FACTORS INFLUENCING E-WASTE DISPOSAL IN PUBLIC ORGANIZATIONS IN KENYA: THE CASE OF UNIVERSITY OF NAIROBI

BY

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DECLARATION

This research project is my original work and has not been presented for a degree in any other University.

Signed…… Date……

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

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DEDICATION

To all those who care about the environment and believe in the principal of sustainable utilization of natural resources and intergenerational equity; that the present generation does not jeopardize the interest of future generations.

ACKNOWLEDGEMENT

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ABBREVIATIONS AND ACRONYMS

CfSK	Computer for Schools Kenya
CRT	Cathode Ray Tube
DfE	Design for Environment
DfD	Design for Disassembly
EEE	Electrical and Electronic Equipments
EMCA	Environmental Management and Coordination Act
EoL	End–of–Life
EPR	Extended Producer Responsibility
ESR	Extended Supplier Responsibility
EU	European Union
ICTs	Information and Communication Technologies
ISO	International Organization for Standards
MENR	Ministry of Environment and Natural Resources
MFA	Material Flow Analysis
NEMA	National Environment Management Authority
NGO	Non-Governmental Organization
OECD	Organization for Economic Cooperation and Development
POPs	Persistent Organic Pollutants
PPOA	Public Procurement Oversight Authority
SMEs	Small and Medium Sized Enterprises
UMIS	University Management Information System
UNEP	United Nations Environment Programme
UNU	United Nations University
UoN	University of Nairobi
UPS	Uninterrupted Power Supply
WEEE	Waste of Electrical and Electronic Equipment

ABSTRACT

The aim of this study was to determine the factors that influence disposal of e-waste in public organizations, in particular at the University of Nairobi, having been selected as being representative of the target organizations. The motivation of the study was to develop a baseline survey on the state of e-waste at the University. Specific effort was deployed towards investigation of the strengths and weaknesses in the handling of e-waste at the University. The objective was, in particular, to investigate the obtaining status in regard to the influence of policy guidelines and disposal regulations in regard to appropriate e-waste disposal, noting that e-waste may increasingly become a major environmental concern. Further, the study sought to determine the influence of Extended Producer Responsibility on disposal of e-waste at the University, as well as determination of how recycling facilitation influenced disposal of e-waste. The significance of e-waste problem in Kenya is that e-waste is relatively new and its quantities are rapidly growing as technology becomes more common. The researcher observes that there are no established environmentally safe disposal methods to keep pace with this change. It is important to note e-waste contains materials that are both valuable and toxic. This then calls for a scientific and business approach to solving the problem. The study design was of descriptive and exploratory techniques. Semi- structured questionnaires and observation methods were deployed to collect information from the respondents who comprised ICT, Procurement Officers and Disposal Committee members at the University of Nairobi. Data analysis was done by both qualitative and quantitative techniques. Quantitative data was analyzed by use of descriptive statistics, that is, frequencies, percentages and averages. Content analysis generated the qualitative data and was reported in narrative form. Data presentation and interpretation was reported through the use of tables. It is anticipated that the outcome of the study will contribute to the way forward in disposal of e-waste in public organizations, as well as assist in implementation of immediate mitigation measures through increased awareness. The study revealed that, the University deployed appropriate ICT procurement tools to ease the assessment and identification of the suitable products. On the other hand, the University had failed to adequately implement systems for vetting imports. Further, that limited capacity of relevant government agencies to deal with e-waste and lack of public awareness on the need for safe e-waste disposal as concerning. Lack of coordinated approach across service providers and the University to deal with e-waste are also common challenges on e-waste disposal. Based on findings of this study, the researcher recommends that: In relation to overall greening of public organizations, indicators of greening the e-waste streams should include the value of - and, jobs related to - the goods generated through the greening of the e-waste sector such as remanufactured products and the services in terms of e-waste collection, segregation, and processing. Economic and social benefits in terms of health, property values, as well as direct and indirect job creation should also be included. Additional efforts are needed to collect data and conduct quantitative analysis in all public organizations to enable policy makers to design their strategy for greening the e- waste sector on a more informed basis. Economic and social benefits in terms of health, property values, as well as direct and indirect job creation should also be included. Not all of these indicators may, however, be readily available and thus may call for further research.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

E-waste also known as "Waste of Electrical and Electronic Equipment" (WEEE) or electronic waste is defined in various ways by different researchers. Davis and Heart (2008) define e-waste as obsolete, end-of-life or discarded appliances that use electricity. On the other hand, Peralta and Fontanos (2006) define e-waste as 'electronic products that no longer satisfy the needs of the initial purchaser'. The term e-waste encompasses computers and their peripherals, consumer electronics, fridge's etc that have been disposed of by firsthand users. However, the term is also used generally to describe all waste containing electrically powered components which are valuable, but hazardous and may require special handling and recycling methods.

Waste Electrical and Electronic Equipment (WEEE) according to the European Community directive 2002/95/EC (European Community, 2010), is growing three times faster than average annual municipal solid waste generation. It is estimated that the total amount of e-waste generated in the European Union ranges from 5 to 7 million tonnes per annum or about 14 to 15 kg per capita and is expected to grow at a rate of 3% to 5% per year. In the USA it accounts for 1% to 3% of total municipal waste generation. In developing countries, it ranges from 0.01% to 1% of total municipal solid waste generation. In China and India however where annual generation per capita is less than 1kg, it is growing at an exponential pace.

The total e-waste generated worldwide rose from 6 million tonnes in 1998 to 20 - 50 million tonnes in 2005. It is predicted that obsolete Personal Computers in developing regions will exceed those of developed regions by 2016 - 2018 and that by 2030 they could amount to 400 – 700 million units (compared with 200 – 300 million units in developed countries) (UNEP 2011).

E-waste presents a serious and growing challenge to both developed and developing countries. It is one of the fastest growing segments of Municipal solid waste, especially in developed and emerging economies. Table 1 gives the estimated quantity of e-waste generated in 11 countries. China generates 64 per cent of the world's e-waste, followed by India (13%) and Brazil (11%).

Senegal, Uganda, India, China and South Africa are examples of countries where e-waste generation is expected to rise by a factor of 2 to 8, by 2020 (UNEP and United Nations University, 2009).

Countries	Assessment date	PCs	Printers	Mobile phones	TVs	Refrigerators	Total
South Africa	2007	19,400	4,300	850	23,700	11,400	59,650
Kenya	2007	2,500	500	150	2,800	1,400	7,350
Uganda	2007	1,300	250	40	1,900	900	4,390
Morocco	2007	13,500	2,700	100	15,100	5,200	38,200
Senegal	2007	900	180	1,700	1,900	650	3,730
Peru	2006	6,000	1,200	220	11,500	5,500	24,420
Columbia	2006	6,500	1,300	1,200	18,300	8,800	36,100
Mexico	2006	47,500	9,500	1,100	166,500	44,700	269,300
Brazil	2005	96,800	17,200	2,200	137,000	115,100	368,300
India	2007	56,300	4,700	1,700	275,000	101,300	439,000
China	2007	300,000	60,000	7,000	1,350,000	495,000	2,212,000

Table 1 Estimates of e-waste generation (tonnes per year)
Source: UNEP and UNU (2009)

E-waste disposal entails special logistic requirements for collecting the e-waste from its generation sources and transporting it to a specified site for recovery and / or disposal. E-waste requires special end-of-life treatment due to its hazardous and valuable content. E-waste disposal also entails the assigning of clearly defined physical and financial responsibilities to the actors involved in the products legislative or economic incentives (Kanda and Taye, 2009).

Kenya's Information and Communications Technologies (ICT) industry is growing fast, specifically that of computers and related accessories. Most ICT products come from EU countries such as Britain, Asian countries such as China and Malaysia and USA. Generally ICT imports are new, and old products are discouraged.

Kenya lacks a regulatory framework for e-waste disposal and that in the past, has not had a recycling policy on electronics. (Waema & Mureithi 2008), state that "There is currently no legislation governing e-waste". Public Procurement Oversight Authority (PPOA) which oversees the procurement process in public sector is said to have not seriously considered end-of-life effects of products procured (Hatton, 2009). In addition, Kenya prepared a strategic plan (2006 – 2010) that aimed at creating "an enabling environment through policy, legal and regulatory reforms" (Waema & Mureithi, 2008). This plan that was to be implemented by Ministry of Environment and Natural Resources (MENR) describes hazardous waste and pollutants. General awareness on environmental issues exists although sensitization has not been specifically done on e-waste.

In a cause to fight against hazardous waste, Kenya is a signatory to numerous multilateral environmental agreements. Such as (1) Basel Convention on the control of trans-boundary movements of hazardous wastes and their disposal; (2) Bamako convention on the Ban of the imports into Africa and the control of trans-boundary movement of hazardous wastes into Africa (3) Nairobi Convention which provides a mechanism for regional (East Africa) cooperation, coordination and collaborative actions on solving pollution problems of the coastal and marine environment; (4) Stockholm convention on Persistent organic Pollutants (PoPs) and (5) Rotterdam convention on the prior informed consent procedure for certain hazardous materials, chemicals and pesticides in international trade (Hatton, 2009).

1.2 Statement of the Problem

Public organizations are facing huge challenges in the disposal of electrical and electronic waste (e-waste) which are either internally generated or imported illegally as 'used' goods in an attempt to bridge the so-called 'digital divide'. The University of Nairobi is a large public institution and inevitably will generate e- waste. It is noted that E-waste contains hazardous constituents that may negatively impact the environment and affect human health if not properly managed.

Obsolescence of electrical and electronic equipment has been observed at the University of Nairobi, in particular, that of Information and Communication technologies.

It is probable that a considerable amount of obsolete electrical and electronic equipment (e-waste) remains in storage for lack of clear disposal policy and regulatory framework and as may have been further compounded by lack of enforceable legislation. There thus appears to be an absence of a practical e-waste disposal system (Waema &Mureithi, 2008).

The fast growth of the ICT sector of the University of Nairobi is driven by institutional initiatives to improve on service delivery and enhance competitiveness and visibility in the international research and academic arena. There is the concern for environmental impacts of these growing e-waste flows. While operational appliances do not pose a danger to the user, it is noted that improper disposal of e-waste can disrupt sensitive eco-systems leading to deterioration of the environment and thus poor human health (Waema &Mureithi, 2008).

The University of Nairobi has an obligation to minimize the probable negative environmental impacts of unsafe disposal of e-waste that has accumulated within its establishment, apparently due to lack of clear policy legislation and regulatory framework in the disposal of e-waste.

1.3 Purpose of the study

This study was conducted as a baseline survey to outline the current status of e-waste in public organizations. Indeed to determine the factors that influence disposal of e-waste in public organizations. It is hoped that the outcome and recommendations will encourage the development of new e-waste related technologies that will facilitate greening of the ICT sector in public organizations. Prevention and reduction of e-waste at source is essential given the rapid growth in adoption of ICTs and increasing electrical / electronic material and resource consumption in public organizations.

1.4 Objectives of the Study

The following were the objectives that guided this study:

i). To investigate the influence of disposal regulations on e-waste disposal at the University of Nairobi

ii). To determine the influence of Extended Producer Responsibility on disposal of e-waste at the University of Nairobi

iii). To establish the influence of policy framework on disposal of e-waste at the University of Nairobi

iv). To determine the influence of recycling facilitation on disposal of e-waste at the University of Nairobi

1.5 Research Questions

i). To what extent do disposal regulations influence disposal of e-waste at the University of Nairobi?

ii). To what extent does Extended Producer Responsibility influence disposal of e-waste at the University of Nairobi?

iii). How does e-waste policy framework and guidelines influence disposal of e-waste at the University of Nairobi?

iv). To what extent does recycling facilitation influence disposal of e-waste at the University of Nairobi?

1.6 Significance of the Study

This study will be useful in a number of ways, in particular, the study;

i) Will assist public officers to develop appropriate procurement regulations that guide disposal of e-waste in public organizations.

ii) Will assist the University of Nairobi management in the formulation of policies, standards, guidance and procedures to be implemented towards appropriate and sustainable disposal of e-waste.

iii) Will add onto the foundation that is being laid in research on environmental issues as relates to disposal of e-waste in both public and private organizations in developing countries.

iv) Will also act as a resource for the government, especially NEMA (National Environment Management Authority) in understanding the need and importance of appropriate disposal of e-waste.

v) It is hoped the outcome of this study will benefit all types of organizations, that are either private, public, small and medium sized enterprises (SMEs), Non-Governmental Organization (NGOs) and others using ICT appliances.

1.7 Delimitation of the Study

The study sought to address the influence of procurement regulations and disposal policy in relation to e-waste flows in public organizations. In particular the study strived to determine the status of e-waste flows at the University of Nairobi with a view to identifying strategies and tools to support e-waste disposal in public organizations. The scope of electrical and electronic appliances was limited to Information Communication and Technology equipment and appliances, specific peripherals such as personal (desktop) computers, laptops, notebooks, CRT and flat panel monitors, printers, power back-up units (such as uninterrupted power supply packs (UPS), and other related computer accessories.

1.8 Limitations of the study

The researcher was constrained for time and financial resources and for those reasons the study was limited to the University of Nairobi, as being representative of public organizations in Kenya. Different organizations may face different e-waste related challenges, but the path to greening the e-waste sector share common milestones.

1.9 Basic assumptions of the Study

The study was based on the premise that University of Nairobi is a large public organization and a major consumer of electronic and electrical products and is bound to observe the public procurement and disposal regulations thereof.

The institution is likely to face challenges related to e-waste disposal as would any other public institution and was thus representative of the population.

1.10 Definition of Significant terms

(i) Green Environment

A green environment is one that results in 'improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities' (UNEP 2011).

This is marked by such indicators as reduction of carbon emissions and pollution, enhanced energy and resource efficiency, and prevention of loss of biodiversity and ecosystem services.

(ii) Hazardous e-waste

The term means solid e-waste or combinations of solid e-wastes which because of its quantity, concentration, or physical, chemical or infectious characteristics may-

(a) Cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible illness or

(b) Pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, otherwise managed.

(iii) Virgin Material

The term means a raw material, including previously unused Copper, Aluminum, Lead, Iron, or other metal or metal ore, any undeveloped resource that is, or with new technology will become, a source of raw materials.

1.11 Organisation of the study

The research report is divided into chapters with specific themes and sub-themes. Chapter one deals with background to the study, statement of the problem, purpose of the study, objectives of the study, research questions, significance of the study, scope of the study, limitations and delimitations of the study. Chapter two describes literature review of the topic under study from all over the world, Africa and then narrows down to Kenya. Chapter three will cover the introduction, area of study, research design, target population, sample and sampling procedure, research instruments, data collection procedures, validity and reliability of the instruments, data analysis. Chapter four covers introduction, response rate, and demographic characteristics of respondents and data presentation. Chapter five covers summary of findings, discussion of findings, conclusions, recommendations and suggestions for further research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter discusses essential issues that form the background of the study. It is organized systematically starting from the contextual background to conceptual framework of the study. This chapter reviews literature in the following pertinent issues; why disposal regulations of e-waste are essential to a public organization, the concept and practice of Extended Producer responsibility, Policy framework on disposal of e-waste and advantages of an appropriate e-waste disposal system, and the challenges and opportunities of recycling facilitation in public organizations.

2.1.1 Disposal of E-Waste

Appropriate e–waste disposal is that multidisciplinary activity that deals with identification, reduction, collection, recycling, and eventual safe disposal of e-waste. The most important objective of appropriate e-waste disposal in developed countries is to protect the environment. All other objectives are, by far, less important. For developing countries, the situation with regard to the objectives of e-waste disposal is not so simple. Environmental protection, productivity improvement, employment generation, resource recovery are major indicators. Welfare needs of a huge population, and so on are also important with respect to disposal of e-waste (Sharma et. al. 2010). Change in attitude by governments, appropriate legislation dealing specifically with e-waste, control of electronic waste dumping, implementation of EPR and transfer of technology on sound recycling of e-waste are the key issues in appropriate disposal of e-waste (Nnorom and Osibanjo, 2008).

2.2 Disposal regulations relating to e-waste

The e-waste concept came to light as far back as in 1970s and 1980s following environmental degradation that resulted from hazardous waste imported to developing countries (Shinkuma and Huong, 2009).

In reaction to hazardous waste importation, the Basel Convention on the control of trans-boundary movements of hazardous wastes and their disposal was instituted in 1992 to control the situation. Since then many countries have become members of the convention.

Electrical and Electronic Equipments (EEE) cover a broad spectrum of products used by businesses and consumers. As defined in the WEEE directive (2002/96/EC), EEE includes equipment that is dependent on electric currents or electro-magnetic field in order to work properly, and include equipments for generation, transfer and measurements of such current and fields. It applies to products that are designed for use with a voltage rating not exceeding 1000v for alternating current and 1500v for direct current. EEE is further divided into 10 categories of waste under the EU WEEE directive (Van Rossem, 2002; Widmer, et al., 2005).

End-of-life electronic product disposal including reverse logistics systems and take-back regulation needs to reflect not just technical requirements and efficiencies. It must also reflect the political structure and underlying cultural models of the society within which the system is to operate (Kahhat, Kim; Xu: Allenby: Williams and Zhang, 2008). One of the most recent developments in the regulations of e-waste is the framework released by the Electronic Industries Alliance (EIA) on 25th May 2007, which paved the way for federal legislation establishing a national programme for recycling household televisions and information technology products such as computers and computer monitors.

It proposes a two-part financing approach, separating televisions from desktop computers, laptops and computer monitors, to reflect their divergent business models, market composition and consumer base. According to the framework, the television collection and recycling would be primarily conducted by an industry-sponsored third-party organization and initially be supported by a nominal fee paid by consumers at the point of purchase. The nominal fee would eventually expire, once a significant number of 'legacy' sets are recovered (Davis and Heart, 2009).

2.2.1 Challenges of e-waste Disposal

The rapid growth in ICT has led to an improvement in the capacity of computers but simultaneously to a decrease in the products lifetime as a result of which increasingly large quantities of waste electrical and electronic equipment (e-waste) are generated annually. The challenges facing the developing countries in e-waste disposal include; an absence of infrastructure for appropriate e-waste management, an absence of legislation dealing specifically with e-waste, an absence of any framework for end-of-life (EoL) product take-back or implementation of Extended Producer Responsibility (EPR). Appropriate management of e-waste demands the implementation of EPR, the establishment of product reuse through remanufacturing and the introduction of efficient recycling facilities (Osibanjo and Nnorom, 2007).

There are also many factors behind the lack of knowledge and research done to support management of informal sectors. One is that lack of human and knowledge capital to undertake analysis and planning. Recycling systems are generally designed in the developed world given constraints of high wages and low demand for used machines and parts. Solutions for the developing world may look quite different, but remain unknown due to lack of appropriate analysis and planning. Another challenge is lack of an information infrastructure supporting analysis (Williams and Sasaki, 2003). Electronic products are present in almost every aspect of our lives. The heavy reliance on these devices, however, has resulted in the growing number of electronic items found in the waste stream. As an initial step toward proper disposal of this waste, it is necessary to estimate the expected flow of waste that will need appropriate disposal (Peralta and Fontanos, 2006).

2.2.2 Disposal of Public Stores and Equipment in Kenya

The Kenya Gazzette Supplement No. 24 of March 3, 2001, (legislative supplement No. 16 and legal notice No. 51), Part ix, 44, provides that disposal of obsolete and surplus items shall be by any of the following means:

(a) Transfer to government departments, with or without financial adjustment;
(b) Sale by public tender to the highest bidder, subject to a reserve price;
(c) Sale by public auction, subject to any reserve price;

(d) Destruction, dumping, or burying as appropriate

2.3 Extended Producer Responsibility

It is clear that some of the discarded electronic gadgets contain highly toxic materials (Liu, 2009). Toxic materials can cause devastating health problems, for example cancer. In addition, e-waste pollutes the environment. Therefore poorly disposed ICT products such as computer hardware pose health threats to society. As the number of ICT users grows, e-waste will increasingly become an environmental/health hazard. Apart from the direct problems, this will also discredit ICT as a tool for development especially in poor regions.

Extended Producer Responsibility is a policy principle to promote total life cycle environmental improvements of products system by extending the responsibilities of the manufacturer of the product to various parts of the products life cycle and especially to the take- back, recovery and final disposal of the product (Li and Geiser, 2005). In order to assist in improving environmental performance within the electronic industry, there has been a growing perception of the need to introduce measures that will improve the ability of governments and corporations to progress environmental performance. This includes a variety of initiatives and legislation that has been introduced by International Standards Organizations (ISO), work by the Organizations for Economic Cooperation and Development (OECD), the United Nations Environment Programme (UNEP) towards providing information on product stewardship and Extended Producer Responsibility (EPR) and guidance on public procurement with a view to improving environment performance (Herat, 2007).

The goal of EPR is to prioritize three major areas. These are prevention, life-cycle thinking and incentive mechanisms for industry to conduct ongoing improvement in processes and product design. This is not just about simply setting up a recycling system that does not encourage manufacturers to examine their own processes. The most comprehensive use of EPR lies in the fact that it states that producers should bear responsibility for all the environmental impact of their products at all stages of the life cycle.

This includes upstream impacts arising from the choice of materials, the manufacturing process and downstream impacts from the use and disposal of the products (Nnorom and Osibanjo, 2007).

Other countries such as USA, Japan and China have also amended laws for e-waste disposal. In China, regulations that specifically deal with e-waste are in implementation. For example, the management measures for the prevention of pollution from electronic products regulation that aims at prohibiting the environmentally adverse processing of e-waste and reducing utilization of hazardous and toxic substance in electronic appliances (Xianbing; Masaru and Yasuhiro, 2006).

2.4 E-waste Policy Framework and legislation in Africa

The rapid growth of electronic, information and communication technologies (ICT) industry world-wide, have revolutionalized social development, and tremendously transformed learning and knowledge. While the developments have been welcome, the electronic products have posed serious challenges for environmental sustainability particularly once the products reach end of life cycle resulting in tonnes of waste.

The increasing demand for electronic goods means that levels of e-waste are growing fast. Noteworthy is the fact that the hazardous substances contained in most of the discarded products pose serious risks to the environment and human health. This emergent accumulation of e-waste stems not only from rapid pace of emerging technologies but also from e-waste disposal (exports) by developed countries to least developed countries in the form of used electronic equipment with short life-spans. It is important that steps must be taken to minimize environmental pollution from e-waste, as well as its consequences for health as far as possible.It is noted that most developing countries are yet to legislate law and guidelines on e-waste and may continue to act as dumping sites from developed countries.

The Constitution of Kenya states the right to a clean and healthy environment for all Kenyans. There are also two key international conventions regulating waste disposal; The Basel and Bamako Conventions. The conventions recommend that signatories ensure that the generation of hazardous wastes and other waste within a country are reduced to a minimum, taking into account social, technological and economic aspects.

The Bamako convention appears to be the only African legal instrument touching on the disposal of hazardous wastes in the African continent. It was adopted under the auspices of the then Organization of African Unity (OAU), now the African Union (AU) at Bamako, Mali on 10 January 1991.

African countries were generally dissatisfied by a mere ban on transitory movement. The scope of this Convention is similar to the Basel Convention, but it adds hazardous substances that have been banned, cancelled or refused registration by government regulatory action, or voluntarily withdrawn from registration in the country of manufacture, for human health or environmental reasons and radioactive wastes. The Convention requires the parties to furnish the Secretariat with their definitions of hazardous wastes under their national laws. The Convention totally prohibits the importation of hazardous wastes into Africa from non-contracting parties, and declares such import to be illegal and criminal.

Most developed countries have in place legislation mandating electronic manufacturers and importers to take-back used electronic products at their end –of-life (EOL) based on the principle of Extended Producer Responsibility (EPR). To effectively articulate and implement appropriate end-of-life management of e-waste, there must be an effective collection or take –back of the WEEE.

The implementation of this would be most difficult in countries where there is no stringent enforcement of regulations on municipal solid waste disposal, no existing environmental protection tradition, nor efficient recycling facilities. Most countries in Africa on the contrary, fall short of a solid waste disposal system that minds the challenges and hazards of poor e-waste handling.

Most developing countries do not have both the necessary infrastructures and effective legislation to avert the hazards that emerge from poor e-waste disposal, according to Mundada, Kumar and Skekdar, 2004 cited in Nnorom and Osibanjo, (2007). Rather, the prominent method of e-waste handling in developing countries involve low-end treatment methods such as backyard recycling, open dump disposal, disposal in water bodies and open burning (Further, 2004) cited in (Nnorom and Osibanjo, 2007).

These may in many instances stem from the lack of recycling and recovery infrastructures or, as witnessed in some cases, a weak environmental policy among many other varying in-situ conditions.

The Government of Kenya has enacted various laws and policies towards environmental protection and conservation. One such law is the Environmental Management and Co-ordination Act (EMCA) of 1999. The Act mainly calls for the adoption of a coordinated approach to the implementation of national environmental law. While EMCA constitutes a useful framework law on environmental regulation and management in Kenya, much emphasis is on fiscal incentives and disincentives, and mandatory command and control in environmental regulations to protect environmental quality. Coercion through regulations can fail in some ways. First, the infrastructure needed to enforce the regulations is weak or even absent.

Second, the transaction costs of imposing coercive solutions are often so high as to make such solutions impractical. Third, when degradation or pollution comes from a large number of small or "non-point sources" as is the case with e-waste flows from consumers, it becomes extremely difficult to determine who is causing environmental degradation. Lastly, information about environmental violations is often inadequate.

In addition, local regulators are often strongly influenced by private sector interests and lack the political will for strict enforcement. In this regard, it may be useful to complement EMCA (1999) with alternative approaches such as public disclosure, and voluntary regulation by individual firms to improve environmental performance (Okidi, Mbote, Aketch 2008)

EMCA (1999) makes provision for both substantive as well as administrative offences. Substantive offences include: Discharge of any poison, toxic, noxious or obstructing matter, radioactive waste or pollutants into the aquatic environment in contravention of the water pollution control standards (Section 72); Discharge and disposal of any wastes in a manner that causes pollution to the environment or ill health to any person (Section 87); Operation of a motor-vehicle, train, ship, aircraft or other similar conveyance in a manner that causes air pollution and importing any machinery, equipment, device, or similar thing that will cause emissions into the ambient air in contravention of prescribed emission standards (Section 82);

Discharge of hazardous substance, chemical, oil or mixture containing oil into any waters or any other segments of the environment (Section 93); Disposal of pesticides or toxic substances into the environment (Section 98); and Importation of hazardous waste.

Administrative offences include: Operation of a waste disposal site without a license (Section 87); Exportation from and transportation within Kenya of hazardous waste without a permit (Section 91).

Section 145 deals with liability of corporations. It states that:

> 'When an offence against the act is committed by a body corporate, the body corporate and every Director or Officer of the body corporate who had knowledge or who should have had knowledge of the commission of the offence and who did not exercise due diligence, efficiency and economy to ensure compliance with this Act, shall be guilty of an offence'

In addition to fines and imprisonment, EMCA also includes innovative punishments such as: Payment for the cost of cleaning the polluted environment and removing the cause of pollution (Section 142(2) (a) Forfeiture of the substance or equipment used to commit an offence to the State, Cancellation of license, Payment of the cost of disposal of substance or equipment forfeited to the State, Restoration of the environment.

2.5 Recycling facilitation on disposal of e-waste

The Polluter Pays Principle addresses liability for environmental damage. It is aimed at ensuring that persons engaged in potentially polluting activities internalize the environmental costs of their activities and put in place preventive measures. The principle is enshrined in the Rio Declaration on Environment and Development as Principle 16 (Okidi, Mbote and Akech 2008). It states as follows:

> National authorities should endeavor to promote the internalization of environmental costs and the use of economic instruments, taking into account that the polluter should, in principle, bear the costs of pollution, with due regard to the public interest and without distorting international trade and investment.

Product stewardship is a related concept that has been a much more popular in many countries where it is argued that excessive regulation is contrary to free market policies.
Product stewardship is defined by the Australian Environmental Protection and Heritage (EPH) as an approach that "recognizes that manufacturers, importers, governments and consumers have a shared responsibility for the environmental impacts of a product throughout its full life cycle". It is also argued that the manufacturer should not be solely responsible for the generation of waste and that this responsibility should be spread across the spectrum including the consumer and governments. Since it is less regulatory than EPR, the approach is seen as providing the various state and federal governments with a means to encourage industry to cooperate, as opposed to legislating for them to do so. It does not allocate all responsibility to the manufacturers but seeks to distribute the duty throughout the supply chain (Herat, 2007).

The EPH argues that product stewardship schemes provide the framework for the total "manufacturer to consumers" supply chain, without focusing on the manufacturer of the end product, to share responsibility for products that are manufactured, purchased and discarded. These trends make it difficult to introduce product stewardship and producer responsibility schemes, as there are a high proportion of orphan products, (where the manufacturer cannot be identified, has ceased trading completely or withdrawn from the market). Furthermore, responsibility may not be accurately assigned due to differences between existing market share and previous market share; additionally overseas importers of equipment may not wish to cooperate (Davis and Herat, 2009).

The Product Stewardship Institute in the US agrees with this approach but goes further by allocating broad responsibility to all stakeholders for the reduction of the health and environmental impacts that result from the production, use and disposal of a product. Much of the environmental cost be externalized prior to it moving towards the end of the life cycle, and this and other economic facets internal to and external of the life cycle should be taken more into consideration when formulating product stewardship schemes (VanRossem, 2002).

2.5.1 Recycling of e-waste

In general recycling refers to the reuse of materials and involves taking apart an old product and using the material it contains to make a new product through reprocessing. For computer products, this is generally a "down-cycling" process as material that would otherwise have been thrown away is being refurbished into different products and generally the process only delays the entry of original products into the waste stream. A proper e-waste product is one that is not only at the end of its life, but is also obsolete in terms of technology and outdated in its architecture (Li and Geiser, 2005).

It is observed that e –waste represents a challenging recycling problem for several reasons. First, the material complexity of the product, a combination of valuable metals with hazardous ones, such as Gold, Mercury, Lead, and low value plastics, making its diversion from landfills an important consideration and one that will continue to drive the development of environmentally sound recycling processes. Second, it is a widely distributed and diverse basket of consumer products with highly variable rates of obsolescence and failure. This means that it is hard to predict whether particular collection program types will be cost effective in a given region and how much volume will be generated.

There are a number of international programmes designed to dramatically increase collection and reuse/recycling of e-waste. In particular, the implementation of the WEEE directive in the EU has a huge potential for increasing the rate of recycling in the EU, which should lead to a large reduction in pollution. In the short-term, there is a need to prioritize recycling, since waste prevention through EPR measures is a long-term process and will be unable to resolve issues associated the current level of existing and potential e-waste generation (Nnorom and Osibanjo, 2008).

Informal dismantling and recycling of e-waste, the so-called 'backyard activities' (jua-kali) is emerging in developing countries. Crude recycling activities are taking place in Asia and Africa aimed at material recovery from e-waste. In these regions, e-waste is mostly treated in 'backyard operations' using open sky incineration, cyanide leaching and simple smelters to recover mainly copper, gold and silver with comparatively low yields (Hageleku, 2006).

To overcome this, there is need to introduce formal recycling facilities in the developing countries. Such facilities will have a major impact on recycling efficiency, in terms of elements and value that are recovered as well as in terms of toxic control and overall environmental performance.

2.5.2 Remanufacturing

While it is necessary to examine closed systems as a whole and account for the energy expended and any external factors that create an environmental impact, they should also be more eco-efficient than linear systems. Remanufacturing is able to make a significant contribution to the eco-efficiency of a product system. Reductions up to three times the energy consumption can be achieved. The high rate of technological change in the electronic industry presents a critical challenge for the process of remanufacturing and is of major importance to levels of e-waste. With only a three year average life span for computers, there is a "technological pull away from the environmental principles of longevity, reuse and resource productivity" and remanufacturing runs the risk of prolonging the life of already obsolete products (Herat, 2007).

However, there is proposition that whilst remanufacturing may run the risk of extending the life of a technologically obsolete product, the energy saved by reuse or refurbishment is huge. Up to 80% of the energy utilized in the life cycle of a computer can be saved in this way instead of manufacturing a new unit from raw materials. Recycling and reuse also provide substantial cost savings over the manufacture of a new product (Li and Geiser, 2005).

E –waste is being generated around the world faster than most other waste streams. The high uptake of information and communication technologies and the rapid development of newer designs by producers on a regular basis result in current electronic equipment becoming obsolete much sooner than before, and contributes more and more towards e-waste generation. In order to address the issue, regulations and policies are being evaluated, developed or implemented urgently in many countries around the world. These incorporate practices such as EPR, Labeling, Product Stewardship, Recycling and Remanufacturing (Kahhat, et al, 2008).

Besides regulations, researchers have suggested various strategies of mitigating e-waste problems and solutions that lead to DfE (Design for Environment) or Green IT. Some of the suggested strategies include methods and models for predicting the flow of e-waste and assessing impact of ICTs. It is argued in Shinkuma & Huong (2009) that a traceability system for tracking/tracing e-waste information is required. Therefore models such as Material Flow Analysis (MFA); a method applied to support the material and substance flow management in the waste (Dwivedy,G. Mittal R. K., 2009) are required for e-waste mitigation. Wang & Chou (2009) has also studied user behavior and willingness to recycle. All these developments have emerged drastically due to urgent needs for green environment and Green IT.

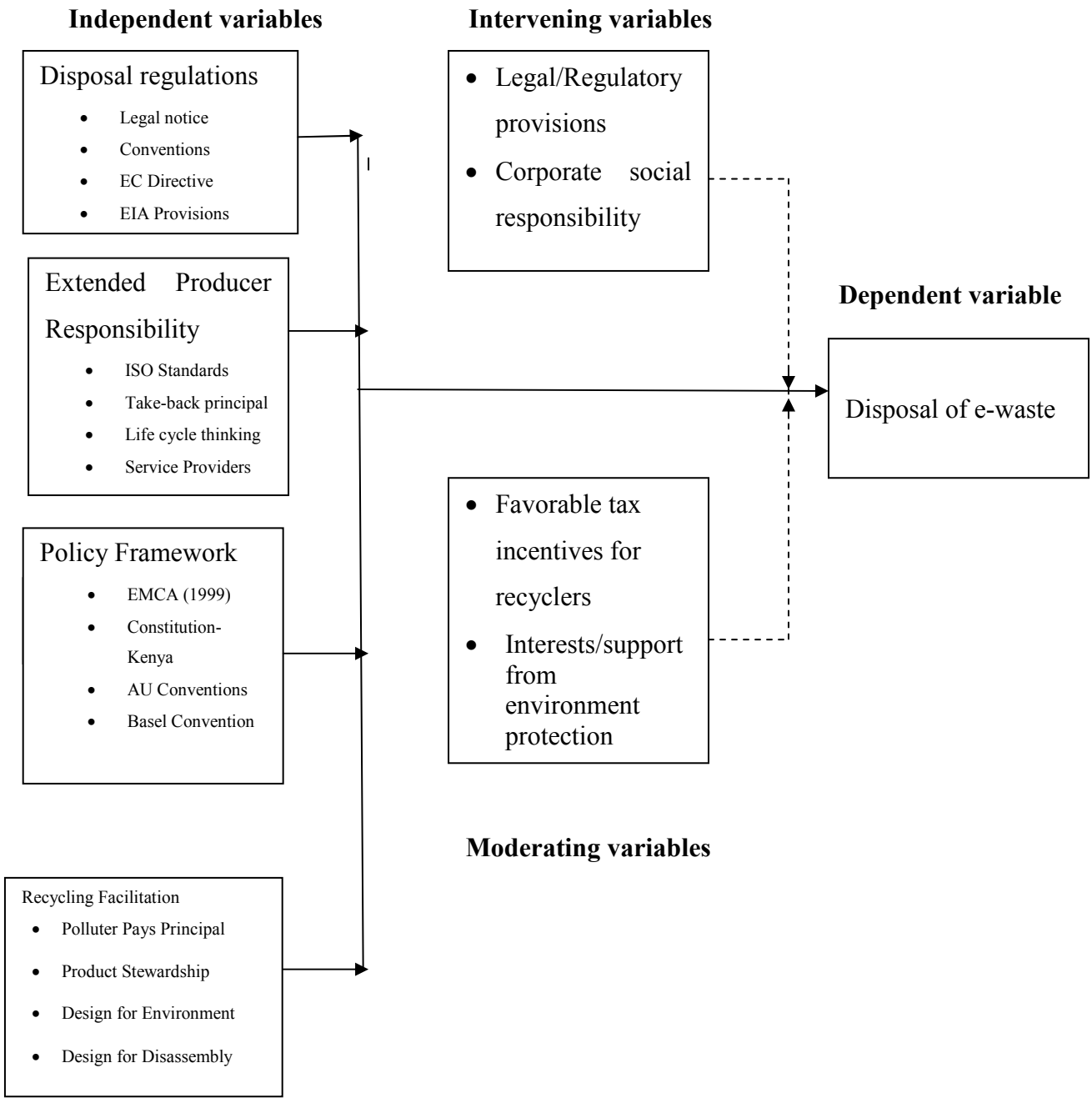
In Europe, the EU implemented two directives i.e., Directive 2002/96/EC on WEEE and Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment (Peralta & Fontanos, 2005). The directives enforce an Extended Producer Responsibility system and encourage reuse, recycling and recovery, and minimizing the environmental impact of e-waste (Schmidt, M. 2005). In addition, EU uses the concept of QWERTY/EE (Quotes for environmentally Weighted Recyclability and Eco-Efficiency) to improve or enable environmental performance of end-of-life products (Huisman & Stevels, 2004). The QWERTY/EE strategies include determining: (I) weight based recycling and recovery targets, (2) restriction on hazardous substances, (3) treatment rules for recyclers, (4) minimum collection amounts, and (5) outlet rules for recyclers.

2.6 Conceptual Framework

The conceptual framework depicted on the following page, diagrammatically shows the relationships that exist between the dependent and independent variables under study. The dependent variable is the disposal of e-waste. The independent variables that were investigated to establish their level of influence on the dependent variable were:

The influence of disposal regulations on e-waste disposal at the University of Nairobi, influence of Extended Producer Responsibility on disposal of e-waste, influence of policy framework on disposal of e-waste and the influence of recycling facilitation on disposal of e-waste at the University of Nairobi. Also depicted are the moderating variables and extraneous variables.

Figure 1: Conceptual Framework



CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter focuses on the type of research design used in this research Project. The issues discussed include the research demography, methods of sampling, the research and the descriptions of research instruments used. Equally, an outline of methods used in the analysis and presentation of the data is provided.

3.2 Research design

In this study descriptive de facto and exploratory survey design were used, involving a mix of qualitative and quantitative methods. Descriptive designs are used in preliminary and exploratory studies to allow researchers to gather information, summarize, present and interpret for the purpose of clarification (Orodho, 2002). On the other hand, In order to uphold these concepts, descriptive survey is preferred because it makes enough provision for the protection against bias and maximizes reliability of the evidence collected (Kothari, 2004). This design helped the researcher to study the situation as it is since the independent variables could not be manipulated. In this study, the design assisted in analysis of both the quantitative and qualitative data since the researcher used a semi-structured questionnaire to collect the data. The aim was to determine and report the current status in regard to factors influencing e-waste disposal in public organizations. A questionnaire was administered as appropriate. The researcher also made observations on the ground during the data collection process.

3.3 Target population

The target population is defined as the population to which a researcher wants to generalize the results of a study. The target population must be comparable on many characteristics with those of an accessible population herein defined as all the 149 ICT officers and Procurement Officers of the University of Nairobi.

3.4 Sample and Sampling Procedures

A sample is a smaller group obtained from the accessible population. In this case the sample was selected as to be representative of the whole population with salient characteristics. According to Gay (1983) he suggests that for descriptive studies, ten percent of the accessible/target population is enough. However, according to Best (1992) an ideal sample should be large enough to serve an adequate representation of the population of which the research wishes to generalize.

Norman and Fraenkel, (2001) suggest that a sample of 20 percent of the population is adequate though the larger the better. This study opted for a larger sample of 55 of the population of 149. To select the sample size, simple stratified random sampling technique was first used to sample out 41 employees from the population with respective cadres composing the strata. Stratified random sampling left 14 divisions not represented by any employee by the virtue that they will not meet the threshold of representation in the sample size. The researcher therefore purposively sampled out employees from such departments to cover all strata to arrive at the sample size of 55. The technique is preferred because it eliminates any bias in the selection of the sample since each element of population has an equal chance of being sampled. The sample size is justifiable as it represented 30 percent of the population and was therefore representative of the same. This was as tabulated below.

Table3.1: Population and Sample Strata

Department	Officers	Population	Stratified sample	Sample Size
ICT Department	Director of ICT	1	0	1
	Deputy Director	5	2	2
	Senior Assistant Registrar	1	0	1
	Manager Data Centre	1	0	1
	Project leader (MIS)	4	1	1
	ICT Maintenance Manager	1	0	1
	Chief ICT Officers	16	5	5
	Senior ICT Officers	29	9	9
	Senior Secretary	1	0	1
	ICT Operator	1	0	1
	ICT Officers	44	13	13

	Assistance Secretary	1	0	1
	Telephone Operator	17	5	5
	Drivers	3	1	1
	Cleaners	2	1	1
	Subtotal – ICT	127	37	44
Procurement Department	Procurement Manager	1	0	1
	Deputy Procurement Manager	1	0	1
	Procurement Officer	1	0	1
	Senior Secretary	1	0	1
	Procurement Assistants	11	3	3
	Junior Procurement Assistant	1	0	1
	Assistant Senior Secretary	1	0	1
	Chair, Procurement Committee	1	0	1
	Member, Procurement Committee	3	1	1
	Subtotal – Procurement	22	4	11
	Total	149	41	55

Source: University Management Information System (UMIS)

3.5 Data Collection Instruments

Collection of data constituted the first step of the fieldwork of this study. The scope was designed to cover a sample size of 55 respondents who were the primary source of data. The method was an open inquiry in which the respondents completed a predesigned semi-structured questionnaire. The researcher also used observation techniques to assimilate salient aspects relevant to the study while content analysis further generated the qualitative data, noting that the study was both exploratory and descriptive.

3.6 Reliability of the instrument

Mugenda and Mugenda (1999) define reliability as a measure of the degree to which a research instrument yields consistent results or data after repeated trial. Piloting enabled the researcher to test the reliability of the instrument. To ensure reliability, the researcher employed the test-retest technique. This involved administering the test to one appropriate group as selected randomly. After two (2) weeks, the same test was administered to the same group. The two sets of scores were regressed using the Pearson's product moment correlation coefficient formula, to determine the correlation coefficient (*r*) between the two sets of scores.

$$r = \frac{n\sum XY - \left(\sum X\right)\left(\sum Y\right)}{\sqrt{\left[n\sum X^2 - \left(\sum X\right)^2\right]\left[n\sum Y^2 - \left(\sum Y\right)^2\right]}}$$

Where X = first set of scores; Y = second set of scores; $\sum X$ = the sum of the first set of scores; $\sum Y$ = the sum of second set of scores; $\sum X^2$ = the sum square of first set of scores; $\sum Y^2$ = the sum square of second set of scores; $\sum XY$ = the sum of cross product of X and Y and n = total number of respondents. According to Mugenda & Mugenda 1999, reliability coefficient above + 0.6 is satisfactory for instrument reliability. The instrument was found to be reliable.

3.7 Data analysis procedures

Once the questionnaires were collected from the respondents, the researcher checked for incompletion error. The data was then coded and entered the data into Statistical Package for Social Sciences (SPSS). Data collected from the respondents was both quantitative and qualitative in nature. Quantitative data analysis consists of measuring numerical values from which descriptions such as mean and standard deviation are made. Descriptive statistics that are percentages, means and frequencies were used to report the data. The results of data analysis were reported in summary form using frequency tables. Qualitative data analysis for open ended questions was done using content analysis. Content analysis describes the form or content of written or spoken material.

Ideas were grouped into themes. The frequencies of the different descriptions were generated by categorizing and coding pieces of data and grouping them into themes.

3.8 Ethical Considerations

Ethical considerations are said to be guiding rules that govern practice of profession. Mouton (2011) proposes that "the ultimate goal of all science is the truth. The epistemic imperative refers to the moral commitment that scientists are required to make to the search for truth and knowledge". Mouton emphasized on epistemic imperative as not a merely good idea but acts as a regulative principle that guides the conduct of scientists. Ethics occupy heart of the research processes; it regulates relationships between the researcher and respondents and requires adhering to standards and ethical principles that address issues of honesty as a fundamental norm in all scientific communications such as honesty in report data, final results, methods and procedures.

Such principles and codes of conduct must be consistent to the University of Nairobi, which attached great significance to the uprightness of this study. Further, great attention was given to the different categories of the respondents to ensure that none was offended both during and after the entire process of the research. Thus ethics is a body of principles or standards of human conduct that govern the behaviour of individuals or groups.

The researcher sought to: Gain informed consent from employees who participated in the study, while observing the principle of voluntary participation as well as maintaining strict confidentiality as regards personal details of the participants.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Introduction

This chapter presents data analysis, findings, interpretation and presentation. The purpose of the study was to investigate factors influencing e-waste disposal in public organizations: the case of University of Nairobi. The study was in particular set to investigate the influence of disposal regulations on e-waste disposal in public organizations; to determine the influence of Extended Producer Responsibility on appropriate disposal of e-waste in public organizations; to establish the influence of policy framework and guidelines on disposal of e-waste in public organizations; to determine how cost influences disposal of e-waste in public organizations as well as determining the influence of staff training on disposal of e-waste in public organizations.

4.2 Response rate

The respondents for this study were Senior ICT and Procurement Officers drawn from ICT and Procurement departments, as well as members to Procurement committees. The study targeted 55 respondents whose return rate is as indicated by Table 4.1.

Table 4.1 Response rate

Response rate	Frequency	Percentage
Response	53	96.4
No response	2	3.6
Total	**55**	**100.0**

From the results, 96.4 percent of the targeted respondents filled and returned the questionnaire which was successful for the purpose of this study. For those students who did not respond to the questionnaire, it was possible that, some did not understand the questions while others were hesitant to divulge information directly related to their work place.

4.3 Demographic Characteristics of the Respondents

Demographic information was based on the respondents' job title/designation; their department/unit in the University; the level of education as well as the duration that respondent had worked with the University of Nairobi.

Table 4.2: Job title/designation

Job title	Frequency	Percentage
Senior ICT Officer	40	75.5
Procurement Officer	11	20.8
Administrator	2	3.8
Total	**53**	**100.0**

From the findings, 75.5 percent of all the respondents were Senior ICT Officer while 20.8 percent were Procurement Officers. Others (3.8%) were administrators/committee members. This indicates that majority of the respondents were senior ICT officers who would be most versed with information regarding e-waste disposal in University of Nairobi, a public organization.

Table 4.3: Department/unit in the University

Work Division	Frequency	Percentage
ICT	42	79.2
Procurement	11	20.8
Total	**53**	**100.0**

Findings indicate that respondents were drawn mainly from two divisions, ICT (79.2%) and Procurement division (20.8%). ICT division was relevant since the division is charged with the role of usage and maintenance of all electronic gadgets in the University of Nairobi. On the other hand it is the Procurement division that is mandated with the role of sourcing and eventual disposal of electronic appliances.

Table 4.4: Level of education

Award	Frequency	Percentage
Diploma/Higher diploma	19	35.8
University graduate	32	60.4
Postgraduate	2	3.8
Total	**53**	**100.0**

Regarding the level of education of the respondents, 60.4 percent were university graduates with 35.8 percent being holders of diploma/higher diploma. Postgraduates, nonetheless, were 3.8 percent. This indicates majority of the respondents were at least university graduates, an education level that would have imparted awareness of issues related to potential negative impacts on the environment associated with inappropriate disposal of e-waste.

Table 4.5: Duration that respondent has worked with the University of Nairobi

Length of Service	Frequency	Percentage
3 years and below	11	20.8
4 - 6 years	21	39.6
7 - 10 years	17	32.1
11 - 15 years	3	5.7
Above 15 years	1	1.9
Total	**53**	**100.0**

From the results, 20.8 percent of all the respondents had worked with the University of Nairobi for 3 years and below, 39.6 percent 4 – 6 year, 32.1 percent 7 – 10 years and 5.7 percent for 11 – 15 years while the remaining (1.5%) had worked with the University for over 15 years. This implies that majority of the respondents had worked with University of Nairobi for at least 4 years. The duration to which the respondents had worked with University of Nairobi was important for this study to gain confidence that the respondents were familiar not only with the University working environment but also with their respective division.

4.4 Influence of Disposal Regulations on e-waste disposal

Table 4.6: Extent to which the respondents think the stated are constraints in sustainable and effective disposal of e-waste system at the University

Constraint	Very little extent	Little extent	Moderate extent	Great extent	Very great extent	Mean	Standard Deviation
Limited capacity of relevant government agencies to deal with e-waste	-	17.0	28.3	34.0	20.8	3.6	1.0
Lack of coordinated approach across service providers and the University to deal with e-waste		28.3	17.0	34.0	20.8	3.5	1.1
Lack of sensitization	-	43.4	11.3	45.3	-	3.0	0.9
Lack of public awareness on the need for safe e-waste disposal	-	1.9	43.4	43.4	11.3	3.6	0.7
Lack of regulatory and policy structures to safeguard health, environmental and social consequences of e-waste	15.1	30.2	43.4	-	11.3	2.6	1.1
It is not clear on whom the burden and / or cost of responsibility in e-waste disposal falls (UoN, producer/supplier, service provider or the government)	-	43.4	11.3	-	45.3	3.5	1.4
Rapid change in technology and growth of Management Information Systems in the University	34.0	43.4	1.9	20.8	-	2.1	1.1
Absence of infrastructure and technology for e-waste disposal	34.0	34.0	11.3	9.4	11.3	2.3	1.3
Limited support for local initiatives such as Computer for Schools Kenya (CfSK)	34.0	34.0	1.9	30.2	-	2.3	1.2
Absence of policy framework for end-of-life (EoL) equipment, take-back or implementation of Extended Producer Responsibility (EPR)	34.0	11.3	34.0	-	20.8	2.6	1.5

Regarding the extent to which the respondents thought the stated factors were constraints in sustainable and effective disposal of e-waste system at the University, it was revealed that, limited capacity of relevant government agencies to deal with e-waste (3.6), lack of public awareness on the need for safe e-waste disposal (3.6), lack of coordinated approach across service providers and the University to deal with e-waste (3.5) as well as lack of clarity on whom the burden and cost of responsibility in e-waste disposal falls (UoN, producer/supplier, service provider or the government) (3.5) are the most common challenges. The respondents however noted that, infrastructure and technology for e-waste disposal support for local initiatives such as Computer for Schools and change in technology and growth of Management Information Systems in the University are not major challenges with mean of 2.3, 2.3 and 2.1 respectively.

Table 4.7: Legislation, Policies, Practice and Standards respondents are familiar with in regard to disposal of e-waste

Concept	Frequency	Percentage
Recycling of e-waste	37	97.4
Legislation on e-waste	32	84.2
Extended Producer Responsibility	19	50.0
Product stewardship	1	2.6
Refurbishment	9	23.7

Regarding legislation, policies, practice and standards respondents are familiar with in regard to disposal of e-waste, recycling of e-waste, legislation on e-waste; Extended Producer Responsibility and refurbishment were mentioned as the most familiar policies with 97.4 percent, 84.2 percent, 50 percent and 23.7 percent respectively.

4.5 Influence of Extended Producer Responsibility on disposal of e-waste

Table 4.8: Extent to which the provisions and concepts observed in respondents' respective division

Concept	Frequency	Percentage
Stored in own premises	29	54.7
Sold as second hand equipment	35	66.0
Threw them away with general waste	4	7.5
Donated them to a recycler	7	13.2
Donated to other departments, schools, etc	1	1.9
Disassembled to reuse some parts	23	43.4

The finding about the extent to which the provisions and concepts observed in respondents' respective division, 66 percent of the respondents said that the e-waste was sold as obsolete equipment while some is stored in own premises (54.7%). Other e-wastes are disassembled for reuse of some parts (43.4%).

4.6 Influence of Policy Framework on disposal of e-waste

Table 4.9: What the University has done towards appropriate disposal of e-waste

Concept	Frequency			Percentage		
	Yes	No	Total	Yes	No	Total
Study the flow of e-waste using tracing systems with a purpose of identifying the source and distribution channels	23	30	53	43.4	56.6	100.0
Implemented systems for vetting imports	-	53	53	-	100.0	100.0
Use of appropriate ICT procurement tools to ease the assessment and identification of the suitable products	40	13	53	75.5	24.5	100.0
Formulate and implement strict e-waste policies to discourage illegal imports	8	45	53	15.1	84.9	100.0
Provide for recycling infrastructure and support to local investors in the recycling industry	5	48	53	9.4	90.6	100.0

The study also sought to find out what the University of Nairobi had done towards effective disposal of e-waste. The study found that, the University deploys appropriate ICT procurement tools to ease the assessment and identification of the suitable products (75.5%). On the other hand, the University had failed to adequately implement systems for vetting imports (100%), provide for recycling infrastructure and support to local investors in the recycling industry (90.6%), formulate and implement strict e-waste policies to discourage illegal imports (84.9%) as well as study the flow of e-waste using tracing systems with a purpose of identifying the source and distribution channels (56.6%).

4.7 Influence of Recycling Facilitation on disposal of e-waste

Table 4.10: Whether the respondent's institution kept inventories of the equipment discarded/disposed of

Practice	Frequency	Percentage
Yes	49	92.5
No	4	7.5
Total	**53**	**100.0**

On the issue of whether the respondent's institution kept inventories of the equipment discarded/disposed of, a vast majority (92.5%) said yes while the remaining 7.5 percent said no. This implies that public institutions particularly UoN keep inventories of the equipment discarded/disposed of.

Table 4.11: Whether the institution had received any clone/second hand equipment

Practice	Frequency	Percentage
Yes	18	34.0
No	35	66.0
Total	**53**	**100.0**

On whether the institution had received any clone/second hand equipment, 66.0 percent said no while the remaining 34.0 percent said yes. This implied that the public institution had not received any clone/second hand equipment.

Table 4.12: What respondents' institution did with electronic equipment when it was no longer useful?

Concept	Frequency	Percentage
Stored in own premises	29	54.7
Sold as second hand equipment	35	66.0
Threw them away with general waste	4	7.5
Donated them to a recycler	7	13.2
Donated to other departments, schools, et	1	1.9
Disassembled to reuse some parts	23	43.4

Regarding what respondents' institution did with electronic equipment when it was no longer useful, 66.0 percent sold as second hand equipment, 54.7 percent store in own premises, 43.4 percent disassembled to reuse some parts while 13.2 percent donate them to a recycler. This implied that most public institutions store electronic equipment no longer useful to them in own premises while others do sell them as second hand equipments.

Table 4.13: Whether respondent was aware that some electronic parts maybe profitably recycled

Concept	Frequency	Percentage
Yes	52	98.1
No	1	1.9
Total	**53**	**100.0**

On whether respondent was aware that some electronic parts maybe profitably recycled, an overwhelming majority (98.1%) said yes while only a few (1.9%) said no. This implied that, respondents were aware that some electronic parts maybe profitably recycled.

Table 4.14: Whether respondent was aware of any company that collected discarded e-waste for recycling

	Frequency	Percentage
Yes	31	58.5
No	22	41.5
Total	**53**	**100.0**

Concerning whether respondent was aware of any company that collects discarded e-waste for recycling, 58 percent said yes while 41.5 percent said no. This implied that majority of ICT and procurement personnel were aware of a company that collected discarded e-waste for recycling.

4.5 Correlations

Table 4.15: Multivariate R-Square

Model Summary									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	0.81	0.656	0.599	0.27	0.66	18.30	4	43	0.000

R^2 is called the coefficient of determination and tells us the proportion of the change in e-waste disposal that is caused by the change in explanatory variables. From Table 4.29, the value of R square was found to be 0.66 at 95% confidence level indicating that disposal regulations, Extended Producer Responsibility, e-waste policy framework as well as recycling facilitation explains 66% of any change in e-waste disposal in the University of Nairobi. The study also reveals that the remaining 34% could be explained by other factors affecting e-waste disposal. When F is greater than 1, the set of explanatory variables is considered to be significantly determining any changes in e-waste disposal in public institutions.

Table 4.16: Pearson's correlation

Variable	E-Waste	Disposal regulations	Extended producer responsibility	E-waste policy framework	recycling facilitation
E-waste	1.00	0.37	0.52	0.51	0.77
Disposal regulations	0.37	1.00	0.37	0.37	0.35
Extended producer responsibility	0.52	0.37	1.00	0.54	0.55
E-waste policy framework	0.51	0.37	0.54	1.00	0.59
Recycling facilitation	0.77	0.35	0.55	0.59	1.00

To determine the degree of relationship between the explanatory variables, the Pearson's correlation as illustrated by Table 4.30 was performed. Pearson's correlation coefficient (r) is a measure of the strength of the association between the two variables. This enabled the establishment of the level to which one variable moved together with the other in explaining changes in e-waste. Findings indicate that, the relationship between all the variables (that is, disposal regulations, Extended Producer Responsibility, e-waste policy framework, recycling facilitation as well as the dependent variable (e-waste)) with each other is significant since the significance level at 95% confidence level; one tail test is less than 0.05.

Highest correlation was found between recycling facilitation and e-waste with coefficient factor of 0.77. Others were recycling facilitation and extended producer responsibility and e-waste and e-waste policy framework with each a correlation coefficient of 0.55 and 0.59 respectively. Least correlation was identified between recycling facilitation and disposal regulations (0.35). The study therefore indicates that it will be necessary to formulate regulations relevant to the e-waste disposal markets to set minimum safety standards that protect environment.

Apart from broad national policies and legislations, there may also be specific organizational regulations. Extended Producer Responsibility (EPR) or Producer Take-Back Responsibility programmes may trigger innovative design concepts such as Design for Environment (DfE) and Design for Disassembly (DfD). This concurs with Shivoga 2010, who proposes that enforcing such concepts as cleaner production and continual quality improvement in manufacturing processes could lead to generation of better quality e-waste for reuse and recycling. These concepts can help heightened green awareness in the supply chain and consumer behaviour. For proper disposal of e-waste, there is urgent need for the implementation of producer/supplier responsibility and introduction of formal recycling, and appropriate disposal technology for toxic wastes that will arise from e- waste disposal activities.

CHAPTER FIVE

SUMMARY OF FINDINGS, DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of the findings, discussion, conclusion drawn from the findings and recommendations made. The conclusions and recommendations focus on the purpose of the study.

5.2 Summary of the Findings

The study revealed that, the University deployed appropriate ICT procurement tools to ease the assessment and identification of the suitable products (75.5%). On the other hand, the University had failed to adequately implement systems for vetting imports (100%). Further, that limited capacity of relevant government agencies to deal with e-waste (3.6), lack of public awareness on the need for safe e-waste disposal (3.6) and lack of coordinated approach across service providers and the University to deal with e-waste are the most common challenges on e-waste disposal. On the Legislation, Policies Practice and Standards, the respondents were familiar with concepts in relating to disposal of e-waste.

This includes recycling of e-waste, extended producer responsibility and refurbishment. On the extent to which the provisions and concepts were observed in respondents' respective division, 66 percent of the respondents said that the e-waste was sold as second hand equipment. Regarding what respondents' institution did with electronic equipment when it was no longer useful, 66.0 percent sold as second hand equipment, 54.7 percent stored in own premises, 43.4 percent disassembled to reuse some parts while 13.2 percent donated to a recycler. Concerning whether respondent was aware of any company that collected discarded e-waste for recycling, 58 percent said yes while 41.5 percent said no.

The study found that the University had failed to formulate and implement strict e-waste policies to discourage illegal imports (84.9%), as well as study the flow of e-waste using tracing systems with a purpose of identifying the source and distribution channels (56.6%).

On whether the institution has received any clone/second hand equipment, 66.0 percent said no while the remaining 34.0 percent said yes.

The study found that the University had failed to provide for recycling infrastructure and support to local investors in the recycling industry (90.6%). On whether respondent was aware that some electronic parts maybe profitably recycled an overwhelming majority (98.1%) said yes.

5.3 Discussion of findings

5.3.1 Influence of Disposal Regulations on e-waste Disposal

The study findings revealed that there exists limited capacity in public institutions to appropriately handle and dispose e-waste. This may be premised on the outcome that there was limited public awareness on the need for safe e-waste disposal as marked by lack of coordinated approach across service providers and public institutions in dealing with the nascent and rapid growth of e-waste. This study outcome concurs with the findings of Cairns (2005) that support the concept that the phenomenon continues to flourish due to rapid adoption and use of ICTs which consequently contributes to increase in e-waste streams.

This scenario portends an environmental crisis for Kenya in the near future. A case in point would be the planned provision of Laptop Computers to all class one pupils in **5.2.4**

5.3.2 Influence of Extended Producer Responsibility on disposal of e-waste

The finding that most public institutions dispose obsolete equipment by selling them second hand equipment, concurs with Okidi, Mbote, Akech (2008), who content that it may be useful to complement legislative provisions under EMCA (1999) with alternative approaches. The long-term vision for the e-waste sector would be to establish a process in which the use of materials and generation of waste are minimized, any unavoidable e-waste recycled or remanufactured, and any remaining e-waste disposed in a way that causes least damage to the environment and human health. To achieve this vision, radical changes to supply-chain management, especially to the product and industrial design part of the supply chain, are needed. Specifically, the 3Rs need to guide industrial design - with implications for materials at all stages - and be overlaid on the entire supply chain. This requirement is, in turn, expected to motivate innovation.

Indeed, the overall finding concurs with Li & Geiser (2005) who support the Principle of Extended Producer Responsibility (EPR) in regard to total product life cycle. There are multiple benefits from greening the e-waste sector, although quantitative data may be hard to come by as yet. These benefits include resources recovered from e-waste helping to avoid extraction of raw materials, avoided health costs, and job creation. Greening of the sector will involve formalization of the informal sector including the provision of proper training, health protection, and decent level of compensation for e-waste workers, and thereby contribute to improving equity and poverty alleviation. Additional efforts are needed to collect data and conduct quantitative analysis at all public organisations - taking a total cost perspective - to enable policy makers to design their strategy for greening the e- waste sector on a more informed basis.

5.3.3 Influence of Policy Framework on Disposal of e-waste

The Kenya Constitution enshrines the Right to a clean and healthy environment for all Kenyans. The study findings would therefore tend to support the Kenya Governments commitment to international agreements such the Bamako and Basel Conventions.

This makes a case for investing in greening of the e-waste sector and aims at providing provide policy makers in public organizations with guidance on how to mobilize such investment. It demonstrates how greening the e-waste sector can create jobs and contribute to economic growth, while addressing environmental issues. The environmental and social (including health-related) benefits from greening the e-waste sector cannot be gain said. The impact of this may, however, be limited as environmental and social concerns are often seen as competing with core performance imperatives.

Greening the e-waste sector refers to a shift from less- preferred e-waste treatment and disposal methods such as incineration and dumping towards the concepts of **3Rs: Reduce**, **Reuse** and **Recycle.** The researcher concurs that the strategy is to move upstream in the e-waste management hierarchy, based on the internationally recognized approach of Integrated Solid Waste Management (ISWM) UNEP (2012).

The ISWM would be a strategic approach to managing sources of e-waste in public organisations; prioritizing e-waste avoidance and minimization, practicing segregation, promoting the 3Rs, implementing safe e-waste transportation, and disposal in an integrated manner, with an emphasis on maximizing resource-use efficiency. This marks a departure from the usual approach where wastes are managed mainly from a compliance point of view characterized by end-of-pipe treatment such as incineration and land filling.

Under ISWM, activities of greening the sector include:

- Resource conservation, which avoids excessive resource consumption;
- E-waste reduction through resource use optimization that minimizes resource wastage;
- E-waste collection and segregation, ensuring appropriate disposal
- End-of-life product reuse, which circulates e-waste and avoids the use of virgin resources;
- E-waste recycling, which converts waste into useful products;
- Dump storage avoidance, which conserves space and avoids risks of contamination; and
- Formulation and implementation of policy for e-waste collection, recovery of materials from e-waste streams (collection and segregation) and application of 3R technologies.

5.3.4 Influence of Recycling Facilitation on disposal of e-waste

There is substantial (54.7%) storage of obsolete electrical and electronic equipment within office space, an indicator that most public institutions do not have consistent or coordinated approaches to disposal of e-waste. This amount of e-waste being held in office space sets the stage for the laying of sound foundation towards the development of a deliberate recycling infrastructure. The findings support Kahhat, et al (2008) proposal that end-of-life electronic product disposal including logistics systems and take back regulation needs to reflect not just technical efficiencies but must also reflect the political structure and underlying cultural models of society within which the system is to operate.

5.4 Conclusion

The results of the study indicate that the University of Nairobi needs to institute specific policy framework to guide the disposal of e-waste to match the rapid increase and continued accumulation of the same within own premises. This outcome would be representative of the situation in other public institutions. It behooves the institutions to ensure safe disposal of e-waste and thus protect sensitive eco-systems else the institutions may unwittingly contribute to deterioration of the environment and thus poor human health. The Kenya Constitution enshrines the right to a clean and healthy environment for all Kenyans. Electrical and electronic waste is a major source of new and complex hazardous waste additions to Municipal solid waste. Globally, UNEP and the United Nations University (UNU), 2009, estimate that 20 to 50 million tonnes of e-waste are disposed of each year, which accounts for 5% of all Municipal Solid Waste.

With sales of electronic products in China, India, across Africa and Latin America, predicted to rise sharply in the next ten years; the challenge is only set to grow.
Inadequate information on the constituents of e-waste products such as valuable raw materials and toxic pollutants makes disposal and trading of e-waste challenging and risky.

The increasing volume and complexity of e-waste is posing threats to ecosystems and human health, but opportunities do exist to 'green' the e-waste proportion at the University and indeed in all public organizations. These opportunities would come from the growing demand for improved e-waste management and from resource recovery from e-waste. This change in demand will be driven by cost savings, increased environment awareness and increasing scarcity of natural resources. The development of new e-waste related technologies on 3Rs will facilitate the greening of the sector. The growth of e-waste volumes would be a reflection of the underlying demand for greening the sector - especially the new paradigm of linking e-waste to resource use across the life- cycle of products. Different organizations face different e-waste related challenges, but the path to greening the e-waste sector shares common milestones. Prevention and reduction of e- waste at source is essential for all organizations, although this is particularly important in public organizations given their rapid growth in adoption of information and communication technologies and increasing electrical / electronic material and resource consumption.

The absolute growth of technology and globalization would mean that the absolute volume of e-waste is unlikely to decline. Greening the sector is therefore the only way to a sustainable future. It is important to reduce conversion of used electronic and electrical materials into Municipal waste. Proper collection, segregation, transport, and recycling of e-waste as well as the construction of basic facilities are essential steps in many public organizations. In most cases, in these organizations, an additional intervention is the cleanup of existing dump storage, which may harm the environment and the health of waste pickers most of whom are poor men, women and even children. Therefore, it is crucial to ensure that stringent regulations are in place and comprehensive environmental policies addressing the necessity of recycling and reducing unsafe dumping are formulated.

The e-waste recovery and recycling part of the waste treatment chain probably holds the greatest potential in terms of contributions to a green economy. As natural resources become scarcer, the commercial value of materials recovered could be substantial. Some developed countries and emerging economies have set high standards for themselves in this area and are likely to acquire comparative advantages in remanufactured and recycled products. Public Organizations, when planning their disposal processes, may want to take into consideration the potential growth of resource recovery as an increasingly significant cost saving measure. The choice of e-waste disposal options ought to include a full range of benefits including avoided environmental and social costs and should not be based only on technology costs.

5.5 Recommendations

Based on findings of this study, the researcher recommends that:

In relation to overall greening of public organizations, indicators of greening the e-waste streams should include the value of - and, jobs related to - the goods generated through the greening of the e-waste sector such as remanufactured products and the services in terms of e-waste collection, segregation, and processing. Economic and social benefits in terms of health, property values, as well as direct and indirect job creation should also be included.

Public organizations should, enter into partnerships with the private sector which has the potential for reducing fiscal pressure while enhancing the efficiency of service delivery.

The success of such arrangements is to a large extent dependant on a reasonably sound institutional framework and sufficient capacity to ensure transparency in awarding contracts to private service providers. Micro-financing, international development assistance and other financing mechanisms can also be explored to support localized e-waste treatment systems that provide employment opportunities to local communities while reducing the need for distant transportation of waste.

The labour force that underpins the recycling sector contributes significantly to solving one or more organizational environmental issues (e.g. climate mitigation or pollution). These workers, whether they are formally employed or are self employed, should be considered a category of the agents of change that environmental and economic policies rely upon. The value of their contributions to environment policies and social value added should therefore be widely and more clearly recognized. Recycling is one of the most important sectors in terms of employment creation.

In developing countries the recycling segment of the e-waste industry is predominantly controlled by the informal sector and it is often hazardous unsafe work. Most of this population is composed of women and children. Hence efforts are needed to provide recognition; respect and appropriate protection to ensure that issues related to health and safety are adequately addressed. Recovery and recycling of used electrical and electronic appliances would create servicing / technician jobs. Such working skills should be developed through training and national certification programmes focusing in repairing and servicing requirements for used appliances. The concepts of creative re-use may also generate new jobs and value added products that could be sold for profit.Pay-as-you-throw (PAYT) could be another way of discouraging e-waste generation. Precaution against illegal e-waste dumping or misuse of recycling facilities should be taken.

5.6 Further research

Additional efforts are needed to collect data and conduct quantitative analysis in all public organizations to enable policy makers to design their strategy for greening the e- waste sector on a more informed basis. Economic and social benefits in terms of health, property values, as well as direct and indirect job creation should also be included. Not all of these indicators may, however, be readily available and thus may call for further research.

Effective management of environmental issues associated with e-waste disposal requires better information gathering and integrated approaches to e-waste management, supported where appropriate by improved environmental governance.

The process of greater cooperation and coordination of waste conventions (Bamako, Basel, and Stockholm) provides an opportunity to enhance awareness raising, knowledge transfer, capacity building and national organizational implementation that should be further explored.

One of the major 0rganizational issues in the e-waste sector is the relationship between the formal and informal segments of the sector. A major cause for thriving informal sector in developing countries is the difficulty to achieve economies of scale in formalizing the existing informal recycling units. These would, therefore, inform possible basis for further research towards resolution of the various environmental issues related to e-waste as narrated herein.

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Appendix ii

Questionnaire

Factors influencing e-waste disposal in public organizations: The case of University of Nairobi.

SECTION A: DEMOGRAPHIC INFORMATION

1. Name of the respondent (Optional)

……

2. Job Title / Designation

……

3. Indicate your Department/Unit in the University

……

(Please tick as appropriate)

4. Level of education [ ]
   Diploma/Higher diploma level [ ]
   University Graduate [ ]
   Post- graduate Qualification [ ]
   Any other (Kindly Specify) …….

5. Duration that you have worked at the University

   (Please tick as appropriate)

   3 years and below [ ]
   4 – 6 years [ ]
   7 – 10 years [ ]
   11 – 15 years [ ]
   Above 15 years [ ]

6. Please state the appropriate ICT procurement process used by the University as you understand it

   ……

   ……..……..

7. To what extent do you think the following are constraints in sustainable disposal of e-waste system at the University? Please indicate as appropriate,

   Using the scale of 1 (very little extent) to 5 (very large extent),

Constraint	1	2	3	4	5
Limited capacity of relevant Government agencies to deal with e-waste					
Lack of coordinated approach across service providers and the University to deal with e-waste					
Inadequate Sensitization and Skills					
Lack of public awareness on the need for safe e-waste disposal					
Lack of regulatory and policy structures to safeguard health, environmental and social consequences of e-waste.					
It is not clear on whom the burden and / or cost of responsibility in e-waste disposal falls (UoN, Producer/Supplier, service provider or the government)?					
Rapid change in technology and growth of Management information systems at the University					
Absence of infrastructure and technology for effective e-waste disposal					
Limited support for local initiatives, such as Computer for schools Kenya (CFSK)					
Absence of policy framework for end-of-life (EoL) equipment take-back / implementation of Extended Producer Responsibility (EPR)					
Any other (specify)					

8. Indicate which of the following legislation, policies, practice and standards that you are familiar with in regard to disposal of e-waste (Tick as appropriate)

a) Recycling of e-waste [ ]
b) Legislation on e-waste disposal [ ]
c) Extended Producer Responsibility [ ]
d) Product Stewardship [ ]
e) Remanufacturing [ ]

Any other (specify) ……..……..

9. To what extent are the above provisions and concepts observed in your division on a scale of 1 (very little extent) to 5 (very large extent)?

	1	2	3	4	5
Recycling of e-waste					
Legislation on e-waste disposal					
Extended Producer/Supplier responsibility					
Product Stewardship					
Remanufacturing					
Any other (specify)					

10. What in your view, has the University done towards sustainable disposal of e-waste? Tick as appropriate.

a) Study the flow of e-waste using tracing systems with a purpose of identifying the source and distribution channels; [ ]
b) Implemented systems for vetting imports; [ ]
c) Use of appropriate ICT procurement tools to ease the assessment and identification of the suitable products. [ ]
d) Formulate / implement policy guidelines to issues of e-waste [ ]
e) Provided for recycling infrastructure and support to local investors in the recycling industry [ ]

Any other (specify)……

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

    Yes [ ] No [ ]

12. Have you received any clone /second hand equipment? Yes [ ] No [ ] Please specify

    ……

    ……

13. What do you do with electronic equipment when it is no longer useful? Tick as appropriate

    a) Store in own premises [ ]

    b) Sell as obsolete equipment [ ]

    c) Throw them away with general waste [ ]

    d) Donate them to a recycler [ ]

    e) Donate to other departments, schools, etc [ ]

    f) Return to seller on a buy-back arrangement [ ]

    g) Disassemble to reuse some parts [ ]

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

    Yes [ ] No [ ]

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

    Yes [ ] No [ ]

    Any other comment

    ……

    ……

    ……

Thank you for participating