairobi Computer Users	Main Campus	Students	10
		Computer Lab Manager (Senior Staff)	5
		ICT staffs (Junior Staff)	
		Academic Staffs	5
		Maintenance and procurement Partners	5
	Chiromo Campus	Students	10
		Computer Lab Manager	5
		ICT staffs	
		Academic Staffs	5
		Maintenance and procurement Partners	5
	Lower Kabete Campus	Students	10
		Computer Lab Manager	5
		ICT staffs (Junior Staff)	
		Academic Staffs	5
		Maintenance and procurement Partners	5
	Upper Kabete Campus	Students	10
		Computer Lab Manager	5
		ICT staffs (Junior Staff)	
		Academic Staffs	5
		Maintenance and procurement Partners	5
Total			**100**

Source: Author 2016

3.5. Data collection sources and methods

The data collection method for the chapter 1, 2 and 3 was sourced from secondary sources from library and internet sources features from articles, journals, and other reference materials. The primary data was obtained using questionnaires administered to students, ICT staff, academic staff, maintenance and procurement partners. Additionally, the data was supported by those secondary sources; and interviews from National Environmental Management Agency(NEMA) and the Ministry of Environment and Natural Resources within Kenya

3.6. Data collection tools

The following tools were used for the research: introductory letter to respondents, respondent, consent form, observation checklist, questionnaires, and interview guide for data collection from key informant which is the National Environmental Management Agency(NEMA) and Ministry of Environment and Natural Resources in Kenya.

3.7. Data analysis and presentation

Before going to the field to collect data, questions were arranged in accordance with the research methodology and data collected in such order from the field and was be thoroughly scrutinized for completeness. Quantitative data was analyzed in accordance to categories; content and study themes and the results were interpreted using descriptive statistical data from questionnaires and interview using the Statistical Package for Social Sciences version 22 (SPSS). Descriptive statistics was used to presents some of the most exemplary ways of summarizing and displaying data by using data presentation tools such as tables, bar chart and graphs. The use of descriptive statistics was used particularly in screening the data to determine its reliability and consistency. Another statistical technique that was in this study is cross-tabulation. Cross-tabulation examines the relationships between the variables; this is good in representing values of two or more variables at the same time.

3.8. Research ethics

Ethics in research are guidelines or codes that enable to reconciled the price disputes. Even though directions are provided through ethical codes, and the choices in research must be made to reached in seeing the exact options obtainable. The potential risks to the participants are choices considered against each case which weigh the potential contribution of the research . Considering these options is fundamentally personal, involves a judgement amongst the required experiences in the research and things anticipated in daily lifetime (Gillespie, 1995).

Creswell (2007) acknowledges that researchers however practical and detailed their approach maybe, often faces varied limitations in the field when gathering data. This study is not exceptional and in its course some limitations might be encountered. Some may include the limitations of time to cover the targeted population but the researcher engaged three research assistants which assisted in data collection.

3.9. Research Limitations

Sampling proposed was to have at least 10 student, 5 academic staff, 5 ICT staff, and 5 maintenance and procurement partners; and this sums up to sample size of 100. However, the study was able to sample 83 persons. whilst conducting key interview at the Ministry of Environment and Natural Resources (MENR), time was a limitation, also considering the fact that the interviewee (Deputy Director for Policy) requested an unstructured and unguided interview. There was low assistance and organizational coordination at the Communication Authority of Kenya (CAK); thus there were no data collected from the said office.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1. Introduction

This chapter provides the demographics i.e. age, gender and educational attainment of the direct and indirect computer users focused in the study. In the chapter, the presentation of data collected from the field focused on the four objectives of this study specifically analyzing in the University of Nairobi, the level of E-waste from induced technological usage; E-waste disposal methods outlining the methods, hazards, and means employed to facilitate proper disposal; regulatory framework of E-waste disposal; and challenges of disposing End-of Life computer devices.

Table 4.1 Sample Distribution Summary

User	**Category**	**Main campus**	**Chiromo Campus**	**Lower Kabete**	**Upper Kabete**	**Total**	Percentage
Direct Users	Students	10	10	8	10	38	**45.78%**
	Academic Staffs	2	3	2	2	9	**10.84%**
Indirect Users	Computer Lab Manager	1	1	1	1	4	**4.82%**
	ICT staffs	4	4	2	4	14	**16.87%**
	Maintenance and procurement Partners	5	5	5	3	18	**21.69%**
Total		22	23	18	20	83	**100.00%**
Percent		**26.51 %**	**27.71%**	**21.69%**	**24.10%**	**100.00 %**	

Source: field work survey, 2017

Out of the 83 sample size, consisting of direct user (56.62%) and indirect users (service providers, 43.38%); 26.51% were from Main campus, 27.71% from Chiromo campus, 21.69% from lower Kabete and 24.10% from Upper Kabete. Thus the sample size takes

into consideration in almost equality both the direct and indirect users with little difference among the respective sample from various campuses.

4.2. Demographics Characteristics

4.2.1 Gender of Respondents

Direct users (student and academic staff)

Out of the 56.6% of direct users, 45.78% were students (12.05% each from Main campus, Chiromo and 12.05% upper Kabete respectively; and 9.64% from Lower Kabete); while 10.84% were academic staffs consisting of 3.61% from Chiromo campus, and 2.41% each from Main campus, Lower Kabete and Upper Kabete respectively. The ratio of academic staff in this study can be considered as fair representation since the ratio of teacher to student in Kenya public educational institution which UoN is part of, is estimated as 1 teacher to 40 student (Global Economy, 2017).

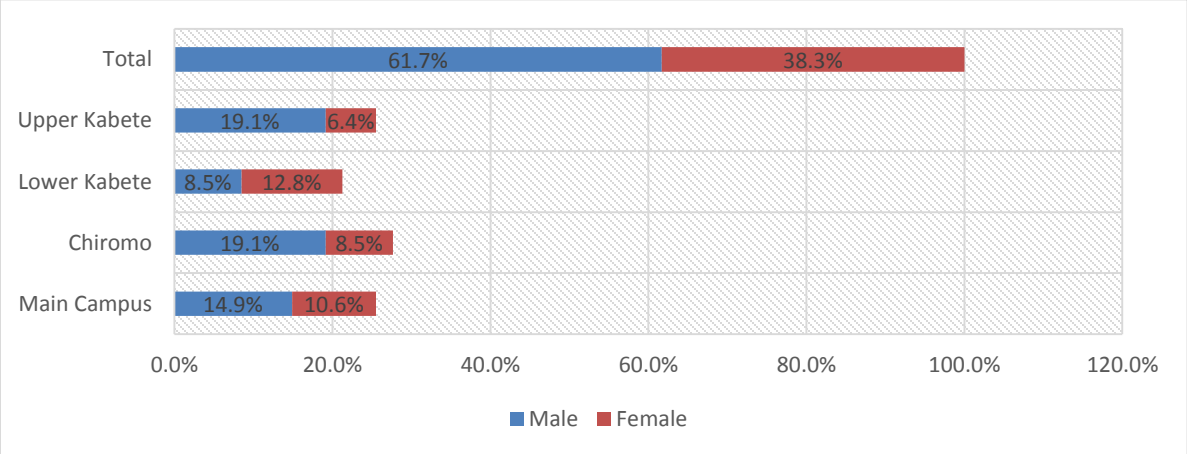


Figure 4.1 Gender of Direct Users

Source: field work survey, 2017

The gender of the direct users were 61.7% male and 38.3% female. In Main campus, Chiromo and Upper Kabete the male were more represented (14.9%, 19.1% and 19.1% respectively) with the least from Lower Kabete 8.5% where the females were sampled more (12.8%). This confirms a report that males are more engaged in the technology and ICT sector as both employee and users (Alison & Mariama, 2013). This means that the

male gender are likely to have end-of-life computer after long usage and thus more likely to produce e-waste.

Computer Lab Manager

There were four computer lab managers one each from the four campuses. The GIS lab in Main campus(Department of Geography and Environmental Studies) and the computer lab in upper & lower Kabetes were both established in 1998 while the computer lab in Chiromo was in 2000.

ICT Staff

The ICT staff interviewed were composed of 9 males and 5 females. More than half of them about 9 are aged below 34 years while majority of them are within the age bracket of 25 to 34 years. This validates Alison & Mariama (2013) assertion that male are more employed in the ICT sector in Africa.

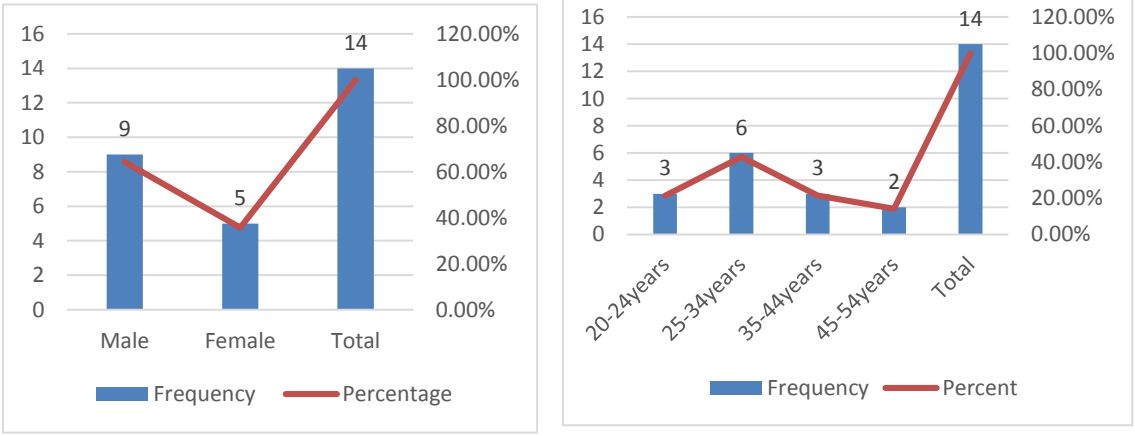


Figure 4.2 Gender and Age of ICT staff

Source: field work survey, 2017

Most of the ICT staff have attained university as their highest level of education while only about 4 have secondary school as their highest educational level. Their level of education. This confirms that the means the ICT sector is an educational sector where there higher number of higher education certificate holders can be found. This gives the sector an

advantage of the foundational knowledge to creating innovative ideas which can a well address the problem of e-waste.

4.2.2 Education Attainment

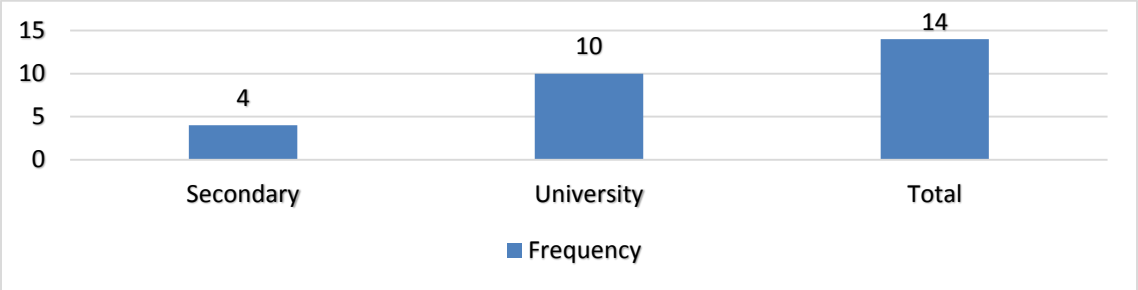


Figure 4.3 Educational Level of ICT staff

Source: field work survey, 2017

4.3. Level of E-waste from induced technological usage in University of Nairobi

The observation checklist covers specifically computer lab and ICT centres within the 4 campus location of this study. The list shows that there are about 1084 pieces of abandoned E-waste in the targeted campus locations. Those e-waste consist of 35% cords and wires, 18% CPUs, 10% Monitors, 9% Keyboards, 8% mouse, 8% touch/shade screens, and other items like laptops, printers, scanners, projectors, UPS and sensors which amounts about 12%. Out of the 49% E-waste within the main campus, 17% were cord and wires, 11% were monitor and Touch screen each with equal share, 7.5% CPU, 6% Keyboard, and 4% were mouse.

Chiromo campus accounted for 24% of the 1084 e-waste, cords and wires (8%) were observed to be the high e-waste within the lab premises, CPU is about 6.5%, and keyboard and monitor at approximately 3% each. Out of the total e-waste in all targeted campuses, Lower Kabete accounted for 16%; 6.6% presence of cords and wires, 3% were CPU and mouse and monitor were 2% each. Upper Kabete accounted for 10%; with recorded 4% cords and wires, while monitor keyboard, mouse and CPU accounted for 1% each.

Plate 1& 2: Indisposed e-waste at the engineering building in one of the offices
Source: Researcher 2017

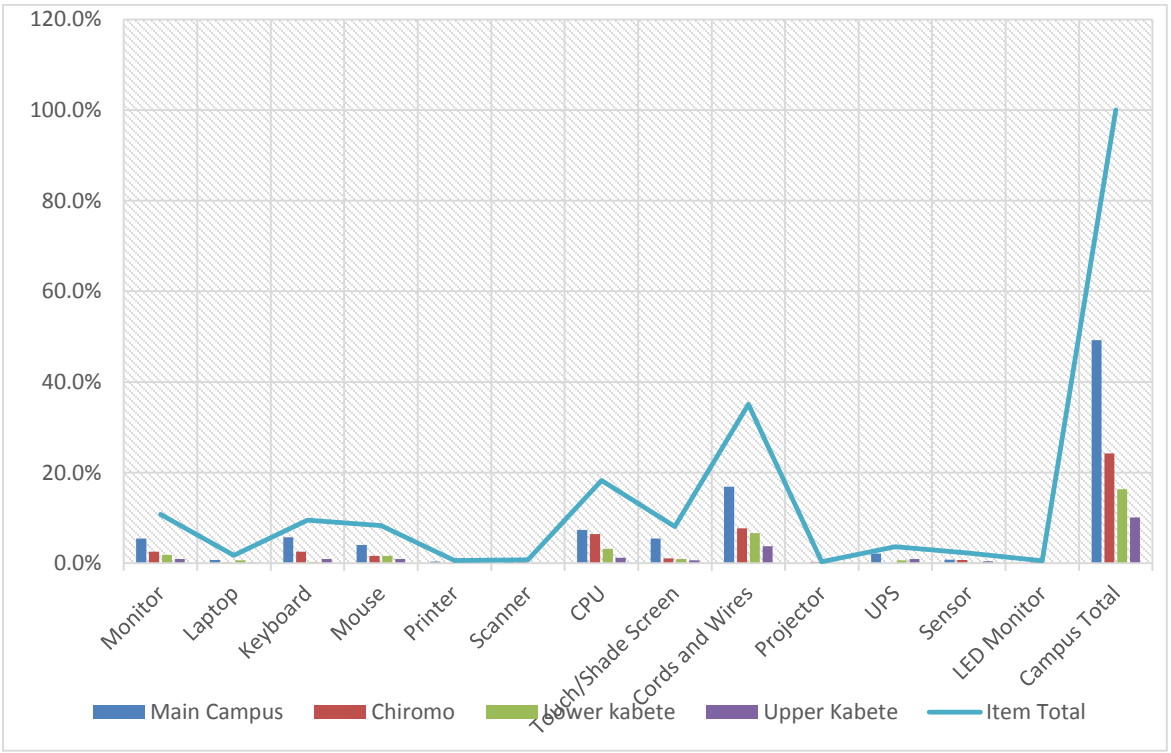


Figure 4.4 Observation Checklist Graph on e-waste Level

Source: field work survey, 2017

The observation checklist indicated that about one third of e-waste in UoN targeted campuses are cords and wires; one fifth are CPUs; and four out of every ten are monitors, keyboards, mouse and touch screen. This also suggest that the main campus has an increased use of technological devices followed by Chiromo, lower Kabete, then upper Kabete. This will literally suggest that the level of e-waste management required will follow in same order among the various campuses. The main campus is home to numerous undergraduate and postgraduate courses and with its geographical location in the Central Business District of Nairobi (CBD), it is not surprising to observe an increased usage of technological devices which poses challenge to e-waste management. The UoN campuses locations decreases in its use of technological devices as their distance from the Nairobi city decreases. The speedy growth and development of the ICT arm in virtually all the sectors and institutions in any country have made it possible for spread WEEE in Africa. (Schluep *et al* 2012). Thus pointing out the influence of urbanization on the increased need and use of technological device which ultimately increases the volume of e-waste. Another justification for this can also be attributed to the fact that the volume of activities decreases from main campus to Chiromo, to lower Kabete and then upper Kabete.

Plate 3 & 4: Indisposed e-waste at the ICT office main campus
Source: **Researcher 2017**

4.4. E-waste disposal methods in University of Nairobi

4.4.1 Current disposal methods

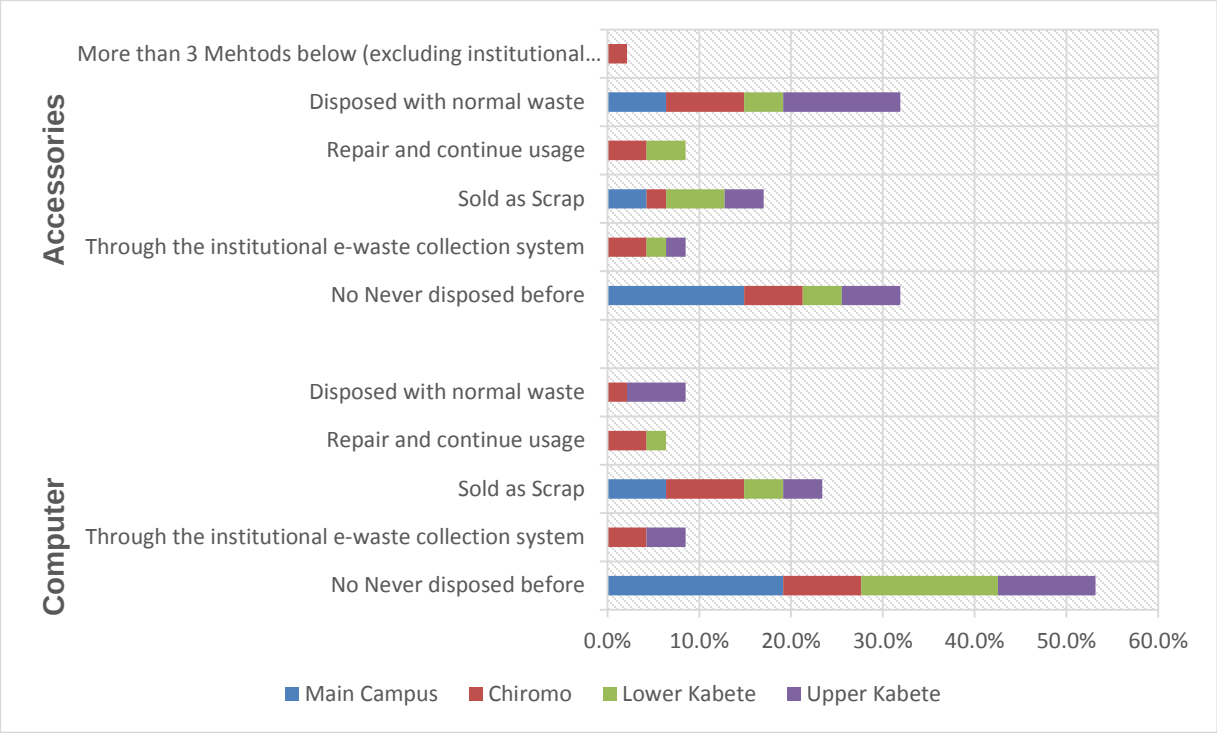


Figure 4.5 E-waste Disposal Methods by Direct users

Source: field work survey, 2017

The direct users dispose more of their accessories e-waste than the computer e-waste; and most of the accessories are disposed with normal waste (mostly in Upper Kabete) or sold as scraps (mostly in Lower Kabete). In main campus, the direct users dispose their accessories through selling as scrap and mainly disposing it with normal waste. While in Chiromo, disposal is chiefly through disposal with normal waste. while Lower Kabete is mainly through selling as scrap. Most of those that have never disposed their accessories were mostly from the Main campus.

The ICT staff from the four campuses, identified the means of computer-disposal to be: through the institutional e-waste collection system, procurement process of reselling, selling as scrap, putting them in storage, repairing them for usage and burning them.

Most of the direct users (52.3%) stated that they have never disposed their e-waste before; most of whom were from the Main campus. The method of e-waste disposal by direct users is chiefly through selling them as scraps (23.4%) most of whom were from Chiromo (8.5%) and main campus (6.4%) while those that have sold them as scrap. The second method is through institutionalized e-waste collection system (8.5%) and likewise the disposal with normal waste (8.5%); both only in Chiromo and Upper Kabete. Repairs for continued usage was accounted in Chiromo and lower Kabete.

Mureithi *et al* (2008) identified that the chief means through which e-waste disposal takes place in Kenya is through mainly reselling which ends up as general waste. This confirms the narrative on the direct users in UoN.

In Main Campus, the direct users usually do not engage in disposal and most of their e-waste are sold as scraps or left unattended; while the ICT staff engage in institutional e-waste collection system, repair for continued usage, and burning. Also for ICT staff; upper Kabete uses all the disposal methods identified while in Chiromo campus, all methods identified are used with an exception to institutional collection and repair for continued usage. This reverse (exclusion of institutional collection) is the case for direct users in those campuses as shown in figure above. In lower Kabete campus, the ICT staff either stores or sells the e-waste through the procurement office; while the direct users repairs for continued use and mostly sells it as scraps.

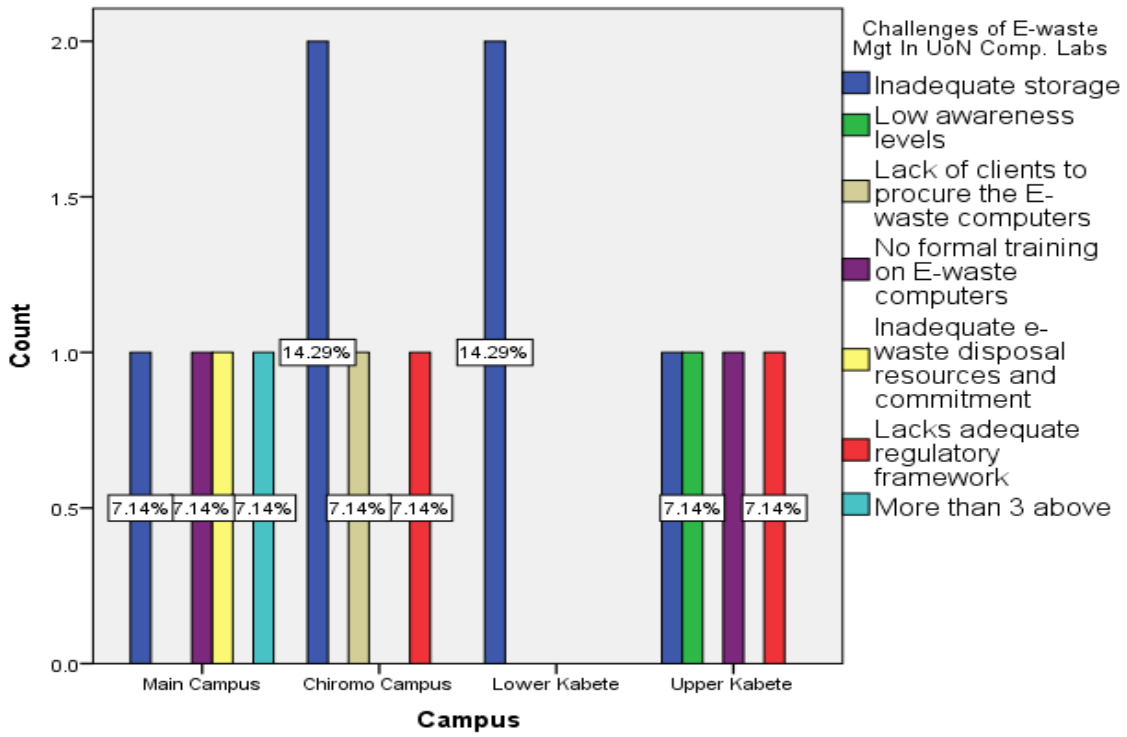


Figure 4.6 E-waste disposal method by ICT staff

Source: field work survey, 2017

The lab managers indicated that: within the Main campus, the GIS and Remote Sensing Lab in order to institutionalized a system of disposing e-waste, have liaised with a company that collects some e-waste within the Lab for disposal and recycling. The lab is faced with the challenge of internal recycling and thus only refurbish and reuse technological parts that can be made useful.[1]

The method of e-waste disposal in the Chiromo campus computer lab is selling the device as craps through issuing of tenders, also some of which are not sold but are put into storage within a designated space. Most of the computer parts are left abandoned while some that are useful are re-paired for re-use[2]

The school of business computer lab in lower Kabete indicated that the method of disposal is storage and selling as scraps upon advertisement while those not sold are reused in during repairs of spoilt computers.[3]

[1] GIS/Remote Sensing Lab interview with Researcher, 2016
[2] Chiromo Computer lab interview with Researcher, 2016
[3] Lower Kabete Computer lab interview with Researcher, 2016

All the computer lab senior staff identified that the method of disposal usually includes: through the institution disposal through liaising with groups that move the computer away; procurement process of reselling through issuing of tenders where bidders have the option to reuse or dispose them; dumping and storage within the premises of the university. While the computer parts are either recycled, thrown away as normal waste, burned, stored, shredded or left unattended.

The MPP as referenced by the ICT staff and computer lab mangers, are the main contact through which most of the e-wastes in UoN are disposed. The MPP identified institutional e-waste collection system of UoN as a system where the un-used ICT devices/e-machines, placed a designated space are systematically inspected to: (a verify its if it is actually non-usable and b) stored to be decided upon (usually burnt afterword or useful part recycled). The UoN' MPP disposal methods across the campuses includes institutional collection system of e-waste, selling the e-waste as scrap, repairing for continual usage and normal disposal of the e-waste with other non-e-waste.

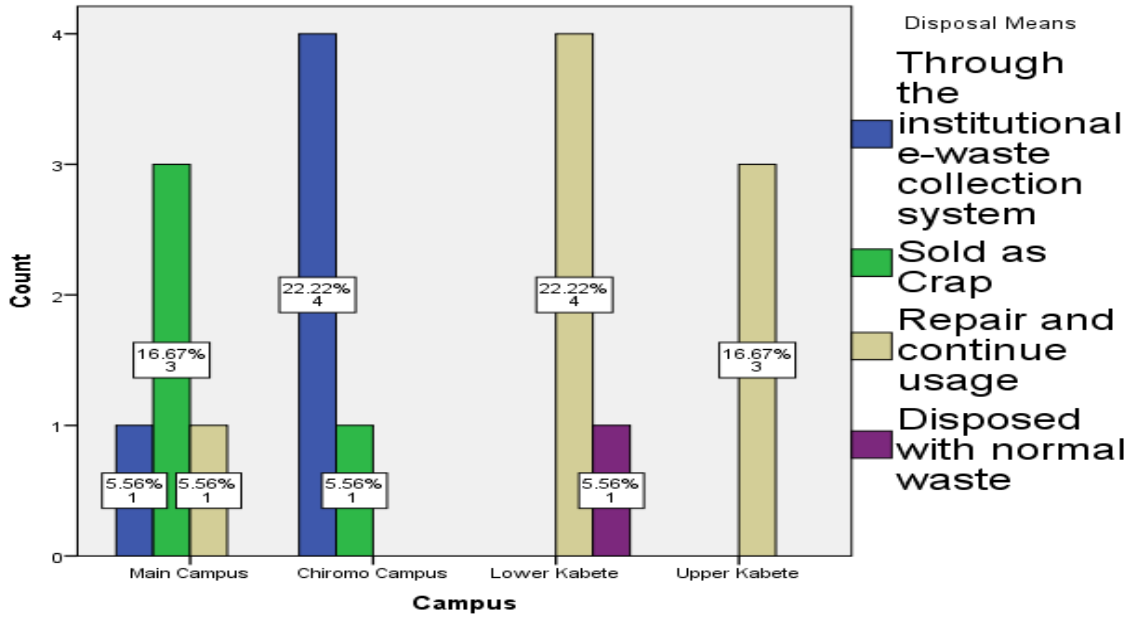


Figure 4.7 Waste disposal by MPP department

Source: field work survey, 2017

In main campus, most of the e-waste collected by the MPP office are sold while few are repaired for further usage, and others either left stored or burnt. Indication from the figure above shows that e-waste are either stored/burnt or sold as scraps, while e-waste are usually repaired for continual usage in upper Kabete. In lower Kabete, the e-waste are mostly repaired and reused while few are disposed with normal wastes.

In Kenya, there are four e-waste disposal management companies officially known to NEMA. Safaricom and Technical University of Kenya in partnership with NEMA which has embarked on the collection of e-waste in many institutions in Kenya. Safaricom has distributed specifically e-waste receptacles in some locations within Nairobi. Also, the company have also established a scheme for the purchase of e-waste at a considerable price.[4]

The major e-waste management Centre in Kenya is in Athi River, in a town outside Nairobi. Egerton University has e-waste management scheme that remodel e-waste into other new gadgets.[5]

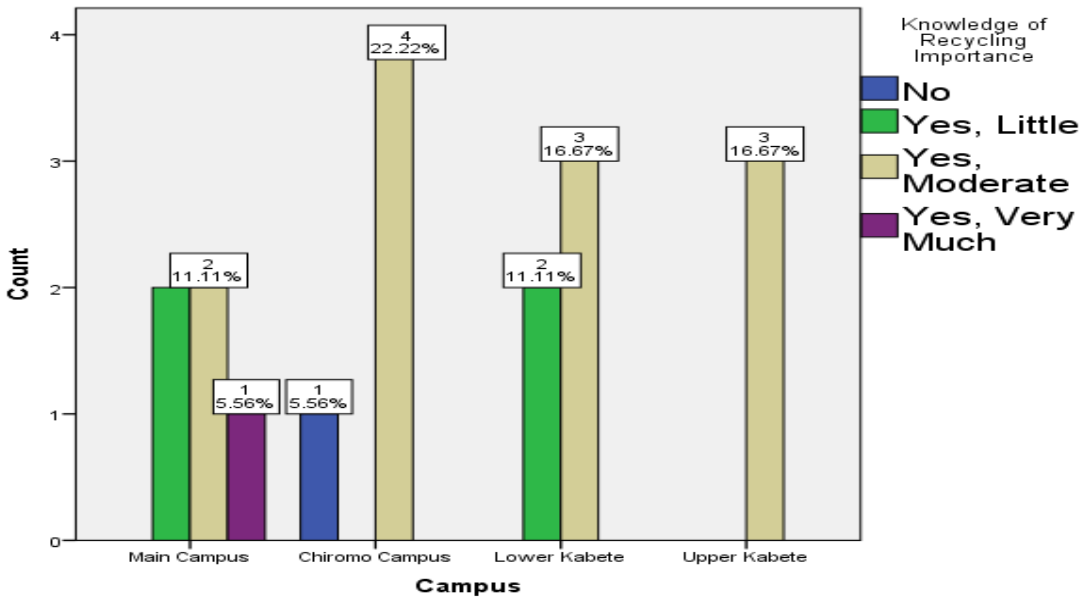


Figure 4.8 MPP knowledge on the importance of recycling

Source: field work survey, 2017

[4] NEMA Head of Waste Management, Interview with Researcher, 2017
[5] MoE Deputy Director for Policy, Interview with Researcher , 2017

Attempts in Kenya to implement university environmental e-waste management policy have not been fully explored as only recently the Kisii university launched e-waste management point in its campus. (MoENR, 2017). Also, Egerton and Technical University of Kenya.[6]

Most of the MPP had moderate knowledge on the importance of recycling seconded by a category with little knowledge about recycling. Most in upper Kabete had moderate knowledge similar to those in upper Kabete who either have moderate or little knowledge about recycling. The campus that had more and divergent understanding of recycling is the main campus. This factually indicates that main and Chiromo campuses have more recycling knowledge than upper and lower Kabete campuses; this explains why in figure 4.3, the main and Chiromo campuses engage in more disposal methods than the other two campuses. And thus lower and upper Kabete are more likely to have continuous contact with end of line e-machines

4.4.2 Hazards of undisposed E-waste

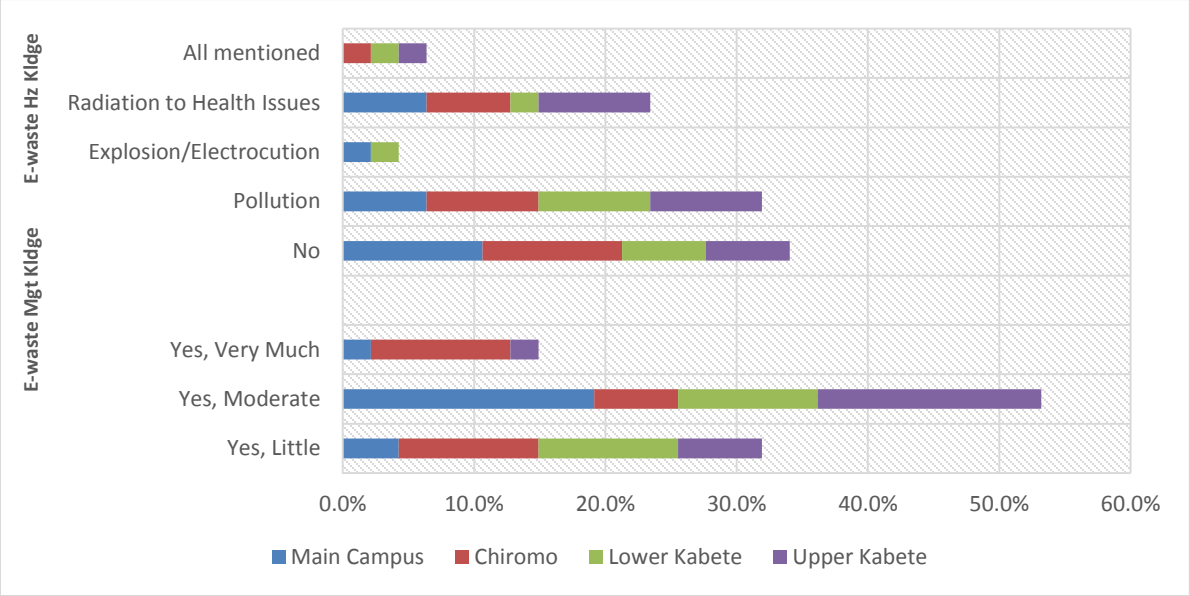


Figure 4.9 Knowledge of E-waste Management and Hazard by Direct users
Source: field work survey, 2017

[6] NEMA Head of Waste Management, Interview with Researcher, 2017

The direct users' majority indicated they (53.2% moderate and 14.8% very much) have above average knowledge on the management of e-waste; most of whom were from main campus and upper Kabete. Those with outstanding knowledge (14.8) were mostly from Chiromo campus (10.6%). In validation of the claim about their knowledge on e-waste: 66% of the direct users mentioned 3 categories of hazards of e-waste. Air and soil Pollution through emission/radiation and leakage of lead/mercury respectively accounted for 31.9% is the most identified; secondly by 23.4% stating issues related to radiation and emission causing health problems; and lastly explosion and electrocution hazards (4.3%).

In validating the direct users claim: most of the ICT staff are aware of the hazards associated with e-waste. their indication suggests that e-waste can cause both air and soil pollution through emission of chemicals which further has consequences on respiratory health; cause environmental pollutions through leakages for example from the batteries which contain lead and mercuric elements, radiation and emissions that are dangerous; and cables and wires which can conduct an electric charge and may result to shock or electrocution if left unattended.

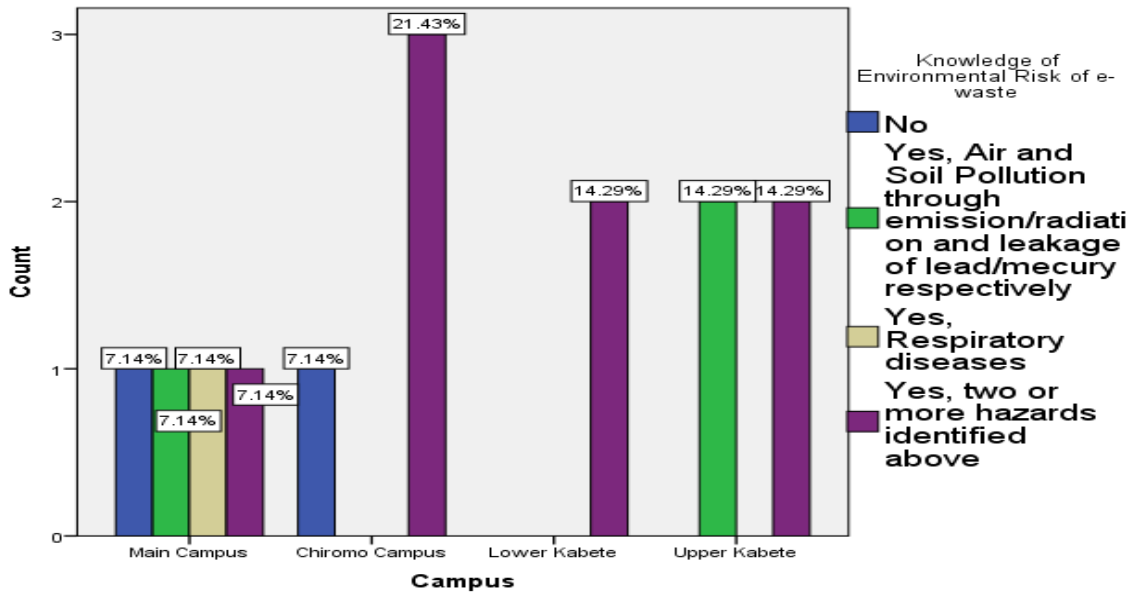


Figure 4.10 Knowledge on E-waste hazards by ICT staff

Source: field work survey, 2017

While most of the ICT staff were able to state the hazards from e-waste: those in upper Kabete specifically stated emission, radiation, lead and mercury leakage which causes pollution.

In validating the significant pollution effect from e-waste as stated by the direct users; burning exposes harmful pollutants like tin, lead, hydroxylated PBDEs (polychlorinated diphenyl ethers), PAHs (polycyclic aromatic hydrocarbons) and other heavy metals to the environment potentially cause pulmonary like chest pain and cough; and carcinogenic issues. (Boaten, 2011; Reddy, 2015; Feldt, T *et al*, 2014) The computer labs[7] were also cognizance of the hazardous components of e-waste especially the Thin Film Transistor components; the potential chemical discharge from burnt e-waste and the possible ozone layer depletion and carcinogenic residue from e-waste. Additionally is the possible discharge of toxics such as lead, mercury and cadmium which cause leak to the soil and water. This leave a gap on the fact that despite the informed knowledge of the personnel in the various computer labs, there are still no proper and safe mechanism initiated to ensure that e-wastes are safely disposed.

The MPP stated that undisposed or improperly disposed e-waste can be explosive, cause radiation, chemical pollution, and health defects from continues contact with e-waste. Some MPP personnel in Chiromo and lower Kabete campus had not one information on the potential hazardous nature of electronic waste. While this figure is low, it is very important that all staff involved in processing e-waste be made aware of the hazards involved.

[7] Computer Labs interview with Author, 2016

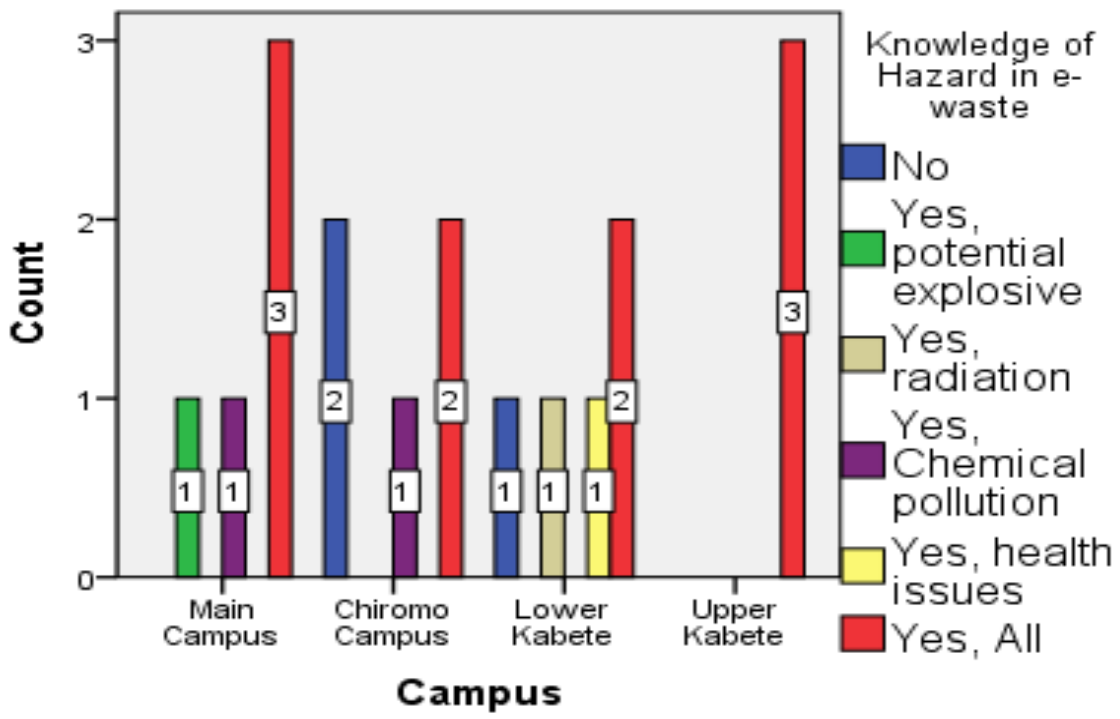


Figure 4.11 Knowledge of e-wate Hazards by MPP

Source: field work survey, 2017

4.4.3 Means employed to facilitate proper e-waste disposal

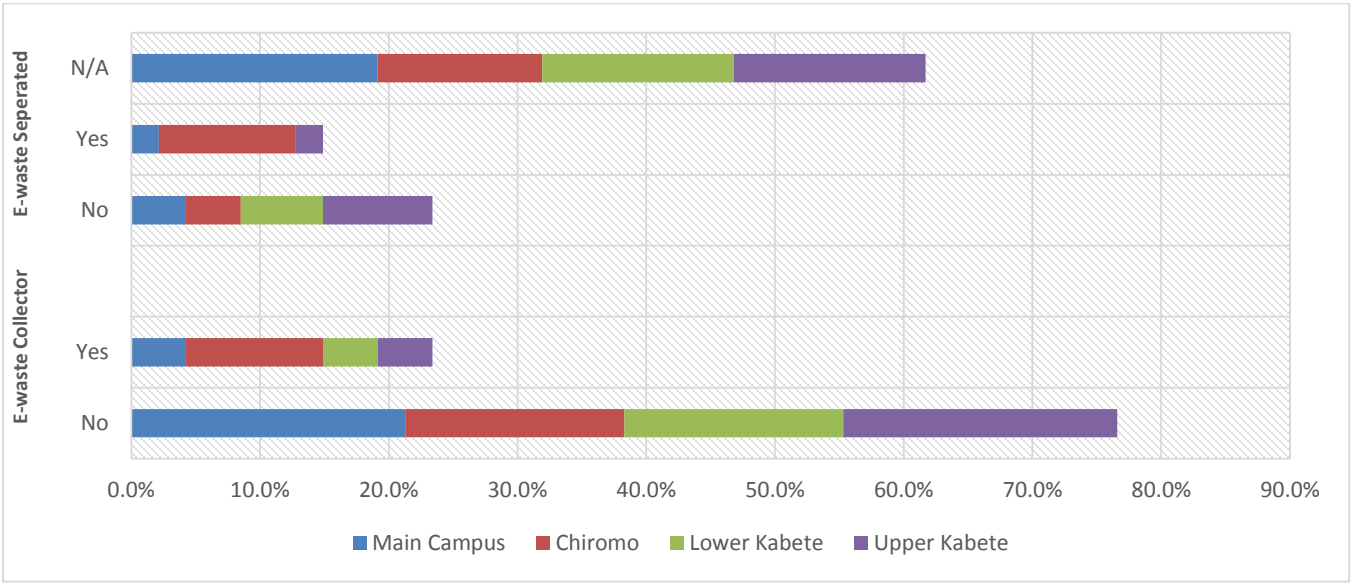


Figure 4.12 Direct user E-waste collection and Separation system

Source: field work survey, 2017

Most of the direct users direct users (76.6%) stated that there are no e-waste collection mechanism through which to dispose their e-waste and this was validated by the 61.7% direct users indicating none applicability of e-waste separation system since there is no e-waste collector. Among those (23.4%) that identified the presence of e-waste collector, only 14.9% stated that there is separation of e-waste from other wastes.

Table 4.2 Presence of e-waste collection identified by MPP

Collection Mechanism in campuses	**Percent of Yes Cases**				
	Main Campus	Chiromo Campus	Lower Kabete	Upper Kabete	All Campus
There is E-waste collector	11.1%	5.5%	22.2%	5.5%	44.3%
The E-waste is separated by the collector	5.5%	5.5%	22.2%	5.5%	38.7%
Weight	8.3%	5.5%	22.2%	5.5%	41.5%

Source: field work survey, 2017

As identified by the MPP, the presence of e-waste collector in UoN is below average (44.3%), showing that large chunk of e-waste are left uncollected or left abandoned within the premises of the campuses; this is in agreement with the direct users' claim. More collection is estimated have occurred in lower Kabete campus with fewer in main campus and lesser in both Chiromo and upper Kabete campus. Also the separation of E-waste as identified by the MPP shows low separation process. The mechanism of collection i.e. both collector presence and separation process fall below average thus an indication that most of the e-waste are not collected and are usually not separated from other form of wastes.

Table 4.3 ICT staff on E-waste Managing Capacity

Mechanism in campuses	Percent of Yes Cases				
	Main campus	Chiromo campus	Lower Kabete	Upper Kabete	All Campus
Presence of E-repair Corner	14.3%	7.1%	0%	14.3%	35.7%
Standard UoN E-waste Manual	28.6%	21.4%	14.3%	14.3%	78.6%
Record Keeping of UoN E-waste	14.3%	14.3%	7.1%	28.6%	64.3%
UoN Staff Training on Occupational Health	21.4%	7.1%	14.3%	7.1%	50.0%
Have E-waste Receptacle	14.3%	14.3%	0%	28.6	57.1%
Recycling aided at UoN E-waste disposal facility	21.4%	0%	7.1%	0%	28.6%
Weight of Mechanism	**19.1%**	**10.7%**	**7.1%**	**15.5%**	**52.4%**

Source: field work survey, 2017

From the agreement scale of the ICT staff on the responses of mechanism to facilitate e-waste management in various campuses: significant response showed that upper Kabete have e-waste receptacle; lower Kabete have been engaged in occupational health training and have standards on waste management; while the main campus also indicated to have standard on e-waste management. Over and above, the mechanisms employed by the main campus have higher in cooperated strategy than upper Kabete, while Lower Kabete had higher than Chiromo campus. However the overall strategy employed cumulatively by all the campuses is still average and slightly above 50% as shown in table 4.3

Specific details from the table 4.3 shows that there are less presence of e-repair corner and less mechanism to aid recycling during disposal of e-waste at the UoN. This is an indication that there are less efforts put in place to ensure recovery of damaged e-machines or repairing spoilt e-machines. It is important to note that the whole campus recorded higher indication of an existing UoN e-waste manual because of their knowledge of the Procurement and Disposal Act. It is however important to note that no clear terms of e-waste disposal was referenced in the document as explained in section 4.5 ‘regulatory framework’.

A study by Munyugi (2012) found that the method of e-waste disposal at the university of Nairobi is not effective and more likely to increase the e-waste generation within the environment of University of Nairobi. This is so because the challenging of e-waste and procurement of electronic devices are not properly managed. He further stated that the GoK is aware of the challenges to e-waste management but have not put measures in-place to address the issue due to low level of e-waste management preparedness level of policy.

4.5. Regulatory Framework and E-waste disposal

Table 4.4 Whose' Responsibility in UoN to Manage E-waste identified by Direct Users

Campus	Waste Management Team/Cleaning Dept.	Collective Responsibility	Procurement and Maintenance and ICT Department	Electronic user	None	Disposal Committee	Total
Main Campus	4.3%	6.4%	4.3%	0.0%	10.6%	0.0%	25.5%
Chiromo	8.5%	0.0%	0.0%	0.0%	14.9%	4.3%	27.7%
Lower Kabete	2.1%	2.1%	0.0%	2.1%	14.9%	0.0%	21.3%
Upper Kabete	10.6%	0.0%	4.3%	2.1%	6.4%	2.1%	25.5%
Total	25.5%	8.5%	8.5%	4.3%	46.8%	6.4%	100.0%

Source: field work survey, 2017

The majority of the direct users stated that there is no organization 46.6% in UoN responsible to manage e-waste while those that identified stated it is the responsibility of the waste management and cleaning department. This indicates that most of the direct users are not aware of any designated department to manage e-waste within UoN. The rest of members stated that it is the job of everyone, MPP, electronic users or disposal committee. Also, most of the direct users stated that there are no e-waste management organization in Kenya. thus an indication of the less effectiveness of e-waste management organization like the NEMA, CAK, DMIT, and WEE as identified by few of the direct users.

Table 4.5 Direct User identification of E-waste Management Organization in Kenya

Campus	No	W.E.E	D.M.I.T	CAK	NEMA	Total
Main Campus	21.3%	0.0%	0.0%	2.1%	2.1%	25.5%
Chiromo	21.3%	0.0%	2.1%	0.0%	4.3%	27.7%
Lower Kabete	19.1%	0.0%	0.0%	0.0%	2.1%	21.3%
Upper Kabete	21.3%	2.1%	0.0%	0.0%	2.1%	25.5%
Total	83.0%	2.1%	2.1%	2.1%	10.6%	100.0%

Source: field work survey, 2017

The MPP personnel identified that the NEMA and CAK are responsible for the regulation of e-waste in Kenya while the ICT office is responsible within the UoN campuses. However the significance of this identification is low because only 12.8% of the MMP indicated such while the rest 87.2% failed to recognized the institutions mentioned above. This validates the direct user's claim (in table 4.4) that there is no designated department to manage e-waste within the UoN. This translate to the fact that the MPP/ICT, NEMA and CAK are not active enough in E-waste regulation for there to be an awareness that they exist with the function of managing e-waste.

Table 4.6 E-waste regulatory body in Kenya and UoN identified by MPP

E-waste Regulatory Body Mechanism in campuses	Percent of Yes Cases			Weight
	Body in UoN	Body in Kenya		
	ICT	NEMA	CAK	
Main Campus	5.5%	11.1%	0%	5.5%
Chiromo Campus	5.5%	5.5%	5.5%	5.5%
Lower Kabete	0%	5.5%	0%	1.8%
Upper Kabete	0%	0%	0%	0%
All Campus	11%	22.1%	5.5%	12.8%

Source: field work survey, 2017

Data collected from the MPP shows that ICT department is more active within UoN; and in Kenya, NEMA is more recognized and functional than the CAK if at all CAK is active. The effect of regulation in all the campuses are minimal with lower Kabete ranking the least while there is none in upper Kabete.

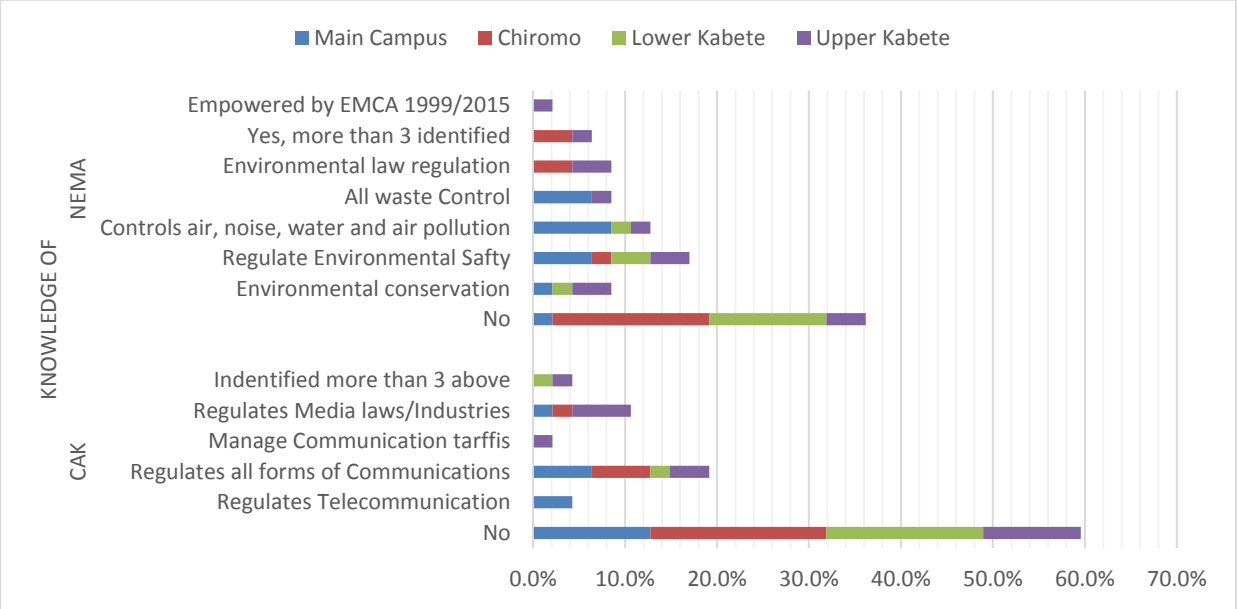


Figure 4.13 Direct Users' Knowledge of CAK & NEMA FUNCTION

Source: field work survey, 2017

While significant figures (majority) shows that both NEMA and CAK specially are less functional, and the direct users indicates that NEMA is more functional than CAK in which ever roles they are engaged in, since 59.6% showed that CAK is not functional while NEMA is 36.2%. The specific role of NEMA includes regulation of environmental safety, control of air, noise, water and air pollution, monitoring environmental laws, control of all wastes, and ensuring environmental conservation as empowered by the EMCA 1999/2015 law. The roles of CAK identified were regulation of all forms of communication, media laws and media centers, regulation of telecommunication and management of communication tariffs. However, those roles of both NEMA and CAK have no clearly defined attribution to e-waste management.

The CAK do not have the mandate to enforce the management and disposal of e-waste since the appropriate authority is NEMA. However, CAK is the strategic agency for the development and formulation of e-waste disposal and management policies with implementation partners like NEMA and other NGOs.[8]

Table 4.7 Knowledge of Direct Users on E-waste Laws in Kenya

Campus	No	Yes	Total
Main Campus	22.2%	4.4%	26.7%
Chiromo	11.1%	15.6%	26.7%
Lower Kabete	8.9%	13.3%	22.2%
Upper Kabete	17.8%	6.7%	24.4%
Total	60.0%	40.0%	100.0%

Source: field work survey, 2017

The majority of the direct users (60%) stated that there are no laws on E-waste in Kenya; most of whom were from the Main campus. while 40% stated that there are laws most from Chiromo campus. This report shows that many of the direct users are unaware if either e-waste management organization of law is in-place in Kenya.

The MPP indicated that NEMA functions as an organization that deals with environmental safety, anti-pollution management, environmental conservation. While CAK is identified to function as an agency that issue media license and regulate the laws on electronic machines. However, as pointed out by NEMA, the guideline on importation of electronics with specific reference to obsolete machines/device are outlined in the Public Procurement and Disposal Act of 2005 (PPDA) and Kenya Revenue Authority (KRA). These stresses the restriction of EoL devices in Kenya.[9] It is important to note that, the PPDA document do not have categorical reference to e-waste disposal.

[8] MoENR Deputy Director for Policy, Interview with Researcher, 2017
[9] NEMA Head of Waste Management, Interview with Researcher, 2017

Kenya is party to the Bamako convention with the objective of reducing the manipulative tactics on developed nation in dumping EoL WEEE in Africa. (Kurt Daum *et al*, 2017) however, those the regulatory framework in Kenya is still insufficient to addressing the ease at which imported electronic are in non-conformity to e-standards (Osibanjo, 2007) due to lack of legislative infrastructure (Schluep, 2009).

The Lab in Main Campus identified that while there are no explicit rules, the university has ebbed the principle of identifying, sorting, and dumping in designated areas for inspection to validate the non-usability. However after the confirmation of its non-usage, limited actions are often taken to ensure proper disposal and recycling. This usually creates a limitation to space management as many usable spaces are filled with abandoned computers.[10] There are no actual disposal method identified within the Chiromo computer lab and no obliged regulation on how technological devices should be disposed within the campus.[11] While the UoN has no identifiable policy on disposal, the procurement and disposal Act states that ICT hardware shall be replaced after every five years of its usage. This in itself creates a loophole for continual procurement without categorically stating what happened to the ICT hardware that are displaced every five year of its usage.[12]

4.6. Challenges Facing University Of Nairobi In Disposing End Of Life Computer Devices

In Kenya, initiated initiatives to enhance recycling is nonexistent as only one of the MPP personnel identified the ICT Act of 2006. The rest 17 MPP personnel failed to identify any initiative of having a knowledge of the 2006 ICT Act. This is because the mandated goal of the Act regarding e-waste have not been reasonably implemented. The act stated that the government shall promote the provision for, and develop regulations for recycling and disposal facilities in order to facilitate an environmental friendly use of ICT technologies - this generally includes e-waste which is not explicitly mentioned in the Act (GoK, 2006).

[10] GIS/Remote Sensing Lab interview with Researcher, 2016.
[11] Chiromo and Lower Kabete lab interview with Researcher, 2016.
[12] Upper Kabete lab interview with Researcher, 2016.

The facilitation of recycling and disposal facilities in all cooperate buildings that uses ICT equipment -inclusive of UoN is yet to be realized by the GoK.

E-waste management within UoN is featured by inadequate storage for the obsolete computers, low awareness levels on e-waste hazards/management, lack of clients to procure e-waste materials, lack of formal training on e-waste management, inadequate resources and commitment for e-waste disposal, lack of adequate regulatory frameworks on e-waste management.

This is not uncommon to the e-waste regulatory as there are lots of obsolete electronic computer devices within the premises of NEMA as observed by the researcher. Additionally, the interviewee from NEMA failed to clearly define the guideline on e-waste management and pointed out challenges in enforcing generally applicable laws that are not directly related to e-waste management but

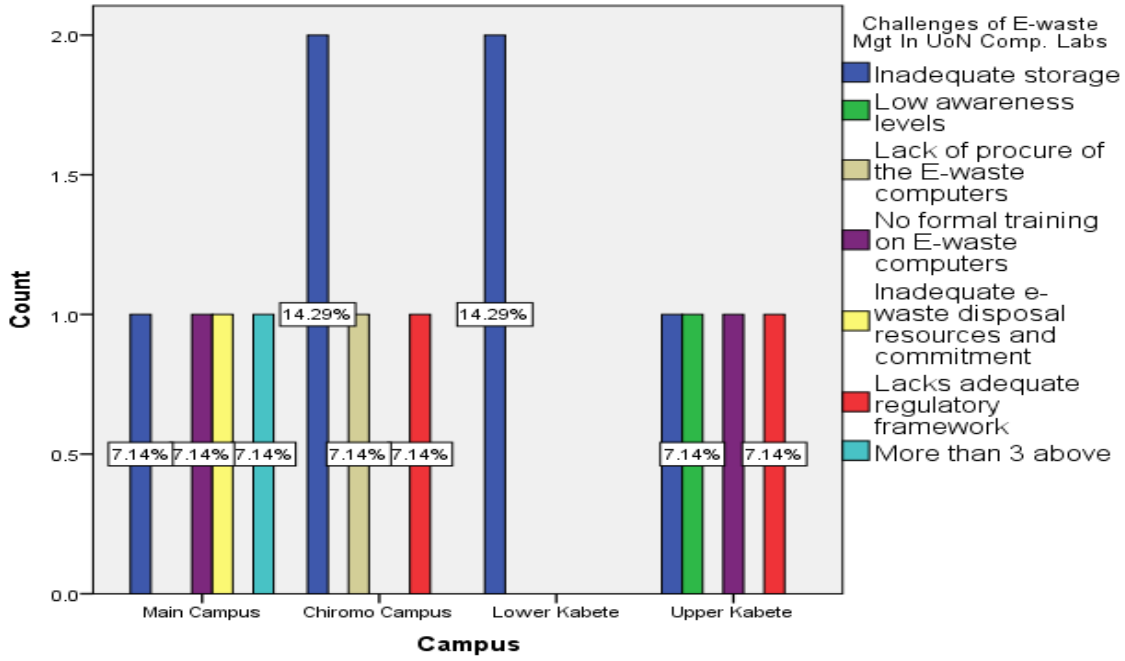


Figure 4.14 Challenges of E-waste identified by ICT staff

Source: field work survey, 2017

In respective campuses, inadequate storage space for e-waste is predominant in Chiromo and lower Kabete campuses; lack of adequate regulatory framework for waste management is more peculiar to Chiromo and Upper Kabete campus. Low awareness level is significant in upper Kabete campus as inadequate commitment and resources for e-waste is significant in the main campus. From the qualitative interviews with the Computer Lab senior personnel across the target campus, in order to overcome the challenge of e-waste disposal within the UoN, there should be: formulation of UoN e-waste policy on collection system, disposal method, disposal procedures and standards; proper space allocation to the waste disposal; educating the UoN ICT user on standard e-waste disposal procedures; strengthening the implementation and cultural adherence of e-waste disposal policies which is seen to be effective in the non-e-waste disposal policy within the UoN; and donation of used computers before its total end of life.

In Kenya, one of the major challenge is the growing and uncontrolled informal sector engaged in electronic-businesses especially in phones, laptops and other portable computers has made it difficult for the implementation of those guidelines[13]. In addition to lack of awareness of the health and environmental hazards of e-waste; compliance to e-waste guidelines is also challenging to many, thus making the efforts of GoK on hazard reduction unsustainable. [14]

[13] NEMA Head of Waste Management, Interview with Author, 2017
[14] MoE Deputy Director for Policy, Interview with Researcher, 2017


Plate 5 & 6: Indisposed e-waste at the lower kabete in one of the offices
Source: **Researcher 2017**


Plate 7& 8: Indisposed e-waste in the corridor, dept. Geog & environmental studies
Source: **Researcher 2017**

CHAPTER FIVE
SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary of key findings

On the first objective, this study found that there is very high level of e-waste within the premises of UoN campuses most of which are computer accessories and mostly found at the main campus and Chiromo campus while upper Kabete accounted for the least in the e-waste found.

With respect to objective two, most e-users in UoN have never disposed their e-waste before, an indication that there is large volume of storage of e-waste. Those that have disposed stated that it was done through mostly selling them as scraps or disposing them through the channel of normal waste disposal. Also, indication shows that more e-accessories are been disposed than computers. However, within UoN, there is institutional disposal methods like burning and repair for re-use but those mechanisms are not effective. Also in Kenya, the Safaricom, Technical University of Kenya, and Egerton University are found to have been in Partnership with NEMA and have made e-waste receptacles available in some areas in Nairobi, engaged in buying and selling schemes and remodeling of e-waste into new gadgets.

Most of those in UoN have general knowledge of the e-waste management and hazards ranging from air and soil pollution through emission/radiation and leakage of lead/mercury; radiation and emission causing health problems; and lastly explosion and electrocution hazards. But there are no facilitating capacities to ensure proper e-waste disposal and management since there are less e-waste collectors, less recycling initiatives, less separation of e-waste from normal waste, less mechanism of repair for continued used, lack of UoN e-waste manual, less recording of e-waste, and less training of staff on occupational health and safety methods.

Regarding objective three, the regulatory framework in UoN is poor considering that there are no clear principles on who is responsible for e-waste and those engaged in the e-waste management have not been very active and functional. Those identified within UoN are the waste management department, the procurement and maintenance and ICT department, the disposal committee and lastly the collective responsibility of both e-users and none e-users.

In Kenya, the regulatory agencies are the CAK which deals with the policy formulation for e-waste and the NEMA which partner with other NGOs and private organizations on e-waste disposal. Responses from the sample in this reports shows that both have not been effective enough to deal with the e-waste problem in Kenya. this is because their roles have not been legislatively enshrined to deal with e-waste and what they currently engage in is a general reference from the term waste and not specifically e-waste. The EMCA 1999/2015, Public Procurement and Disposal Act of 2005 (PPDA) and Kenya Revenue Authority (KRA); and the 2006 ICT Act are the existing regulatory law which the sampled individuals in this study have stated not to be effective to strengthen the relevant agencies responsible for e-waste management.

Finally, the study clearly indicated that policy challenge was very clear in this study as the major hindering factor to e-waste management. This have created inadequate e-waste collection; influx of WEEE that are their EoL; lack of training, awareness and sensitization on e-waste; lack of funding, partnership and resource commitment to the 4R model of e-waste management. Also, the existing institutionalized system of e-waste disposal is highly informal managed by unlicensed and unregulated entities.

5.2. Conclusions

This study concludes that the current level of e-waste accumulation within the UoN is on the raise and can potentially cause environmental health challenges to the safety of student and staff within the UoN most especially those in-contact with EoL WEEE and e-waste in the university. The continual storage and rudimentary e-waste disposal at the UoN poses a

threat not only to the lives of UoN staff and students but in addition to the ecosystem surrounding the UoN environment.

According to the University of Nairobi Environmental Policy 2015, the Vice Chancellor will be responsible for the implementation of this policy. On section 7.9 of the policy, the university will adopt cost-effective measures to ensure that all electronic waste is disposed of in an environmentally sustainable manner in line with the Environmental Management and Coordination Act, but such measures has never be effectuated due to the findings from this study.

Due to the results and investigation presented; this study accepts the null hypothesis that there is significant relationship between the increased use of computer devices and the challenges of the effective E-waste management methods at the university of Nairobi. The study reject the alternative hypothesis that there is no significant relationship between the increased use of computer devices and the challenges of effective E-waste management methods at the university of Nairobi.

The incapacitation of the UoN to engage in and effective e-waste management policy and implementation draws background to the existing national framework that have not addressed e-waste as priority for policy and intervention actions. The significant effects from these implications is that the risk do not pose short term threat but a long term effect that unfolds on personal and environmental health basis.

Thus a validation of the Pongrácz, *et al* 2004 Waste Management Theory as applied to this study: that within the UoN, there is an increased use of electronic gadgets like laptops; desktop computers; palmtops and computer hardware which requires e-waste management by the UoN management through reduced technological influence; effective disposal methods; appropriate regulatory framework; among other challenges that needs to be addressed in order to improve waste management at UoN University with considerable influence on good personal and environmental health, increase occupational safety and revenue from the 4R management.

5.3. Recommendations

To Learning institution like UoN

Apart from the recommendation that the NGOs and private sector should be strongly facilitated in e-waste management sector across all the campuses; the direct users highly recommended that there should be an initiated e-waste collection centres and programmes especially in lower Kabete campus; and mass e--waste disposal and hazard education and sensitization especially in Main campus. Those in Upper Kabete highly recommend both methods. While all the campuses opposes the initiative of buying and exchange of e-waste for other goods with few support from those in Main Campus, those in Chiromo campus strongly oppose the buying and exchange initiative.

In support of the direct users' recommendation, the MPP from all the campuses recommended that there should be e-waste collection centres/programmes; mass education and sensitization on e-waste disposal and hazard management; facilitation of NGOs and Private sector in e-waste management; exchange programme where old electronic machines and technological devices are exchanged for an item of its equivalent worth; and lastly a mechanism put in place to buying of E-waste from owners that would not want to dispose them.

The identification of monetary mechanism as a solution to e-waste management was put forward by the an MPP in Chiromo campus. However, majority of the MPP indicated that the such mechanism which involves monetary terms should be discouraged as it will further create a ambiguity on an effective e-waste collection system. While respective campuses recommends all the identified approach, the main campus and lower Kabete specifically identified the need for mass education on e-waste disposal and hazard management; and additionally, e-waste collection centers in main campus.

Therefore, the UoN should initiate a regulatory framework within the institution to manage not only waste but e-waste included; partner with private and relevant government agencies responsible for e-waste management; and finally, as a higher learning institution, innovative ways on the proper and appropriate methods of e-waste management should be

continuously put-in-place. Therefore, a call to institutions of higher learning to re-model the disposal of e-waste using the 4R methods (Rethink, Reduce, Reuse and Recycle) as opposed to the current 3R.[15]

To Government

There is urgent need to disallow EoL electronic into the country and specifically: the GoK needs to refer to the effective implementation of EMCA waste management regulation Act of 2006; and draft specifically, electronic waste management regulation to supplement the EMCA; full implementation of National Solid Waste Management Strategy; and adherence to the Bamako Convention on the Control of Transboundary Movements of Hazardous Wastes within Africa[16].

A study by Eunice (2013) stated that the method of E-waste disposal at the University of Nairobi are repairs, sale and reuse which are not guided with clearly outlined policies. And further recommended that NEMA need to adopt and implement the draft waste management policy on e-waste. The e-waste collectors should be encouraged to license their e-waste disposal organization with NEMA to enhance adherence to e-disposal standards towards ensuring the reduction of e-waste hazards in Kenya.

Studies by Ibrahim and Elijah outlined that there should be public private partnership in the e-waste management sector, promotion of e-waste management sector, citizen awareness on e-waste and amendment of public procurement procedures all working to ease the burden of e-waste management on the part of the government. (Ibrahim and Elijah, 2015)

To NGOs and private sector

The private sector needs to partner with the relevant government agencies in ensuring that the standards on e-waste disposal is not compromised. Also, the e-waste collecting agencies need to register with NEMA to ensure, strengthened and monitoring of e-waste

[15] NEMA Head of Waste Management, Interview with Author, 2017
[16] NEMA Head of Waste Management, Interview with Author, 2017

disposal in Kenya. The large percentage of e-waste collectors are from the informal sector (Oteng-Ababio, 2014) and thus the need for the formal private sector to take advantage of this dynamics to incorporate with the informal e-waste collection in existence to arrest the large flow of e-waste that goes into destruction without being recycled.

5.4. Suggested Areas for Further Studies

Based on the findings and recommendations from this study, the following areas are recommended for further studies: Implications of informal e-waste disposal mechanism on public health in Kenya; and Health effects and environmental contamination of stored e-waste in UoN.

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APPENDICES

Appendix I: Introductory letter

Dear Respondent:

My name is D. Enoch Foday, a student in the University of Nairobi, carrying out a research on the Electronic waste in the university of Nairobi premises; A case of computer e-waste in three selected campuses(Main, chiromo and upper & lower kabetes). The reason for this questionnaire is to have understanding on e-waste disposal measures at the university. In order to help address the above, your contribution in this research is important. For this reason, you are generously asked to provide the researcher with precise information. Your responses will be purely for the purpose of this research and as such, it will be treated as confidential. Provide the following information by *ticking/ writing the applicable number answer (s) in the blocks or space provided. You may use separate paper if the space is not enough.*

Note: if you intend to get results from this survey, please provide your details below or your ignore if not interested.

Email address:_____

Telephone number(s):_____

Appendix II: Questionnaires for Computer lab Manager

Date:_____ Name of computer Lab:_____

Name:_____

Position:_____

1. In which year was this computer lab established?_____
2. How many employees do have?

Male		**Female**	
Age	Number	Age	Number
15-19 years		15-19 years	
20- 24 years		20- 24 years	
25 – 34 years		25 – 34 years	
35- 44 years		35- 44 years	
45 – 54 years		45 – 54 years	
55- 64 above		55- 64 above	

3. What is their division of your workforce:
   a. Permanent
   b. Contact
   c. Apprentice/trainee
   d. Casual
   e. Other (please specify)_____
4. How do your dispose your computer after being considered as e-waste?_____
   _____
   _____
5. What is the method use to dispose your e-waste?_____
   _____
   _____

6. What do you do with computers parts that are not useful?_____
   _____
   _____
7. Are you aware of the potential hazardous substances on the computer e-waste?_____
   _____
   _____
8. Do you recycle some parts of the computer? If yes, please explain:_____
   _____
   _____
9. What regulatory framework the university have put in place to dispose e-waste within your computer lab?_____
   _____
   _____
10. What do you think should be done to avoid or overcome these obstacles?_____
    _____
    _____

Appendix III : Questionnaires for ICT staff

Date:_____

Name of computer Lab:_____

Name:_____

Position:_____

1. Gender
   a. Male ☐ b. Female ☐
2. What is your age range?
   a. 15 – 19 years ☐ d. 35 – 44years ☐
   b. 20 – 24 years ☐ e. 45 – 54 years ☐
   c. 25- 34 years ☐ f. 55 – 64 years ☐
3. What is your level of education?
   a. Primary ☐
   b. Secondary ☐
   c. University ☐
   d. None ☐
   e. Other (please specify)_____
4. How do you dispose your computer e-waste if there any?

   _____

   _____

   _____
5. Are you aware of both the health and environmental risks of e-waste? If yes please explain:

   _____

   _____

   _____
6. Do the university/lab has a repairing shop of old computers? If yes, please explain:_____

_____

_____

7. Is there a documented internal e-waste control in the university with written uniform guidelines by the University Management regarding management of e-waste, allocating responsibilities to specific staff members regarding their respective roles concerning the management of e-waste?
   a. Yes ☐
   b. No ☐
8. Do you keep e-waste management records maintained by the university, by which one can ascertain the qualities of the waste generated by the university and whether it has all been disposed of in the recommended way?
   c. Yes ☐
   d. No ☐
9. Do the university provide any supervisory in-house training for staff on occupational health and safe?
   e. Yes ☐
   f. No ☐
10. How are the e-waste from your section handled and disposed ?

    _____

    _____

    _____

11. Do have a designated waste receptacle?
    a. Yes ☐
    b. No ☐
12. Does your waste treatment/disposal facility allow for waste recycling
    g. Yes ☐
    h. No ☐
13. If no, how does the university control the large volume of e-waste that would require the use of most of the land available on landfills??

_____

_____

_____

14. What challenges do you face in your computer lab with regard to the management of electronic waste mainly desktops and laptops?

_____

_____

_____

15. Lastly, have you or anyone you know benefited from any form of environmental education and awareness or environmental clean-up by the university authority?

_____

_____

_____

Appendix IV: Questionnaires for Academic staff/Students

Date:_____

Name: _____

Position:_____

1. Gender
   b. Male ☐ b. Female ☐
2. Have you disposed of a spoilt or old computer before
   i. Yes ☐
   j. No ☐
3. If yes, how did you dispose it?

   Threw it in the dustbin with other waste ☐ Threw it in a separate dustbin for electronic waste only ☐

   took it for recycling ☐ sold it ☐ Give it out ☐
4. Have you ever disposed of any spoilt part of your computer accessory, eg. Batteries, adaptor, etc
   a. Yes ☐
   b. No ☐
5. If yes, how did you dispose it?

   Threw it in the dustbin with other waste ☐ Threw it in a separate dustbin for electronic waste only ☐

   took it for recycling ☐ sold it ☐ Give it out ☐

General environmental awareness and behaviour

6. Do you know e-waste or waste of electrical and electronic equipment is?
   a. Yes ☐
   b. No ☐
7. How much would you say you know about the importance of recycling electronic waste?

Nothing ☐ Moderate ☐

Very little ☐ Very much ☐

8. Do you know about the environmental hazards caused by obsolete electronic equipment (e.g: desktops, laptops, etc)
   a. Yes☐
   b. No ☐

If yes, please
:_____
_____
_____

9. Do you know that some hazardous parts in the e-waste need a special treatment in order to be safely disposed of?
   a. Yes☐
   b. No ☐

10. Do you have waste collectors in your community?
    a. Yes☐
    b. No ☐
11. If yes, do you have e-waste collectors who come and pick-up at your door?
    a. Yes☐
    b. No ☐
12. Do they take out electronic waste separately from the rest of the wastes?
    a. Yes☐
    b. No ☐
13. In your mind, who is responsible for the management of e-waste at the university of Nairobi?_____
14. Are you aware of any organization that is responsible for the regulates the management of disposing e-waste?
    a. Yes ☐

b. No ☐

if yes, please name:_____

15. Do you know of any laws regarding the management of electronic (computer e-waste) in Kenya?
    a. Yes☐
    b. No ☐
16. Are you aware of the Communication Authority of Kenya (CAK)
    a. Yes☐
    b. No ☐
17. If your answer number 16 is yes, what do you know about them?

    _____

    _____
18. Do you know about the National Environmental management Authority (NEMA)?
    a. Yes☐
    b. No ☐

19. If your answer is yes in question 17, what do know about them?

    _____

    _____

20. Do you know of any computer waste recycling initiative in Kenya ?
    a. Yes☐
    b. No ☐

21. If your answer is yes in question 19, please name_____
22. Will you like to offer your old computer or any parts for recycling?
    a. Yes☐
    b. No ☐
23. If your answer in question 21 is no, please state your reasons:

_____

_____

24. What would you suggest to the government in order to effectively and efficiently manage policies on e-waste?
    a. Start collection programmes/centers ☐
    b. Initiate mass education programmes ☐
    c. Sensitization on the dangers of e-waste ☐
    d. Delegate the collection and disposal to NGos ☐

Appendix V: Questionnaires Maintenance and procurement Partners

Date:_____

Organization Name: _____

Position:_____

Please answer the following with respect to works and activities carried out within the University of Nairobi

1. Have you disposed of a spoilt or old computer before
   a. Yes ☐
   b. No ☐
2. If yes, how did you dispose it?

   Threw it in the dustbin with other waste ☐ Threw it in a separate dustbin for electronic waste only ☐

   took it for recycling ☐ sold it ☐ Give it out ☐
3. Have you ever disposed of any spoilt part of your computer accessory, eg. Batteries, adaptor, etc
   a. Yes ☐
   b. No ☐
4. If yes, how did you dispose it?

   Threw it in the dustbin with other waste ☐ Threw it in a separate dustbin for electronic waste only ☐

   took it for recycling ☐ sold it ☐ Give it out ☐

General environmental awareness and behaviour

5. Do you know e-waste or waste of electrical and electronic equipment is?
   a. Yes ☐
   b. No ☐
6. How much would you say you know about the importance of recycling electronic waste?

Nothing ☐ Moderate ☐

Very little ☐ Very much ☐

7. Do you know about the environmental hazards caused by obsolete electronic equipment (e.g: desktops, laptops, etc)
   c. Yes☐
   d. No ☐

If yes, please
:_____
_____
_____

8. Do you know that some hazardous parts in the e-waste need a special treatment in order to be safely disposed of?
   c. Yes☐
   d. No ☐

9. Do you have waste collectors in your community?
   c. Yes☐
   d. No ☐
10. If yes, do you have e-waste collectors who come and pick-up at your door?
   c. Yes☐
   d. No ☐
11. Do they take out electronic waste separately from the rest of the wastes?
   c. Yes☐
   d. No ☐
12. In your mind, who is responsible for the management of e-waste at the university of Nairobi?_____
13. Are you aware of any organization that is responsible for the regulates the management of disposing e-waste?

c. Yes ☐

d. No ☐

if yes, please name:_____

14. Do you know of any laws regarding the management of electronic (computer e-waste) in Kenya?

c. Yes☐

d. No ☐

15. Are you aware of the Communication Authority of Kenya (CAK)

c. Yes☐

d. No ☐

16. If your answer number 16 is yes, what do you know about them?

_____

_____

17. Do you know about the National Environmental management Authority (NEMA)?

c. Yes☐

d. No ☐

18. If your answer is yes in question 17, what do know about them?

_____

_____

19. Do you know of any computer waste recycling initiative in Kenya ?

c. Yes☐

d. No ☐

20. If your answer is yes in question 19, please

name_____

21. Will you like to offer your old computer or any parts for recycling?

c. Yes☐

d. No ☐

22. If your answer in question 21 is no, please state your reasons:

_____

_____

23. What would you suggest to the government in order to effectively and efficiently manage policies on e-waste?

    e. Start collection programmes/centers ☐
    f. Initiate mass education programmes ☐
    g. Sensitization on the dangers of e-waste ☐
    h. Delegate the collection and disposal to NGos ☐

Appendix VI: Observation Checklist

Date: _____

Campus: _____

Location: _____

Unused Device/E-waste	**Presence**	**Number/Volume**
Monitor	☐	
Laptop	☐	
Keyboard	☐	
Mouse	☐	
Printer	☐	
Scanner	☐	
CPU	☐	
Touch Screen/Screen shade	☐	
Cords and Wires		
Other computer accessories 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____ 7. _____ 8. _____ 9. _____ 10. _____	 _____ _____ _____ _____ _____ _____ _____ _____ _____ _____	 _____ _____ _____ _____ _____ _____ _____ _____ _____ _____

Appendix VII: List of Interviewees

S/N	Interviewee	Organization	Date
1.	Deputy Director for Policy	Ministry of Environment and Natural Resources, Kenya	Feb. 15th 2017
2.	Principal Compliance Officer/ Head of Waste Management	National Environment Management Authority	Feb 3rd 2017