

**FACTORS INFLUENCING E-WASTE MANAGEMENT IN  
KENYA: A CASE OF MOBILE PHONES DISPOSAL IN  
NAIROBI COUNTY, KENYA**

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**A Research Project Report Submitted In Partial Fulfillment For The Requirement Of  
The Award Of Degree Of Master Of Arts In Project Management Of The University Of  
Nairobi**

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**DECLARATION**

This research project report is my original work and has not been presented for the award of a degree in any other university or institution for any other purpose.

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This research project report has been submitted with my approval as the university supervisor.

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## **DEDICATION**

This research report is dedicated to my mother, Mrs. Florence Yagan, who taught me that the best kind of knowledge to have is that which is learned for its own sake. I am as ever indebted to you for the love and support throughout my life.

I owe my deepest gratitude to my family for the enormous support; both emotionally and financially.

This project would not have been successfully completed without the love and patience from, my friend Martin, my sisters and brothers. I sincerely thank them.

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## **ABBREVIATIONS AND ACRONYMS**

<b>CCK</b>	Communication Commission of Kenya
<b>CCN</b>	City Council of Nairobi
<b>CFSK</b>	Computers for School Kenya
<b>EC</b>	European Commission
<b>EEE</b>	Electrical and Electronic Equipment
<b>EIA</b>	Environmental Impact Assessment
<b>EoL</b>	End of Life
<b>ESM</b>	Environment Sound Management
<b>EPR</b>	Extended Producer Responsibility
<b>EU</b>	European Union
<b>E-waste</b>	Electrical and Electronic waste
<b>GSM</b>	Globally System for Mobile communication
<b>ICT</b>	Information and Communication Technology
<b>KNPC</b>	Kenya National Cleaner Production Centre
<b>IPR</b>	Individual Producer Responsibility
<b>KEBS</b>	Kenya Bureau of Standards
<b>KRA</b>	Kenya Revenue Authority
<b>MSW</b>	Municipal Solid Waste
<b>MPPI</b>	Mobile Phone Partnership Initiative
<b>NEMA</b>	National Environment Management Authority
<b>NGOs</b>	Non-Governmental Organizations
<b>NWSC</b>	North West Stewardship Council
<b>OECD</b>	Organization for Economic Development
<b>PRM</b>	Product Recovery Management
<b>PAK</b>	Practical Action Aid Kenya
<b>PVOC</b>	Pre-export Verification of Conformity
<b>SIM</b>	Subscriber Identity Module
<b>SWOT</b>	Strengths Weakness Opportunities and Threat
<b>TV</b>	Television
<b>UNEP</b>	United Nations Environment program
<b>WCED</b>	World Commission on Economic Development
<b>WEEE</b>	Waste Electrical and Electronic Equipment

## ABSTRACT

As technology quickly evolves and new products are outdated almost as soon as they are available for purchase, the need for proper and safe disposal of electronics is apparent. As we become more dependent on electronic products to make life more convenient, the stockpile of used, obsolete products grow. When old electronics are thrown into a landfill, it creates a new problem of electronic waste because most of the devices are made with a huge number of chemicals that make disposing of this electronic waste a challenge. Certain materials, particularly metals, in electronic devices can be salvaged and recycled, and proper handling of electronics ensures that no harmful materials such as lead will contaminate our landfills or water supply. According to United Nations Environmental Program (UNEP), it is estimated that 17,000 tons of used computers and mobile phones are shipped to Kenya every year, adding to the e-waste generated by the new electronic goods that Kenyans are already buying. The uniqueness of e-waste problem in Kenya is that e-Waste is relatively new and its quantities are rapidly growing as technology becomes more common. Finding ways to improve e-waste management has become a priority for the Kenyan government. Kenya currently like most developing countries does not have policies and legal frameworks that guides on management of e-waste. The National Environment Management Authority (NEMA) of Kenya has now put in place a draft e-Waste Management Regulations, which, when gazetted, will provide an appropriate legal and institutional framework and mechanisms for the handling, collection, transportation, recycling and safe disposal of E-waste

This study was guided by the main objective which is to investigate the Factors that influence e-waste management in Kenya. The research design that was utilized was a cross sectional survey .The study was carried out in Nairobi County and the target population was the consumers of Telecommunication, manufacturer's service centers, Regulatory body's e.g NEMA KEBS and CCK, and the County Council of Nairobi (CCN). The study utilized both the primary and the secondary data. Primary data was collected using the questionnaire and was analyzed using the SPSS v 20. This was a clear indication that a sizeable portion of the respondents were ignorant on the potential dangers of toxic substances from the e-waste from the obsolete phones. Majority of the respondents would not sell obsolete mobile phone to the waste collectors or give it for free while only a few would give them out to waste collectors for safe disposal. On the action that would facilitate e-waste management on mobile phones, majority of the respondents looked forward to an increase in the scope of the municipal councils to collect the e-waste. They also cited the absence of recycling solutions, as the main obstacles in e-waste management on mobile phones. The government should be at the forefront in public education on the hazardous effects of retaining e-wastes. The mandated organizations should be disposing the e-waste safely and also facilitate by providing the incentives of proper disposal of obsolete mobile phones. Also the manufacturers, retailers and distributors should be at the fore front in collection of the obsolete phones. There should be convenient collection points countrywide as this would enhance effective and efficient collection of obsolete mobile phones.

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# CHAPTER ONE

## INTRODUCTION

### 1.1 Background of the Study

Information and Communication Technologies (ICTs) play a significant role in areas of development such as health (Kleine & Unwin, 2009), education (Hayford & Lynch, 2003), et cetera. However, ICTs are expensive to acquire and maintain. Difficulty in acquiring ICT materials such as hardware and software in developing regions has led to consumption of second hand products and software piracy. Some of the second hand products that are extremely old are commonly referred to as e-waste (Schluep, et al., 2008). According to CCK quarter report (2010-2011), the quarter under review recorded 1.9 million new mobile subscriptions representing 9.5 percent growth. The significant growth could be attributed to the availability of bundled package that promotes cheaper handsets preloaded with airtime and SIM cards coupled with the reduction of tariffs

Besides affordability factors, Nnorom & Odjango (2007) suggest that e-waste is “internally generated or imported illegally as used goods in an attempt to bridge the so-called digital divide”. Economically, urbanization and the growing demand for consumer goods in different regions of the world have increased the demand and supply of electronic products (Babu et al., 2007). This has led to increased volume of e-waste. For example Robinson (2009) shows that computers, mobile telephones and television sets will contribute 9.8 million tons in e-waste stream by 2015. These figures indicate that there was a rise of 4.2 million in e-waste stream from 2010 to 2015 resulting from only computers, mobile telephones and television sets. A study by Greenpeace in 2008 estimated that, 25% and 20% of the e-waste is recycled safely in Europe and USA (Greenpeace, 2008). It also shows that China and India which have the biggest population in the world have large informal recycling sectors. For example 99% of India’s e-waste goes to informal recycling sectors. This indicates that biggest portion of e-waste generated worldwide is not properly recycled. 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 and health hazard. Apart from the direct problems, this will also discredit ICT

as a tool for development especially in poor regions. In relation to the above background, drastic measures are required to prevent e-waste from escalation.

E-waste also known as Waste of Electrical and Electronic Equipment (WEEE) or Electronic waste is defined in various ways by different researchers. Davis & Heart (2008) and e-waste guide (2009) define e-waste as obsolete, end-of-life or discarded appliances that use electricity. On the other hand, Peralta & Fontanos (2005) define e-waste as “electronic products that no longer satisfy the needs of the initial purchaser”. The term e-waste encompasses mobiles phones, computers and their peripherals, consumer electronics, fridges, etc. that have been disposed of by firsthand users. However, the term is also used generically to describe all waste containing electrically powered components which are valuable, but hazardous and may require special handling and recycling methods.

Some definitions of e-waste reflect divergent but significant meanings. Secondhand products (some which are imported by developing countries) that are fully functional are regarded as e-waste because they (products) can no longer serve the needs of the original purchaser. The nature of some of these used e-products may not suit such definitions. For example a consumer can buy a product *B* before their previously bought product *A* is obsolete i.e., it has been used for a month when its end-of-life time is 3 years. The consumer’s action could result from luxurious needs or product preferences e.g. new technology features appearing in a new version of the product.

Disposing of product *A* should not qualify it to be “e-waste” if it was used by a secondary user at any time in its life time. Accordingly, the above definitions of e-waste can be referred to as: electronic equipment that are considered to be hazardous and do not, in their functional state, serve any purpose to any intending user unless the equipment has been refurbished.

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

“creating innovative solutions for the environmentally sound management of electronic waste” (Buenker, 2007). E-waste phenomenon continues to flourish due to rapid adoption and use of ICTs which has contributed to increase in e-waste stream. E-waste is said to be one of the fastest growing waste streams (Cairns, 2005); growing at a rate of 3–5% per annum i.e., approximately three times faster than an ordinary municipal solid waste (Davis & Heart, 2008). Increase in e-waste stream has attracted the attention of many governments, individuals and researchers due to its impact on the environment and human health.

In Europe, the EU implemented two directives i.e., Directive 2002/96/EC on WEEE and Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS). Council of the European Commission (2006, p. 39) describes the purpose of its proposed Registration, Evaluation and Authorization of Chemicals (REACH) regulatory framework: “The purpose of this Regulation is to ensure a high level of protection of human health and the environment as well as the free circulation of substances on the internal market while enhancing competitiveness and innovation (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, 2005; Wen et al., 2006; Dwivedy & Mittal, 2009). In addition, EU uses the concept of QWERTY/EE (Quotes for environmentally Weighted Recyclability and Eco-Efficiency) to improve or enable environmental performance of end-of-life products (Huisman & Stevels, 2004). The QWERTY/EE strategies include determining: (1) 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. Other countries such as USA, Japan and china have also amended laws for e-waste management. In China, regulations that specifically deal with e-waste are in implementation. For example, the Management Measures for the Prevention of Pollution from Electronic Products regulation that aims at prohibiting the environmentally adverse processing of e-waste and reducing utilization of hazardous and toxic substances in electronic appliances (Xianbing et al., 2006).

Besides regulations, researchers have suggested various strategies of mitigating e-waste problem and solutions that lead to DfE (Design for Environment) or Green IT. Some of the suggested strategies include methods and models for predicting the flow of e-waste and assessing environmental impact of ICTs. For example the concept of ‘Product stewardship’ helps to define how responsibility for a product is shared among its stakeholders. Product

Stewardship is 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 (Environment Protection and Heritage Council 2004). It is argued in Shinkuma & Huong (2009) that a traceability system for tracking/tracing e-waste information is required. Therefore models like Material Flow Analysis (MFA); a method applied to support the material and substance flow management in the waste (Streicher-porte et al., 2005) is required for e-waste mitigation. Wang & Chou (2009) has also studied user behavior and willingness to recycle. All these developments have emerged drastically due to urgent needs for green environment and Green IT.

According to Moyo (2012), in a fact sheet titled “Recycled Cell Phone-treasure Trove of Valued Metals” provided a breakdown for the 180 million cell phones then in the use in the USA another 130 million expected to be retired that year and the 500 million obsolete cellphones sitting in the drawers and the closets awaiting disposal. Those 810 million cellphones contains over thirteen thousands metric tons of metal, with collective net worth of a half a billion US dollars. One estimates hold that there are now over 327 million cellphones in use in the USA alone. China and India amongst the most rapidly growing economies in the world together have nearly two billion cellphones in use, close to a billion in China alone. Estimates were based on 1000 inhabitants and 100 inhabitants for years 2003 and 2010 respectively. The table shows figures which are converted to percentages. The difference in the number of telecom users from 2003 to 2010 is significant. The number of ICT users is expected to increase further after constructing broadband networks. This implies that there was a rise in the e-waste stream. In summary of all the above, ICTs have raised concerns related to health and environmental degradation thus “ICT development without an eye on Environmental Protection is not sustainable” (Tedre et al, 2009). Governments need to strengthen their role in environmental management and preservation.

Kenya’s ICT industry is growing fast. The rate of ICT acquisition specifically computers and mobiles is increasing. Most ICT products come from EU countries such as Britain, Asian countries such as China and Malaysia and USA. Generally ICT imports are new and old products are discouraged. However, there is a considerable portion of refurbished and old products brought in country through various channels such as NGO donations to institutions like schools. The primary reason for importing refurbished and old products is that people prefer cheap goods.

The ICT sector in Kenya has witnessed significant growth; this can be attributed to the number of mobile phone subscribers, telephone lines, internet service providers (ISP), number of internet users, broadcasting stations and the market share (MIC 2006). The status of the ICT sector penetration can be summed up as follows based on the National ICT policy 2006:

As of June 2007 there were approximately 10 million mobile phone subscribers as opposed to 3 million in the year 2004. As of June 2005 there was 73-registered ISP, over 1000 cyber cafes and telephone bureaus and approximately 1,030,000 users. According to the 2010-2011 quarter review, the total number of internet subscriptions registered 4.3 per cent growth from 3.09 million in the previous quarter, Jun-10, to 3.2 million in the quarter under review. The number of internet users was estimated at 8.69 million from 7.8 million users in the previous quarter (quarterly sector statistics report 1st quarter, July-Sept 2010/2011).

There are 16 operational television stations and 24 FM radio stations. An estimated 60% of the population has access to television and 90% have access to radio services ICT issues are regulated under various statutes including but not limited to: *The Science and Technology Act, Cap. 250 of 1977*, *The Kenya Broadcasting Corporation Act of 1988* and the *Kenya Communications Act of 1998* (MIC 2006). These statutes are inadequate in dealing with end of life management of the ICT equipment. They basically cover the licensing and frequency distribution. In the National ICT policy (2006), the environmental considerations mentioned are in line with the government, promoting environmentally friendly IT products that will address the cost issues and the environment issues. In line with this is the development of regulations for recycling and disposal facilities. These are mentioned in the policy but in reality none of these great ideas has been implemented. It may be too soon to judge the implementation as the policy is dated 2006. The mobile phone telephony is regulated under this sector, but the mobile phone, as a good/product is not regulated in this sector although it is associated with the services under this sector.

However, the country lacks a regulatory framework for e-waste management and that in the past; Kenya has not had a recycling policy on electronics. This is mentioned in Mureithi et al., (2008) that, in Kenya, "There are currently no legislation governing e-waste". Public Procurement Oversight Authority (PPOA) which oversees the procurement process in public sector is said to have not seriously considered end-of-life effects of products procured. There are environmental regulations which are not specifically designed for e-waste. These include



the waste management regulations of 2006 enforced by NEMA-the institution that implements all policies relating to the environment. These laws help in controlling generation, handling, transportation, storage, or disposal of waste that threatens public health, the environment or natural resources. There is also an ICT policy instituted by Ministry of Information and Communications (MoIC) in 2006. The policy demands electronics dealers to demonstrate their readiness to minimize the effects of their infrastructure on the environment in order to get their licenses renewed.

In addition, Kenya had a strategic plan (2006-2010) that aimed at creating "an enabling environment through policy, legal and regulatory reforms" (Waema & Mureithi, 2008). Implemented by Ministry of Environment and Natural Resources (MENR), the plan described hazardous waste and pollutants. The environment awareness is high although sensitization is not specifically done on e-waste; the government is planning to have guidelines for e-waste. In a cause to fight against hazardous waste, Kenya is a signatory to numerous multilateral environmental agreements. some of these agreements as: (1) Basel convention on the control of Trans boundary movements of hazardous wastes and their disposal; (2) Bamako convention on the Ban of the imports into Africa and the control of trans-boundary movement of hazardous wastes into Africa; (3) Nairobi convention which provides a mechanism for regional (East Africa) cooperation, coordination and collaborative actions on solving pollution problems of the coastal and marine environment; (4) Stockholm convention on Persistent Organic Pollutants (POPs) and (5) Rotterdam convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade.

Other agreements are promotion of mechanisms and infrastructure needs for greener environments, controlling and providing guidelines for cross boarder movements of hazardous components.

## **1.2 Statement of the problem**

This rapid growth can also be attributed to the huge consumer demand and the willingness of the network operators to expand into the new markets that are not in the urban areas. According to 2010-2011 quarter review overall tele-density rose to 56.9 per cent from 53.3 per cent in Jun-10, with mobile services accounting for 55.9 per cent. The fact that the mobile phone networks need no cables to run over vast distances and the availability of solar energy

as a power source in rural areas has also played a fundamental role in the proliferation and use of the mobile phones. The insatiable desire for the cell phones in Kenya and Africa at large has made the continent a profitable market for this high tech equipment, which is mostly second hand or refurbished products with a short life span. This situation in return results in increasing number of obsolete products (Kang & Schoenung, 2004). This poses a major challenge in the end of life (EoL) management of this equipment alongside other ICT equipment. There has been an exponential increase in e-waste volumes due to the high influx of imported second hand electronics (Muteti 2008, 2nd April, personal interview). The equipment and their accessories contain toxic heavy metals such as cadmium, lead, mercury, manganese, lithium, zinc, arsenic, antimony, and beryllium and copper (Oiva, 2000).

According to Hagelucken (2007), open burning of mobile phones release dioxins and furans. If the mobile phones or the ICT equipment end up in landfills or dumpsites, as is the case in many African countries, they can pose long-term pollution of the environment including ground water and soil; and they could have serious effects on human health. It is therefore imperative to address the EoL management of this equipment so as to ensure that these products do not end up in landfills and dumpsites. All products in the market at the end of their useful stage are potential waste. Producers of these products should have a strategy that can be used in the final disposal of the product during the manufacturing stage (Rose, 2000). That is, the products are manufactured with considerations of the environmental impacts arising from various stages of the life cycle of the product including the end of life phase. This calls for the Extended Producer Responsibility (EPR). The EPR principle is used as the basis for an effective policy approach by the OECD countries and gaining fast acceptance globally in addressing the problems associated with e-waste by promoting the total life cycle environmental improvements of product systems by extending the responsibilities of the manufacturer of the product to various parts of the product's life cycle, and especially to the take-back, recovery and final disposal of the product (Lindhqvist, 2000). Due to the trans-boundary movement of e-waste, the lack of state-of-the-art recycling and waste disposal facilities, EPR in developing countries has become a necessity (Osibanjo and Nnorom, 2008). In the light of this, the study will investigate the factors that influence e-waste management in Kenya, looking particularly at mobile phones in Nairobi County.

### **1.3. Purpose of the study**

The purpose of the study is to investigate the factors that influence e-waste management in Kenya, A case of mobile phones in Nairobi County, Kenya.

### **1.4 Research Objectives**

The study was guided by the following objectives;

- i. To examine how the level of awareness of dangers of improper disposal of e-waste on the mobile phones influences e-waste management in Nairobi County.
- ii. To examine how the existing policies and institutional mechanisms influence the management of e-waste in Nairobi County.
- iii. To determine the influence of the existing systems of e-waste disposal on the management of e-waste in Nairobi County.
- iv. To **determine** how attachment of value to obsolete phones among mobile users influences the management of e-waste in Nairobi County.

### **1.5 Research Questions**

The study attempts to answer the following research questions:

- i. How does the level of awareness of dangers of improper disposal of e-waste on the mobile phones influence e-waste management in Nairobi County?
- ii. What is the influence of the existing policies and institutional mechanisms on the management of e-waste in Nairobi County?
- iii. What is the influence of the existing systems of e-waste disposal on the management of e-waste in Nairobi County?
- iv. How does attachment of value to obsolete phones among mobile users influence the management of e-waste in Nairobi County?

### **1.6 Significance of the Study**

It is hoped that the findings of this study would be useful to the policy makers such as NEMA and the County government as they formulate policy measures on the e-waste in the country. They would also provide useful information to future researchers in the area of e-waste management.

### **1.7 Delimitation of the Study**

The study covers Nairobi County and focuses only on the e-waste generated from the mobile phones. The target population of the study is the service providers, consumers, mobile repairers and the regulatory body (NEMA).

### **1.8 Limitations of the Study**

The study was faced with limitations and this included financial aspect. The area covered was wide and fare transport from one point to another was required and also hiring of taxi to carry you from one area to another. Time aspect also was a limiting factor, in that more adequate time was needed for this type of study but all efforts were made to come up with a comprehensive study. Moreover some of the areas visited by the researcher during data collection were inaccessible, and also some of the respondents expected financial rewards. On the literature, availability on mobile e-waste generation and collection in Kenya was also a key limiting factor. A lot of materials on e-waste are on general e-waste material e.g computers, fridge and batteries but not specifically on e-waste from mobile phones.

### **1.9 Basic Assumptions of the Study**

The study assumed that the respondents were well versed with the e-waste management and the challenges faced in its management in Kenya. The study further assumed that the respondents were available for interview and that they would provide answers to the best of their knowledge.

### **1.10 Definition of Significant terms used**

The following are the significant terms of this study.

**E-waste management**-refers to the organization and coordination of collection, transportation, storage, dismantling and recycling and disposal of the obsolete, end-of- life or discarded mobile phones.

**Level of awareness of disposal of e-waste** refers to the extent in which the consumers know the various ways of proper disposal of the e-waste generated from their mobile phones

**Policies and institution mechanisms of e-waste management** refers to the legal policies and frameworks and the institutional mechanisms that have been put in place in the country to regulate the e-waste management.

**Systems of disposal of e-waste** refers to the various methods that have been put in place by the local institutions, manufacturers and the retailers of the electronic goods towards collection and disposal of the e-waste.

**Attachment of value to obsolete mobile phones by** the consumer refers to the reluctance by the consumers to dispose obsolete mobile phones and thus leading to accumulation of obsolete e-waste on to their obsolete electronics due to perceived usefulness and their symbolic value.

### **1.11 Organization of the Study**

This study is organized in five chapters. Chapter One is the introduction and gives the background of the study. Chapter Two reviews the literature on factors influencing management of the e-waste from the mobile phones at the global, African and Kenyan perspectives, while Chapter Three describes the research methodology of the study. Chapter Four presented the data analysis, presentation and interpretation while Chapter Five presented summary of the findings, discussion, conclusion, recommendation and suggestions for further study.

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1 Introduction

This chapter examines what various scholars and authors have said about e-waste management on the mobile phones and other electronic devices and finally it presents a conceptual framework on which the study is based.

#### 2.2. Status of e-waste management

This section looks at e-waste management in general and the mobile phone in particular from global perspective before zeroing in on Kenya.

##### 2.2.1 Electronic waste in the global context

As the fastest growing component of municipal waste across the world, it is estimated that more than 50 metric tons of e-waste is generated globally every year. In other words, these would fill enough containers on a train to go round the world once. However, since the markets in the West have matured, it is expected to account for only 2 per cent of the total solid waste generated in developed countries by 2010. Therefore, with increasing consumerism and an anticipated rise in the sales of electronic products in the countries experiencing rapid economic and industrial growth, the higher percentage of e-waste in municipal solid waste is going to be an issue of serious concern. A report of the United Nations predicted that by 2020, e-waste from old computers would jump by 400 per cent on 2007 levels in China and by 500 per cent in India. Additionally, e-waste from discarded mobile phones would be about seven times higher than 2007 levels and, in India, 18 times higher by 2020.

Such predictions highlight the urgent need to address the problem of e-waste in developing countries like India where the collection and management of e-waste and the recycling process is yet to be properly regulated. According to the UN Under-Secretary General and Executive Director of the United Nations Environment Programme (UNEP), Achim Steiner, China, India, Brazil, Mexico and others would face rising environmental damage and health problems if e-waste recycling is left to the vagaries of the informal sector. China already produces about 2.3 million tonnes of e-waste domestically, second only to the U.S. with about three million tonnes. The EU and the U.S. would account for maximum e-waste generation during this current decade. As per the Inventory Assessment Manual of the UNEP,

2007, it is estimated that the total e-waste generated in the EU is about 14-15 kg per capita or 5MT to 7MT per annum. In countries like India and China, annual generation per capita is less than 1kg. In Europe, e-waste contributes up to 6 million tonnes of solid waste per annum. The e-waste generation in the EU is expected to grow at a rate of 3 per cent to 5 per cent per year. In the past, e-waste had increased by 16 per cent to 28 per cent every five years which is three times faster than average annual municipal solid waste generation (Mureithi et al, 2008).

In the U.S., e-waste accounts for 1 to 3 per cent of the total municipal waste generation. As per the United States Environmental Protection Agency (USEPA), it generated 2.6 MT of e-waste in 2005, which accounted for 1.4 per cent of total wastes. Electronic waste is generated by three major sectors in the U.S.: individuals and small businesses; Large businesses, institutions and governments; and Original equipment manufacturers (OEMs)

### **2.2.2 E-Waste in Kenya**

The exact amount of e-waste generated in Kenya is not known. Mureithi et al, (2008) estimate the annual tonnage of e-waste in Kenya at about 2 984.35 per year. The authors also note that e-waste in Kenya consists of old PCs and cathode ray tubes (CRTs) in almost equal proportions. A separate study by UNEP (2009b) puts the quantity of electric and electronic equipment (consisting of PCs and mobile phones alone) in the Kenyan market at 5 650 metric tonnes per year. The same assessment puts the stock (installed base) of electric and electronic equipment at 58 110 tonnes per year. This is broken down as follows: 21 300 tonnes of PCs, 610 tonnes of mobile phones, 22 600 tonnes of TVs and 13 600 tonnes of refrigerators. It places the quantity of e-waste generated in metric tonnes per year at 11 400 tonnes from refrigerators, 2 800 tonnes from TV sets, 2 500 tonnes from PCs, 500 tonnes from printers and 150 tonnes from mobile phones, making a total of 17 350 tonnes. According to industry research, Kenya is already well on the way to becoming a major e-waste producer and runs the increased risk of corresponding health, economic and social implications (Scott et al 2004).

The key driver to the rapid generation of e-waste in Kenya is policy failure particularly with respect to importation of second hand (refurbished) mobile phones, used computers and other electronic equipment. Vision 2030 is expected to worsen this policy gap. The first Medium Term Plan (2008-2012) of Vision 2030 states the government's commitment to improve ICT infrastructure as a foundation for a knowledge economy. The same document states the

government's commitment to simulating investment in the ICT sector. This has seen a rapid expansion in the use of ICT through interventions meant to promote use of computer technology, mobile telephony and other ICTs. If growth in these sectors is not well managed, the problem of e-waste could rapidly worsen (Scott et al., 2004).

The e-waste problem in Kenya was brought to the spotlight in September 2006, during the Eighth Conference of Parties (COP 8) to the Basel convention on Trans-boundary waste management that was held in Nairobi. Before that, it was not considered urgent due to the assumed relatively low consumption of Electrical and Electronic Equipment (EEE) and the general trend by households to store EEE, reuse it or dump it along with the MSW. To date there has been no comprehensive study conducted on e-waste generation and management in the country. There is a variety of EEE found in the country ranging from computers, cellular phones, televisions sets, refrigerators, and entertainment electronics amongst others. Kimutu (2008) states that the e-waste in Mombasa in relation to mobile phones is basically the battery and the accessories. On the status of e-waste in Kenya UNEP Executive Director Achim Steiner (2007) stated that ...Right now we see the emergence of e-waste being dumped here in Kenya. He pointed out that the dumping is carried out under the guise of donations. His views have been echoed by other people, such as, Musili (2008) the Director of Computer for Schools Kenya who claimed that there were too many computers coming to Kenya and that there was no system in place to handle e-waste in the country. The unusable computers donated to Kenya are shipped back to the donor countries by NGO. Up to a quarter of the donations sent to the recipient countries are unusable and are dumped in the recipient countries. Nearly 10 to 20 per cent of the computers in Kenya received from the United Kingdom and the United States are unusable (Make it Fair, 2008). Kenya just like any other developing countries has a huge market for second hand computers; due to the low prices as compared to the price of new computers. It is estimated that in the period from 2007 to 2010, a billion computers would be recycled globally and that Africa should take advantage of half of them (Diarra, 2007). While such enthusiastic forecast seems to be addressing the problem of bridging the digital divide between the developed and developing countries, it is not addressing the management of e-waste (Scott et al 2004).

### **2.2.3 Mobile Phones use in Kenya**

Globally, mobile phone users have grown exponentially from early 1970s to mid-2000s. In the year 2004, it was estimated that there were 2.4 billion people using the mobile phone (UNDP, 2003). This trend has also been reflected in the developing countries where there is



the fastest growing market for new and used phones. There has been a significant leap in telephone subscriber's landline and cellular from 9.4/ 100 people in 1990 to 35.3/ 100 in 2001(UNDP, 2003).

The mobile phone demand across Africa is rapidly expanding: it is estimated that over 50 million people have mobile phones in Africa, accounting for 7% of the population (Scott et al 2004). Over the past five years there has been a 65% increase in mobile phone subscribers in Africa (Eagle 2005). The number of mobile phone users in many African countries has overtaken the number of fixed landline users (Banks and Burge, 2004). Kenya has not been left behind in the rapid growth in the mobile phone subscription. From June 1999 there were only 15000 mobile phone subscribers and by the end of 2004 the number had risen to over 5.6 million (Eagle, 2005). As of 2008, it is estimated that there are approximately 10 million subscribers in Kenya (CCK, 2008). Currently, the mobile subscription base has risen to over 28 million (CCK, 2011). This rapid growth can be attributed to the fast and reliable means of communication and the opportunity it presents regarding the deficiency of pro-poor service in the remote and rural areas (Scott et al 2004). The growth of mobile phones in the rural areas can be attributed to the ease of carrying them around thus making them suitable for use in these areas that lack infrastructure. The prepaid system with low cost denomination recharge cards and per second billing has increased the accessibility of the services to the rural population, as it is commensurate with the economic situation (Scott et al 2004). This rapid growth can also be attributed to the huge consumer demand and the willingness of the network operators to expand into the new markets that are not in the urban areas. The fact that the mobile phone networks need no cables to run over vast distances and the availability of solar energy as a power source in rural areas has also played a fundamental role in the proliferation and use of the mobile phones.

The insatiable desire for the cell phones in Kenya has made the country a profitable market for this high tech equipment, which is mostly second hand or refurbished products with a short life span. This situation in return results in increasing number of obsolete products (Kang & Schoenung, 2004). This poses a major challenge in the end of life (EoL) management of this equipment alongside other ICT equipment. There has been an exponential increase in e-waste volumes due to the high influx of imported second hand electronics. The equipment and their accessories contain toxic heavy metals such as cadmium, lead, mercury, manganese, lithium, zinc, arsenic, antimony, and beryllium and copper (Oiva, 2000).

E-waste consists of old electronic items such as computers, printers, mobile phones, refrigerators and televisions. Increasing demand for electronic goods in Kenya and in the developing world means that levels of e-waste are growing fast and the hazardous substances such as heavy metals contained in most of these products are posing a serious risk to the environment and to human health. However, e-waste also presents an economic opportunity through the recycling and refurbishing of discarded electronic goods and the harvesting of the precious metals they contain. A recent baseline study done in 2008 that showed Kenya generates 3,000 tons of electronic waste per year. The study predicts that the quantity is expected to increase as demand increases. Internationally, China, India and Pakistan receive much of the world's e-waste. Worldwide, e-waste generation is growing by about 40 million tons a year. "Raising recycling rates and re-using valuable metals and components, as well as increasing safe waste management and its regulation, is critical if countries and businesses are to transform mountains of e-waste into an asset.

#### **2.2.4 Challenges in management of e-waste in Kenya**

There are various challenges in e-waste management in Kenya. The challenges discussed below are similar to the finding in Osibanjo and Nnorom, (2008) and Hicks et al., (2005) as reasons behind developing countries low-end management of e-waste and the existence of ineffective informal e-waste processing sector. The consumers perceive their waste is a resource that can generate income, thus the unwillingness of consumers to give out their EoL goods for free. This perception is further enhanced by the value attached to products by the consumers; there is a tendency to store EoL EEE especially mobile phones at home even if these products are obsolete as opposed to disposing them. The consumers' reluctance to pay for recycling and disposal services reinforces the notion that nothing goes to waste and that garbage is money. The above perceptions make consumers reluctant to freely participate in EoL management of EEE. Meinhardt (2001) discusses the lack of awareness of users, industry and government regarding end-of-life computer issues: Users also lack awareness of the range of reuse and recycling options available to them. Another type of information failure is the lack of data on e-waste trade. A number of international manufacturers of computers and printers provide information online on extending the life of purchased computers, reducing environmental impacts during product use and purchasing at lower cost. However, this information is mostly targeted to the developed countries market and generally does not incorporate Africa contacts" (p. 88). There is serious lack of awareness on the potential hazards of e-waste amongst the stakeholders such as collectors, consumers,

recyclers and scavengers. This is coupled with the lack of information on e-waste, there is little or inadequate literature in the country on e-waste, thus the e-waste issue is a big grey area. The lack of awareness on the possible health and environmental effects of e-waste is a major obstacle in the management of e-waste. Puckett et al (2005) state that African nation (and other developing countries), the primary destination of e-waste, do not understand the hazards associated with e-waste. They continue: “Consequently almost all of the discarded imported electronic waste is thrown into formal or informal dumpsites, all of which are unlined, unmonitored, close to the groundwater and routinely set afire” (Pucket et al. 2005, p. 6). *Africa is very susceptible to e-waste dumping because there is often a desperate hunger to catch up with the rest of the world in terms of technology* (Okono, 2008). This susceptibility has opened floodgates of second hand products and donations. There is high level of importation of e-waste as second hand devices. This importation is uncoordinated and most of the zero rated products such as computers can be imported without being changed at the point of entries as it does not generate any revenue to the government. Mobile phones and the accessories are easily imported into the country without any duty being paid on them as they can be carried in as hand luggage most of these handsets are sold as part of the grey market.

The entire e-waste management is coupled with the lack of necessary regulations, comprehensive policies, standards and guidelines that specifically address the e-waste issue and the laxity in implementation of the existing regulations. This is compounded with the absence of take-back schemes for EoL EEE and ineffective or failed take-back schemes. In most cases there are no take-back schemes in place and where there is one the end users are not even aware of its existence so such schemes do not succeed. There is generally lack of interest in EoL management of ICT products, but most of the multi-national companies that do not have offices in Kenya, but operate under distributors with the introduction of necessary regulations the producers/distributors should be more responsible for their products. The following are the various policies and the institutional mechanisms in the country that are mandated to manage e-waste.

### **2.3 Existing Policy instruments and institutions of e-waste management and e-waste management**

The following are the various policies and the institutional mechanisms in the country that are mandated to manage e-waste

### 2.3.1 Extended Producer Responsibility Policy instruments

The fundamental principle for development of E-waste policies/ laws/ regulations is based on conceptual the life cycle of electrical and electronic equipment (EEE). “Extended Producer Responsibility” or “Product Take Back” forms the basis of policy framework in developed countries. WEEE directives provide a regulatory basis for collection, recovery and reuse/ recycling targets in EU. The development of legislation and compliance structure as per EU directives is an on-going process in all EU countries. The member states have to guarantee minimum collection, recovery and reuse/ recycling targets as specified in the directive (Lindhqvist, 2000). The understanding of EPR from the above definition captures the variety of instruments that can be implemented as EPR programmes (Tojo, 2004). The EPR instruments can range from administrative instruments, economic instruments and informative instruments. As seen in EPR programmes it normally adopt more than one policy instrument to achieve intended results. Table 2.1 presents the examples of EPR policy instruments

**Table 2.1: Examples of EPR policy instruments**

<b>policy instruments</b>	<b>Responsibility</b>
<b>Administrative instrument</b>	Collection and/ or take-back of discarded products, substance and landfill restrictions, achievement of collection, reuse (refill) and recycling targets, fulfilment of environmentally sound treatment Standards, fulfilment of minimum recycled material content standards, product standard, utilization mandates
<b>Economic instruments</b>	Material/product taxes, subsidies, advance disposal fee systems, deposit-refund systems, upstream combined tax/subsidies, tradable recycling credits
<b>Informative instruments</b>	Reporting to authorities, marking/ labelling of products and components, consultation with local governments about the collection network, information provision to consumers about Producer responsibility/ source separation, information provision to recyclers about the structure and substances used in products

Source: Tojo (2004)

The policy instruments can also be applied in non-EPR instruments, as they are not inherently EPR oriented (Manomaivibool *et al* 2007). Components of some of the EPR policy instruments have already been discussed in section 2.3.1, above. The instruments can be categorized as mandatory or voluntary instruments depending on the level of coerciveness (Tojo, 2004). The mandatory initiatives are implemented by legislation that compels all

actors involved to fulfil the stated requirements whereas the voluntary initiative is left to the actors to set up the goals and strive to achieve them. The scenario in Kenya at this point in time is based on the voluntary initiative of companies, as there is no regulation encompassing EPR.

### **2.3.2 Institutions for e-waste management**

The following presents the various stakeholders and the mechanisms frameworks in the country which are involved in the management of the e-waste.

The ICT sector just like the other sectors is regulated by different state agencies charged with different responsibilities. The actors listed here should not be viewed as an extensive all inclusive listing of the actors. The regulator s main roles, in relation to e-products and e-waste, entail: Pre-export verification of products as conducted by the Kenya Bureau of Standards (KEBS), Import verification at the point of entry conducted by Kenya Revenue Authority (KRA), Kenya Ports Authority (KPA), and KEBS, Type approval of telecommunication EEE is conducted by Communication Commission of Kenya in consultation with KEBS, Development of e-product standards is conducted by KEBS in consultation with the relevant government agencies, Development of e-waste regulations and management of e-waste falls under the docket of the National Environment Management Authority (NEMA) in consultation with the other relevant agencies and stakeholders.

NEMA developed waste management regulation in 2006. Part IV of this regulation deals with hazardous waste in totality, i.e. the hazardous waste specifications, requirement for Environmental Impact Assessment (EIA), handling, storing and transporting, export permit and its validity, transit of hazardous was and insurance amongst other issues. The waste management regulations of 2006 are not explicit when addressing e-waste; the components of e-waste are covered under various facets of the regulation such as hazardous waste management and chemical waste management. The lack of explicit and detailed mention on e-waste has created loopholes in the regulation as the e-waste handlers and actors do not comply with the regulations requirements on waste handling, as they state that the regulation does not cover e-waste.

The Communications Commission of Kenya (CCK) is an Independent regulatory authority for the communications sector, and is mandated to provide licenses and regulate telecommunications, radio communication and postal/ courier services in the country. The CCK conducts type-approval of telecommunication equipment in Kenya, but their mandate is

limited to equipment that can connect directly to or inter-work with public telecommunication network to send process or receive information. The CCK has rejected some of the telecommunication equipment due to their interference with public telecommunication network but not based on their environmental performance. The CCK works in synergy with the Kenya Bureau of Standards (KEBS) to develop standards for the ICT sector. CCK has to some extent control on the mobile phone industry under its licensing regimes and regulations.

The objectives of the KEBS that are relevant to this study include preparation of standards relating to ICT products, testing and quality management and the pre-export verification of conformity to standards. Kenya has standards on some electrical and electronic equipment but not on mobile phones. However, where there are no national standards the KEBS used international standards to regulate the goods entering into the country. The pre-export verification of conformity program (PVOC) was formed with the objective of verifying the quality of certain regulated goods coming into Kenya.

The main challenge facing the KEBS is the safe disposal of the rejected hazardous goods as the country lacks the necessary infrastructure to destroy these goods although it is stipulated in the law that the importer of the rejected good is to meet the disposal cost. The other challenge lies in the regulation of donations, which in most cases entail computers and laptops. The donations of computers and laptops that have less than one year of life left should not be allowed into the country.

Most EEE sold or found on the Kenyan market are imported as the big manufacturers are not based in Kenya, but they do have distributors and retailers who import the products and sell them on the Kenyan market. There are a few producers with offices in Kenya, or in the wider East African region, such as Nokia and HP. The other producers such as Siemens and Sony Ericsson have network offices and not product offices in Kenya. This situation makes the importer of the EEE to be the responsible party for the EoL management. The MPPI 2006 has stressed on the need for the producer responsibility in developing countries as these countries do not have the legislation and infrastructure for collection of EoL products.

It is estimated that there over 100 independent importer and distributors of mobile phones in Kenya, the authorized importers deal with handsets from companies such as Motorola and Siemens, while Nokia has set up a direct import channel (Berry and Knowles, 2007). There are several retailer outlets that sell EEE. The role and function of the retailers in a take-back

scheme needs to be clearly defined as they hold a strategic position in the product chain (OECD, 2001). Retailers can be the take-back points and information dissemination points on EPR programmes due to their proximity and intimate relation with the consumers. In case of a well-established take-back scheme with incentives, the retailers who are registered and deal with products from a specific producer could collect the charges or fees and provide refunds to the EoL products (OECD, 2001).

The consumers/ end users play a crucial role in the take-back schemes. The main challenge the producers face in the implementation of take-back programmes is how to make the end users return the used product for recycling as opposed to taking it to the repair shops or storing the phones at home. The main issue with sending the EoL EEE to repair shops relies on the final disposal of this obsolete equipment by the repair shops. EEE is stored by the owner, as it is perceived to be of value ranging from sentimental, emotional or physical before being disposed of as MSW (Osibanjo and Nnorom, 2007). The level of consumer awareness on the on-going take-back scheme initiated by Nokia is very low. Consumer awareness is a crucial area for an effective take-back scheme. The willingness to participate in a take-back scheme by consumers will determine the success of the scheme.

#### **2.4 E-waste disposal systems/ Collection Systems**

Electronics waste needs to be collected separately from other waste in order to the recycle and reuse the material content. E-waste can be collected on a voluntary basis or to fulfil legislative regulations. The motivations for collecting electronics for recycling range from economic to environmental protection and to brand enhancement motivations. The main objective for the majority of the legislations for e-waste is to prevent it from being disposed together with household waste. Collection methods can be classified by the used models and by the persons or organizations responsible for organizing and/or financing the operations. The following models are available for collection (Chancerel, 2010, Hai-Young, 2005). First is the Drop-off program, with permanent collection centers or retailers, containers on the streets, or temporary collection events; the second method is the Pick-up program, where the e-waste is collected at the homes or offices and thirdly is the Distance collection, where the user sends the e-waste by post to the collector.

There are neither earmarked funds, nor investments that can be used to finance improvements in e-waste recycling and e-waste management. This is coupled by lack of appropriate infrastructure for recycling as most of the recycling activities are conducted by the repairers

and refurbishes in unregulated premises. The lack of resources needed in planning, strategizing and management of e-waste has led to the problem being regulated and not properly addressed. There is lack of relevant technology that can be used in the management of e-waste; this applies mostly to recycling technologies. The technological gap between the North and the South compounded with the high price of acquiring this technology has led to the emergency of backyard recyclers who resort to usage of rudimentary techniques that pose a major threat to the environment and to their health (Osibanjo and Nnorom, 2007).

The lack of an efficient collection, recycle and reuse system is one of the problems for e-waste management in Kenya. Hence, some suggestions to improve the efficiency of e-waste collection recycle, and reuse systems are provided. As stated before, a key consideration is the cultural imperative in the Kenya for market-driven solutions that enable competition. Given this context, Kenya should adopt a form of deposit-refund system designed to incentivize collection while at the same time establishing a competitive market for reuse and recycling services. The following are three characteristics that a deposit-refund system in the U.S. should satisfy the collects revenue to ensure proper recycling; provides a financial incentive for consumers to turn in their equipment; and also creates a market in which firms compete to offer more efficient reuse and waste management services (Ramzy Kahhat et al, 2011).

The core concept of the system is that consumers pay a deposit at time of purchase, a variable portion of which is returned when the electronic or electrical equipment is turned in at the end-of-life. This deposit should be sufficient enough to cover transportation and recycling cost of the product. Reuse and recycling firms compete on an electronic market to receive the deposit by bidding different values of rebates to consumers. The possibility of reuse is also included in this process, in which case consumers may even receive more return than the deposit paid, for example, a functional computer still attractive for the reuse market. If the firm chooses to refurbish or resell the computer in lieu of recycling, the transfer of deposit is deferred until true end-of-life processing. (Ramzy Kahhat et al, 2011).

## **2.5 Attachment of value to obsolete mobile phones**

Consumer study by Nokia shows that less than 10 % of people have recycled their old mobile phones. Most of the unused phones are still at home, making the recycling potential huge. The lack of awareness that recycling is even possible and knowledge on existing recycling programs and locations are the main obstacles for consumers. Based on the first consumer



survey on consumer recycling behaviour and attitudes at 2007 it was found out that despite the fact that households on average have each owned around five phones, very few of these have been recycled once they are no longer used (Osibanjo and Nnorom, 2007).

The role of accumulating of obsolete electronic items and reluctance to dispose of these materials has led to accumulation of a large number of electronic materials, that appears to be of useless or of little value and have difficulties to dispose such items without clear conscious motivation or control (Greenberg et al., 1990; Sookman, Abramowitz, Calamari Wilhelm & McKay, 2005). According to Carisma (2010), in terms of behavioural aspect, Kenyans have strong penchant to keep prized items such as electronics due to the sentimental value attached to the product. It is common in many Kenyan houses to keep old and non-functional television, radio and refrigerator as household display or just for storage. As a general observation, ordinary Kenyans who cannot easily afford to buy expensive items such as electronics may find it hard to dispose valued possession right away.

In terms of waste segregation and recycling, it needs a change in mindset for new generation to internalize waste segregation and recycling and become part of their habit. In fact, the concept of materials recovery has been part of the Kenyan culture for a long time. Itinerant vendor would go house-to-house on a regular basis buying disposed bottles, iron, and newspaper and glass container eliminating the need to segregate waste at source. This business practice, however, is no longer common especially in big and urban areas. This idea of house-to-house collection should be explored in an EPR programme.

## **2.6 Awareness of dangers of improper disposal**

According to Diarra, (2007), electronics such as cellphones, laptops, TV's, and batteries all contain materials that are harmful for humans if disposed of improperly. E-waste in landfills can threaten humans through leaching into the soil and groundwater. Lax labor standards in developing nations lead to dangerous working conditions and the direct exposure of processing center workers to hazardous materials. The harmful materials contained within electronics necessitate separate processing from typical waste (Kimutu, 2008).

There is low awareness on hazards of e-waste among the public stakeholders and nationally but extremely limited to the community surrounding the University. Community awareness campaigns on how to safely handle e-waste are non-existent (Musili, 2008). Schmidt (2005) continued to note that the current awareness regarding the existence and dangers of e-waste are extremely low, partly because the e-waste being generated is not as large as in developed

countries. Urgent measures are required to address this issue. Awareness on the effects of discarded e-waste to the environment and human health should be created at all levels of governance and the general public by making information available through appropriate means (e.g. websites, workshops/seminars, campaigns, etc.); and by identifying target groups (e.g. schools, universities, vocational institutions, informal sector, government, retailers, etc.) with tailor made solutions towards sustainable e-waste management.

Interest groups have formed to educate consumers on the dangers of improper electronic waste recycling and encourage them not to throw electronics in their typical waste bin. For example, E-cycling Central offers tools such as listings for companies that specialize in e-waste recycling and advertisements for electronics drop-off events. The Electronics Take-Back Coalition ranks manufacturers recycling efforts and has created a scorecard to raise consumer consciousness and potentially impact buying decisions. The Basel Action Network audits recycling companies through its e-Stewards program to inform consumers of reputable drop-off centers (Schmidt, 2005).

## **2.7 Theoretical Framework**

Marx and Darwin used this theory in their work. System theory (as we know it) was used by L. von Bertalanffy, a biologist, as the basis for the field of study known as ‘general system theory’, a multidisciplinary field (1968). Some influences from the contingency approach can be found in system theory.

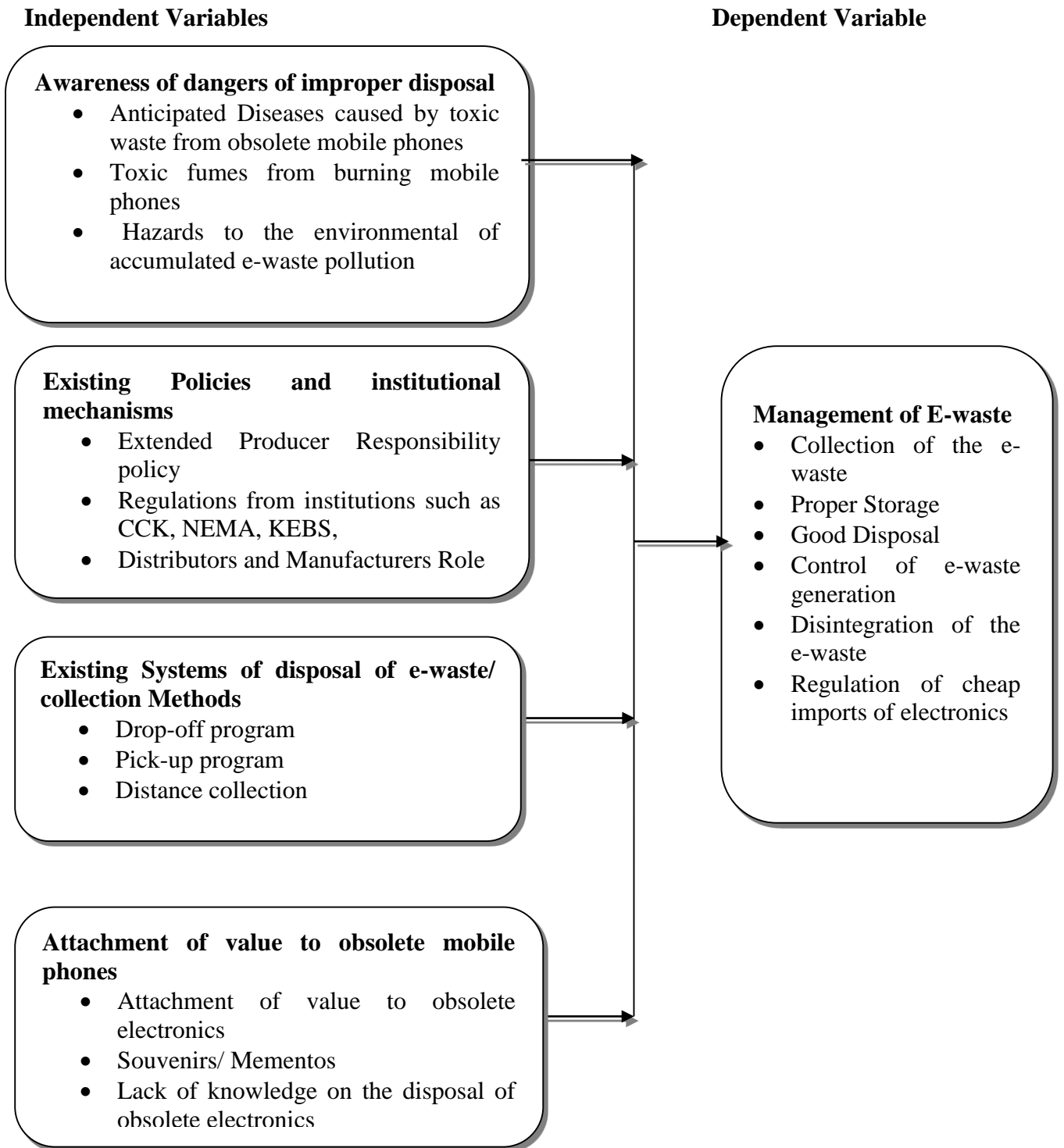
System theory is the transdisciplinary study of the abstract organization of phenomena, independent of their substance, type, or spatial or temporal scale of existence. It investigates both the principles common to all complex entities, and the (usually mathematical) models which can be used to describe them. A system can be said to consist of four things. The first is objects – the parts, elements, or variables within the system. These may be physical or abstract or both, depending on the nature of the system. Second, a system consists of attributes – the qualities or properties of the system and its objects. Third, a system had internal relationships among its objects. Fourth, systems exist in an environment. A system, then, is a set of things that affect one another within an environment and form a larger pattern that is different from any of the parts. The fundamental systems-interactive paradigm of organizational analysis features the continual stages of input, throughput (processing), and output, which demonstrate the concept of openness/closedness. A closed system does not interact with its environment. It does not take in information and therefore is likely to

atrophy, that is to vanish. An open system receives information, which it uses to interact dynamically with its environment. Openness increases its likelihood to survive and prosper. Several system characteristics are: wholeness and interdependence (the whole is more than the sum of all parts), correlations, perceiving causes, chain of influence, hierarchy, suprasystems and subsystems, self-regulation and control, goal-oriented, interchange with the environment, inputs/outputs, the need for balance/homeostasis, change and adaptability (morphogenesis) and equifinality: there are various ways to achieve goals. Different types of networks are: line, commune, hierarchy and dictator networks. Communication in this perspective can be seen as an integrated process – not as an isolated event.

Waste Management Theory (WMT) has been introduced to channel environmental sciences into engineering design. WMT is a unified body of knowledge about waste and waste management. It is an effort to organise the diverse variables of the waste management system as it stands today. WMT is considered within the paradigm of Industrial Ecology, and built side-by-side with other relevant theories, most notably Design Theory. Design Theory is a relatively new discipline, still under development. Following its development offers valuable insights about evolving technical theories. According to Love (2002), it is crucial to theory development to integrate theories from other bodies of knowledge, as well as the clarification of the definitions of core concepts, and mapping out key issues, such as domains, epistemologies and ontologies. At the present stage of WMT development, scientific definitions of key concepts have been offered, and evolving of WMT under the paradigm of Industrial Ecology is in progress. The function of science is to build up systems of explanatory techniques; a variety of representative devices, including models, diagrams and theories (Toulmin 1953). Theories can be considered milestones of scientific development. Theories are usually introduced when previous study of a class of phenomena has revealed a system of uniformities. The purpose of theory is then to explain systems of regularities that cannot be explained with scientific laws (Hempel 1966). Formally, a scientific theory may be considered as a set of sentences expressed in terms of a specific vocabulary. Theory will always be thought of as formulated within a linguistic framework of a clear specified logical structure, which determines, in particular, the rules of deductive inference.

## **2.8 Conceptual Framework**

Conceptual framework is a logically developed, described and elaborated network of interrelationships among the variables deemed to be integral to the dynamics being investigated, explains the theory underlying these relations, and describes the nature and direction of the relationships (Matoko J.M. et.al 2009). While according to Mugenda and Mugenda (1999) conceptual framework refers to a situation where a researcher conceptualizes the relationship between variables in the study and shows the relationship graphically or diagrammatically. Figure 1 gives the conceptual framework of this study.



**Figure 3.2: Conceptual Framework**

The schematic diagram in Fig. 2 indicates the various factors that affect or enhance proper management of e-waste. Creation of the awareness to the public on dangers of improper disposal will promote proper disposal of the e-waste to the designated locations in both rural

and urban centers. The government and other stakeholders can implement policies and institutional frameworks that can be used to regulate the management of the e-waste in the country. On the contrary, the various stakeholders can provide collection centers for the e-waste from the mobile phones and other sources while the cultural aspect can be reduced through the mass education on the dangers of retaining the obsolete electronics as memoirs/souvenirs.

## **2.9 Summary**

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

## **CHAPTER THREE**

### **RESEARCH METHODOLOGY**

#### **3.1 Introduction**

This chapter presents the methodology of the study that was used in the collection of data pertinent in answering the research questions. The methodology is divided into research design, study population, sample design, data collection, data procedures, data analysis methods and ethical issues. The chapter also presents the operationalization of variables table.

#### **3.2 Research Design**

According to McMillan and Schumaker (2001), a research design is a plan for selecting subjects, research sites and data collection procedures to answer the research questions. A research design is the arrangement of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure, (Seltiz, 1963).

This research was conducted through descriptive survey design. Descriptive survey is preferred for it is used to obtain information concerning the current status of a phenomenon. The purpose of this method was to describe “what exists” with respect to situational variables. According to Cooper and Schindler (2003), a descriptive study is concerned with finding out the what, where and how of a phenomenon. This is advocated by Young (1960) and Kothari (1990) who both acknowledge that descriptive survey is a powerful form of qualitative analysis that involves a careful and complete observation of a social unit, irrespective of what type of unit is under study. It’s a method that drills down, rather than cast wide.

#### **3.3 Target Population**

Population refers to an entire group of individuals which are the concern for the study within the area of the study (Mugenda and Mugenda, 1999). They further explain that the target population should have some observable characteristics, to which the researcher intends to generalize the results of the study.

The target population of this study was the consumers (users of mobile phones) in Nairobi County who are approximated 3.4 million (KNBS, 2009), manufacturing service centres (20 centers) , the national regulators (CCK) and staff of City Council of Nairobi (CCN) approximated to be 5000.

### 3.4 Sample Size and Sample Size Determination

#### 3.4.1 Sample Size

According to Mugenda and Mugenda (1999), sampling is the process of selecting a number of individuals for a study in such a way that the individuals selected represented the large group from which they were selected. This is done to secure a representative group which will enable the researcher to gain information about a population. A sample was taken using stratified random sampling from the various categories which will give each item in the population an equal probability chance of being selected. The selection was as shown in Table 3.2

#### 3.4.2 Sample Size Determination

For this study, the sample of the mobile phone consumers was obtained by calculating the sample size from the target population by applying a Yamane (1967) formula as quoted by Israel (1992).

$$n = \frac{N}{1 + N(e)^2}$$

Where:

$n$ = Sample size,

$N$ = Population size

$e$ = Level of Precision.

At 95% level of confidence and  $P=5$

$$n = 3.4 \text{ million} / (1 + 3.4 \text{ million} \{0.05\}^2)$$

$$n = 399.95$$

$$= 400$$

Thus a sample size of 400 respondents was required. Due to the time and financial constraints the researcher tried to contact 50% of the sample size and this translates to 200 respondents. On the City Council of Nairobi employees, the same formula was used and this resulted to 370.4 respondents (approximately 370) and again the study tried to get 50% and this were 185 respondents



**Table 4.2: Sample Size**

<b>categories</b>	<b>Sample Size</b>	<b>Sample size Percentage</b>
Consumers and phone repairers	200	47.05
Manufacturing Centres	20	4.7
City council of Nairobi employees	185	43.5
Regulators	20	4.7
<b>Total</b>	<b>425</b>	<b>100</b>

### **3.5 Research instruments**

Instruments are developed to collect the necessary information (Mugenda and Mugenda, 1999). The study used questionnaires. A questionnaire was designed to obtain details on their basic knowledge on e-waste disposal management.

#### **3.5.1 Reliability of Instrument**

To ensure instrument reliability, the questionnaire was piloted prior to the actual survey. 10 respondents was selected from among the consumers and the NCC employees while among the manufactures and other stakeholders, 2 respondents was selected for this purpose and were not selected for the final data collection. Those selected for piloting were not included in the final survey. They were selected by purposive sampling (Mugenda and Mugenda, 1999) as they are more available. The pre-test questionnaire was filled under the researchers' observation. The piloting will ensure clarity and sustainability of the language used.

#### **3.5.2 Validity of data collection instruments**

Instruments validity refers to the degree to which as test measures what it purports to measure (Borg and Gall, 1989). It also refers to the data that is true and accurate for the purpose it is collected. For this study, validity was ensured by discussing the instrument with expert in the subject and with my supervisor.

### **3.6 Data Collection Procedures**

The respondents are expected to fill in the questionnaires. The questionnaires was filled and collected on the same time. The study used questionnaires and interviews to discover the knowledge in disposal of e-waste management at dumpsites in Kenya. This method is believed to provide reliable and valid data. The interviews were limited to the operators. About a hundred respondents were targeted to fill the questionnaires. The researcher was asking the respondents the questions and fill in the appropriate answers from the respondents,

and it is hoped that by filling the questionnaires, the respondents was able to corroborate information obtained from the interviews. The overall approach used in the study was qualitative analysis whereby data was described.

### 3.7 Data Analysis and Presentation Techniques.

Data collected was subjected to quantitative analysis. This technique enabled the researcher to fully describe the findings from interviews and questionnaires using a few statistics. After the data is collected from the field, it was analyzed and interpreted. Statistical data analysis method of frequency analysis and geographical presentation of frequency distribution was used. Tables were used to present the finding. Statistical Package for Social Sciences (SPSS) programme was used in speeding up the data analysis.

### 3.8 Ethical considerations

While collecting the data, the respondents were assured of their privacy and confidentiality of the information given. Privacy was ensured by not recording the names of the respondents anywhere. It ensured this privilege was not abused and that respondents understood that their responses would be used purely for academic purposes and nothing else.

### 3.9 Operationalization of variables

The study addressed the objectives as indicated in the following Table 3.5 in which the respective indicators are indicated as well as their data collection method and the data analysis.

**Table 3.3: Operationalization of variables**

	Variable	Indicator(s)	Measurement	Scale	Data collecting method	Data Analysis
To examine how the level of awareness of dangers of improper disposal of e-waste influences e-waste management in Nairobi County.	<b><u>Independent variable</u></b> Awareness of the dangers of e-waste disposal	<ul style="list-style-type: none"> <li>• Knowledge of diseases caused by toxic waste by mobile phones</li> <li>• Knowledge of effects of burning obsolete mobile phone</li> <li>• Knowledge of the environmental pollution due to improperly</li> </ul>	<ul style="list-style-type: none"> <li>• diseases caused by exposure to e-waste</li> <li>• Possible explosion</li> <li>• Effects to the lungs of fumes from burning phones</li> <li>• Illnesses from polluted soil and water</li> </ul>	Ordinal	questionnaire	Descriptive statistics

		discarded mobile phones				
To examine the influence of the existing policies and institutional mechanisms (in place) on the management of e-waste in Nairobi County.	<b><u>Independent variable</u></b> policies and institutional mechanism	<ul style="list-style-type: none"> <li>EPR Policy</li> <li>Regulations from NEMA, CCK and KEBS</li> <li>Types of policies and institutional mechanism</li> <li>NEMA laws</li> <li>Role played by the institutions</li> </ul>	<ul style="list-style-type: none"> <li>Types of frameworks governing e-waste,</li> <li>Various institutions that manage e-waste</li> <li>Bills passed for e-waste management</li> </ul>	Ordinal	questionnaire	Descriptive statistics
To determine the influence of the existing systems of e-waste disposal on the management of e-waste in Nairobi County.	<b><u>Independent variable</u></b> systems of disposal of e-waste	<ul style="list-style-type: none"> <li>Drop-off program</li> <li>Pick-up program</li> <li>Distance collection</li> </ul>	<ul style="list-style-type: none"> <li>Presence of e-waste disposal methods</li> <li>number of collection centres</li> <li>number of collected obsolete phones</li> </ul>	Ordinal	questionnaire	Descriptive statistics
To investigate how disposal behavior of mobile users influences the management of e-waste	<b><u>Independent variable</u></b> disposal behavior	<ul style="list-style-type: none"> <li>Attachment to old phones</li> <li>Keeping phones as souvenirs</li> <li>Attachment of values</li> </ul>	<ul style="list-style-type: none"> <li>Frequency of disposal of old phones</li> <li>Number of old and obsolete phones they possess,</li> </ul>	Ordinal	Questionnaire	Descriptive statistics
To determine the factors influencing e-waste management in Kenya	<b><u>Dependent Variable</u></b>	<ul style="list-style-type: none"> <li>Collection of obsolete phones</li> <li>Proper Storage of obsolete phones</li> <li>Good Disposal of obsolete phones</li> <li>Knowledge Control of obsolete phones</li> <li>Dismantling of obsolete phones Regulation of cheap imports of electronics</li> </ul>	<ul style="list-style-type: none"> <li>Ways of disposal of obsolete phones</li> <li>Methods of storage of obsolete phones</li> <li>Ways of dismantling of obsolete phones</li> </ul>	Ordinal	Questionnaire	Descriptive statistics

## CHAPTER FOUR

### DATA ANALYSIS, PRESENTATION AND INTERPRETATION

#### 4.1 Introduction

This chapter presents the analysis and findings from the primary data that was gathered from the respondents. The information so gathered is presented in terms of tables before interpretation.

#### 4.2 Response Rate

Of the 425 questionnaires sent to the sampled subject, 409 were filled and returned which translates to 96% response rate. According to Mugenda and Mugenda (2003), a response rate of 60% of the respondents is considered adequate but if unresponsive rate is high the researcher is required to follow up study to check the factor behind the lack of response since it can be a relevant factor in the study.

#### 4.3 Socio-Demographics of the Respondents

This section presents the biodata of the respondents in terms of gender, age and educational levels. Their responses are presented in Tables 4.3 to 4.6

Table 4.1 presents the study findings on the gender of the respondents.

**Table 4.4: Gender of the Respondents**

Gender	Frequency	Percent
Male	245	59.9
Female	164	40.1
Total	409	100.0

As shown on Table 4.3, majority (59.9%) of respondents were male while 40.1% were females.

**Table 4.4** presents the age of the respondents

**Table 4.5: Age of respondents**

Age	Frequency	Percent
< 20 years	40	9.8
21-30 years	169	41.3
31-40 years	121	29.6
41-50 years	67	16.4
More than 50 years	12	2.9
<b>Total</b>	<b>409</b>	<b>100.0</b>

While the study attracted respondents from all age brackets, Table 4.2 indicates that the majority of mobile users, at about 80%, were youthful at less than 40 years old.

The study also sought to determine the level of education of the respondents. This information appears on Table 4.5

**Table 4.6: Education Level of the Respondents**

Education Level	Frequency	Percent
Primary Level	36	8.8
Secondary Level	98	24.0
Tertiary / College Level	176	43.0
University Level	69	16.9
Postgraduate Level	30	7.3
<b>Total</b>	<b>409</b>	<b>100.0</b>

Table 4.3 shows that a huge majority of respondents, at over 80%, had at least secondary education. In fact those with tertiary education and above were a full 60%. This should not be surprising as a fairly high level of education is needed in order to operate the phone satisfactorily.

#### **4.4 Period using or repairing mobile phones or working for the firm**

The study sought to determine the period that the respondent have been using or repairing mobile phones or working for a mobile firm.

**Table 4.7: Period using or repairing mobile phones or working for the firm**

<b>Period</b>	<b>Frequency</b>	<b>Percent</b>
Less than one year	63	15.4
Between 1-4 years	141	34.5
Between 5-8 years	151	36.9
More than 8 years	54	13.2
<b>Total</b>	<b>409</b>	<b>100.0</b>

It was established that the majority of the respondents (84.6%) have at least had been using or handling mobile handsets for more than one year while a 15.4% indicated less than one year. This confirms that the equipment is not a new phenomenon to the majority of respondent.

#### **4.5 Frequency of mobile phone replacement**

The study sought to determine the respondents' rate of mobile phone replacement.

**Table 4.8: Frequency of mobile phone replacement**

	<b>Frequency</b>	<b>Percent</b>
Very	55	13.4
Minimal	245	59.9
Never	109	26.7
<b>Total</b>	<b>409</b>	<b>100.0</b>

It was established that only a small percentage of 13.4% of respondents replaced their obsolete phones on a regular basis. The majority of the respondents (86.6%) tend to use one phone for a longer period before replacing it.

Table 4.8 presents the action taken by the respondents after their mobile phones becomes obsolete.

**Table 4.9: Action taken after mobile phones becomes obsolete**

<b>Action taken</b>	<b>Frequency</b>	<b>Percent</b>
Discard them	190	46.5
Keep them as souvenirs	157	38.6
Sell them to the repairers	48	11.7
Take them back to manufacturer	13	3.2
<b>Total</b>	<b>409</b>	<b>100.0</b>

Table 4.9 establishes that only a mere 3.2% of the respondents returned their obsolete to the manufacturers. This implied that there is high percentage rate (96.8%) of e-waste accumulation from the discarded phones by the end users/consumers.

#### 4.6 Aware that there is some hazardous e-waste from mobile phone

The respondents were asked if they were aware of the hazardous e-waste from mobile phones. Their responses are shown in Table 4.9

**Table 4.10: Aware that there is some hazardous e-waste from mobile phone**

Awareness	Frequency	Percent
Yes	198	48.4
No	207	50.6
Total	405	99.0
System	4	1.0
<b>Total</b>	<b>409</b>	<b>100.0</b>

As shown on Table 4.10, a majority of the respondents (50.6 %) were not aware of the potential dangers of toxic substances from the e-waste from the obsolete phones.

The respondents were asked if they were aware of disease that could be caused by hazardous materials from the e-waste. Their responses appear on Table 4.8.

**Table 4.11: Aware any disease that is caused by hazardous materials from the e-waste**

Awareness of disease	Frequency	Percent
Yes	195	47.7
No	214	52.3
<b>Total</b>	<b>409</b>	<b>100.0</b>

From Table 4.11 it is clear that majority of the respondents 52.3% were unaware of possible diseases caused by the hazardous materials from the e-waste; hence increasing their tendency of retaining obsolete phones as mementos.

#### 4.7 Diseases caused by the e-waste toxins

The respondents were asked whether they know the various diseases that were caused by e-waste toxins and their responses are presented in Table 4.12

**Table 4.12: Diseases caused by the e-waste toxins**

<b>Diseases</b>	<b>Frequency</b>	<b>Percent</b>
Cancer	35	8.6
Tetanus	11	2.7
Skin diseases	89	21.7
Allergies	43	10.5
Neurological disorders.	17	4.2
Non responsive	214	52.3
<b>Total</b>	<b>409</b>	<b>100.0</b>

Majority of the respondents 52.3% did not respond to this question because they were not aware of any disease caused by the toxins emitted by a mobile phone which has reached the end of life. At least 47.7% could at least name one of the diseases that are caused by the toxins and the majority of the respondents cited skin diseases.

#### **4.8 Giving out obsolete mobile phone to the waste collectors for free**

The study further inquired from the respondents if they were willing to surrender the obsolete and the responses are given in the Table 4.12.

**Table 4.13: Giving out obsolete mobile phone to the waste collectors for free**

	<b>Frequency</b>	<b>Percent</b>
Yes	95	23.2
No	314	76.8
<b>Total</b>	<b>409</b>	<b>100.0</b>

Majority of the respondents (76.8%) would not surrender their obsolete mobile phone to the waste collectors for free while 23.2% of them would give them out to waste collectors for safe disposal and this indicates why there are huge accumulations of the same at the household levels.

#### **4.9 Action to facilitate e-waste management on mobile phones**

Table 4.10 presents responses of the respondents on the actions to be taken in implementing to facilitating e-waste collection.



**Table 4.14: Action to facilitate e-waste management on mobile phones**

	<b>Frequency</b>	<b>Percent</b>
Provide incentives to the consumers to give them up	21	5.1
Provide sites for collection	133	32.5
Increase the scope of the county councils to collect e-waste	168	41.1
All of above	87	21.3
<b>Total</b>	<b>409</b>	<b>100.0</b>

73.6% of the respondents indicated provision of collection sites and collection of e-waste by county council as the most critical factor in the management of e-waste while a small percentage of 21.3% cited incentives to the consumer in order for them to give up their old and obsolete phones as measures.

#### **4.10 Main Obstacles in e-waste management of mobile phones**

The respondents were asked on the main challenges in e-waste management of the mobile phones in Kenya and their responses are presented in the Table 4.14

**Table 4.15: Main Obstacles in e-waste management of mobile phones**

	<b>Frequency</b>	<b>Percent</b>
absence of recycling solutions	86	21
lack or inadequate legislation	73	17.8
lack or inadequate infrastructure or policy,	51	12.5
lack of awareness	50	12.2
lack or inadequate or absence of collection system	49	12
high cost	14	3.4
Missing	86	21.02
<b>Total</b>	<b>409</b>	<b>100.0</b>

The study established that the main hindrance to e-waste management is the lack of the legislations and policies (40.3%) while the absence of recycling solutions was at 21%. High cost of management was rated the least at a mere 3.4%. This indicates that if policies and legislations are put in place, there could be proper management of e-waste.

#### **4.11 Legislation on e-waste management of mobile phones in Kenya**

The respondents were asked on the presence of any legislation governing e-waste management in Kenya and the responses are provided in Table 4.15

**Table 4.16: Any legislation on e-waste management of mobile phones in Kenya**

	<b>Frequency</b>	<b>Percent</b>
Yes	204	49.9
No	205	50.1
<b>Total</b>	<b>409</b>	<b>100.0</b>

About half (49.9%) of the respondents indicated that there was legislation and the rest were not aware of any legislation on e-waste management of mobile phones in Kenya. This indicates the high rate of ignorance and thus retention of obsolete mobile phones and disposal of the same.

#### **4.12 Aware of the principle of EPR**

Table 4.16 presents the responses on awareness of the EPR.

**Table 4.17: Aware of the principle of EPR**

	<b>Frequency</b>	<b>Percent</b>
Yes	83	20.3
No	326	79.7
<b>Total</b>	<b>409</b>	<b>100.0</b>

A mere 20.3% were aware of the Extended Producer Responsibility (EPR) and this implied that majority of the consumers are not aware that there are producers who are willing to collect the obsolete phones as part of their responsibilities to manage e-waste.

#### **4.13 If EPR is well applied in Kenya**

Table 4.17 presents the findings on the query on the application of the EPR in Kenya.

**Table 4.18: If EPR is well applied in Kenya**

	<b>Frequency</b>	<b>Percent</b>
Yes	13	3.2
No	70	17.1
Non response	326	79.7
<b>Total</b>	<b>409</b>	<b>100.0</b>

Majority (79.7%) of the respondents did not respond to this question since they were not aware of this method of collecting and disposing of e-waste through EPR.

#### 4.14 Goal of e-waste legislation

The study sought to determine the goal of e-waste legislation in the county. Respondents' answers appear on Table 4.18

**Table 4.19: Goal of e-waste legislation**

	<b>Frequency</b>	<b>Percent</b>
Reduce hazardous processing of e-waste	49	12.0
Promote reuse	95	23.2
Promote recycling	105	25.7
Waste prevention and better product design	105	25.7
Most of above	55	13.4
<b>Total</b>	<b>409</b>	<b>100.0</b>

It was established that 48.9 % of the respondents believed that the goal of e-waste legislation was to promote re-use and recycling of the useful components that are found in the obsolete mobile phone while a very small percentage 12.0% tied the goal of legislation to trying to put in place regulations that will help reduce the hazardous products from harming environment and health.

#### 4.15 The responsibility of collecting the obsolete mobile phones

The following Table 4.19 presents the responsibility of collecting the obsolete mobile phones as from the respondents' responses

**Table 4.20: The responsibility of collecting the obsolete mobile phones**

	<b>Frequency</b>	<b>Percent</b>
Brand owner	103	25.2
Manufacturer	105	25.7
Importer	67	16.4
Distributor	67	16.4
All of above	67	16.4
<b>Total</b>	<b>409</b>	<b>100.0</b>

Only 16.4% of the respondents were aware that all the stakeholders were responsible for collecting and disposing obsolete mobile phones.

#### 4.16 Institutions mandated to collect and dispose e-waste in Kenya

On the local level the researcher wanted to know whether the respondents knew who was mandated with the responsibility of collecting the obsolete mobile phones. Their responses appear on Table 4.20.

**Table 4.21: Institutions mandated to collect and dispose e-waste in Kenya**

	<b>Frequency</b>	<b>Percent</b>
CSK	184	45
NGOs	141	34.5
KEBs	49	12
NCC	16	3.9
CCK	2	0.5
NEMA	17	4.2
<b>Total</b>	<b>409</b>	<b>100.0</b>

Virtually all respondents did not know that it was the NCC that was mandated with the responsibility of collecting and disposing of e-waste.

#### **4.17 Level of agreement on e-waste management**

The respondents were asked on their agreement on the e-waste management in the country and their responses are presented in the Table 4.21

**Table 4.22: Level of agreement on e-waste management**

	Mean	SD
It is important to effectively manage e-waste of mobile phones?	1.9321	0.0261
It is profitable to manage and reuse/resell e-waste of mobile phones?	4.9130	1.40114
Kenya has got laws sufficient enough to regulate e-waste	4.5435	1.43022
E-waste management of mobile phones is an important function of our organization	4.0432	0.09652
We have well defined norms about how to manage e-waste of mobile phones	2.6043	0.35414
E-waste management of mobile phones is not important to us since we produce very little or insignificant figure on the same.	2.1230	0.40114
The e-waste disposal systems of mobile phones available at present are sufficient for our e-waste needs	2.4560	0.4376

From Table 4.19, it is clear that the respondents were aware of strengths and weaknesses of e-waste management in Kenya

#### **4.18 Convenience of current e-waste collection of mobile phones**

The study asked the respondents to comment on the convenience of e-waste collection of obsolete phones. Their responses are recorded in Table 4.22

**Table 4.23: Current e-waste collection of mobile phones convenient**

The study wanted to establish whether the collection of obsolete mobiles was convenient. Their response are presented in Table 4.22

	<b>Frequency</b>	<b>Percent</b>
Yes	122	29.8
No	287	70.2
<b>Total</b>	<b>409</b>	<b>100.0</b>

Majority (70.2%) of the respondents indicated that the current e-waste collection of mobile phones was not convenient. This was expected as the current legislation and framework for e-waste recycling and disposal are not well much articulated.

#### **4.19 Role of manufacturers, retailers and the distributors in e-waste collection of mobile phones**

The respondents were asked if the various actors in the electronic vendors should commence on e-waste collection from the phones. Their responses are given in Table 4.23

**Table 4.24: Manufacturers, retailers and the distributors' involvement in e-waste collection of mobile phones**

	<b>Frequency</b>	<b>Percent</b>
Yes	329	80.4
No	80	19.6
<b>Total</b>	<b>409</b>	<b>100.0</b>

Majority (80.4%) agreed that manufacturers, retailers and the distributors should be involved in collecting of e-waste generated from the phones. This response is important since it would increase the effectiveness and the efficiency in the e-waste management in the country.

#### **4.20 Processes for e-waste management of obsolete phones**

The respondents were asked on the methods that they knew of e-waste of obsolete phones and the responses are provided in the Table 4.24.

**Table 4.25: Processes for e-waste management for obsolete phones**

	<b>Frequency</b>	<b>Percent</b>
Leaching	6	1.5
Burning	71	17.4
Cable stripping granulation	29	7.1
Shredding	46	11.2
Manual dismantling	175	42.8
Sorting of product parts	82	20
<b>Total</b>	<b>409</b>	<b>100.0</b>

The study established that majority of the respondents would prefer that instead of just discarding the obsolete phones; the useful parts should be saved for further use through shredding, manual dismantling and sorting out useful product parts.

#### 4.21 Aware of obsolete mobile phone can be profitably recycled

The respondents were asked if they were aware if obsolete phones could be recycled

**Table 4.26: Aware of obsolete mobile phone can be profitably recycled**

	<b>Frequency</b>	<b>Percent</b>
Yes	217	53.1
No	192	46.9
<b>Total</b>	<b>409</b>	<b>100.0</b>

Majority (53.1%) of the respondents indicated that they were aware that obsolete mobile phone could be profitably recycled but this was contrary to the previous data on which the respondents sought to retain them.

#### 4.22 Retained an obsolete mobile phone

On the query if the respondents ever retained an obsolete mobile phone, the following were the responses obtained.

**Table 4.27: Retained an obsolete mobile phone**

	<b>Frequency</b>	<b>Percent</b>
Yes	223	54.5
No	186	45.5
<b>Total</b>	<b>409</b>	<b>100.0</b>

It was established that majority (54.5%) had retained their obsolete phones and this led to the accumulation of the e-waste from the retained phones.

#### 4.23 Period they have been holding on to obsolete mobile phones

Table 4.26 presents the responses on the period the respondents have been retaining the obsolete mobile phones.

**Table 4.28: Period they have been holding on to obsolete mobile phones**

	<b>Frequency</b>	<b>Percent</b>
Less than 1 year	125	30.5
1-5 years	68	16.6
5-10 years	21	5.1
More than 10 years	9	2.2
Non	186	45.5
<b>Total</b>	<b>409</b>	<b>100.0</b>

A third (30.5%) of the respondents indicated that they have kept the phones for less than one year while 2.2% cited for more than ten years. The majority of the respondents informed the researcher that they handed over the phones to other people to repair or use them once they are no longer need them.

#### **4.24 Main reason for retaining the obsolete phones**

The following Table presents the key reasons why the respondents chose to retain the obsolete phones.

**Table 4.29: Main reason for retaining the obsolete phones**

	<b>Frequency</b>	<b>Percent</b>
Kept as souvenir/ sentimental attachment	223	54.5
Has value	164	40.1
Children use it as toy	22	5.4
<b>Total</b>	<b>409</b>	<b>100.0</b>

The study reveals that majority of the respondents (94.6%) cited that they valued the mobile phone because of attachments placed on them and kept them as souvenir, while 5.4 % kept them for their children to play with then as toys.

#### **4.25 If they would take them back for proper disposal**

Lastly the respondents were asked if they would take their obsolete mobile phones back for proper disposal and their responses are presented in the Table 4.30

**Table 4.30: If they would take them back proper disposal**

	<b>Frequency</b>	<b>Percent</b>
Yes	207	92.8
No	16	7.2
<b>Total</b>	<b>409</b>	<b>100.0</b>

Majority (92.8%) reported that they would take them back for proper disposal and this would eventually reduce the accumulation of obsolete electronics in the households.

**Summary** The study has presented the analysis and findings from the primary data gathered from the respondents.



## CHAPTER FIVE

### SUMMARY OF FINDINGS, DISCUSSION, CONCLUSION AND RECOMMENDATIONS

#### 5.1 Introduction

The chapter presents summary of the study findings, discussion and the conclusions arrived at. The chapter also gives recommendations and the suggestions for further study.

#### 5.2 Summary of the findings

The study sought to investigate the factors that influence e-waste management in Kenya, A case of mobile phones in Nairobi County, Kenya. This section presents the main findings based on the objectives of the study.

It was established that though the majority of the respondents were aware of the danger and diseases' that are brought about by improper disposal of the mobile phones, they were still holding on to them. Findings on the existing systems of e-waste collections and disposal in Kenya indicated that there is no proper and professional method of separating and collecting of e-waste in the Country. The study sought to establish if there exist some regulations, policies and institutional mechanisms that guides on the collection and disposal of electronic waste. The study established that currently there are no clear legislations or laws that are implementable in Kenya when it comes to e-waste management. The findings indicated that the respondents' majority were unwilling to dispose off the mobile phone and would rather keep them as souvenirs or give them to their children to play with them as toys because of the sentimental value attached to it.

#### 5.3 Discussion

From the study findings there seems to be no proper, effective and efficient systems of e-waste management in collections and disposal of obsolete mobile phones in Kenya. The study also indicates that Kenya lack sustainable e-waste management infrastructure. This means that e-waste is collected and disposed in crude methods. These include burning of mobiles phones and disposing them in landfills or dumpsites. According to Ramzy Kahhat et al, 2011, the lack of an efficient collection, recycle and reuse system is one of the problems for e-waste management. The same problems are experienced in most African nations. Puckett et al (2005) states that African nations (and other developing countries) dispose the e-waste in formal and informal dumpsites in disregard of the hazards associated with e-waste.

The study found that some of the respondents were aware of the hazards posed by the e-waste emanating from improper disposal of discarded mobile phones. From the findings, the study concludes that there is lack of awareness of users and to some extent the industry regarding the end-of-life of the mobile phone. Community awareness campaigns on how to safely handle e-waste are non-existent (Musili, 2008). Kimutu (2008) indicated that e-waste in landfills can threaten humans through leaching into the soil and groundwater. Schmidt (2005) note that the current awareness regarding the existence and dangers of e-waste are extremely low in developed countries than in developing countries. This is partly because the sensitization and awareness creation on e-waste is carried out and also consumers of mobile phones are willing to participate in e-waste management.

Urgent measures are required to address this issue. Awareness on the effects of discarded e-waste to the environment and human health should be created at all levels of governance and the general public by making information available through appropriate means. Kenya does not have strong and well implemented policies that guide on the generation and disposal of e-waste. The guidelines on e-waste management in Kenya; E-waste guide (2009) have not been well implemented and no clear policies have been given, thus giving a loop hole in the e-waste management in Kenya. This failure is at variance with practices in other countries especially the developed one. For example in the European Community (EU), member states have to guarantee minimum collection, recovery and reuse/ recycling targets as specified in various directives (Lindhqvist, 2000). The study established that accumulating obsolete electronics, mostly the old phones, is a firm habit due to the people's attachment of values such as the mobile phones being their first phones. The habit of accumulating obsolete electronic items and reluctance to dispose of these materials has led to accumulation of a large number of electronic materials. Greenberg et al., (1990) and Sookman, Abramowitz, Calamari Wilhelm & McKay, (2005) have also indicated in their studies that this behaviour is also found in other countries. According to Carisma (2010), in terms of behavioural aspect, Kenyans have strong penchant to keep prized items such as electronics due to the sentimental value attached to the product. It is common in many Kenyan houses to keep old and non-functional television, radio and refrigerator as household display or just for storage. As a general observation, ordinary Kenyans who cannot easily afford to buy expensive items such as electronics may find it hard to dispose valued possession right away

## **5.4 Conclusion**

Although a majority of respondents claimed to be aware of the dangers emanating from improper disposal of e-waste, including the diseases thereof, they, however, were unwilling to surrender the obsolete mobile phones for recycling or destruction due to sentimental values and attachment linked to the equipment. They would rather keep the obsolete phones as souvenirs or give them to their children to play with as toys. This regrettable situation is exacerbated by lack of articulation of the current legislation and framework for e-waste recycling and disposal and also the inconvenience of e-waste collection and disposal practices. It is for these reasons that the study recommends that public education and sensitization on the relevant legislation on e-waste and dangers posed by obsolete equipment be intensified so that all stakeholders play their rightful roles towards the elimination of dangers posed by e-waste.

## **5.5 Recommendations**

The study recommends that the government should be at the forefront in public education and sensitization on the hazardous effects of retaining e-wastes. It is also recommended that those organizations mandated to safely dispose the e-waste and also should do so effectively and efficiently and also in a professional manner e.g. separating the waste from onset. The study also recommends that the manufacturers, retailers and distributors should be at the fore front in the collection of the phones once it is obsolete. It is also recommended that some strategic places or points to be marked as drop off points or collection points countrywide as this would enhance effective and efficient collection of obsolete mobile phones.

EPR policy framework should be put into place In Kenya to govern the management of the e-waste. On a governmental level, further research into the applicability and effectiveness of various instruments for managing e-waste would be very useful. One of the most interesting directions for such research would be to develop a systems dynamics model of the stocks and flows that take place, and how policy interventions might affect them. Research in sustainable electronic product design is needed to eliminate the production of e-products that end up to be a threat to the environment and the society; at the end of their life cycle. Furthermore, research in alternative business models that will allow new revenue streams for the e-producers can provide a way out of planned obsolescence.

### **5.6 Suggestions for further study**

- i. Similar study should be done on diverse areas and towns to find out if the same results would be obtained.
- ii. Other studies on electronic wastes other than mobile phones should be conducted to establish whether the factors influencing e-waste on phones are similar to other electronics wastes.

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## APPENDICES

### Appendix I: Questionnaire for the Consumers and Phone Repairers

Dear Respondent

My name is Irene Kimeli, a student in the University of Nairobi, carrying out a study on the Factors influencing e-waste management in Kenya; A case of mobile phones in Nairobi County. The purpose for this questionnaire is to gain insight on e-waste management measures for mobile phones. In order to help address the above, your contribution in this research is important. Therefore, you are kindly requested to provide the researcher with accurate information. Your responses was processed by computer and was treated as confidential. Please do not write your name on this paper. Also do not write the name of the institution. Provide the following information by *ticking/ writing the applicable number in the blocks or space provided. You may use separate paper if the space is not enough.*

#### PART A: Demographic Characteristics

Name of the Respondent..... (Optional)

1. What is your gender?
  - a) Male ( )
  - b) Female ( )
2. What is your age bracket?
  - a) < 20 years ( )
  - b) 21-30 years ( )
  - c) 31-40 years ( )
  - d) 41-50 years ( )
  - e) >50 years ( )
3. What is your highest level of education?
  - a. Primary ( )
  - b. Secondary ( )
  - c. Tertiary College ( )
  - d. University ( )
  - e. Post Graduate ( )
4. What is your occupation?
  - a) Consumer ( )
  - b) Mobile Repairer and other electronics ( )
  - c) Others (Specify)
5. How long have you been using or repairing mobile phones?
  - a) Less than one year ( )

- b) Between 1-4 years ( )
- c) Between 5-8 years ( )
- d) More than 8 years ( )

**PART B: FACTORS INFLUENCING E-WASTE MANAGEMENT**

**LEVEL OF AWARENESS OF DANGERS OF IMPROPER DISPOSAL OF E-WASTE**

6. How often do you replace your mobile phone?
- a) Very ( )
  - b) Minimal ( )
  - c) Never ( )
7. Have you ever discarded unwanted or obsolete mobile phone?
- a) Yes ( )
  - b) No ( )
8. What happens to your mobile phone when they become obsolete?
- Take them back to the manufacturer ( )
  - Discard them ( )
  - Keep them as mementos/ memoirs ( )
  - Sell them to the mobile repairers ( )
9. Are you aware that some hazardous e-waste from your mobile phone needs a special treatment in order to be safely disposed of?
- a) Yes ( )
  - b) No ( )
10. Do you know any disease that is caused by hazardous materials from the e-waste?
- Yes ( )
  - No ( )
11. If yes to the above questions, can you name two (2)?
12. Would you give out your obsolete mobile phone to the waste collectors for free if you could be sure that the waste was well taken care of in a way that is useful and that does not pollute the environment?
- a) Yes ( )
  - b) No ( )
13. What would you think should be done in order to facilitate e-waste management on mobile phones?
- a) Provide incentives to the consumers to give up the old phones ( )

- b) Provide sites for collection ( )
- c) Increase the scope of the municipal councils to collect e-waste ( )
- d) Others (Specify)

14. What are the main obstacles for a proper e-waste management mostly from the mobile phones?

- a) High Costs ( )
- b) Lack of infrastructure and/or policy ( )
- c) Lack of legislation ( )
- d) Absence of recycling solutions ( )
- e) Absence of collection system ( )
- f) Lack of Awareness ( )
- g) Attachment of value by the consumer

### **EXISTING POLICIES AND INSTITUTIONAL MECHANISMS**

15. Are you aware of any legislation on e-waste management of mobile phones in Kenya?

- a) Yes ( )
- b) No ( )

16. Are you aware of the principle where the phones are taken back after end of life to the retailers or manufacturers for disposal called “Extended Producer Responsibility” (EPR)

- a) Yes ( )
- b) No ( )

17. If your answer is yes to the above, do you think it’s well applied in Kenya?

- a) Yes ( )
- b) No ( )

18. What do you think is the goal of e-waste legislation?

- a) Reduce hazardous processing of e-waste ( )
- b) Promote reuse ( )
- c) Promote recycling ( )
- d) Waste prevention and better product design ( )

19. Who do you think should be given the responsibility of collecting the obsolete mobile phones?

- a) The brand owner ( )
- b) The manufacturer ( )
- c) The importer ( )
- d) The distributor ( )
- e) All of the above ( )

20. Which institutions do you know are mandated to collect and dispose e-waste in Kenya?

- a) NEMA ( )
- b) CCK ( )
- c) NCC ( )
- d) KEBS ( )
- e) Others (Specify) ( )

21. Please indicate your level of agreement for the following statements by marking each statement on the following scale:

5-Strongly Agree 4-Agree 3-Neither Agree or Disagree 2-Disagree, 1-Strongly Disagree

	5	4	3	2	1
It is important to effectively manage e-waste of mobile phones?					
It is profitable to manage and reuse/resell e-waste of mobile phones?					
Kenya has got laws sufficient enough to regulate e-waste					
E-waste management of mobile phones is an important function of our organization					
We have well defined norms about how to manage e-waste of mobile phones					
E-waste management of mobile phones is not important to us since we produce very little or insignificant figure on the same.					
The e-waste disposal systems of mobile phones available at present are sufficient for our e-waste needs					

**EXISTING SYSTEMS OF E-WASTE DISPOSAL**

22. Is the current e-waste collection of mobile phones convenient to you?

- a) Yes ( )
- b) No ( )

23. Are you aware of any system of e-waste collection of mobile phones in Kenya?

- a) Yes ( )
- b) No ( )

24. If yes to the above question, explain

25. Do you think the manufacturers/ retailers and the distributors should start e-waste collection of mobile phones in the country?

- a) Yes ( )
- b) No ( )

26. Which are the main e-waste collectors of mobile phones in country?
- a) Safaricom
  - b) Airtel
  - c) Computer Society of Kenya
  - d) NEMA
  - e) NGOs
  - f) None of the above
27. Which processes are you familiar with for e-waste management that can be used in the e-waste from the mobile phones?
- a) Sorting of products ( )
  - b) Manual dismantling ( )
  - c) Shredding ( )
  - d) Cable stripping/granulation ( )
  - e) Burning (e.g. cables, cases) ( )
  - f) Leaching (e.g. printed wiring boards) ( )
28. Among the above methods, which ones are the most common used for Phone e-waste disposal in the country?
- a) Sorting of products ( )
  - b) Manual dismantling ( )
  - c) Shredding ( )
  - d) Cable stripping/granulation ( )
  - e) Burning (e.g. cables, cases) ( )
  - f) Leaching (e.g. printed wiring boards) ( )
  - g) None of the above

**ATTACHMENT OF VALUE TO OBSOLETE MOBILE PHONES BY MOBILE USERS**

29. Are you aware that some parts of your mobile phone once it has reached end-of-life may be profitably recycled?
- a) Yes ( )
  - b) No ( )
30. Currently do you have or retained an obsolete mobile phone?
- a) Yes ( )
  - b) No ( )
31. If your answer is yes, how long have you been holding on to it
- 10 years and above ( )
  - 5-10 years ( )
  - 1-5 years ( )
  - Less than 1 year ( )

32. What is the main reason you haven't disposed it?
- a) Kept as a souvenir ( )
  - b) Has a value ( )
  - c) It was my first mobile and I have sentimental attachment ( )
  - d) My children uses it as a toy ( )
33. Would readily take it back to your distributor/retailer/service provider for proper disposal?
- a) Yes ( )
  - b) No ( )

**E-WASTE MANAGEMENT**

34. What is your opinion on the current status of e-waste management in Kenya?
- Excellent ( )
  - Good ( )
  - Medium ( )
  - Poor ( )
35. What should the government do in order to effectively and efficient implement e-waste management policies?
- Start collection programmes/centers ( )
  - Initiate mass education programmes ( )
  - Sensitization on the dangers of e-waste ( )
  - Delegate the collection and disposal to NGOs ( )

36. Other opinions on the e-waste management in Kenya.

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**Thank you for participation**