Extended Producer Responsibility for the Management of Waste from Mobile Phone

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Abstract

This thesis explores the functionality of Extend Producer Responsibility (EPR) in the management of Electrical and Electronic waste (e-waste) in Kenya using a case study on manufacturer involvement in end-of-life management. To achieve the purpose of the study the analytical framework used incorporates Environmental effectiveness, Economic efficiency, Political acceptability, Administratabilty and Innovative advancement in discussing the EPR policy instrument used by the manufacturer. On the practical front the data on the take-back scheme was discussed under the following factors that affect the efficiency and effectiveness of a take-back scheme: economic incentives, disincentives, convenience, inconvenience and information. On the other hand the thesis provides preliminary insights into the overall e-waste management scenario in Kenya.

Literature and practical knowledge were used to explore and establish a picture of the dynamics of EPR in e-waste management under the ICT sector with special focus on mobile telephony and the actors in the sector. Suggested policy directions are based on the gaps identified through an analysis of the materials and information collected while in the field. The research confirms that there is need to develop waste management policies and regulations in Kenya structured and guided by EPR principles. The thesis emphasizes that EPR is a necessity in the management of e-waste in Kenya and the developing countries at large. Further it notes that there is need for knowledge transfer and exchange from the developed countries to the developing countries grappling with e-waste management in formulation of appropriate institutional and legislative frameworks customized to the ground realities.

Executive Summary

The global market for electrical and electronic equipment has expended. In recent decades the use of electronic equipment such as mobile phones and computers has experienced enormous growth. Developing countries and countries in transition provide the fastest growing markets for the electrical and electronic equipment. These countries import large amounts of EEE while other countries receive generous donations in the form of EEE.There is a growing concern over waste from these useful products electronic waste (e-waste) due to increasing amounts generated, coupled by the toxic content and the valuable materials in the e-waste. The main problem with e-waste in developing countries is uncontrolled burning and recycling of e-waste using rudimentary skills and technologies that pose a danger to the environment and human health. In inaddtion to the waste from domestic consumption there is an emergence of trans-boundary movement of the e-waste from the developed countries to the developing countries that have neither infrastructure nor regulations that govern the environmental sound management of the e-waste.

With this emerging problem in mind this thesis has the purpose of *exploring the role of Extended Producer Responsibility (EPR) in electronic waste management in Kenya*. In order to achieve this purpose the thesis ventures into looking specifically at the situation surrounding the end-of-life management of mobile phones. The mobile phone is selected for this study due to its global presence and its growing use in the Kenyan market. EPR is explored in this study due to its increasing popularity among policy makers worldwide; many governments have incorporated it into the environment policies especially in the OECD countries. However the concept and practise has not been widely adopted in the developing countries. EPR aims at improving the environmental performance of a product throughout its entire life cycle by extending the responsibility of the manufacturer on their products. It prioritises prevention over end of pipe solutions.

In order to achieve the purpose of the thesis, the author conducts a case study on the involvement of one of the largest mobile phone manufactuerer Nokia in the end-of-life management of mobile phones in Kenya, with the aim of identifying the challenges and opportunities that exist for the improvement of the take-back scheme. The thesis does not only look at the manufacturer involvement its also examines the current status of e-waste management in Kenya, the policies and institutional capacity in place to address e-waste problems.

The study uses selected analytical frameworks to evaluate the findings. The SWOT analysis is used to identity the challenges and opportunities in manufacturer involvement in EoL management of the products. In line with the SWOT analysis, the stakeholders views were analysed where the gaps where identified and discussed along side potential solutions. The data collected was analysed using the following criteria based on the OECD (2001) model: Environmental effectiveness, Economic efficiency, Political acceptability, Administratabilty and Innovative advancement.

The discussions on take-back schemes that achieve high collection and recycling results were guided by factors that were identified by Lindhqvist 2000), these factors are: economic incentives, disincentives, convenience, inconvenience and information.

The study was carried out in three overlapping phases involving literature review, data collection and the case study. The Background information on the functioning of the ICT sector was collected from the journals, newsletters and internet homepage of the regulators

and the service providers. *In-depth open ended interviews* were conducted with the regulators and manufacturer.

The main findings of this study based on the research questions, can be summarized as follows: Currently there is no system or government involevemnt in the e-waste management. However, there are plans to develop a strategy on e-waste management. On the policies and institutional mechanisms in place, there are institutional mechanisms in place that regulate the various facets of the e-product from market entry point to end-of-life. The study identified various life-cycle stages of electronic products which come into the Kenyan border, and actors involved in the respectives stages. These actors range from the formal set up to the informal set up and their roles in the management of EoL products vary. The challenges in the establishing of an effective and efficient take-back scheme for EoL phones were identified as: lack of awareness on the existing scheme, consumer willingness to participate pegged on incentives, lack of convenient collection centres and competition from repairers. As for the opportunities they can be summarised as the existence of EoL mobile phones, the opportune time for intervention as there is no backyard recycling, the availability of usage of existing infrastructure and the competitive edge over other producers.

In concluding the study I have provided recommendations to the policy makers and to the manufacturers. The movement and development of environmental policies and regulations on e-waste structured and guided by EPR is inevitable based on the current waste management scenario in Kenya. There is a need for knowledge transfer from the developed countries to the developing countries on e-waste management to benefit from the experience of the developed countries. For instance the experience of the member states of the European Union who are already in the process of implementing European Unions directive 2002/95/EC could help in formulation of appropriate institutional and legislative frameworks customized to the ground realities in Kenya. Future environmental regulations in line with products and production process will be based on analysis of the entire life cycle of the product service systems as opposed to the current system based on end-of-pipe treatment.

The recommendations for the regulators can be summed up as: need to undertake comprehensive studies on e-waste status in Kenya: The study will determine the baseline for e-waste in the country and provide the basis for the formulation of a strategy to handle e-waste. Currently the data on EEE and e-waste is scant as there has been no data management practises in place. The study will provide the necessary mechanism to collect and collate this data. From the study there is a need to develop a comprehensive national strategy on e-waste management that is holistic in addressing the challenges facing Kenya in e-waste management. The adoption and implementation of EPR in Kenya: From the study findings there is a need for a regulation that can introduce EPR mandating the producers and importers to take responsibility of their products at the EoL, it can also introduce standards, specifications and mandatory labelling of second hand products, donations and refurbished products as a way of keeping track on these products and differentiating them from new products. The necessity of this regulation is due to the gaps in the Waste Management Regulation (2006) this regulation addresses various components of waste management ranging from solid waste, hazardous waste, industrial waste, pesticides and toxic substances, biomedical waste and radioactive substance management but does not take cognisance of e-waste as an explicit waste stream or category. In order to fill the gaps identified in the existing policies, institutional and regulatory mechanisms in addressing e-waste there is a need to incorporate EPR into Kenyan legislation. Multi-sectoral management of e-waste will ensure that all pertinet sectors are involved in the development of the e-waste strategy as well as in the management of the e-waste. This incorporation of all sectors in e-waste management will result in better and coordinated management as opposed to the problem being left to one regulator or sector. It will also

increase the efficiency in the licensing procedure and reduce conflicting requirement by the regulators. Regulatory impact assessment is necessitated by the scattered and sectrol polcies managing the same issue but under many different regulations. This will streamline the management of e-waste and avoid duplication of efforts and waste of tax payers' money. This will also provide for synergistic inclusion of the relevant regulations and strengthen their implemetaion. The recommendations to the manufacturers included: the need to review existing system and design a system that provides incentives to consumers to return their end-of-life products. Stakeholder involvement and level of convenience, from the interviews there is a need for the manufacturer to formulate and calculate working relations with the various stakeholders for the collection scheme to be effective and efficient. The network providers wield a big influence on the consumers and it would be a bonus to the manufacturer to include them in the scheme. Awareness and information dissemination: There is a need for the manufacturer to create awareness on the schemes existence and purpose. And also dedicate funds to environmental issues that concern the EoL management of the mobile phones.

Areas for future research are enormous especially in a Kenya and Africa as a whole as e-waste issues are now emerging and there is a big information gap on e-waste and strategies of managing it. I recommend the following general thematic areas to be considered for future research: the first area should deal with the identification of the flows and quantities of e-waste generated in the country and the e-waste imported in to the country. The second research area can look into adoption and integration of EPR into national legislations and what impact it would have to the various players and actors in the e-waste scene. The third thematic area would involve knowledge transfer and the possibilities of transfer of the e-products along with the EoL fee from jurisdictions with the provisions to the jurisdictions not covered but are grappling with management of e-waste from the covered jurisdictions.

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1 Introduction

This section introduces the background and problems addressed in the thesis, the research objective and research questions, the intended audience, the scope and limitations of the study, the study methodology, the relevance of the study and the study outline.

1.1 Background and problem definition

Globally mobile phone users have grown exponentially tracing from early 1970 to mid 2000. 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 subscribers – land line and cellular – from 9.4/100 people in 1990 to 35.3/100 in 2001(UNDP, 2003).

The mobile phones 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 over taken the number of fixed land line 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). Currently it is estimated that there are approximately 10 million subscribers in Kenya (CCK, 2008). 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 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, beryllium and copper (Oiva, 2000). Some of the materials in the mobile phone are persistent in the environment and could also bio-accumulate and could pose serious threat to the environment if not well disposed. There is a growing concern regarding the handling, treatment and disposal of e-waste while there is no appropriate e-waste management strategy in the country. The mobile phones contain heavy metals such as mercury and other toxic elements that make them unsuitable for land filling (Hageluken, 2007). Open burning of mobile phones release dioxins and furans (Hageluken, 2007). If the mobile phones or the ICT

equipments 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 these equipments 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*).*

Globally the EPR concept has gained popularity. Manufacturers are considered to be in the best position to redesign the products for recyclability and longevity amongst others. The principle has made manufacturers more aware of the end of life management of their products thus creating a feedback loop; this in turn should be reflected in design change of the products as this is the core of the EPR principle that discerns it from simple take-back systems (Tojo, 2000). Due to the trans-boundary movement of e-waste, the lack of state-of-art recycling and waste disposal facilities EPR in developing has countries has became a necessity (Osibanjo and Nnorom, 2008).

1.2 **Objectives and research questions**

The research aimed at exploring the application of Extended Producer Responsibility (EPR) for e-waste in Kenya with particular focus on the mobile phone, with the interest of understanding how various factors such as legal requirements, awareness, convenience and financial incentives can impact on the collection of used and EoL EEE. In line with this objective the study looked at the current e-waste management system in Kenya with the aim of streamlining the existing EoL management of used mobile phones paying special attention to reuse, repair and recycling as ways of diverting the phones from the dumpsites.

In addressing the objective the study seeks to answer the following research questions:

a. What is the current status of e-waste management in Kenya?
b. What policies and institutional mechanisms are in place to address the e-waste problem?
c. From e-product inception into the Kenyan market till the EoL what are the different stages and who are the actors at each stage?
d. What are the challenges and opportunities of establishing an effective and efficient take-back scheme for EoL phones?

1.3 Intended audience

The findings of this study are expected to provide a realistic picture on the e-waste scenario in Kenya for the policy makers, producers and other interested parties such as NGOs and academia. By exploring the Extended Producer Responsibility in e-waste management, it is hoped that it will help in the provision of practical ways in which it can be adopted and

implemented by policy makers. The stakeholders' views are anticipated to provide the producers with valuable insights necessary in improving the existing collection scheme.

1.4 Scope and Limitations

The scope of this study is limited in many ways; it covers the ICT sector within the electronic industry but with particular reference to mobile phones and limited reference to television sets and PCs. The choice of the mobile phone is based on the fact that the mobile phone industry is a growing industry in the developing countries. This is a situation reflected in Kenya. The interest in the mobile phones was triggered by the ongoing debates in the developed countries surrounding environmentally responsible approaches to managing used and end-of-life mobile phones whereas the developing countries have paid very little attention to the management of end-of-life electronics especially the mobile phones. This gap triggered the study. The other interest in mobile phones relates to the fact that amongst the other electronic equipment in Kenya, it is the most widely used and affordable due to the necessity to communicate and the poor fixed line infrastructure. This translates to the availability of cheap and second hand phones with a short life span if not well managed at the end-of-life could pose a serious threat to the environment. The mobile phone amongst the other EEE is equipment that has value attached to it due to the precious metals in the phone; this brings about the necessity to establish collection schemes that aim at recovery of the material in the phones. On the institution front the mobile telephony institutions in Kenya are well developed and traceable within the limited timeframe to conduct this study.

The television sets were given a limited reference as compared to the mobile phones due to the fact that the traceability of the actors and institutions related to the TV sets is gigantic task that requires more time and the TV sets life span is longer. The focus on TV sets albeit limited among the EEE is based on the requirement of the Regional Radio communication Conference (RRC-06) that was held in Geneva in 2006 that requires countries to start preparing to migrate from analogue to digital terrestrial broadcasting technologies which should be implemented by 17th June 2015. A number of countries while in the process of implementing the digital switch over will have many redundant analogue TV sets. Developing countries including Kenya are at a risk of receiving this obsolete TV sets and also the TV sets that exist in the domestic scene. This therefore calls for special mention on TV sets amongst the other EEE.
In relation to mobile pnoes and TV sets the current problem is the mobile phones while the TV sets will be a big problem in the next 7 years due to the digital migration.

The study's geographical boundary is limited to Kenya with focus on the three major cities: Nairobi, Mombasa and Kisumu[1]. The three cities were chosen since they are the major cities in Kenya and are feeder cities to the peri-urban areas that surround them. Due to the geographical limitation the study focuses on the manufacturer with a presence in Kenya.

EPR programmes are not only aimed at improving the end-of-life management (down stream changes) they also provide the manufacturers with incentives to design products (upstream changes) that have less environmental impacts at the end-of-life. In relation to the above aims this study looks at the EPR concept but with limitations to the downstream changes which are based on the EoL management of the products. The main components in e-waste management/eco-efficient recycling process of e-waste entail:

[1] Appendix 1 provides the map of Kenya and the research sites

1. E-waste collection
2. E-waste dismantling and treatment
3. Material recovery
4. Reuse
5. Environmental sound disposal of E-waste

Figure 1-1 depicts the eco-efficient recycling process; this study will mostly focus on the component 1 that is collection. The focus is on collection as it is the weakest point in recycling efficiency as pointed out by Hageluken (2007). Component 2 which involves treatment will not be discussed at length as Kenya has no e-waste treatment plant. Component 3, 4 and 5 are not addressed in detail in this study.

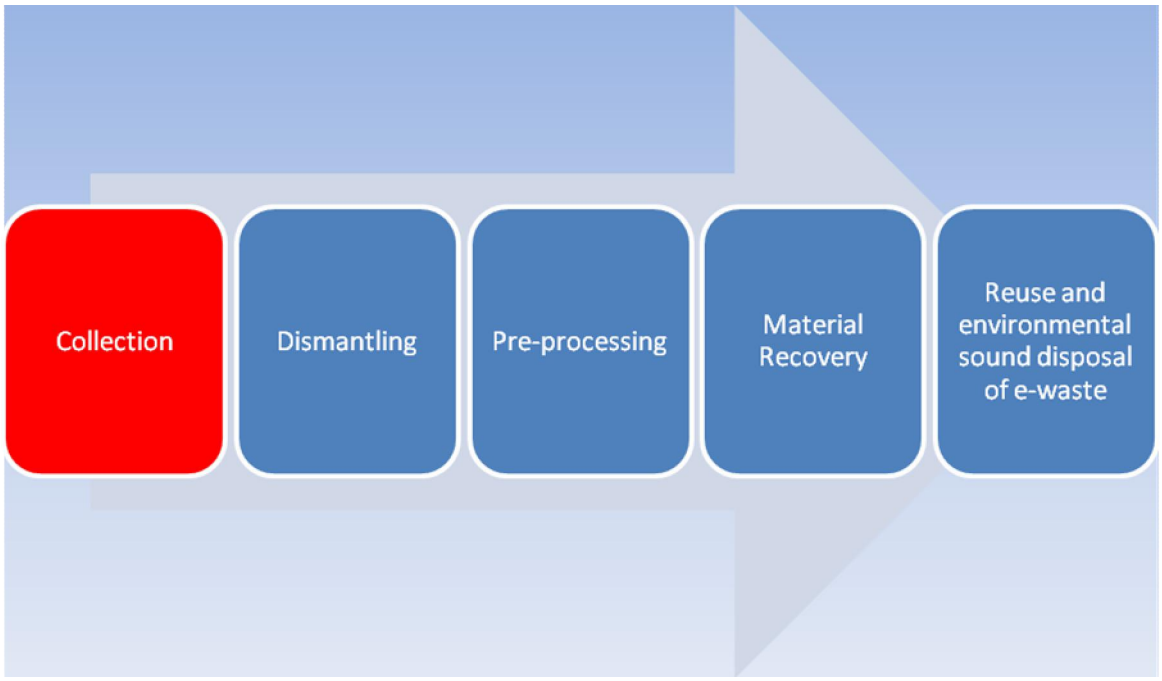

Figure 1-1 Eco-efficient recycling process Source Hageluken (2007)

In line with this the study addresses the EPR policy instruments with detailed analysis on the take-back scheme/collection scheme. This is guided by the main goals of a collection system as identified by the Mobile Phone Partnership Initiative (MPPI[2]) 2006 namely:

a) Divert end-of-life mobile phones from waste streams destined for disposal in landfills or incinerators;
b) Repair, refurbish and preserve used mobile phones in working order, so that they can be used again; and
c) Channel unusable (end-of-life) mobile phones into environmentally sound material recovery and recycling.

[2] MPPI was created within the framework of the Basel convention in 2002. It aims at addressing the issue of environmental sound management of end-of-life phones. There are four working groups that address: mobile phone refurbishment, collection and transboundry movement rules, material recovery and recycling, and design considerarions. www.basel.int/industry/mppi.html

The thesis addresses the incentives/disincentives for collection of the EoL products such as regulatory/ mandatory influence, convenience of the collection points to the consumers, information provision and incentive to consumers. The study will highlight the challenges and opportunities that exist in setting up an efficient and effective collection scheme, and to a lesser extent the legal challenges of exporting the EoL products/ waste under the Basel Ban of the Basel convention. The thesis also addresses foreseeable challenges and opportunities that may arise in the collection of EoL phones such as:

- What will happen to products collected that are not mobile phones and end up in the collection points?
- In case a producer sets up his/her own collection scheme what would happen to products/ brands that do not belong to the producer when they end up in the collection points established by the producer?
- How will other initiatives or collection efforts interact, synergize, or collaborate with this initiative?

1.5 Methodology

The study was conducted in three overlapping phases with phase one entailing the review of pertinent literature, while phase two encompassed data collection and phase three covered the case study focused on the mobile phone collection scheme. Data was collected through literature review, review of official documents, in-depth and open ended interviews of various players and stakeholders in the ICT sector including the regulators and network providers in Kenya. The questionnaires used were semi structured as this enables one to collect the data needed while at the same time getting interesting and unexpected data. Background information on the functioning of the ICT sector was collected from the internet homepage of the regulators, the service providers, newsletter, and journals. This information was validated by the various interviews conducted in Kenya from February 2008 to April 2008.

1.5.1 Literature review

Literature reviews was carried out so as to gain an in-depth understanding of the EPR concept, e-waste take-back schemes, the challenges and opportunities that exist, and the manufacturer involvement in waste management. The aim of the literature review other than gaining an in depth knowledge on the various concepts, ideas and practices; was to create a clear picture of the core elements in an effective and efficient collection system and to enable building on research experience from ongoing research and previous research.

1.5.2 Interviews /personal contact and site visits

The aim of the literature review was to provide the background material necessary for the research. Subsequently the interviews and personal contacts were conducted in order to obtain primary data and supplementary information that indicated a clear picture of the situation on the ground and the challenges and opportunities that existed in reality. The interviews and personal contacts were also aimed at:

Testing the findings from the literature by confirming the concepts, this was especially related to the factors that determine an effective and efficient take-back scheme. During the interviews this factors were pointed out by the interviewees as the barriers to the success of the existing scheme.

The personal interviews and site visits provided a practical view of the situation and provided an opportunity for acquisition of current data in the ICT sector in Kenya. The research used various methods when gathering primary data. The methods included:

1. On-the-spot questionnaire/Face-to-face interviews
2. Focus group discussions
3. Site visit

On-the-spot questionnaire/Face-to-face interviews which were semi structured were used due to their flexibility in data collection. This means that they provide more quantitative data they are open to discussions and inclusion of new ideas while in the field. The personal interviews were used based on the fact that the EPR concept in Kenya is new and many people may not have heard about it, thus the interviews provided the opportunity to clarify the concept and define it in the process of discussion.

Focus group discussions were handy when dealing with several groups involved in waste management especially the informal repair shops and scavengers. The focus groups offered the interviewees the opportunity of talking to each other and discussing the questions and providing more information.

Site visits offered an insight and better understanding of the current situation and shed more light on the unforeseen aspects of e-waste management in Kenya.

A total of 20 key informants were interviewed from the following organizations. The details of the interviewees are found in the parentheses. The interviews were structured, in-depth and open-ended.

a) National Environmental Management Authority (NEMA) Kenya (interviewed 5 officers). The mode of data collection used was face-to-face interviews as this provided an opportunity to discuss the E-waste and EPR concepts in depth)
b) Basel Convention[3] focal point in Kenya (conducted a face-to-face interview with the officer in-charge of implementing the Conventions proposals with in Kenya)
c) Kenya Revenue Authority: customs department (Interviewed 1 officer at the Kilindini harbour in Mombasa and did a site visit to the port to observe the process of inspecting EEE imports)
d) Nairobi City Council/Mombasa and Kisumu municipal councils (Face-to-face Interviews with 2 officers. The Mombasa council official was not available at the time of collecting the data)
e) Kenya National Cleaner Production Centre (Face-to-face interview with 2 officers and it was more like a focus group discussion)
f) Kenya Bureau of Standards(Face-to-face open discussion with 2 officers)
g) Kenya Ports Authority (Face to face interview with 1 officer)
h) Nokia Kenya (Face-to-face interview with one employee, this was the mode of data collection used due to the flexibility in the interviewing and the exchange of ideas)
i) Communication Commission of Kenya (Face-to-face interviews with 2 officers)
j) E-waste Recyclers (Face-to-face interviews, site visits and focus group discussions as most of the e-waste recyclers work in groups and had a keen interest and participating in the survey)

[3] Basel Conventional on the control on transboundary movement of hazardous waste and their disposal enacted in 1989 and entered into force on 5th May 1992.

k) Mobile phone repair shops (Face-to-face interviews, site visits and focus group discussions. Some repairers work in groups of 2 or more and most repairers are based in retail shops, which made it easy to have discussions with the repairers in the premises and the retailers who house the repairers. 70 repairers were interviewed)
l) Mobile phone dealers, retailers and care centres (Face-to-face interviews with one dealer and site visit to the care centre in Nairobi. Another face-to-face interview with the manager of the proposed care centre in Kisumu at the site to be the care centre. In total 20 retailers were interviewed so as to understand their role in the collection scheme.)
m) Network providers: Safaricom and Celtel(Face-to-face discussions, telephone interviews and online questionnaires. This did not yield much information as they were reluctant to participant in the study and they did not respond to the questionnaires they had requested I sent to them.)
n) Non Governmental Organizations (two NGOs were chosen due to the role they played in e-waste management. The data was collected via face-to-face interviews and site visits. The site visit was to understand the refurbishing process and the conversion of the monitors into TVs. This provided more information on the activities of the NGO.)
o) Members of the society/ public selected randomly (Approximately 160 people were interviewed. This was done with the aid of research assistants who administered the questionnaires.)
p) Other stakeholder institutions like universities (United States International University (USIU) in collaboration with NEMA have developed a proposal on e-waste that will address the entire management cycle of the different e-waste categories. Personal interview with the officer in charge of the project in NEMA. The Professor in charge from USIU is currently out of the country for one year.)

1.5.3 Case study

The case study examines the role of the extended producer responsibility in e-waste management in Kenya. The aim of the case study was to:

- Provide first hand information on how EPR can be applied by specific manufacturer in a developing country context and to put various findings on collection schemes into practice
- Provide a conduit through which various e-waste management initiatives can be synergized under EPR

The focus was the activity of Nokia which initiated the take-back of their products in the year 2006. The case study involved studying Nokia's existing take-back /collection scheme in Kenya and identifying the challenges and opportunities that exist in making it an efficient and effective collection scheme

The advantages of having a case study as listed by O'leary (2005) are listed as follows:

- Case studies allow in-depth exploration of the study area
- They concentrate the research efforts on a particular situation that is being studied
- They allow examination of subtleties and intricacies of the research problem
- They attempt to be holistic in nature and provide opportunities to explore processes as well as investigation of the context

O'leary (2005) points out that case studies are not always representative and generalisable when compared to large scale surveys. All in all a case study approach was chosen based on the intrinsic interest in EPR and added value in tackling the role of EPR in e-waste management in Kenya.

1.5.4 Data Evaluation

The data gathered by the above methods was evaluated using different analytical tools, starting with the EPR model developed by Lindhqvist (1992). The researcher applied SWOT analysis to identity the main challenges and opportunities in manufacturer involvement in EoL management of the products. In analysis of the stakeholders, gaps regarding the current e-waste management and the manufacturer involvement were identified and discussed along side potential solutions. The data collected in line with the research objectives and questions was guided and evaluated by the following factors based on the OECD model (2001)[4]:

1. Environmental effectiveness
2. Economic efficiency
3. Political acceptability
4. Administratabilty
5. Innovative advancement

1.6 Relevance of the Study

The research in essence is meant to contribute to the ongoing endeavours in Africa to bring about change in the management of e-waste. It will contribute to the ongoing activities in Sub Saharan Africa to address the e-waste problem and develop appropriate environmental sound management practices for EoL and appropriate policy packages for e-waste management. in line with the Basel Convention held in Nairobi in November 2006 the study will provide the needed background information by the Kenyan government on accelerating efforts and setting priority launching of pilot projects that will establish take-back systems for used and EoL electronic products.

The ongoing initiatives are operating in a regulatory vacuum, as there is no clear and neither specific policy nor regulation on e-waste, it is anticipated that this study will lead to the formulation of intervention measures that can be used in addressing the e-waste issue today and in the future. By introducing some globally accepted principles and practises this study aims to share and transfer knowledge from the developed countries to the developing countries by provision of useful information and recommendations that can lead to formulation of policy measures in the country and the continent at large.

On the manufacture's end the study will provide useful information on how the manufacturer can improve the existing collection scheme.

1.7 Outline

Sections 2: This section provides the theoretical framework used in the study. It introducers e-waste management and discusses the following questions: What is EPR and why EPR? What are the instruments used under EPR principle? Why focus on mobile phones? The reader will be introduced to the logic behind choosing the ICT sector in e-waste management with special focus and reference to the mobile phone. The section also introduces the product recovery management and provides the analytical framework that guided data collection. The aim of this section is to provide relevant theoretical information to the reader.

Section 3: In this section I will discuss the waste management scenario in Kenya followed by the current status of e-waste management in Kenya and the challenges of e-waste management. I will finalize this section by introducing the readers to the ICT sector in Kenya.

[4] The factors are discussed in section 2.8.

The ICT is introduced to the reader as it is the focus sector for this study among the EEE product categories. The purpose of this section is to provide an insight to the readers on the situation in Kenya, the information may be necessary when reading the upcoming chapters.

Section 4: This section revisits the one of the EPR policy instruments (take-back) to provide the readers with the necessary background to the manufacturer's involvement in EoL management with a case study of Nokia. The SWOT analysis highlights and discusses the challenges and opportunities of manufacturer involvement. The problematic issues are identified and analysed using the analytical framework provided in section 2.8. The final sections provide a comparative analysis of the salient e-waste features between Kenya and India. I conclude this section by providing a glimpse of the generic flows of other types of e-waste with focus on their EoL. In discussing the EoL management I introduce the stakeholders who will be discussed in detail in section 5.

Section 5: In this section I will discuss the institutional mechanisms that interplay within the ICT sector from product inception into the market till the products end of life. In discussing and analysing the interplay I will discuss the various stakeholders in the ICT sector and identify the institutional gaps in e-waste management.

Section 6: In this section I revisit the need to introduce EPR in Kenya based on the interviewees and research finding on waste management. I will discuss the drivers and barriers that will shape the future outlook of e-waste management in Kenya focusing on the potential of introducing and implementing EPR in Kenya. The information provided in this section is drawn from the discussion during the interviews and from the literature.

Section 7: This chapter revisits the research questions and the research objective while highlighting the main findings and reflects upon the study and wraps up with the recommendations to the various stakeholders involved in e-waste management in the country.

2 Theoretical Review

This section provides the theoretical framework used in the study. It introducers e-waste management and discusses the following questions: What is EPR and why EPR? What are the instruments used under EPR principle? Why focus on mobile phones? The reader will be introduced to the logic behind choosing the ICT sector in e-waste management with special focus and reference to the mobile phone. The section also introduces the product recovery management and provides the analytical framework that guided data collection. The aim of this section is to provide relevant theoretical information to the reader.

2.1 E-waste Management

Electrical and electronic equipment (EEE) is defined by Directive 2002/96/EC as

> *"equipment which is dependent on electric currents or electromagnetic fields in order to work properly and equipment for the generation, transfer and measurement of such currents and fields falling under the categories set out in Annex IA*[5] *and designed for use with a voltage rating not exceeding 1 000 Volt for alternating current and 1 500 Volt for direct current"*.

There is no agreed definition of WEEE nor e-waste but Schafer *et al*. (2003) defines e-waste or rather WEEE is as "any equipment that is dependent on electronic currents or electromagnetic fields in order to work properly, including equipment for the generation, transfer and measurement of current".

The main components of the E-waste collection system as discussed by UNEP (2007) include producer take-back schemes, municipal collection schemes and recycler/dismantlers collection schemes. Efficient e-waste management schemes have components of reuse and recycling that ensure that hazardous substances in e-waste are not damaged and thus do not pose a danger to the environment. According to UNEP (2007) the efficiency of the collection schemes are determined by the following factors:

- Accessibility and efficiency of the collection facilities
- Minimal product movement
- Minimal manual handling
- Removal of hazardous substance
- Separation of reusable appliances
- Adequate and consistent information to the user

2.2 Designing an effective e-waste management system

Widmer *et al.* (2005) lists the following as the parameters that should be considered in designing an effective e-waste management system

- Legal regulation, this deals with the level of details in the legislation and the legislations specificity on the operational management of the system.
- System coverage deals with the type of responsibility allocated i.e. individual responsibility or collective responsibility. And it also deals with an all inclusive system that caters for all the product categories or have a differentiated system that covers each product differently under the e-waste umbrella
- System financing addresses the sources of financial resources that will run the system, external funding versus internal funding. In external funding the cost of collection and recycling are passed on to the product user or producer or the municipality. This is done through provision of funds for the products end of life treatment whereas under internal funding the product generates funds for the collection and recycling.

[5] See appendix 3

- Producer responsibility entails designing of a system that considers the amount of responsibility the producers should bear, the points in the system that the responsibilities apply and how the practical application of the responsibility will be carried out. The systems flexibility is also considered in that it allows for both individual responsibility and collective responsibility
- Ensuring compliance can be achieved through having checks and balances in the system that will prevent free riders, incorporate collection and recycling targets and have penalties in place for non compliance. A system may have various degrees of such measures ranging from high, medium and low or in extreme cases none at all.

2.3 What is Extended Producer Responsibility (EPR)?

The term "Extended Producer Responsibility" was defined by Lindhqvist (1990) in a report for the Swedish Ministry of the Environmental and Natural Resources as

> *…… an environmental protection strategy to reach an environmental objective of a decreased total environmental impact from a product, by making the manufacturer of the product responsible for the entire life-cycle of the product and especially for the take-back, recycling and final disposal of the product.* (Lindhqvist 1992, Tojo 2004)

The definition above spells out the manufacturer's role in the product life cycle emphasizing on take-back, recycling and final disposal. The OECD defines EPR under the shifting of responsibility upstream to the producers and away from the municipalities and provision of incentives for design change that will take into account environmental considerations. This approach extends the producer's responsibility to post consumer stage of a product's life cycle (OECD, 2001). It continuously involves the producers and importers of goods to the post consumer stage for sound management of the EoL of the products. The post consumer focus of EPR programmes provide *pressure points* that drive changes upstream in material selection and design aspects which reduces environmental impacts of products (OECD, 2001). EPR is designed not only to reduce the impacts of products downstream at the treatment, recovery and disposal level but as well as the upstream level by reducing the amounts of material used and the hazardous chemicals in the materials. The burden being on the producer to manage the EoL of the product provides the producer with the incentives of designing and marketing their products while taking into account the cost of EoL disposal (OECD, 2006).

On producer responsibility WEEE Directive states that:

> *The establishment, by this Directive, of producer responsibility is one of the means of encouraging the design and production of electrical and electronic equipment which take into full account and facilitate their repair, possible upgrading, reuse, disassembly, and recycling* (Directive 2002/95/EC, Recital 12)

> *In order to give maximum effect to the concept of producer responsibility, each producer should be responsible for financing the management of the waste from his own product* (Directive 2002/95/EC, Recital 20)

The Directive stresses on the financial responsibility of the producers in the EoL management of their waste. Traditionally the Polluter-Pays Principle (PPP) has been featured in many statutes including the environmental laws in Kenya. This principle was to ensure that the polluters bear the cost for environmental impacts associated with their activities instead of passing the cost to the society. EPR principles have broadened the PPP by including other players in the product chain thus sharing out the responsibility (OECD, 2001).

According to Lifset (1993), EPR incentives can be dived into four:

1. Achievement of high levels of reuse, recycling and related forms of recovery
2. Behaviour change brought about by change in decisions on product design and material use
3. Expertise exploration of producers in the design, manufacture and distribution
4. Obtainment of financial resources that will motivate ambitious waste management goals that could not be achieved through the public tax base.

The Northwest Product Stewardship Council (NWPSC, 2001) in the United States defines product stewardships as

> *"….. an environmental management strategy that means whoever designs, produces, sells, or uses a product takes responsibility for minimizing the product's environmental impact throughout all stages of the products' life cycle. The greatest responsibility lies with whoever has the most ability to affect the lifecycle environmental impacts of the product"*

The above definition encompasses stakeholder participation in the management of the product throughout its entire life cycle (Sheehan and Speigelman 2005 as cited in Nicol and Thompson 2007). This kind of stakeholder participation shares out responsibilities between the different stakeholders in the EoL management of products as a way of optimizing take-back and recycling schemes. Product stewardship has often been equated to EPR in the United States (Elliott, 1997) though it is mostly associated with the chemicals industry's code of conduct while the code is not associated to product policies (Lifset, 2003). But the definition by the Northwest product stewardship Council encompasses the internalization of waste management issues in product strategies which is also echoed by EPR as the producers are responsible for their products through out the products life cycle. In practise EPR and product stewardship are very different. EPR requires the producers to pay for the cost of recycling their post-consumer waste whereas products stewardship does not specifically target producers as it relies upon the stakeholders for instance the consumers meet the cost of products recycling (Sachs 2006, Walls 2006). EPR has set targets for recycling while products stewardship has no required recycling targets (Schwartz & Gattuso 2002, Short 2004, Walls 2006). The ideal splitting of responsibilities under the product stewardship for the stakeholders is based on the following model: producers ensure that collection and recycling infrastructure is in place, consumers pay levies and deliver the products to the collection point, retailers participate in collection of waste and the Government establishes standards and ensure there are no free riders Thrope *et al.* (2004). Generally product stewardship programmes as put forth by Thrope *et al.* (2004) *are a step in the wrong direction because they will not lead to better and safer product design nor will they lead to the phase out of hazardous chemicals in the product.* Table 2-1 provides an overview of the distinction between EPR and Product stewardship

Table 2-1Distinction between EPR and products stewardship

←---------- Decreasing producer responsibility ←----------				
Product stewardship	Shared responsibility	Shared producer responsibility	Producer responsibility	Extended producer responsibility
----------→ Increasing producer responsibility ----------→				

Source Thrope et al (2004)

2.3.1 Types of responsibilities

The different types of responsibilities as categorized by Lindhqvist (1992, 2000) are:

I. Economic (financial) responsibility
II. Physical responsibility
III. Informative responsibility
IV. Ownership

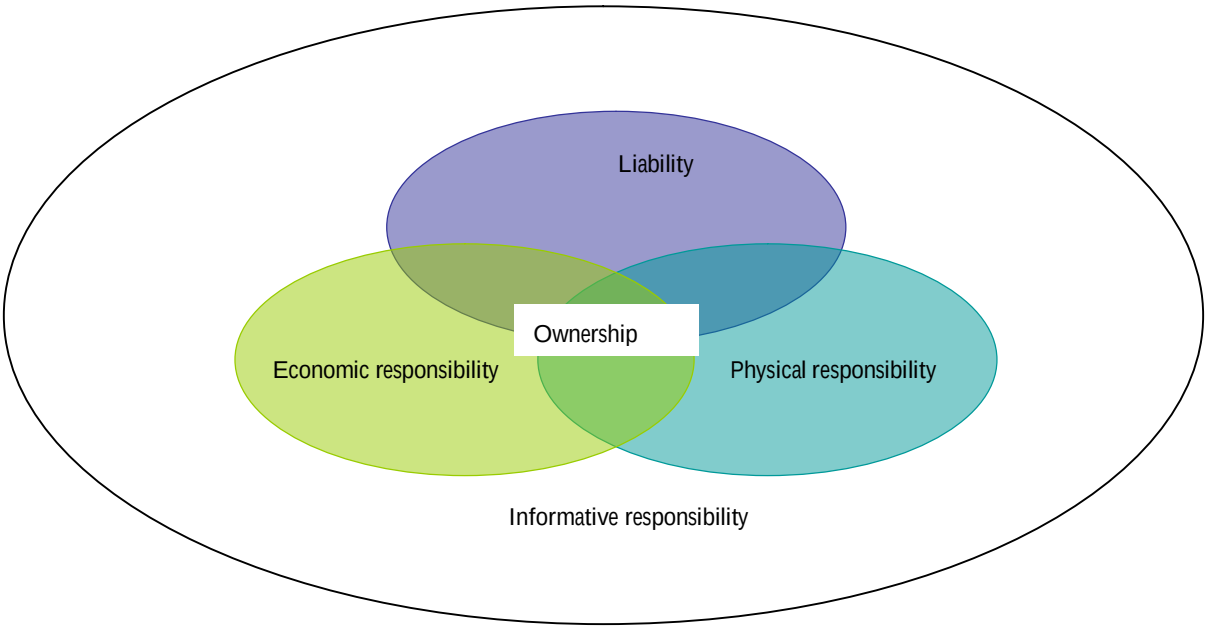

Figure 2-1 Model for Extended producer Responsibility (Lindhqvist 2000, Tojo 2004)

The different types of responsibilities depicted in Figure 2-1 can be defined as follows:

> **Liability** *refers to a responsibility for proven environmental damages caused by the product in question. The extent of the liability is determined by legislation.*
>
> **Economic/financial responsibility** *means that the producer will cover all or part of the costs for e.g. the collection, recycling or final disposal of the products (s)he is manufacturing. These costs could be paid for directly by the producer or by a special fee.*
>
> **Physical responsibility** *is used to characterise the systems where the manufacturer is involved in the actual physical management of the products or of the effects of the products. The manufacturer may also retain the* **ownership** *of his products throughout their life cycle, and consequently also be linked to the environmental problems of the product. The producer retains ownership of the product through leasing of the product.*
>
> **Informative responsibility** *signifies several different possibilities to extend responsibility for the products by requiring the producers to supply information on the environmental properties of the products he is manufacturing.* (Lindhqvist, 2000, Tojo 2004)

The different types of responsibilities illustrate that an EPR programme needs to be specific about who is responsible and what his responsibility is (Lindhqvist, 2000). Allocation of responsibility in the case of EEE has been a contentious issue amongst the various

stakeholders (Kalimo, 2006). Most EPR legislation in the electronic industry obliges a combination of economic, physical and informative responsibilities on the producers (Herold, 2007). The EoL management decision lies with the final holder of the EEE; he/she will decide when and how to discard it, in some instances the final holder may not discard it in an environmentally sound manner, thus the need for information and awareness.

The economic and physical responsibilities do not necessarily have to be equally spilt but to ensure security of a reasonable proper inclusion of the costs incurred in handling the product, the combination of the economic and physical responsibility may be proportioned as a way of giving control of the systems organization to the stakeholders responsible for the cost element. This builds incentives for cost optimization and improvements into the product system (Lindhqvist, 2000, Kalimo, 2006). In reality the sharing of responsibilities on an equitable basis is not an easy task. Table 2-2 divides the responsibilities as per the actions from the final holder of the EEE to the environmentally sound disposal.

Table 2-2 Division of responsibility in an EPR scheme

Action	Responsibility
Return of e-waste for separate collection	Final holder
Take-back returned e-waste	Distributor
Collection of e-waste	Producer
Management of collection points	Authorities? Producers?
Transfer of e-waste from collection points	Distributor? Authorities?
Treatment	Producer
Recovery	Producer
Environmentally sound disposal	Producer (why not the user/consumer too?)

Source Kalimo (2006)

Fishbein (2002) points out that an effective EPR programme is defined by the following:

- Has a specific focus on waste generated by the end-of-life product
- Defines clearly the type of financial responsibility producers have for collection, transportation and recycling of their products at the EoL
- Collection and recycling targets are well set and meaningful
- Has clear differentiation of recycling from waste to energy technologies
- Has incorporated enforcement mechanism and reporting requirements as part of the EPR programme
- Has incentives for producers to design their products for re-use and recycling
- Has incentives for consumers that return their used goods

2.3.2 What are the Benefits of EPR?

EPR policy principle as an environmental protection strategy that can aid in reduction of a products total environmental impact as the manufacturer of the product is responsible for the products whole life cycle with reference to the products take-back, recycling and final disposal. The benefits of EPR are manifold and can be divided into benefits to the producer, municipalities, environmental benefits and societal benefits. The benefits discussed below are adopted from Thrope *et al.* (2004) and OECD (2001, 2006)

Benefits to producer

- Encouragement of product chain management which offers the possibilities for closing material loops. Closing of material loops leads to advanced efficient and effective use of natural resources as less virgin resources would be required in the production process

due to reuse and recycling while at the same time improving the management of materials (Lee, 2002; Peck, 2003);

- Foster integrated environmental management as EPR lays emphasis on the products life cycle, these will provide for Feedback loops from downstream (end -of- life management) *to upstream* (design of products). This will minimize the associated costs of end-of-life management as the product will be designed for recyclability, disassembly and ease EoL management.
- Foster and promote efficient and competitive manufacturing

Municipalities

- Less burden on municipalities for waste management due to the reduction in financial and physical burdens upon waste management authorities as producers take physical and/or financial burden of waste management

Environmental benefits

- Reduction in environmental impacts associated with products final disposal.
- The reuse and refurbishment of products will extend the products life span thus reduces the associated environmental impacts of product disposal and the number of dumpsites
- Reduction and removal of hazardous chemicals in products as the producers are made to bear the burden of collecting the EoL products and disposing them off in an environmentally sound way thus encouraging advanced cleaner production process and products

Societal benefits

- Encourage and cultivate the culture of recycling and reuse of products which in turn improves the design for disassembly
- Nurturing product reuse and recycling which in turn demand for the development of collection/recycling technology
- Improve relationships between the communities as consumers and the producers of the products
- Reduction in waste management cost and increased efficiency of waste management practices due to the involvement of private actors

2.4 EPR Policy instruments

EPR is a *policy principle that promotes 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).

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 Table 2-3 .

Table 2-3 Examples of EPR policy instruments

Administrative instrument	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
Economic instruments	Material/product taxes, subsidies, advance disposal fee systems, deposit-refund systems, upstream combined tax/subsidies, tradable recycling credits
Informative instruments	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: adopted from Tojo (2004)

EPR programmes normally adopt more than one policy instrument to achieve intended results. 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 2.3.1above. 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.

2.4.1 Components of EPR policy instruments

A policy principle is the basis for selecting the mix of policy instruments that are to be used in a particular case (Lindhqvist, 2000).Table 2-4 provides the various EPR policy instruments and their applicability to the various waste streams, the stage at which they are applicable in the product chain, the various responses to the policy instrument and the implementing body. Lindhqvist 2000 points out *that the role of EPR is to give direction for how the mix of policy instruments in this field could be configurated to be efficient.*

Table 2-4 Components of EPR policy instruments

	Product or waste stream	Stage in product chain	Direct response to intervention	Implementing body
Deposit/refund	Specific products (e.g. beverage containers)	Disposal, with signals to design stage	Re-use and design	All levels of governments, industry based- firm level or private sector organisation
Take-back	Product and waste streams (and sectors)	Disposal with strong signals to resource extraction and design stages	Re-use, recycling some source reduction and design	All levels of governments, industry based -firm level or private sector organisation
Materials tax	Product (specific inputs)	Resource extraction and design stages	Reduced inputs of targeted materials and design	National and sub-national government

Advance disposal fee	Product	Disposal stage	Recycling and some reuse and recovery	All levels of governments, private sector organization
Combined upstream tax/subsidy	Product	Design and disposal stage	Reduced material input and recycling	National and sub-national government, private sector organization (waste management)
Recycling incentives	Product (e.g. paper and plastics, etc.)	Design, signals to disposal stage	Design, reduced raw material input	All levels of governments, industry based- firm level or private sector organisation

Source: adopted from OECD (2001)

The EPR policy instruments as depicted in Table 2-4 are further defined below

1. Deposit-refund system

In this system some deposit is charged when the product is being sold with the aim of later refunding the buyer when the product is returned for reuse, recycling or for safe disposal. In this scheme the producer/retailers are often responsible the EoL management of the product and collection of the deposit. In some instances the full deposit may not be returned (OECD, 2005).

2. Product take-back

Product take-back systems are viewed as the heart of EPR policies (Herold, 2007). They involve the assignment of taking back the products to the producers at the EoL of the product (OECD, 2005). Take-back systems operate under three schemes, namely 1. House to house "Kerbside" collection, 2. "Bring system": In "bring back system" the consumer is responsible to return the product to a designated area. This may be at a drop off point, recycling station or a care centre (Lindhqvist, 2000), finally 3. Retailer collection system: where the retailers are mandated to take-back the EoL products. This thesis analyses this EPR policy instrument in details in section 4.1

3. Advance disposal fee

This is a charge levied during the sale of a product; the charge is meant for the EoL waste management costs for that product. This is included in the cost of the product. The producers could be responsible for levying and collection of this charge and forwarding the money to the responsible public authority charged with waste management. This absolves the producers from the physical collection and disposal of the waste (OECD 2005).

4. End-of-life waste management fees

This is the system where the consumer pays for the disposal of the EoL products. They pay for part of the marginal collection cost and treatment cost as part of the general household waste or specific waste product. This is usually charged as "*pay as you throw*" or though specialized fees for collection of waste such as refrigerators and car tires and end of life vehicles (OECD, 2005).

5. Recycling incentives

Recycling incentives work as stimulants to the recycling market. Subsidies are used to stimulate collection of recyclable materials, reprocessing of recyclable materials and use of recycled products. This could also include the provision of collection facilities for the recyclable products. Regulations play a crucial role in encouraging material recycling; this can be in line with requirements of minimum recycled materials contained in certain products or taxes on virgin materials (OECD, 2005).

6. Disposal disincentives

This is where there are taxes on the EoL management of products; this usually takes the form of land fill taxes or incineration taxes and is aimed at influencing the choice of disposal and may discourage disposal of products itotality. On the other hand, these types of taxes only work well with organized waste management agencies such as municipalities and cannot influence consumers or producers unless supplemented with other measures (OECD, 2005).

2.5 What is a mobile phone and why mobile phones?

The MPPI (2006) defines a mobile phone/cell phone/cellular phone as

> …. *.a small, sophisticated personal two-way radio. It sends and receives radio signals, carrying voice in personal communications with other mobile phones and landline telephones.*

The mobile phone just like other EEE are made from a variety of materials: these materials include plastics, metals, ceramics and glass. Mobile phones contain the same materials as personal computers or other ICT devices and are very similar in the way they are made. The only significant difference is in the size of the mobile phones as compared to the size of the laptops. MPPI (2006) lists the following components as essential components of a mobile phone:

- The hand set
- A battery
- Microphone and speaker

The handset consists of the screen or display that can be monochromatic or coloured protected by a glass cover. It has a keypad and an antenna. Inside the handset there is a printed wiring board with integrated chips, resistors, capacitors and wires. This makes up the electronic components of the phone or the phones' brain (MPPI 2006). There are many different types of mobile phone manufacturers and different types of phone models therefore the material quantities and substances may differ slightly from model to model and from the different manufacturers (MPPI 2006). However, the main materials found in mobile phones have been summed up by the MPPI (2006)[6] as:

- Plastics
- Glass and ceramics
- Copper and its compounds
- Nickel and its compounds
- Potassium hydroxide

6 A detailed list of the components is given in

Appendix 2

- Cobalt
- Lithium
- Carbon
- Aluminium
- Steel
- Tin

The mobile phone from the above list indicates that they only contain solid materials. The main aim of looking at the ICT sector is because the equipments in this sector do contain potentially hazardous substances though in small amounts which if released into the environment due to poor or lack of EoL management could impact negatively on human health and the environment at large

2.6 Individual versus collective responsibility

Individual producer responsibility means that each producer bears the responsibility of managing his/her products EoL, whereas collective producer responsibility means that the EoL management of a product is shared with other producers of similar products regardless of the brand (Tojo 2004, Herold 2007). Research conducted previously found out that IPR was better placed to provide incentive for design change as the feedback loops to the manufacturer is more efficient in introduction of design change at low costs at the end (van Rossem, *et al* 2006). The main distinction between IPR and CR lies in the fundamental question surrounding EPR on the responsibility of producer to create incentives for design change pegged on the feedback loop to the manufacturer (van Rossem, *et al* 2006). It is generally assumed that IPR based programmes under EPR, promote design change more than CR programmes and that IPR implementation faces more administrative challenges thus making it a burden to producers as opposed to CR programmes.

2.7 Product Recovery Management (PRM)

There are numerous activities covered under product recovery that involve the extension of the products useful life, the materials and components. Thierry *et al* (1995) define product recovery management as an all encompassing process that covers the *management of all used and discarded products, components and materials that fall under the responsibility of a manufacturing company.* The objective of product recovery management is to reduce waste quantities and recover as much as possible the economic and ecological value of the product. The OEMs can restore their own returned products to as good as new products and use the reconditioned parts in the manufacture of new products (Kulkarni *et al* 2005). There are various product recovery options; repair, refurbish, remanufacture, cannibalize, and recycle (Thierry *et al* 1995). PRM involves used product and component collection, processing and redistribution. There are long term economic benefits to OEMs in recovering of returned products.

Product repair

This involves fixing and replacement of broken components or damaged parts; the aim of the repairing products is to return the product to a useable state. Repairing of products entails limited product disassembly and reassembly (Thierry *et al* 1995). Traditionally product repair especially in the EEE is done by the product manufacturer or by the involvement of the product manufacturer especially for products with warranty.

Refurbishing or reconditioning

This involves product upgrading by replacing outdated modules and parts with technological superior parts (Thierry *et al* 1995). The main aim is to restore used products and extend their service life. Most EEE sold in Kenya are refurbished products imported from Asia. The big second hand car market in Kenya is sustained by refurbished cars imported from Japan and Singapore. The refurbished mobile phones are also on sale in many retail outlets.

Remanufacturing

This involves the complete disassembly of all components of a product, the inspection and replacement of worn out parts with new parts and the damaged but repairable parts are fixed and tested and gauged against set standards for new products. At times remanufacturing is coupled by technological upgrading (Thierry *et al* 1995). Remanufacturing of products has been suggested as one way of creating economic value while at the same time obtaining environmental benefits. It is a sustainability operationalising technique (WCED 1987). Rose (2000) defines remanufacturing as a process in which large quantities of similar products are disassembled in a central facility, the parts sort according to part type, cleaned and inspected for repair and reuse.

Cannibalization

This is the recovery of usable parts from used components; components gotten from cannibalized goods are used in repair, refurbishment or remanufacture of other products or components. In most instances this involves selective disassembly of useable parts (Thierry *et al* 1995).The most common forms of cannibalization happen in the ICT sector especially in integrated circuit systems.

Recycling

This is the reuse of materials from used products and components after disassembly of parts and the separation of these parts for production of new products (Thierry *et al* 1995). Recycling generally returns a product into raw material form. Product recyclability should be taken into account in the initial design stages of a product that is; if a products EoL management is known then the design of the product should reflect its recyclability. Table 2-5 provides an overview of the comparison between the different product recovery options.

Table 2-5 Comparison between product recovery options

	Level of disassembly	Quality requirements	Resulting product
Repair	Product level	Restore product to working order	Some parts fixed or replaced by spares
Refurbish	To module/component level	Inspect all critical modules and upgrade to specified quality level	Some modules repaired/replaces potential upgrade
Remanufacture	To part level	Inspect all modules and parts and upgrade to as new quality	Used and new parts/modules combined into new product; potential upgrade
Cannibalize	Selective retrieval of parts	Depends on process in which parts are used	Some parts reused; remaining products recycled/disposed
Recycle	To material level	High for production of original parts; less for other parts	Materials reused to produce new parts

Source Thierry et al (1995)

PRM just like EPR calls for the manufacturing companies to take responsibility of the end of life management of the products. EPR is covered under legislation such as the WEEE directive of the European Union and thus encourages the producers to take responsibility of their products at the EoL. For effective EoL management practices there is need for value added product recovery, material recovery and energy recovery forming the basis of the EoL strategy.

2.8 Analytical framework

The factors discussed below provide the analytical framework used to discuss the findings on the collection scheme. The factors that determine the achievement of high collection rates and recycling results are the same with or without EPR system: these factors are economic incentives, disincentives, convenience, inconvenience and information (Lindhqvist, 2000). These factors are grouped as:

1) Financial incentives: this includes refunds or redemptions given to waste handler/person handling the waste to the designated collection point.

2) Level of convenience or inconvenience: this addressed the kind of effort is needed to dispose of the waste at the designated collection point and it could also look at the how inconvenienced the consumers are.

3) Level of information and awareness: this looks at the level of awareness among the members of the public, that is the system known to the public, and do the members of the public comply with the system requirements. The flip side to this is the ease of the ordinary person understanding the system

The general analysis was directed by the criteria set out by the OECD (2001) model for evaluating EPR programmes. The model is based on analyzing the value and advantage of

establishing EPR policy and on the selection of appropriate policy instruments. The criterion is based on the following factors:

1. Environmental effectiveness
2. Economic efficiency
3. Political acceptability
4. Administratabilty
5. Innovative advancement

Table 2-6 Criteria used in analysis of the data collected in relation to the take-back scheme

Environmental effectiveness	Economic efficiency	Political acceptability	Administratability	Innovative advancement
Instruments impact on upstream changes in product design and composition and downstream changes in waste diversion	Extent of instrument saving resources i.e. capital and labour materials and energy	Political support of the policy at national and international level	Feasibility of carrying out the programme, capability and capacity of governments and producers. Free riders, orphaned and existing products. Trade and competition	Can the programme stimulate technological and managerial improvements

3 Context specific: The Kenyan scenario

In this section I will discuss the waste management scenario in Kenya followed by the current status of e-waste management in Kenya and the challenges of e-waste management. I will finalize this section by introducing the readers to the ICT sector in Kenya. The ICT is introduced to the reader as it is the focus sector for this study among the EEE product categories. The purpose of this section is to provide an insight to the readers on the situation in Kenya, the information may be necessary when reading the upcoming chapters.

3.1 Waste management in Kenya

Kenya is a developing country with a population of 36.1 million in the year 2006 (CCK 2006/07), and land area of 549,137 km^2. 34% of the total population in Kenya lives in the three major cities (Nairobi, Mombasa and Kisumu which were the focus of the study) and two major towns namely Nakuru and Eldoret (CCN 2007). Solid waste management services in Nairobi (the situation reflects the practice country wise) is characterized by poor solid waste management services, uncontrolled dumping leading to serious pollution problems, unregulated private sector participation because most of the waste collection in Nairobi has been privatized, lack of solid waste management infrastructure (that include well managed transfer facilities, waste separation etc), and lack of waste policies and strong waste recycling and recovery industry (UNEP, 2006). The per capita waste generation within urban areas ranges between 0.29 and 0.66kg/day (SOE, 2003). JICA (1997) points out that on average 21% of the waste generated in urban centres emanates from industrial areas while 61% from residential areas, 6% from roads and the rest is not stated where it comes from[7]. It is estimated that Nairobi generates 1,5000 tons of solid waste daily and only 25% of this waste is collected and sent to the Dandora dumpsite (this is an open dumpsite and covers 27 hectares) (UNEP, 2005). The remaining waste is mostly composed of chemicals (salts, heavy metals, detergents and medical waste) is dumped in undesignated areas or in the rivers and wetlands (SOE, 2003). There are several illegal dumpsites emerging in Nairobi along the introduction of road, in residential backyards and commercial premises this has been attributed to the waste management regulations of 2006, there seems to be light fact that the end of the tunnel if only the regulations will be enforced. Dandora dumpsite has reached its full capacity (CCN 2007).

In the mid 1970s the Nairobi city council collected over 90% of all the waste generated (JICA, 1997). This collection percentage fell in the mid 1980s when the waste management attracted private sector due to the demand for Municipal waste management. In 1998 there were 60 private companies engaged in solid waste collection but they still could not manage to hit the 90% collection mark (UNEP 2005). These companies mostly operate in the high class and middle class residential areas where the people can afford to pay for the services while low income areas are generally not included in these schemes (JICA, 1997). The waste is collected and sent to the Dandora dumpsite (There is no waste segregation as all type of waste is disposed here ranging from hospital waste to household and industrial waste. The dumpsite has scavengers trying to make a living from salvaging more than 30 different types of material mostly metals for use by the industries (JICA, 1997). Other than the scavengers there are gang like cartels who recover the recyclables oblivious of the contamination in the dumpsite and other dangers such as fires due to methane production. It is estimated that there are 600 scavengers operating in organized groups that work at the dumpsites (Palczynski 2002). The scavengers build squatter colonies within the dumpsite and anything within the squatter colony belongs to the scavenger and trespassing by another squatter colony is not taken

[7] This shows the data situation in the country, the most extensive study on waste management was consucted in 1998 by JICA. Since the there has been no know comprehensive study conducted

lightly. Any new members or waste pickers face tough challenges of integrating into the existing system as they need to have established linkages to the recovered products market. The materials recovered by the scavengers are sold to middle men who have connections with the various industries. The middle men sell the recovered materials to the industries (Palczynski 2002). Efforts to enter Dandora and Mwakirunge dumpsites were thwarted by the squatter colonies and the high tension in the country at the time of collecting data. There is substantial potential in recycling and this includes e-waste recycling but the problem is the contamination of the recyclables and other hazardous waste alongside the rudimentary methods used. The lack of legislation on recycling has resulted in some industries exploiting waste pickers and also importing waste materials into the country. Several industries encourage the set up of formal waste recycling firms. Such schemes cover both plastic and glass bottles. This is done mainly to improve the environment and to help generate income for the poor. At this point in time it is essential to note that the recycling trend is being embraced but at a slow pace as there are no incentives to the recyclers and it's done by the youth groups in the slums. The rapid population growth in Nairobi and the mushrooming of unplanned informal business has played a role in the increase of solid waste in the city (CCN 2007). Various components of waste management were unregulated. Waste transportation for a long time has not been regulated therefore the waste collected form the households is transported in open lorries and gets blown away by the wind as the lorries move. But now with the introduction of the Waste Management Regulation 2006, this section of waste management has been covered. In a snap shot waste management in Kenya entails collection, transportation and open air dumping. There are a few private incinerators and the rest are owned by hospitals. The incinerators are not used in conversion of waste to energy as done in Europe.

3.2 Current status of e-waste management in Kenya

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 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's 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. Musili (2008) the Director of Computer for Schools Kenya 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 NGOs, up to a quarter of the donations sent to the recipient countries are unusable and are in effect dumped in the recipient countries. 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 (Okono 2008, 7th April, personal interview). 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[8]). While such enthusiastic forecast seems to be addressing the problem of bridging the digital divide between the developed countries and Africa the main

[8]Microsoft Africa president

worry is the high influx of these computers in countries that have neither infrastructure nor policies on the EoL management of these equipments. This raises the issue of transfer of financial guaranteed goods from an EPR jurisdiction to a non EPR jurisdiction (van Rossem, 2006). Most of the EEE goods in Europe have a financial guarantee allocated to the product in some instances an advanced disposal fee, so should the financial guarantee of these goods be transferred when the goods are transferred to developing countries for their recycling at the products end of life? The price difference between a used PC and a new PC can be 30% of the cost of the new product and the functionality of these PCs as viewed by the buyers largely depends on simple applications such as emailing and use of the Microsoft office function. The speed of the PC does not really matter if it can handle the applications desired by the users.

The telecommunication sector is one of the fastest growing sectors in the country; it has witnessed continued growth due to the introduction of wireless systems for providing fixed telephones services and heavy investment in the mobile sub sector. The mobile telephony has been a preferred option over the fixed land line by majority of the people due to the ease of acquiring the mobile phone as compared to the installation of the fixed landline and the widespread coverage including the rural and remote areas and the better services provided. There are many other services provided by the mobile service providers that have attracted the large numbers in subscription, which include the M-Pesa money transfer services and the credit transfer services. The number of mobile subscribers grew from 6.4 million in 2005/06 to 9.3 million in 2006/07; this represents a 43% increase in the subscriber base (CCK, 2007). This growth has in effect increased tele-accessibility in the country by about 28% (CCK, 2007). The growth in the mobile subsector in effect means that there has been an increase in the number of mobile phones purchased. The mobile market segment had an annual turnover of KSh 58 billion (60 million Euros) in the period 2006/07, against the previous year's KSh 45 billion (47 million Euros) (CCK, 2007). There has been an influx of second hand computers, mobile phones and accessories from Europe and Asia. The development in the ICT sector at large depends on second hand/reconditioned EEE that is imported into the country.

There is no data or statistics on the availability of various EEE in the country. The data available for televisions sets is contradictory with one source estimating that in the year 2004 only 17% of Kenyans owned a television set (Omosa and McCormick, 2004), while the other states that in 2005 32% of Kenyans owned a television set (Intermedia, 2004). The other sources like the Kenya press estimate that only 3 million people own a television in Kenya out of the total population of 33 million. The discrepancies in the numbers can be attributed to the fact that no study has been conducted to validate the TV or radio ownership in the country. It has been difficult to own a TV set due to the high cost, but the conversion of old computer monitors into television sets has made it easier. The adopted television costs no more than 75 dollars (55 Euros) while a second hand television costs 150 dollars (110 Euros) (Okono 2008, 7th April, personal interview). Currently on the market there is an influx of cheaper television sets from Asia both second hand and new sets. Now more and more people can afford to purchase these products, and the contentious issue is the end of life disposal of these EEE as they have a short life span, especially the second hand television sets. The amount of pollutants in the television sets is much higher than in other EEE such as the washing machines and refrigerators. TVs contain hazardous and toxic components such as lead and phosphorescent (Barba- Gutierrez *et al* 2007).

In general little has been done in management of e-waste in Kenya however; there have been various initiatives of e-waste management in Kenya after the eighth COP to the Basel convention. The Forum for the Future and the Practical Action Aid in collaboration with Vodafone conducted an e-waste pilot project primarily focusing on mobile phone waste with

the aim of determining the volume of the waste and the possible collection methods. Nokia[9] in the last two years has been setting up a take-back scheme for the EoL mobile phones. Several NGOs have developed project proposals on e-waste management with special focus on ICT equipment. Currently Computer for Schools Kenya (CFSK) program has a functioning computer repair and refurbishing centre and intends to expand the program into a fully fledged e-waste management centre. This thesis will provide more information on the current take-back scheme and the CFSK project. Nevertheless, there has been a large influx of second hand EEE not only in the ICT sector but also in other household goods such as TV sets, Printers, radios etc. Figure 3-1 shows an EoL table top cooker dumped at the Kachok dumpsite alongside other MSW, small EEE are easily disposed off with the household waste.

Figure 3-1 EoL table cooker dumped at Kachok dumpsite Kisumu with other MSW

3.3 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; 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.

Consumer perceptions on e-waste

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 that has not benefit to them.

[9] The case study provides more information on this initiative

Lack of financial resources, infrastructure and relevant technology

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 refurbishers in unregulated premises. The lack of resources needed in planning, strategizing and management of e-waste has lead to the problem being relegate and not addressed as it should be. 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 lead 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.

Stakeholder awareness

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

Illegal imports

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 flood gates 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.

Absences of regulations and lax regulatory control

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.

3.4 ICT sector in Kenya

The ICT sector in Kenya has witnessed significant growth; this can be attributed to the number of telephone lines, internet service provides (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

1. As of June 2007 there were approximately 10 million mobile phone subscribers as opposed to 3 million in the year 2004.

2. As of June 2005 there were 73 registered ISP, over 1000 cyber cafes and telephone bureaus and approximately 1,030,000 users.
3. There are 16 operational television stations and 24 FM radio stations
4. An estimated 60% of the population have access to television and 90% have access to radio services

ICT issues are regulated under various statues 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 statues 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. Inline 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 is not regulated in this sector although it is associated with the services under this sector. The next sections in the study will be discussed under the ICT umbrella.

4 Managing End-of-Life electronics

This section revisits the one of the EPR policy instruments (take-back) to provide the readers with the necessary background to the manufacturer's involvement in EoL management with a case study of Nokia. The SWOT analysis highlights and discusses the challenges and opportunities of manufacturer involvement. The problematic issues are identified and analysed using the analytical framework provided in section 2.8. The final sections provide a comparative analysis of the salient e-waste features between Kenya and India. I conclude this section by providing a glimpse of the generic flows of other types of e-waste with focus on their EoL. In discussing the EoL management I introduce the stakeholders who will be discussed in detail in section 5.

4.1 Take-back schemes

Product take-back whether voluntary or mandatory has been listed by the OECD (2001) as the most active use of EPR in managing EoL electronics. Lindhqvist (2000) points out that EPR take-back policy can be distinguished from other take-back schemes due to the feedback to the product system development. In a study conducted by van Rossem *et al* (2006) points out that companies that take-back their own brand products are more capable of designing cleaner and more resource efficient products. But the main challenge facing take-back programmes is to make end users play their role and return the EoL products for recycling as opposed to indiscriminate disposal of these products. In evaluating the take-back policy instrument I have applied the criteria discussed in section 2.8. The criterion evaluates the economic effectiveness of the take-back scheme, its economic efficiency, the political acceptability, the administratability and the innovative advancement. Figure 4-1 provides the analysis of the criterion for the take-back policy instrument. The criteria can be used by policy makers in selecting an EPR policy instrument that would be best suited to the prevailing condition and needs.

Figure 4-1 Evaluation of the voluntary product take-back programme

4.2 Manufacturer involvement in end-of life management of mobile phones (case study of Nokia's collection scheme)

EPR exemplifies the idea of producers taking responsibility of the environmental impacts of their products at the EoL; this can be physical, economic, informative and liability. The EPR policy involved in the case study of manufacturer involvement in EoL management is the product take-back scheme. The take-back scheme being implemented in Kenya by Nokia is based on its Middle East and Africa strategy and it relies on the usage of existing infrastructure. The take-back is organized around the customer care centres. At the time of this research the take-back boxes/recycle boxes are available at the Nokia care centre in Nairobi. Figure 4-2 shows the envisioned take-back scheme by Nokia. Tier 1 indicates that the scheme would be operated under the Nokia customer care manager; the manager has so far identified two companies as indicated in tier 2, the companies are responsible for setting up the various collection points in the major cities. The take-back scheme is to be fully operated by the collection points that are tier 2 in the legend, tier two will decide on how to engage tier

3 and 4 into the collection scheme. From the personal interviews with the managers of the care centres indicate that the regional care centres will establish collection points with using various methods banking on the existing infrastructure.

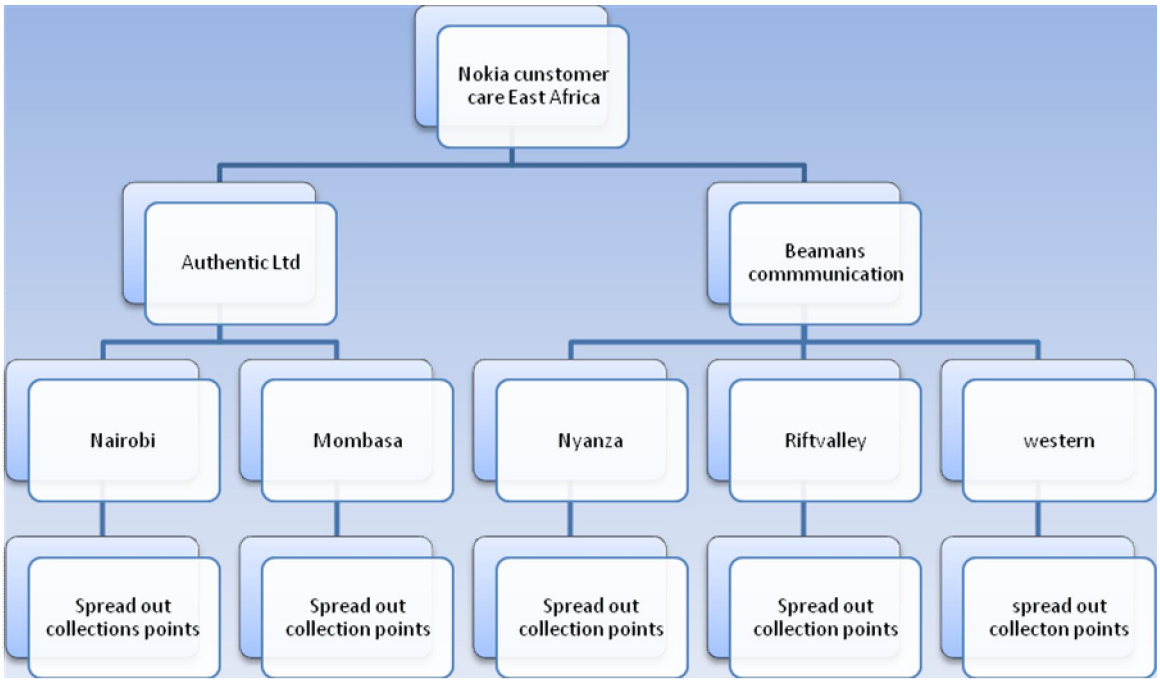

Figure 4-2 The envisioned collection scheme by Nokia

The collection methods range from

- Business to business collection schemes
- Designated collection facilities
- Customer care schemes

Business to business collection schemes

The care centres intend to operate the take-back schemes though the existing infrastructure set up by the network providers. The network providers (Safaricom and Celtel) have well established care centre's spread out in the country the care centre's intended to use this existing network by setting up the EoL mobile phones and accessories take-back bins in the centre's (Patlingaro 2008, 10th March, personal interview). The second B2B scheme would entail setting up take-back boxes in the Nokia authorized phone dealer premises, which account for 30% of the existing phone dealers in the country. The third B2B scheme would involve selected setting up of take-back bins in selected retailer shops especially in the small towns (Otiende 2008, 5th March, personal interview). The necessity of setting up of the take-back boxes/recycle boxes in the retailers' shops is because most distributors of mobile phones do not have retail outlets; they import the products and sell them to the retailers (Maina 2008, 13th March, personal interview).

Designated collection facilities

The main designated collection centres' will be the care centres and the appointed subsidiary collection points. The care centres'' expect to be compensated by Nokia for the logistics and transportation of the EoL phones from the collection points (Otiende 2008, 5th March, personal interview).

4.3 Stakeholder views on the collection scheme

The stakeholders can be divided into four groups based on their views on the collection schemes as depicted in Table 4-1. The supporters of the collection scheme are the producers in this case Nokia as the scheme is established under Nokia. The care centres' and Nokia distributors support the initiative based on the working relationship with Nokia. Those against the schemes base their argument on the loss of revenue generated in the repair of the phones and sale of second hand and refurbished phones. If the producer collects the phones and also repairs them the repair shops will be out of business. The retailers who were against the scheme based their argument on the second hand market sales and the fact that they housed the repair shops, if repairers are out of market it will directly affect the retailers especially those who sold second hand repaired phones. The neutral stakeholders are the regulators though must of them applaud the imitative but noted that it was not working as expected. The stakeholders in the last category are not well informed on the collection scheme and the role it plays in waste management. Detailed information and analysis on stakeholders in provided in section 5.

Table 4-1 Stakeholder views on collection schemes

Supporters of the collection schemes The producers The customer care centres'	Against collection schemes The repair shops Some retailer shops
Neutral stakeholders The regulators The network providers	Not sure End users Scavengers and recyclers

4.4 SWOT analysis on manufacturer involvement in EoL management of mobile phones

The Strengths, Weakness, *Opportunities* and Threats (SWOT) analysis on the manufacturer involvement in EoL management of mobile phones. Table 4-2 highlights SWOTS analysis. The SWOT analysis in a nut shell provides the internal and external factors that influence the manufacturer's involvement in the EoL management of the phones. A detailed and merged analysis of the SWOT is provided under the challenges and opportunities of establishing and effective and efficient collection scheme in section 4.5.

Table 4-2 SWOT analysis on manufacture involvement in EoL management of mobile phones

Manufacturer (NOKIA) involvement in End-of-Life management of e-waste (the collection scheme)	
Strengths • The scheme is economical/cheap as the consumers are supposed to return their EoL phones • The scheme if fully implemented will set the industry standards as it is the first of its kind. • Competitive advantage will provide a unique selling point: green image for the manufacturer • Set the benchmark for government regulation as this is not in place at the moment • The material content in the phone makes it an attractive product for recycling and thus cutting	• Weaknesses • The intricacies in control and channelling of the EoL Phones • Lack of well established collection points which might ruin the reputation of the whole scheme during this initial set up stage • Lack of competition from other manufacturers in collection of the EoL phones • The geographical coverage of the collection points is limited to the major cities at the

out the orphaned and historical waste. • Producers commitment in implementation of the take-back/collection scheme	moment • Lack of funds ear marked for the advertisement of the collection/take-back scheme and environmental issues
Opportunities • Use of existing infrastructure for the collection of the EoL phones • Competitive advantage due to early start • Potential for business and product development • Potential for partnership development with ongoing initiatives and upcoming initiatives • Open for more research and information dissemination • Large numbers of EoL phones	• Threats • Competition from repair shops and the market demand for the second hand shops • EoL disposal of the mobile phones and accessories by the repair shops and ignorant users • Lack of awareness on the scheme and the schemes intention • The dependence of the collection scheme on end users to return the products • The collection schemes continuity due to the lack of active participation from the end of life users

4.5 Main challenges and opportunities of establishing an effective and efficient take-back scheme for EoL phones

The Collection points are key elements of a recycling system, Huisman (2005) emphasized this by stating that

"Research shows a clear link between number of collection points and kg's collected. Especially in the start-up phase of take-back, the availability of collection points is crucial.

4.5.1 Challenges

Convenience and inconvenience

The challenges faced in the current scheme start from the lack of well spread out collection points, the collection scheme started at a very slow pace with only one collection point in the country for the last two years. The care centre in Nairobi has been the operational collection point and has only received one EoL phone that was irreparable due to liquid damage (Patlingaro 2008, 10th March, personal interview). Currently the collection point is highly inconvenient to most of the end users as it's based in Nairobi. Figure 4-3 shows the generic movement of mobile phone from the point of entry into the market till its end of life. The main challenge lies in the end of life decision taken by the end user, the end users would decide whether store the phone at home or sale if to the repair shops.

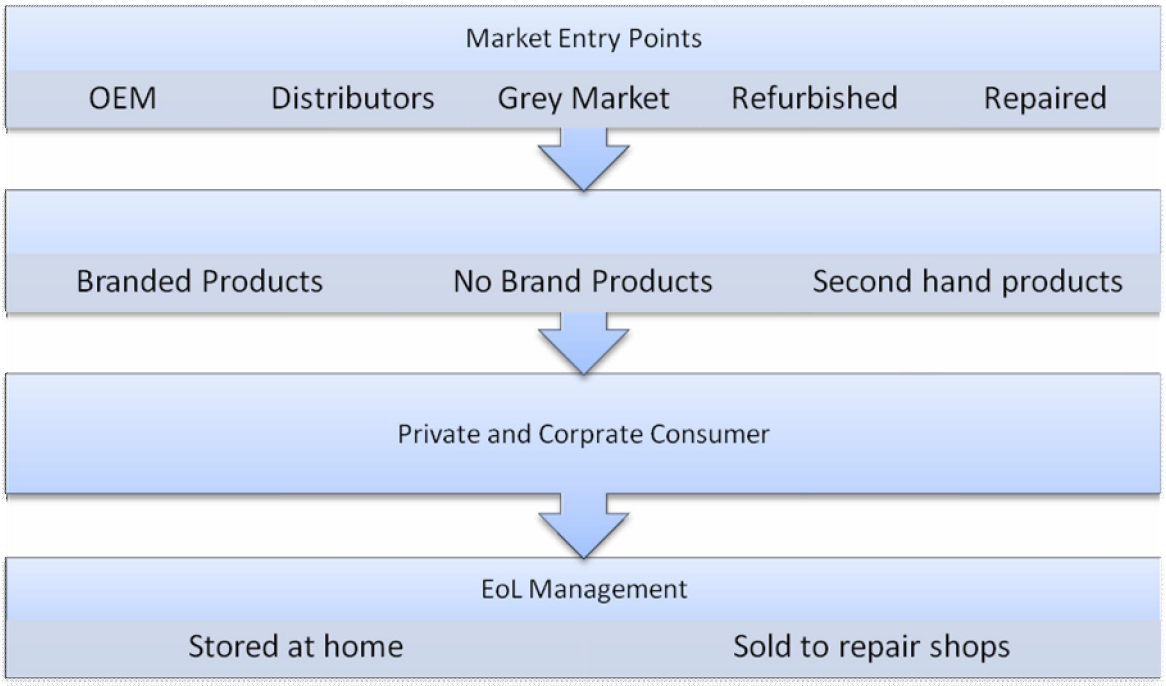

Figure 4-3 Generic movement of mobile phones

Incentives and disincentives

The other challenge of collecting end of life phones lies in the lack of incentives to the end users, the end users preferred to store the phones at home or sell to repair shops, rather than hand them into a collection scheme that had no incentives. The above preference was echoed by the middle class and the low class groups. The affluent group, however, had no problem handing in their phones without any incentives as long as the system was transparent and the phones would be recycled as opposed to refurbished and sold. The type of incentives suggested by the consumers ranged from trade offs/discount on new phones (35%), air time 4%, financial compensation 38% accessories (4%), none (12%) and those who were open to any kind of incentive (7%). Figure 4-4 depicts the consumer incentives discussed above. The consumer willingness to participate in a take-back scheme will determine the success or failure of the scheme. Past trends in waste collection in Kenya indicate that waste is money, with this kind of mind set it would be an onerous task selling the voluntary take-back scheme as most waste that is recyclable is sold. Old news papers, both glass and plastic bottles, old shoes and clothes can still be sold to the door to door waste collectors for recycling or reuse. On the issue of incentives Maina stated that incentives would encourage theft of mobile phones so as to benefit from the scheme (Maina 2008, 13th March, personal interview). Mobile theft currently is an issue and thus it is unjustifiable to claim incentives would increase mobile phone theft.

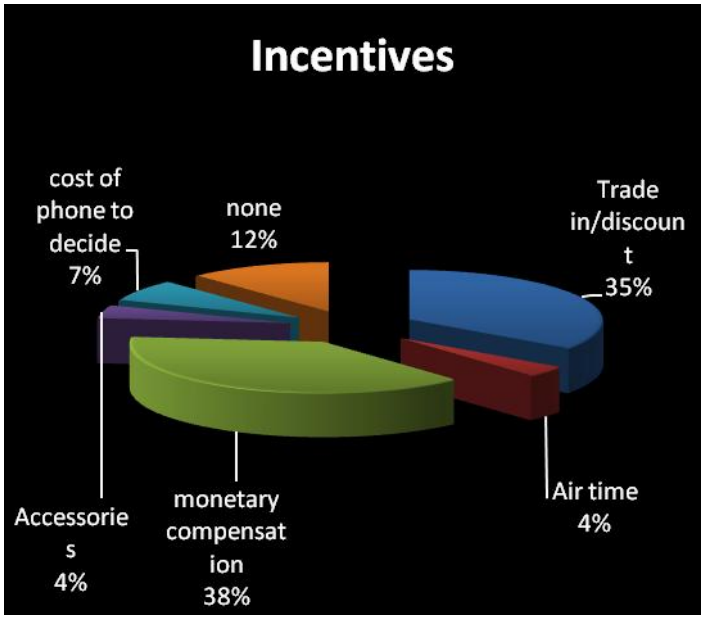

Figure 4-4 Types of incentives suggested by consumers

Competition for resources

Competition for material resources from the end of life phones between the repair shops and the take-back scheme. The repair shops value the EoL phones as material resources for spare parts and thus buy back the phones as opposed to the take-back schemes intention of collecting the phones without any monetary exchange. Nicholas Maina the customer care manager for Nokia East Africa 2008 attributed this competition for resources by the repair shops in down town Nairobi as the major reason why the take-back scheme has not received any EoL phones (Maina 2008, 13th March Personal interview). The collection of mobile phones for recycling by Nokia is an onerous task as compared to the repair shops, as the repair shops refurbish the phones and resell them or reuse the parts, and buy the old phones from the end users thus breaking even for collection schemes is difficult, due to the fact that Nokia is not buying back these phones from the end users. UNEP (2007) points out that e-waste collection, transportation and recycling in the past years has grown to be a profitable business in the informal sector the growth in the informal sector can be attributed to the low level of investment needed. The attraction of trade in e-waste is the financial benefit as opposed to environmental, occupational and health issues. This trade is not only beneficial to the e-waste collectors and recyclers as consumers are paid for their e-waste. This poses a challenge to producers who intend to introduce a formal scheme and investors interested in operating recycling schemes. For the set up of cheaper cost effective collection schemes the producer needs to liaise heavily with the network operators who can facilitate the take-back initiative due to their extensive outreach.

The development of an all inclusive scheme would also pose a major challenge in the division of roles. The current scheme is focused on the collection of EoL phones for shipment to Hungary for recycling (Maina 2008, 13th March, personal interview).

Awareness

The slow start up of the collection scheme can be attributed to various factors such as lack of awareness, most of the consumers interviewed (90%) were not aware of the collection scheme nor of the existing initiative, and those who were aware of the scheme had heard about the scheme in the past weeks. The lack of awareness creation about the scheme by the producer

has been attributed to the lack of dedicated resources to environmental issues (Maina 2008, 13th March, personal interview). The resources are dedicated to marketing of the new models in the market and not creation of awareness on the EoL management of the obsolete phones. There is need to integrate the EoL management of obsolete phones in the daily activities of the Nokia Kenya office and the field force team. Awareness can be created through various initiatives that target the communities and schools in the initial set up of the scheme the producer can set up an initiative that will encourage the collection of intact EoL phones. The initiative can be used to create awareness on the existence of the take-back scheme.

How do you determine that the phone is an EoL phone? Will it be based on the year of manufacture, Functionality of the phone, or if the phone has been in use for more than a certain period of time? This is a pertinent question as there are the consumers who frequently buy new models when the old model is still in working order.

4.5.2 Opportunities

Quantities of mobile phones

There are several opportunities in setting up of collection schemes: From previous studies conducted in Kenya by Practical Action Aid and from the interviews with the consumers it is reasonable to conclude that there are reasonable quantities of obsolete phones in the country. The quantities are set to increase with the introduction of the third network provider and with the current shift and popularity of the wireless and mobile landlines introduced by Telkom Kenya. The introduction and availability of cheap mobile phones also plays in role in the quantities of obsolete phones. Thus the amounts of obsolete phones that can be channelled into the system exist.

No back yard recycling

It is an opportune time for manufacturer involvement as there are no problems of backyard recyclers as in the case of India, China and Nigeria. This provides for ease in tackling the problem now before it gets out of hand.

Existing infrastructure

Use of existing infrastructure for collection points, the network providers have well established care centres' spread in the country, a partnership with these care centres to act as collection points would aid the producer in reaching a wider population as opposed to the current system of using 3 or 2 care centres. This is limited to the collection points.

Competitive edge

Competitive edge over other manufacturers due to early start, looking at the situation at the moment in relation to the producers who are involved in the EoL management of their products, in the mobile telephony no producer has initiated such as scheme other than Nokia. If the competitive edge is well explored by the producer it could increase the producers image and the products desirability but with the consideration of the stakeholders views on the collection scheme.

Historic and orphaned products

No case of historic products and orphaned products, the unique nature of the mobile phones makes them desirable products for a collection schemes. There are no problems in relation to orphaned and historic products as the manufacturer is willing to collect their brand products and any other brands that enter the system. This is due to the fact that the products have similar material component and thus would not be a problem in recycling.

4.6 Problematic issues and solution analysis in Manufacturer involvement in End of Life management of e-waste

From the challenges and opportunities discuss above there are various problematic issues that need to be addressed if the manufacturer intends to set up an efficient and effective collection scheme.

Consumer willingness to participate and incentives

The first problem is the incentives' and consumer willingness the issue of consumer incentives has been raised as a major hindrance to take-back schemes in developing countries. This has been aggravated by the consumer's unwillingness to return their obsolete products for recycling or collection in formal schemes as they can get some incentive from the repair shops as it is the case in Kenya or sell them to the informal sector as it is the case in India. Figure 4-5 illustrates the generic flow of the EoL mobile phones from the end users to the repairers and the repairers' options. The end users have two options, option one they can opt to store the phone at home or send it to the repair shops. The repair shops intern have three options in handling the EoL phone, they can either repair, and refurbish the phone and sale it as a second hand phone, or cannibalize the materials in the phone and use them to repair other phones, and the unused parts are dumped as waste. The main challenge in dealing with the repair shops would be the intervention point by the producers. Should they intervene and collect the phones from the end of life users or intervene and collect from the repair shops.

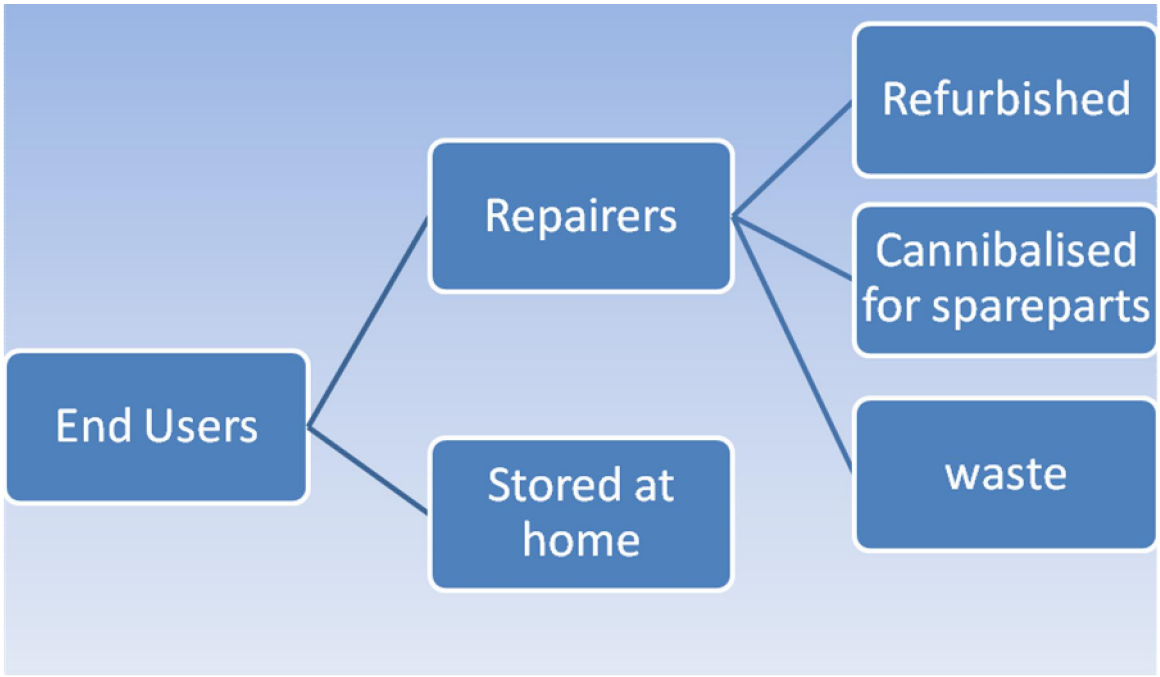

Figure 4-5 Generic flow of EoL mobile phone

The challenge above can be addressed by the producer from various angles, the producers may need to intervene before the products are sold to the repair shops that cannibalize the product and throw away the useless parts. The producers may intervene by introducing a competitive offer to the consumers who return their EoL WEEE, the offer has to be competitive so as to entice the consumers to return the products in the formal channel as opposed to the consumers selling the products to the repair shops. The second point of intervention would be the producers working with the repair shops this can be in the repair

shops being used as collection points; this option has its pros and cons. The repair shops are the main competitors for these EoL products and it would be an onerous task for the producers to get the products from the repair shop intact. This option then means that the producers would be collecting the waste and useless parts from the repair shops for finally disposal and thus the parts collected most probably cannot be of any use to the producer. The main question here is if this channel would be economically viable to the producers. The challenge then is how to integrate the repair shops into a collection scheme without compromising the schemes purpose. Still in line with the mobile e-waste generation by repair shops, it would be prudent to look at the repair shops as the main polluters and thus make them responsible for safe disposal of the useless e-waste generated after their activities? In such a scenario who is responsible for the environmental sound disposal of the EoL EEE the producers or the waste generators? The third intervention could be in the adaptation of Product service systems run by network providers; this would involve the manufacturers dealing with the network providers to sell the service and not the products as widely done within Europe. But will the network providers agree to take this responsibility?

Ignorance and lack of awareness

The second problematic issue is the ignorance and lack of awareness on e-waste and the existing collection scheme; the manufacturer's scheme has been operational for the last two years and the awareness level amongst the end users is very low. There is need for the manufacturer to take reach out to the end users and inform them on the existence of the collection scheme. The collection scheme can only work if the end users are aware. This involves the manufacturer setting aside resources to be used to create awareness on the scheme. The effort put by the manufacturer to advertise their products in the market is not commensurate with the effort put in to advertise the collection scheme. The end users of the mobile phones are spread across the country and it is of paramount importance that the information spreads out across so that the EoL phones can be sent to the appropriate collection points. On the other hand there is need for information on how to handle the EoL EEE as most people interviewed had no information on the materials and chemical content in the products. If this information was passed to the consumers and the, maybe it would play a great role in influencing the end of life decisions made by the consumers and the type of disposal mechanism chosen by the repair shops. If they are aware of the potential environmental pollution the products could cause if indiscriminately disposed off with MSW it could change the attitude towards the EoL management of WEEE. This therefore calls for the education of the members of public on the hazardous nature of the e-waste and the need for sound environmental management strategies. Agarwal (2003) points out that the ignorance on e-waste is reflected both on the government part and the public this therefore means that e-waste issues are not taken serious by the government and thus the lack of stringent measures as seen in the developed countries.

Lack of mandatory collection schemes

The third problem is the lack of mandatory collection schemes thus implies that the manufacturers are implementing the collection schemes on a voluntary basis and thus the schemes efficiency and effectiveness depends on the manufacturer's good will and determination and they cannot be held accountable for the dumped e-waste. This also means that not all manufacturers will collect and manage the EoL EEE, currently there are other mobile phone companies selling the phones in Kenya and not doing anything in line with the EoL management of their products this also applies to the network equipment and the base transmitter station equipment. Thus the system is open to all free riders. The lack of government involvement in the management of e-waste increases the countries risk of being a dumpsite for all the EoL EEE from areas where there is legal intervention.

Impact of second hand phones

The fourth problem on the producer's side is the impact of second hand goods on sales of new products. The second hand phones sold by the repair shop and refurbishers impact on the sales of new phones in that some of the buyers of the second hand phones could have purchased new phones. This reduces the amount of phones that could have been sold by the manufacturers if the second hand market was non-existent.

Impact on brand image

The repaired phones and refurbished phones on sell without manufacturer standards are mostly substandard and have a shorter lifespan. This phones when sold under the guise of new phones as done by many unscrupulous retailers, can have a negative impact on the brand image. Most of the obsolete phones, sold to repairers can be refurbished for sale, or reused for parts, while the unusable parts are thrown out as waste. The waste generated by the repair shops is dumped along side other MSW. In many cases the waste mostly contains the mobile faces some still bare the manufacturer's brand. The repair shops generate from approximately 1 kg of waste per month to 20 kg of waste per month. The pollution levels and environmental effects of small-scale enterprises like the repair shops could be insignificant at individual firm level but when the firms are put together they could have significant impacts on the environment (CCN, 2007).

4.7 Comparative analysis of the salient e-waste issues in Kenya and India

Kenya and India just like any other developing countries are grappling with the e-waste management, the comparative analysis of Kenya and India is done with the aim of providing information on how the two countries are handling the e-waste situation.

Table 4-3 Comparative analysis of selected e-waste issues in Kenya and India

Issue	Kenya	India
End of life options for consumers	The consumers have the option of selling the products to the repair shops or storing the products at home.	The consumers normally trade the functional high value obsolete items when they buy new products. products with no trade in value are sold to rag pickers or simply disposed off with MSW (Manomaivibool et al. 2007)
Incentives/ manufacturer take-back schemes	There are no incentives in the current system and this has been one of the major hurdles for the system take off	The take-back schemes have not been successful as the consumers prefer to sell the equipment to the scrap dealers. A few of the large customers use the take-back system (SDA 2008)
Competition for resource between formal schemes and informal schemes	The only formal scheme currently is run by Nokia, the scheme faces stiff competition form the repair shops who cannibalize the EoL phones for spare parts or repair and sale them. There is no authorised facility in Kenya that can handle E-waste	E-waste recycling in India is a market based activity that is carried out by small to medium sized enterprises in the informal sector (Widmer et al.. 2005, Streicher-Porte et al. 2005, Liu et al., 2006). The main challenge especially in the Indian case is the lack of formal recycling infrastructure; the (2008) report states that there are 4-5 formal recyclers. While a study conducted by Manomaivibool et al. (2007) states that there are only two authorized facilities to recycle WEEE. The formal plants face stiff competition from the informal recyclers due to the non compliance with environmental sound management regulations and standards, no related costs and tax payments yet the secondary market for products from the two recyclers have similar prices (Manomaivibool et al.,

		2007). This provides the informal recycler with an undue edge over the formal recyclers
Awareness	There is lack of awareness among consumers, waste collectors, scavengers and recyclers on the potential hazards of e-waste recycling and other disposal practices. On the backyard recycling and use of rudimentary methods the practice is not so wide spread in Kenya as compared to other developing countries such as India and China	The same applies to the Indian situation; this is compounded by the high number if informal backyard recyclers who use crude and rudimentary recycling methods. SDA (2008) states that there is lack of awareness both at the end user and at the manufacturing sector. The lack of awareness has resulted in Lack of awareness both at the user end and the manufacturing sector this has resulted ineffective e-waste management. The level of awareness on the e-waste concept and the producer take-back scheme is equally low on the private and corporate users end SDA (2008)
Consumer willingness to participate	The consumers' willingness to participate in e-waste management, especially in the take-back schemes is pegged on the incentives and the value they will get back from the product. A scheme without incentives is unlikely to succeed.	There is a well established informal trade back scheme in India, thus the consumers are more willing to participate in the informal scheme due to the value back. India just like any other developing country has value in the waste.
Illegal imports	High volumes of illegally imported waste, second hand goods or products for refurbishment and obsolete donations. The functionality of these goods is not tested, it is approximated that between 25-75% of all EEE imported cannot be used as it is obsolete (Osibanjo O. and Nnorom, I. C., 2007). This sums up the situation in Kenya.	This is the main source of the waste recycled by the informal sector, if this illegal imports did not exist then the number of informal recyclers would reduce drastically as they cannot be sustained by the domestic waste only (Manomaivibool P. et al., 2007).
Data Availability	There is no available data as yet on the e-waste generation per capita, nor is there data on closed loop recycling, on efficient material recovery and quality of material recovered in Kenya. So it is hard to quantify the material flows of e-waste the technologies and the financial flows. The lack of ready data on the types of EEE imported into the country and the quantities of e-waste would make it a difficult and gigantic task trying to compute an input output data on the EEE. The lack of data can also be attributed to the lack of comprehensive studies on EEE and WEEE.	The case in India may not be the same as in Kenya as there is scattered data on the EEE and e-waste as there have been various studies undertaken in the past in this field. In India the figures from various sources differ ranging from 146,000 tons two years ago to 330,000 tons in 2007 domestically generated and 50,000 tons imported (MAIT and GTZ 2007).
Transparency	There is high corruption and ineffective data collection and dissemination on material flow of EEE and WEEE. Corruption in Kenya is wide spread in all the sectors and it ranks 144th out of 158 countries. This has been a major setback in waste management in that the waste	

	sector is limited to a few wealthy individuals connected to the Local Authorities and they do not necessarily deliver and there is no follow up as they can bribe their way into the business (Transparency international 2007).	

4.8 Generic flow of other types of WEEE

The different types of e-waste have different flows. The major flow of the EoL cell phone from the end users can be summed up into two distinct channels. The end user can either store the phone at home for various reasons or they can sell the phone to the repair shops as depicted in Figure 4-3. The EoL management of computers has a different flow as compared to the mobile phone. The common feature in the two flows is the home storage, most consumers in Kenya are not part of the throw away culture (Denley 2008, 26th February, personal interview). They tend to store the EoL products at home. This is also evident within the government most of the EoL products used by the government are stored in the basement as there are stringent bureaucratic processes that are to be followed in disposal of government property. Figure 4-6 depicts the life cycle of a donated computer under the CFSK[10] programme. The major question is does CFSK take back the computers at their EoL? The generic movement of the computers outside the CFSK programme can be divided into private consumers and corporate consumers. The private consumers would store the computers at home, hand them down and sell the usable parts like the keyboard and mouse. There are a few cases of whole disposed of computers. The corporate consumers basically the government would store the computers in the stores or basements due to the bureaucracies attached to disposal of government property, non governmental agencies would donate the computers to schools and community groups or auction them to the employees, this has been done by the Kenya Ports Authority. Figure 4-7 depicts the generic movement of computers outside the CFSK programme.

[10] The more details on the CFSK programme are discussed in section 5.3.7

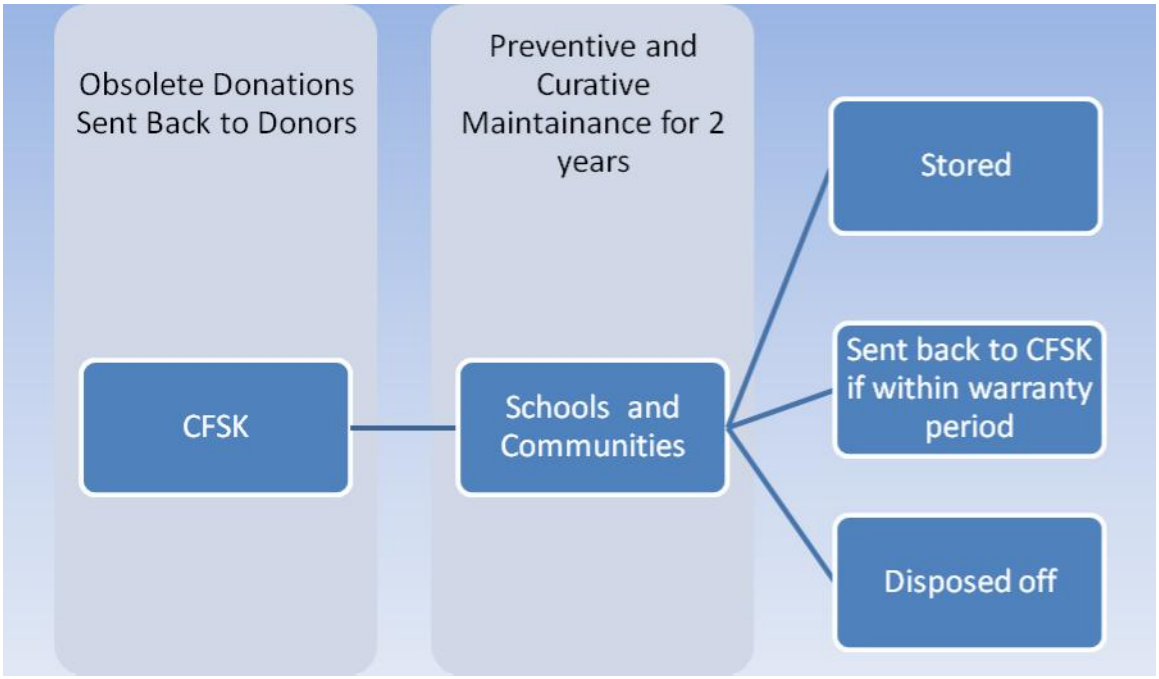

Figure 4-6 The flow of a computer from donation to EoL

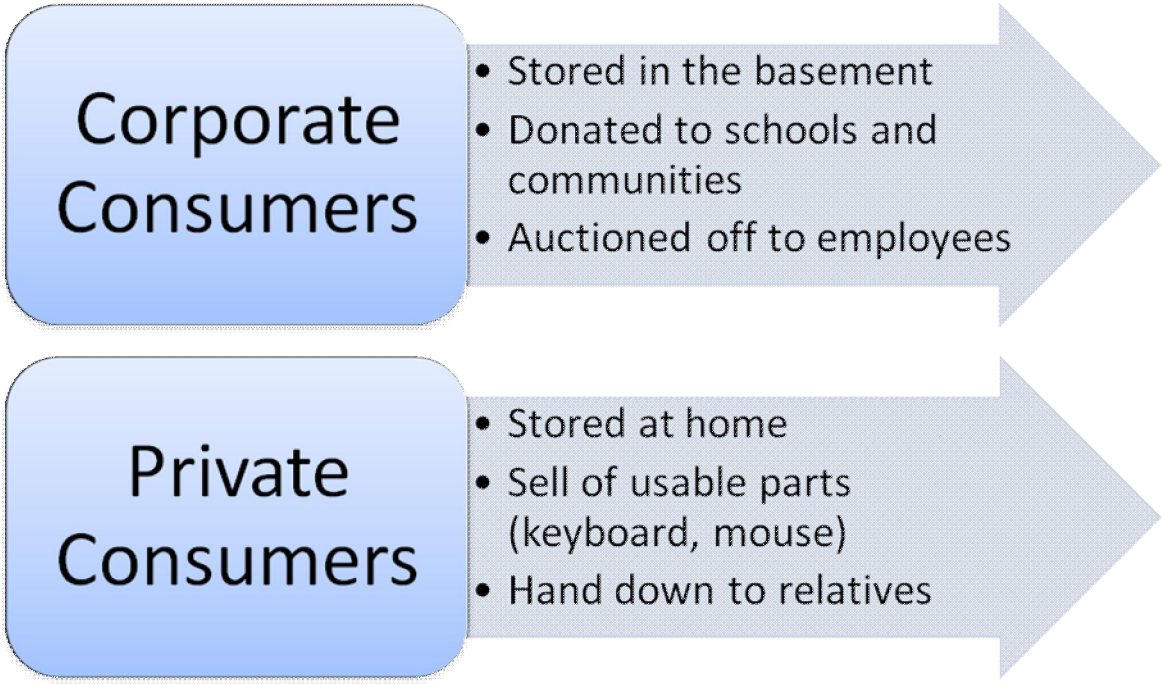

Figure 4-7 Generic movement of corporate and privately owned computers

The generic flow of the TV set from the end users is less complex and has fewer choices as compared to the mobile phone where the end user can sell it to the repairers, store if at home, hand it down or disposed it off. Though the study did not focus much on the TV sets there is general concern on the amount of e-waste that will be generated by the shift from the digital TVs to the analogue TV. This concern cuts across the domestic e-waste and the donations and imports that will be send to Kenya. Figure 4-8 provides the generic movement of the EoL Tv set, this is my view of the situation. The TV sets will be disposed of by the household into the dumpsite as there is no established recycling of TV sets, no repairer would be the TV as

they will be of no use to them, it's cheaper and economical to buy the new TVs from Asian then try to repair the old TV and finally the analogue TVs will not be able to work function well after Kenya adopts and implements the 2015 rule.

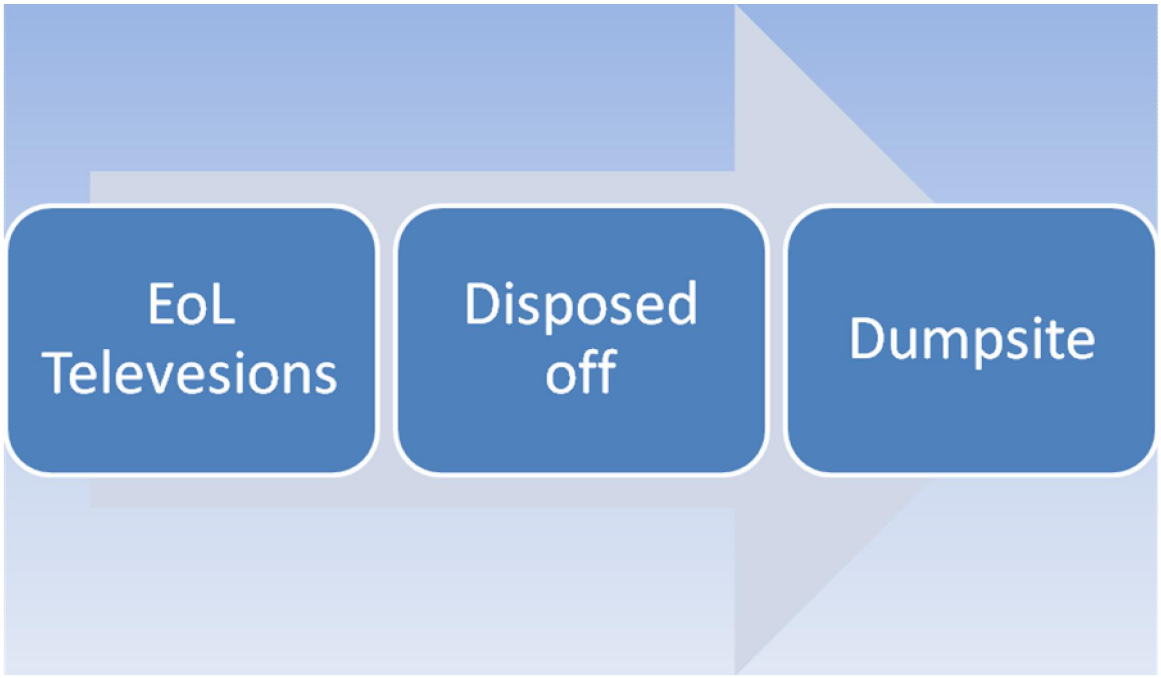

Figure 4-8 Generic flow of the EoL TV set from end users

5 Stakeholder analysis

In this section I will discuss the institutional mechanisms that interplay within the ICT sector from product inception into the market till the products end of life. In discussing and analysing the interplay I will discuss the various stakeholders in the ICT sector and identify the institutional gaps in e-waste management.

5.1 Definition of stakeholders

Stakeholders can be defined as individuals and groups that affect and/or are affected by an organization and its activities (Greenwood, 2001). Figure 5-1 depicts the major stakeholders in the ICT sector (mobile telephony) in Kenya.

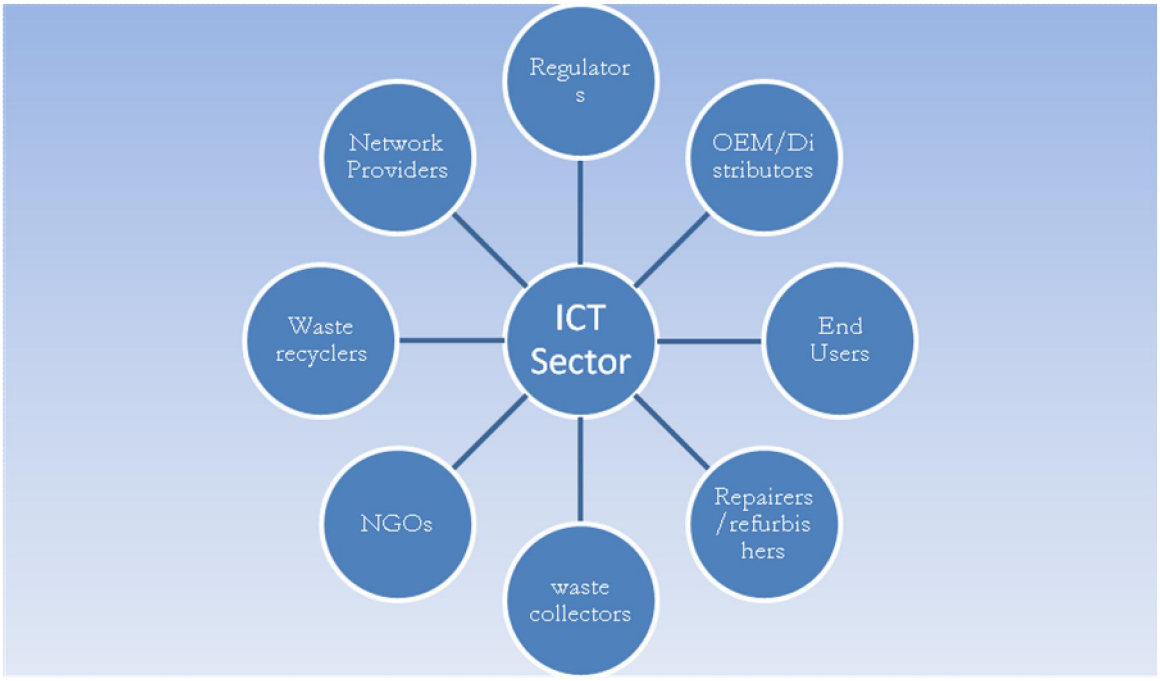

Figure 5-1Stakeholders in the ICT sector (Mobile telephony) in Kenya

5.2 Institutional mechanisms/Regulators

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. Figure 5-2 depicts the main regulator agencies in the ICT sector in Kenya. The regulator main roles in relation to e-products and e-waste entails:

1. Pre-export verification of products as conducted by the Kenya Bureau of Standards(KEBS)
2. Import verification at the point of entry conducted by Kenya Revenue Authority (KRA), Kenya Ports Authority (KPA),and KEBS
3. Type approval of telecommunication EEE is conducted by Communication Commission of Kenya in consultation with KEBS
4. Development of e-product standards is conducted by KEBS in consultation with the relevant government agencies
5. 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

6. The approval of environmental impact assessments (EIA) in line with the telecommunication transmission stations is the prerogative of the NEMA in conjunction with the relevant line ministries
7. Waste management i.e. collection, transportation and disposal falls under the Local Authorities docket

Figure 5-2 Main regulators of various components in the ICT sector

5.2.1 National Environment Management Authority (NEMA)

The National Environment Management Authority (NEMA) was established by the 1999 Environmental Management and Coordination Act (EMCA 1999), but was not functional until 2003. The Act sets out the normative and institutional framework for environmental management in Kenya. NEMA is mandated *to exercise general supervision and co-ordination over all matters relating to the environment and to be the principal instrument of Government in the implementation of all policies relating to the environment* (NEMA 2008).

Waste management in Kenya is under the auspices of the Local Authorities as mandated under the Local Government Act (CAP 265) and Public Health Act (CAP 242). These pieces of legislation make the local authorities responsible for the provision and management of municipal waste. The main shortcoming with these statutes is the fact that they are silent on sound environmental management of waste. However enactment of the Environmental Management and Coordination Act (EMCA 1999) provides a conduit to address the waste management scenario in Kenya as there are provisions on the manner in which waste should be handled. The provisions by EMCA regarding handling and disposal of wastes state that: *…no person shall discharge or dispose of any wastes in a manner that would cause pollution, to the environment or ill health to any person; no person shall transport wastes except to a licensed wastes disposal site established and in accordance with a valid license issued under the Act* (EMCA 1999).

This Act mandates the National Environmental Management Authority (NEMA) to develop regulation on waste management including hazardous waste management. In line with the mandate 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 2006 are not explicit on 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 regulation's requirements on waste handling as they state that the regulation does not cover e-waste. In response to this loophole and on the status of e-waste in the country Malwa stated that there is e-waste in the country and the NEMA would soon develop a strategy on e-waste management that will include guidelines to be anchored in the waste management regulations 2006 (Malwa, 2008 26th March, personal interview). Malwa added that the law could be amended to incorporate EPR. The stakeholders also voiced the lack of explicit mention of e-waste or e-waste was a gap in the regulation and added that the average Kenyan reading the regulation would not link hazardous waste to EEE and especially to the ICT goods. In discussion with Mwai of NEMA it emerged that there was a proposed project between NEMA and the United States International University, the project would address the different e-waste categories and the management cycle (Mwai, 2008 7th April, personal interview). Mwai pointed out that the main issues with e-waste management in Kenya are the awareness, the amount of secondary e-waste imported into the country and lack of waste segregation. On the mobile phone the main problem was the disposal of the batteries. The second hand and refurbished phones often have batteries with a shortly life span, these batteries are dumped alongside other MSW due to lack of awareness on the contents and the danger they pose to the environement. The NEMA field officers stipulate that there is a need for well organized collection collection points with protection against theft and suggested that the existing scheme could use NEMA field offices as collection points (Inganga, 2008, 3rd March, personal interview).

5.2.2 Communication Commission of Kenya (CCK)

Communication Commission of Kenya (CCK) was established in February 1999 by the Kenya Communications Act of 1998. 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 interconnection system could be by wire, radio and optical or other electromagnetic system (Haji 2008, 13th March, personal interview). 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, the CCK has to some extent control on the mobile phone industry under its licensing regimes and regulations (Haji, 2008, 13th March, personal interview). KEBS complements CCK's role in type-approval in terms of quality of the equipment. The mobile phones are inspected by the CCK and the KEBS based on standards developed by KEBS (Wepukhulu 2008, 31st March, personal interview).

5.2.3 Kenya Bureau of Standards (KEBS)

The Kenya Bureau of Standards (KEBS) was established in July 1974 by an act of Parliament to act as a trade facilitator. 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 good 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 inspections are carried out at the country of export by appointed contractors to minimize the risk of unsafe and substandard goods entering the Kenyan market and to protect Kenyans' health, safety and environment (Wepukhulu 2008, 31st March, personal interview). The PVOC programme covers most of the high risk goods including electronic goods which require a certificate of conformity before being accepted into Kenya, the inspections are based on Kenyan standards, and where Kenyan standards are not sufficient or there are no standards they can be based on equivalent international standards or manufacturer/ company standards (Onjore 2008, 31st March, personal interview). At the Kenya port of entry the KEBS conducts visual inspections to ascertain that the products are labelled and have user instructions, they have the necessary trademarks and expected markings and have a user manual (Wepukhulu 2008, 31st March, personal interview). After the visual inspection the documentary inspection is conducted to ascertain if the product is certified, and has a certificate of analysis. In some instances test reports are requested for as provide more information on the specification the product was tested against (Wepukhulu 2008, 31st March, personal interview). With the influx of second hand electronic equipment and refurbished equipment the PVOC comes in to ensure that the products entering the Kenyan market are not waste or EoL products. The PVOC team has rejected some EEE, including mobile phones which were old and refurbished. But it is an onerous task regulating the ICT products, especially mobile phones, as they can be brought into the country undetected in some ports of entry. Most communication equipment is high value goods and they are flown into the country as opposed to importation via the Mombasa port.

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 life left should not be allowed into the country. Donations are a new conduit through which e-waste is dumped into the country; donations in good-will do not necessarily have to be forty old computer two new computers are a better and worthy donation (Wepukhulu 2008, 31st March, personal interview). The communities that receive these donations view the KEBS as an obstacle in bridging the digital divide. The main concern at the moment is the new wave of televisions that may enter the country as the developed countries move from the analogue televisions to the digital televisions. Therefore there is need for the ministry of information to gazette a notice prohibiting importation of this analogue sets as they will increase the amount of e-waste in the country (Wepukhulu 2008, 31st March, personal interview).

5.2.4 Kenya Revenue Authority (KRA)

Kenya Revenue Authority (KRA) was established in 1995 by an act of Parliament with the sole mandate of collecting revenue on behalf of the Government of Kenya. The role of KRA of interest to the research is the custom services and KRA's role as the watch dog function for

the Government agencies by controlling exit and entry points to the country to ensure that prohibited and illegal goods do not pass through Kenyan borders. Hazardous wastes and their disposal as provided for under the Basel Convention are listed as part of the restricted goods that are controlled by the customs services department of KRA (KRA 2008). Over and above the fiscal responsibilities of the custom services department, KRA is also responsible for the facilitation of legitimate trade and protection of society from illegal entry and exit of prohibited goods. The KRA has complemented well the work of KEBS in for instance the implementation of the motor vehicles rule under the Kenyan quality standard KS 15:15:2000 that prohibits the importation of vehicles older than 8 years. This requirement is enforced by the KRA's customs department (Wepukhulu 2008, 31st March, personal interview, KRA 2008). Computers and computers parts are not charged any duty and any media containing computer software is exempted from import duty too (The East African Community Customs Management Act, 2004).

5.2.5 Kenya National Cleaner Production Centre (KNCPC)

The Kenya National Cleaner Production Centre (KNCPC) was established in July 2000 through the Kenya Industrial Research and Development Institute (KIRDI), the United Nations Development Programme (UNDP) and the Government of Kenya. The centre's core function is to build national capacity to implement Cleaner Production (pollution prevention) programmes in industry and businesses (KNCPC 2008). The centre has been instrumental in coordinating waste minimisation and resource efficiency projects through continuous awareness and training activities, demonstration projects and policy dialogues (Nyakang'o 2006). KNCPC has been involved in various waste management initiatives in the country. The two notable ones include the plastic waste management project that lead to the ban on flimsy plastic bags and the on-going Nairobi River Basin Programme; "Less Waste Initiative" (Mungai Olive and Rotich Nicholas 2008, 28th February Personal interview).

5.2.6 Local Authorities

The local authority's environment department is charged with the following chores: solid waste management, beautification of the cities, enforcement and implementation of deterrent laws [amongst others]. The research looked at three of the Local Authorities' which are Nairobi City Council, Mombasa Municipal Council and Kisumu Municipal Council with the aim of understanding their role in waste management in Kenya. The Local Authorities are mandated to offer waste services (Otieno 2008, 3rd March Personal interview). Regarding waste management the mandates of the Local Authorities' include proper waste storage, collection, transportation, safe treatment and disposal of the MSW waste other than the above services the Local Authorities are responsible for

- Regulating and monitoring waste generators
- Regulating and monitoring private companies which participate in solid waste management
- Formulating and enforcing relevant laws and regulations
- Formulation and implementation of MSW polices

(Nairobi City Council 2008)

Currently the Local Authorities have not invested in the management of waste and most waste management activities are carried out in an ad hoc manner, which can be attributed to the lack of resources and capacity. There is sufficient legislation covering waste management; the problem is the capacity to implement the legislation. Rotich et al (2005) points out that most of the local authorities are financially constrained in offering efficient services in MSW management though they are willing to adopt new ideas that will improve MSW management.

5.2.7 Kenya Ports Authority (KPA)

Kenya Ports Authority (KPA) was established in 1978 through an act of Parliament as a statutory body under the Ministry of Transport (KPA 2008). Then KPA covers the following ports: Kilindini, Malindi, Mtwapa, Kilifi, Kiunga, Shimoni, Funzu and Vanga all along the Indian Ocean. Kilindini habour in Mombasa is the only fully equipped port. It is the second biggest port in the region after Durban in terms if tonnage and containers handled (KPA 2008). It has 17 shipping lines and is directly connected to 80 ports worldwide. The Mombasa port (Kilindini habour) serves the hinterland markets of Kenya, Uganda, Rwanda, Burundi, Eastern Democratic Republic of Congo, Northern Tanzania, Southern Sudan and Ethiopia. It handles 14 million tons of cargo annually (KPA 2008). The interest in KPA lies in its role in the verification of imports with special reference to the EEE imports. The data on the total imports is computerized but there is no specific data on the number of EEE that enter the country: the only data that can be retrieved would be on the number of containers received at the port (Hassan2008, 19th March, personal interview). The EoL computers for the KPA were sold to the members of staff at low prices so as to motivate the employees to buy the computers in an auction that was based on first come first served (Hassan 2008, 19th March Personal interview). The KPA transferred the computers from their custody into individual employees hands the concern here is what will happen to this computers when they reach the EoL?

5.3 Pertinent stakeholders

Other than the regulators there are other stakeholders who are directly or indirectly affected and affect the ICT sector in Kenya.

Figure 5-3 provides an overview of the stakeholders in relation to the e-waste management chain starting from the market entry points to the final disposal. The stakeholders in the figure are not the comprehensive list.

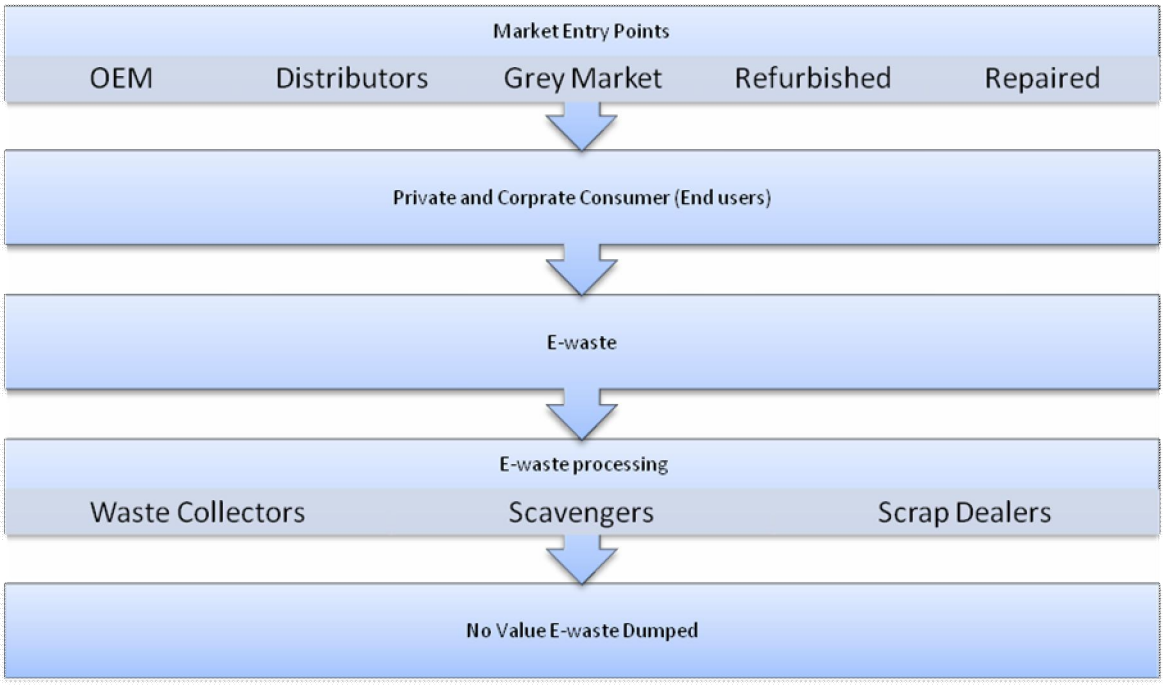

Figure 5-3Simplified diagram of e-waste process and pertinent stakeholders in Kenya

5.3.1 Consumers/ end users

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 in 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 ongoing take-back scheme[11] initiated by Nokia is very low. Out of the approximately 200 consumers interviewed only 30 were aware of the take-back or recently heard something about it in the news and did not know the details of how the scheme would operate. Most of the consumers interviewed stored the phones at home (53%) for a variety of reasons ranging from sentimental attachment to the phone, or they just didn't think about the EoL phones. Some consumers handed the phones down to their relations (3%) or sold them to the repair shops (31%). 11% disposed off their phones alongside the MSW only 1% were willing to take the EoL phone back to the collection point. Figure 5-4 depicts the consumer preferences pointed out above. 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. Most of the consumers interviewed were willing to participate in the scheme if there were incentives given when they returned the EoL phones. The willingness to participate was pegged on incentives from the producers. The affluent and middle class consumers were willing to participate if they were assured that the scheme was transparent and that the EoL phones would be recycled and not refurbished and resold. The issue of accessibility of the collection point was raised by several interviewees, currently there is only one established collection point that is running. The other points are still being set up.

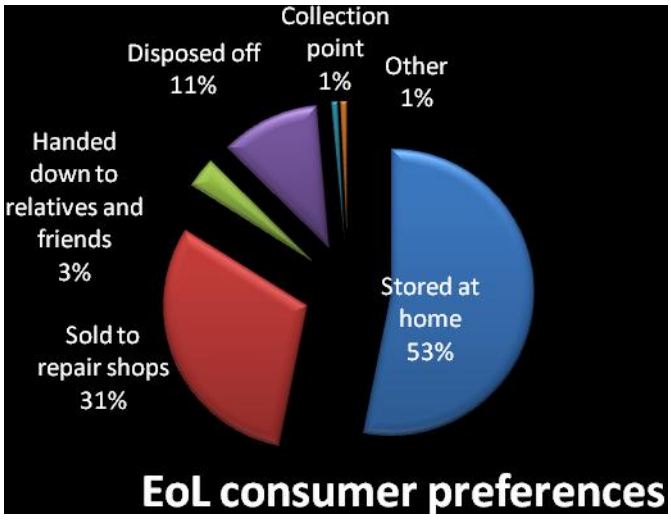

Figure 5-4 Consumer preferences on EoL management of mobile phones in Kenya

[11] More information on the take-back is provided in part 4 Managing End-of-Life electronics

5.3.2 Manufacturers, Distributors and Retailers

Most EEE sold or found in 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 in 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.

> *The need for collection systems and producer's responsibility to create, or participate in them, is especially acute in developing countries where legislation and infrastructure for collection is likely lacking. Producers are encouraged to share the physical and/or financial obligations for such collection and management for used mobile phones as part of EPR systems (MPPI collection guide 2006)*

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 as depicted in Figure 5-5. In the case of mobile phones and accessorises there are approximately 7000 informal retail outlets spread out in the country (Berry and Knowles, 2007). 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).

Figure 5-5Mobile phone (retailer) shops

A cross section of the retailers interviewed pointed out that they were willing to collaborate with the manufacturer in the collection of EoL phones under a scheme like the current

scheme on appointed Nokia agents. With special desks designated to the collection scheme. But just like the consumers they retailers stated that if the manufacturer could provide incentive to the participating retailers the scheme would be a success. The retailers in Kenya just like the retailers in India as pointed out by Manomaivibool *et al*. (2007) determine the discount rates on the new products and also the discount rates on the trade in products, though some retailers interviewed claimed that they did not deal in trade-in phones. The retailers in downtown Nairobi did admit to trading in of phones that still had a resale value and taking in phones that the owners deemed as obsolete and sold them to the repairers who in most cases are also based in the same premise as the retailers.

5.3.3 Network providers

Currently there are two network providers in Kenya; Safaricom and Celtel[12]. Between them they have 700 authorized dealer shops that sell various handsets from the manufacturers (Berry and Knowles, 2007). The international Data Corporation (2008) articulates that the Kenyan market has a capacity of 15 million subscribers from the country's 35 million people. Currently the subscriber base stands at slightly over 10 million subscribers with Safaricoms' customer base at 8.2 million (Safaricom 2007) and Celtels' at 1.9 million (MTC 2007). The communication sector reforms have paved way for new network providers; Econet and Orange (E. A. STD 2008). Safaricom provides a host of products and services for telephony these include GPRS, 3G, EDGE, data and fax (Safaricom 2008). Safaricom declared a pre-tax profit of Ksh. 17 billion (175 million Euros) in March 2007 (Safaricom 2008). Celtel Kenya's revenues reached a record US $ 175 million (MTC 2006).

The network providers do sell mobile phones in their dealership shops, for instance Safaricom has retails centres that provide the customers with quality products backed with reliable warranty. Celtel shops sell phones, SIM cards, airtime top-up cards and accessories. The network providers work closely with the GSM network suppliers such as Nokia Siemens, Alcatel and Ericsson. Recently the network providers launched the blackberry phones into the Kenyan market in partnership with various enterprises (Safaricom and Celtel 2008). This raises the question of the network providers being responsible for the products sold in the market or introduced in the market through the partnerships and dealerships.

Previously (2 years ago) Safaricom had initiated a mobile collection scheme through the dealers but the scheme did not attract much attention and it was discontinued (Inform 2007). Most of the consumers interviewed were not aware of the existence of such a scheme. The schemes failure can be attributed to the lack of publicity. While collecting data in Kenya the network providers did not respond to the questionnaires sent to them, despite the fact that during the telephone interviews and personal visits they requested to be sent for the questionnaire as they needed to consult before participating in the research.

5.3.4 Repair and refurbishment

The repair and refurbishment of phones is conducted within the informal sector with few or no controls and standards. The repairers and refurbishers pose the major challenge to any take-back scheme. The main activities in most of the repair shops are to restore, repair, upgrade, disassembly, and material recovery of spoilt phones/non functioning phones along side this activities the repair shops also conduct a host of other activities such as: sale of new and old phones, sale of air-time, sale of accessories, charging of phones, Printing services, graphics design and also repair of computers. Reuse and repair activities are very popular Kenya as opposed to recycling (Denley 2008, 26th February, personal interview). They are a

[12] Part of the Zain gruop and operates in 15 African countres (celtel 2008)

challenge to the collection scheme in that the repair shops do buy EoL phones from the end users, refurbish and resale them. The price is differentiated on the phone model and the cost of the phone. Such a transaction would entail the purchase of an old phone for approximately 2 to 15 Euros and then upgrade the phone and resale it at 10 to 25 Euros. There is a ready market for these phones due to their availability and price. Most of the repair shops interviewed would not participate in a take-back scheme as they get their spare parts from the EoL phones thus such a scheme would greatly affect the availability of spare parts. A good number of the repair shops host on average 3 phone repairers each with his/her cliental and share the repair machines.

5.3.5 Care centres

Nokia aims at establishing care centres in Kenya to deal with software upgrade and repairs and act as collection points for the end of life phones. So far there is only one care centre, Authentic ltd that has been set up and is operational. This care centre covers Nairobi and its environs. The other care centres will be established in the major cities. The Kisumu care centre to be operated by Beamans communication is in the process of being set up. Authentic ltd will also establish the Mombasa care centre to serve the wider coastal region while Beamans will cover the wider North rift region. (Patlingaro 2008, 10th March, and Otiende 2008, 5th March, personal interviews). The Nairobi care centre repairs approximately 50 phones per day while the repair shops in Nairobi repair approximately 5-100 phones in a day. Majority of these repairs are on software. The care centres' are to set up collection points throughout the entire country, they are run by independent business and benefit from Nokia through free software and are expected to purchase the spares directly from Nokia (Patlingaro 2008, 10th March Personal interview, Otiende 2008, 5th March Personal interview). The EoL phone collection will be problematic if the consumers demand for incentives and price cuts on new phones (Otiende 2008, 5th March, personal interview).

5.3.6 Scavengers/ waste recyclers

Majority of the stakeholders in this category can be classified under unorganized/informal sector (UNEP 2007). Scavengers play an important role on the economic survival of the existing waste management structure. The waste recyclers and scavengers operate at different levels; this involves door to door collection, sorting waste in communal bins and waste sorting at the dumpsites all this is done with the aim of collecting recyclables for sale. At the dumpsites there are gang-like cartels and scavengers who recover recyclables for their livelihood and at times make the dumpsite inaccessible. John Otieno, one of the waste recyclers at Kachok dumpsites in Kisumu, stated that there were incidences of e-waste being dumped at the site by the repair shops but not on a regular basis. He stated that the most common e-waste dumped at the site were old mobile phones(Sony Ericsson, Siemens, Sagem and Motorola), the mobile cases(mostly Nokia) but not the integrated circuit boards, table top cookers, refrigerators and old televisions. The waste recyclers/scavengers break down the e-waste for the metallic parts especially copper and aluminium. The plastic casing from the mobile phones has neither resale nor recyclable value to the scavengers (Otieno 2008, 4th March, personal interview). Once the scavengers finish sorting out the recyclables from the non recyclables from the dumpsite they set the remaining waste on fire as a waste management strategy (Orinda 2008, 4th March, personal interview). A study conducted by JICA (1997) discovered that the scavengers recovered more than 30 different types of materials at the Dandora dumpsite in Nairobi with the major materials being ferrous metals (aluminium and copper) the same scenario is realizable in the other major cities and towns as explained by the Kachok dumpsite scavengers. The recovered products are sold to the scrap dealers who decide which items ought to be dismantled for parts and which items are resold,

the decision is based on the resale value of the second hand products. Some items are dismantled by the scavengers before being sold to the scrap dealers. There is ready market for the recovered materials the middle men are the main link between the scavengers and the industries. The challenges the scavengers face include exploitation by the middle. Price fixation by the industries; the prices of the recovered materials are controlled by the industries thus the scavengers have no choice but to sell the recovered materials at the prices set by the industries. No local authority has specific policies that address the plight of the scavengers this can be attributed to the lack of research conducted on the role and activities involved in scavenging (Rotich et al 2005).

The main concern voiced by the scavengers and the community groups in relation to an organized waste management system or policy involving producer responsibility would be a loss in their livelihoods as some of the scavengers have been operating in the dumpsite over six years. Most of the recyclers and scavengers have little knowledge about the chemicals contained in the products they dismantle this poses a grave danger to their health and the environment in which they dispose of the rejects. The scavengers and scrap dealers focus on the economic value of the goods and have no regard to the environment.

Figure 5-6 Scavengers at work in Kachok dumpsite

5.3.7 NGOs

Computer for schools Kenya (CFSK) was registered in October 2002 as a charitable non-governmental organization. It is the first African initiative adopted from the award winning computers for schools Canada (CFSK 2008). CFSK aims to build ICT infrastructure in the country and in the region in resource poor and marginalized groups, schools and community access centres that can not afford new ICT equipment (Okono 2008, 7th April Personal interview). CSFK sources for computers overseas mainly from Great Britain. The computers have to meet certain specifications (10GB hard disk, Pentium 3, 128 RAM) and they also have to be functional. These specifications meet the intended group's needs (Okono 2008, 7th April, personal interview). CFSK works with various certified computer groups in the UK,

Netherlands amongst others. The donated computers are received cleaned, refurbished, installed with software and then sent to learning institutions that meet CFSK's standards (appropriate laboratories, competent trainers, trained head of institution, approved by oversight board e.g. the schools board of governors and certified copy of the minutes approving the computers). The schools or recipient institutions pay Ksh 10000 (100 Euros) per computer and this has to be for a minimum of 20 computers (Okono 2008, 7th April, personal interview). The sum covers a comprehensive maintenance and support for two years, two automatic visits annually, curative services (anti-virus installation, software upgrade), replacement of the unit should it become obsolete in the 2 year period. The provision of expertise and spare parts are covered in the sum too (2008, 7th April, personal interview). The decommissioned computers are dismantled and used for technical support, the plastic parts and metal parts are collected and sent for recycling, and the PCBs are accumulated for safe disposal which may entail exportation. The CRTs are converted into television for sale and those that are obsolete are accumulated for export (2008, 7th April, personal interview). CFSK has rejected computers that are obsolete and faulty computers are also sent back to the donors (2008, 7th April, personal interview). CFSK has been handling e-waste for several years, though it has been limited to ICT good such as printers, scanners and facsimile machines. The envisioned E-management programme that is underway based on the experience in recovery, dismantling, sorting, categorizing and shipping of the e-waste intends to cover other types of e-waste especially the mobile phone waste. The e-waste handling facility needs to be upgraded to handle mobile phone waste (Muteti 2008, 2nd April, personal interview). The refurbishing section of the CFSK tests the computers if they are functioning, load the relevant software and standardize the machines. The demand for these refurbished computers in Kenya is higher than the supply and now the local organizations are being encouraged to donate the old computers to CFSK (Kahotha 2008, 7th April, personal interview). The main challenge facing CFSK in the EoL management of the obsolete computers is the lack of market for the electronic boards and the hard plastic (Kahotha 2008, 7th April, personal interview).

Practical Action Eastern Africa is an international development agency that works with the poor communities by helping them choose and use technology to improve their livelihoods. ICT is one of the sectors that practical action aid consulting work have been conducted (PAEA 2008). Practical Action conducted a pilot study on mobile waste within Nairobi and its surroundings in late 2007. The broad objective of the study was

> *…. to collect and categorize the mobile phone wastes, establish collection, sorting and weighing points for mobile phone wastes and test various collection mechanisms and the willingness of the repairers to engage in the collection and to chart the way forward in management of e-waste (PAK 2008)*

The survey collected mobile phone waste from 65 repair premises within Nairobi and its surroundings in the 3 month period a total of 350.5 kilograms of mobile phone waste were collected (Muteti 2008, 2nd April Personal interview). Nairobi alone hosts more than 2000 repair shops, in a period of three months these repair shops can generate up to 1.1 tons of mobile phones waste. If this is extrapolated to one year period it means that 2,000 shops can generate up to 40 tons of waste (PAC, 2007). The study concluded that there was need for public awareness on the e-waste problem, and that there was urgent need for a policy process that will prepare e-waste regulations. In line with the findings the study proposed the need to improve the skills and technologies used by the various actors in the e-waste chain, the need for producers' involvement in the management of e-waste, and the need of economic instruments in e-waste management (PAC 2007).

5.4 Analysis on stakeholders

The analysis of the stakeholders will be guided by the Environment Sound Management[13] (ESM) of e-waste-based on the Basel Convention (2008). The analysis will cover the functions in proper e-waste management, the functions of the regulators in practise and in theory and point out the gaps in the current e-waste management and discuss the way forward in e-waste management.

What functions should be covered for proper handling of e-waste

Functions to be covered in proper handling of e-waste (Environment Sound Management (ESM) of e-waste) Based on the integrated life cycle approach the functions to be covered in proper handling of e-waste include: collection, storage, transportation, segregation, reuse, recycling, recovery, treatment and disposal. Currently in Kenya there is no coordinated e-waste management system other than the take-back scheme being implemented by Nokia, thus each stakeholder is at liberty to take care of his or her own interests without having a holistic view of the e-waste management system. Waste collection is the prerogative of the local authorities, but at the moment the waste collection services have been privatized. There is neither waste separation nor segregation at the household level, all the waste stream are mixed together. The reuse, recycling and recovery of waste is done by the waste scavengers at the final disposal site or by community youth groups in various places. E-waste is not treated any differently from the MSW thus there is need to connect all the stakeholders already playing the various roles in the e-waste chain ranging from recycling to reusing of the e-waste.

What functions do existing authorities cover in theory and practice?

The existing authorities cover various functions in theory and in practice relating to the various stages in the e-product's life cycle. The regulation and enforcement of import related regulations are primarily covered by the KRA, KEBS and KPA. The end of life management of the e-products or the waste is covered by the NEMA and the local authorities. The CCK is the main regular of the ICT sector. The institutional capacity in Kenya to handle e-waste is enormous, the regulators and actors play different roles in regulating various facets of the ICT sector and in a wider scope the e-waste management. The regulators mandates in waste management can be synergized so as to complement each other. The main ICT regulator (CCK) can incorporate EoL waste management requirements in the licences with the help of the other regulators and stakeholders. This calls for a multi-sector approach and a multi-stakeholder involvement in the management of e-waste. The different regulators and stakeholders could develop a comprehensive regulation that could be used throughout the life cycle of electronics starting from the point of entry into the country till the EoL of the product. The concerned stakeholders should adopt life cycle thinking in the management of e-waste (Haji 2008, 13th March, personal interview). The need for more national programmes that are cross-sectoral currently KPA, KRA, NEMA, port police and KEBS have a committee that determines if the imports into the country are fit for human consumption. The committee also decides on the mode of destroying the rejected cargo. The process is also followed for counterfeit goods. So far no EEE has been rejected but various EEE accessories that are counterfeit have been rejected (Hassan 2008, 19th March, personal interview) such cross-sectoral initiatives in management provide a holistic approach to the management of imports and should be encouraged and strengthened and replicated in management of e-waste.

Gaps in the current system of e-waste management in Kenya

[13] Under the Basel Convention ESM means *taking all practicable steps to ensure that hazardous wastes or other wastes are managed in a manner that will protect human health and the environment against the adverse effects which may result from such wastes.*

Despite the existing institutional capacity there are inadequate regulatory and enforcement mechanisms that ensure compliance with the relevant regulations dealing with the various facets of E-products to e-waste. The standards in place used to reject EEE are based on health and safety and no consideration of the environment (Anonymous 2008, 19th March personal interview). Thus most of the EEE that are imported into the country could have negative effect on the environment if not disposed of in an environmental safe manner. This calls for the urgent need of a regulation on e-waste. The different regulators interviewed, stipulated that the regulation should have already been place and that it was the responsibility of NEMA to spearhead this process Haji (2008, 13th March, personal interview, (Wepukhulu 2008, 31st March, personal interview). The regulation should cover the safe disposal and destruction of rejected EEE (Hassan 2008, 19th March, personal interview). In line with the safe disposal of e-waste, there is need to develop guidelines that will guide the corporate consumers, the private consumers and the government bodies on the best way to address the EoL e-waste stored in the basements and government stores, the guideline could be discussed with the producers on the best alternative for the EoL management, in my view such a move could help initiative the shift from products to product services as adopted by some companies in Europe.

The fact that there are no recycling policies in the country has necessitated the participation of the industries in encouraging the end users to return certain used products like glass bottles. Previously in the country industries have encouraged setting up of recycling schemes with deposit refund system to improve environmental conditions while also generating income to the poor. The beverage industry in Kenya has applied the deposit refund system which has been popular in the whole country because of its ease of administration which is all inclusive and works in collaboration with the wholesalers, retailers and consumers. The consumers pay a deposit for reusable glass bottles, the deposit ranges from Ksh. 10 for soft drinks bottle and Ksh 25 for beer bottles (Rotich *et al.* 2005). E-waste take back schemes that involve the community groups and provide incentives for participation will attract higher returns than the current system which has no incentives. The recycling trend in the country is changing albeit slowly as there are no incentives that encourage recycling or setting up of take-back schemes that can promote recycling.

Presently there are neither authorized facilities nor adequate technological knowledge in EoL management of e-waste. There is need for the existing facilities (if there are any) that meet the criteria set in the waste management regulation 2006 to seek relevant authorization to handle e-waste. Setting up of e-waste processing facilities will provide more job opportunities to the existing waste pickers and other stakeholders and open up an avenue for environmental sound waste management.

The existence and EoL management of e-waste in the country is a grey area that needs to be addressed. There is need to conduct a nation-wide study on the status of e-waste to determine the extent of the problem, if indeed there is a problem. The study will provide the relevant data need to make sound policies on e-waste. This should be looked at in line with the EEE imports into the country. From the discussion with the various stakeholders it is apparent that there is e-waste in the country but this view differ amongst the stakeholders as there are those who view e-waste as a problem and those who do not view e-waste as a problem. At this point in time the volumes may not be alarming. The small electrical appliances especially cell phones, toasters and electric kettles are easily disposed of with the normal MSW.

There are various small enterprises' such as repair shops that are handling second hand e-waste and e-products. The lack of authorized facilities has serious implications on the

monitoring of the hazardous activities of these facilities. In line with the recommendation on status of e-waste in the country there is also need to conduct a survey to identify the e-waste handlers in the country. This includes the repair premises of all EEE products. This survey will help in determining the appropriate actions to be taken such as closure of facilities and premises that pose a danger to the environment and human health.

A point of concern at the moment is the capability, awareness and training of the people involved in the management of e-waste. Most of the e-waste activities have not yet been regulated thus making it impossible to know the e-waste handlers and there level of awareness on the hazardous nature of e-waste. While conducting the interviews and focus group discussions it was very clear that the waste handlers, the scavengers and the repairers were not aware of the contents in the EEE that they were handling. Most was handled without appropriate protection in dismantling as they were not informed on the potential hazardous material in the EEE. The lack of awareness applies to the consumers too; most of the consumer interviewed had no information on how to dispose of their EoL EEE, thus necessitating creation of awareness on e-waste management and safe disposal channels.

The other challenge is the involvement of all the stakeholders in the collection scheme as some of the stakeholders like the network providers were not willing to participate and be tied down to such a scheme. In an efficient and effective take-back scheme there is need for well-defined roles for all the stakeholders including the retailers. In the current scheme initiated by Nokia, the role of the retailers does not feature prominently and the scheme does not cover waste from the repair premises and the refurbishers. The challenge of working with the repairers is based on the fact that majority operate in the backstreets and are not regulated and the perception amongst consumers and regulators that the repair shops encourage phone theft. Integration of the repairers in a formal collection scheme would entail formalization of their activities, provision of training and formation of repair cooperatives that would govern the repair activities. In the discussion with the repairers on the need to formalize the repair activities for sustainability and improved waste management, the repairers stated that sustainability in the sector was threatened by the introduction of cheap phones that has made the consumers opt to purchase new phones as opposed to the repaired one or talking the faulty phones for repair. The introduction of the cheap phones into the market may be the demise of the repair activities. There is need to expand more on the complimentary role of producers in the whole scheme. These calls for a regulated take back scheme stipulating the roles of all the stakeholders so that there are no free riders. The end of life responsibilities must be well assigned in the development of waste policies, if it is aimed at reduction of post consumer waste. The policies should address all the possibilities and alternatives in waste reduction from source reduction, recycling, material substitution to the final disposal (Sachs 2006, Walls 2006).

The role of the network provider and the dealership shops need to be well articulated in any e-waste programme. In my view the collection schemes can be successful if initiated as a joint venture between the network providers and the manufacturers; the network providers have an existing relationship with the GSM network suppliers who in this case are also the mobile phone manufacturers or the technical arm of the manufacturers thus a joint venture in the collection of EoL mobile phones can be established. The joint venture can also collect the EoL base transmitter station equipment. The network providers' dealership shops do provide a great avenue for use of existing infrastructure by the manufacturers in the collection of the mobile phones. The dealerships also offer an avenue to provide incentives. The joint ventures need more research on the technicalities of their operation and how the responsibilities will be shared out and who has the final responsibility of recycling the EoL phones.

The computer for schools Kenya initiative has had its fair share of criticism. On one hand it's viewed as a schemes that favours donations from the developed world yet donations have been a great source of e-waste in the developing countries and also encouraging trade in hazardous waste while on the other hand the initiative is viewed as a great way of bridging the digital divide and providing ICT equipment to the resource poor communities. The economically motivated trade in hazardous waste was banned due to two fundamental reasons focusing on the down stream impacts and the upstream impacts

> *"Downstream Impacts: Hazardous waste trade is fundamentally unjust and environmentally damaging since it victimizes the poor, burdening them with toxic exposure and environmental degradation. (…)" "Upstream Impacts: Hazardous waste trade allows waste generators to externalize their costs, creating a major disincentive to finding true solutions upstream for the problems they create. (…)"*Puckett et al., 2002

Then main argument used for the donations is that there are not direct importations of hazardous waste. At the time of their importation, they are products that are in working order and that the obsolete computers are sent back to the donors. But what happens to the other donations that have a short lifespan left and can barely function for more than 6 months?

In line with the above initiatives by the producer and by CFSK, there is a need to showcase the good parts within the current initiatives and improve, formalize, strengthen and monitor them so as to continuously improve the processes. In conclusion, it is very clear that there is need for intervention on the management of e-waste in the country, as pointed out in the gaps that exist in the country system. The consumption of e-waste is on the rise, it will soon be a problem especially with the influx of the second hand EEE and the cheap EEE. The regulators placed the onus of providing the intervention on the management of e-waste in Kenya within the mandate of NEMA.

6 Future outlook of e-waste management: Embracing Extended Producer Responsibility in Kenya

In this section I revisit the need to introduce EPR in Kenya based on the interviewees and research finding on waste management. I will discuss the drivers and barriers that will shape the future outlook of e-waste management in Kenya focusing on the potential of introducing and implementing EPR in Kenya. The information provided in this section is drawn from the discussion during the interviews and from the literature.

6.1 Why introduce EPR in Kenya

The lack of physical capacity and/or financial resources in management of waste in general reflects the situation that will develop if there is no intervention in e-waste management. Meanwhile, *EPR programmes generally increase collection and recycling rates significantly by making resources available that governments, by themselves, through taxpayer funding, are typically unable to commit* (Lindhqvist, Tojo, & Davis, 2001). Currently the government is unable to commit resources to the management of MSW, in line with the lack of resources in management of waste. It would therefore be prudent to implement EPR programmes suited to the Kenya scenarios especially in the downstream management of the products. The sections below I point out the drivers and barriers for the implementation of EPR.

6.2 Potential drivers

The common drivers for EPR adoption and implementation can be categorised as legislative/regulatory/ market and internal company drivers:

Legislative/ regulatory drivers

Legislative and regulatory driver have been defined as mandatory government policy instruments that exert substantial influence on the actions of companies (*Johansson et al. 1999*). These include introduction of legislation that requires the produce involvement in the EoL management of their products. Currently in Kenya there has been a hint on the introduction of producer responsibility as reported in the E. A STD (28 November 2006). The then Information Minister Honourable Mutahi Kagwe pointed out that generation of toxic waste had reached crisis levels and that there was a need to put in place policies and legal measures aimed at polluter pays principle and producer responsibility. International environment agreements and politics can play a role in the implementation of EPR from developed countries to developing countries.

Market drivers

The market drivers can be classified under direct consumer demands or consumer choices while selecting products (Johansson *et al.* 1999). This could be reflected in the choice of eco-labelled products. The interviewees stated that public procurement by the state agencies had a big role play in demanding for introduction of collection schemes. The state agencies and corporations are major consumers of EEE thus if they demanded from the producers a scheme that would ensure the EoL management of their products be put in place, there is a high likelihood that the producers would put it in place. The other factors that influence market drivers include consumers' awareness. Consumers can also influence EPR introduction/ implementation through usage of brand loyalty and satisfaction. Johansson *et al.* (1999) point out that ignoring the market pressure could lead to loss or reduction in the number of customers and revenue.

Internal company/ industry drivers

This can be grouped under: competitive edge and profitability, efficient resource use, prestige and brand image, environmentally conscious top management and globally company initiatives (Davis 1997). The competitive edge of implementation of EPR by companies in areas where there is no regulatory requirement provides the company the opportunity of being a step ahead of the regulators while at the same time providing channels for efficient resource use. This also provides the companies with a green image thus boosting the prestige and brand image of the products which could in effect increase the sells of these products in an aware society. The introduction of a collection scheme by Nokia could be a driver for the regulators to implement EPR in the country and mandate the producers to be responsible for the EoL management of their products. This also means that Nokia as a company has created the green company image even if the scheme has not been well publicized.

6.3 Potential barriers

The barriers to EPR implementation can be categories as, lack of awareness and understanding of the EPR concept, organisational structure, political interference and corruption.

Lack of awareness and understanding/misunderstanding of the EPR concept

The lack of awareness and understanding of the EPR concept was observed both in the consumers and the regulators. This is compounded by the lack of information and tools to access overall product system impacts. In Kenya there is reasonable understanding of producer responsibility by some regulators but there is no in-depth knowledge on how EPR works and can be applied in the countries context. During the discussions with the interviewees, it was clear that the lack of EEE producer presence in the country was a major concern in the acceptance and implementation of EPR. Yet this should not be the reason as producer definition covers importers of products into the country. Such misunderstanding of EPR is a barrier to its implementation. An anonymous source pointed out that while formulating the waste management regulation 2006 the producer responsibility was discussed and included but when the regulations were reviewed and gazetted it had been removed. This was attributed to the lack of understanding and awareness on EPR.

Organizational structure

The environmental regulations focus on compliance and thus the industries focus on meeting the compliance at minimal costs. This is a barrier to voluntary EPR implementation in countries without the regulatory mandate as companies will not adopted a proactive approach (Johansson *et al.* 1999). Hazardous waste regulations have also been blamed as barriers to implementation of EPR in that they introduce bureaucratic requirement such as obtaining waste permits for collection and take back of certain products (Davis, 1997). In line with the organizational structures it is difficult to build relationships amongst the actors in the different life cycle stages of the product or who interact with the product. Cases of mistrust exist between some repairers and retailers and also consumers. Thus consumers will not be willing to participate in a scheme where they have to drop the phones with the repairers as they are not guaranteed that the phone will be recycled or managed well.

Lack of political acceptance and goodwill

Lack of political acceptance and goodwill can be attributed to the reason why EPR was excluded from the Waste Management Regulation 2006 (Anonymous 2008). Environmental issues in Kenya have not taken prominence as they are viewed as barriers to development. This is exemplified by the wayside political directives that overturn environmental decisions (Anonymous 2008). There is need for political acceptance of the EPR concept and the good

will to include it in the environment policy being developed. Inline with political acceptance, the other barrier to adoption of EPR is based on the view that the EU approach on e-waste management is tough and that Kenya needs a regulation that will help it decide on the right balance as the situation in Kenya and the developed countries differ (Denley 2008, 26th February, personal interview).

Corruption

Rampant corruption will undermine the effectiveness of the application of EPR programmes.

7 Conclusion

This chapter revisits the research questions and the research objective while highlighting the main findings and reflects upon the study and wraps up with the recommendations to the various stakeholders involved in e-waste management in the country.

7.1 Revisiting the research questions

The research explored the applicability of EPR for WEEE in Kenya, with special reference to collection of EoL mobile phones. The study was guided by the following research questions:

1. What is the current status of e-waste management in Kenya?
2. What policies and institutional mechanisms are in place to address the e-waste problem?
3. From e-product inception into the Kenyan market till the EoL what are the different stages and who are the actors at each stage?
4. What are the challenges and opportunities of establishing an effective and efficient take-back scheme for EoL phones?

The first research question *provides an over view of the current status of e-waste management in Kenya.* This question was extensively handled in 3.2. The status e-waste management in the country can be summed as non existent. There have been various initiatives undertaken but none of the initiatives provide a holistic picture of the e-waste management. The initiatives are undertaken by interested parties with minimal regulatory/government involvement. The regulators on their part have not conducted any study on this and this makes it impossible to determine the extent of e-waste in the country. Globally e-waste management is undertaken with the shift of responsibilities to the producers. The country lacks e-waste management initiatives driven either by the government or private industry. This could be attributed to the lack of acknowledgement of e-waste as a problem.

The second research question explores the *policies and institutional mechanisms in place to address the e-waste problem.* This question was extensively covered under the stakeholders with more focus on the regulatory institutions in place in management of e-waste. The policies looked included the National Information & Communications Technology (ICT) Policy of 2006 by the Ministry of Information and Communication and the Waste Management Regulations of 2006 by the National Environment Management Authority. This policies/ regulations cover different aspects of the e-products and e-waste. The cohesive and well functioning of the different institutional mechanisms and frameworks is an essential factor in attainment of e-waste management in Kenya. Although the ICT sector is regulated under the Communication Commission of Kenya it is essential that the regulators, the institutions and stakeholders play their respective roles in an interdependent and synergistic way that will ensure effective and efficient management of e-waste. The government involvement in management of e-waste, implementation of the existing policies/ regulations and adopting new mechanisms in addressing the e-waste problem will ensure that the e-waste issue does not get out of hand as in the case of the Asian countries. It is indeed the opportune time for the establishment of preventive and curative measures in e-waste management. As pointed out earlier there is a need to put preventive measures in place in anticipation of the shift from analogue to digital TV sets. This will ensure that the country is protected from the illegal importations and dumping.

The third research questions looks at the possible flows of e-waste in Kenya from e-*product inception till the EoL*, that is the stages and the actors involved at these stages with the aim of determining what influences the flows especially at the EoL. The study also provides the flow of computers and TV sets albeit in a small section as opposed to the discussion on the EoL mobile phone. The main different between the flow of mobile phones and the other EEE is based on the perceived material content and the well developed second hand market of the EEE. Mobile phones sold to repair shops that use the materials in repairs while TV sets are basically stored at home or dumped with the MSW. There are TV repair shops but they do not buy the EoL TVs as in the case of the mobile phone. The computer flow looked into was based on the Computer for Schools Kenya refurbishment program. The author examined the computers that enter the system and what happens to them in comparison to the computers that are purchased by institutions and personal users. From the analysis conducted in 4.8 it become clear that consumers' in Kenya are not part of the "*throw away"* culture, most of the EoL products are stored in the homes, handed out to relatives who would try to repair and reuse them or sold to the repair shops. Very few consumers throw away their e-products. The end-of-life flows of e-waste are determined by the consumers' perception of the products.

The forth research question addresses *the main challenges and opportunities of establishing an effective and efficient take-back scheme for EoL phones?* This research question is answered in section 4 and 5 with the research focusing on the current collection scheme being implemented by Nokia. The challenges and opportunities are discussed in detail in section 4.5. In a nut shell the main challenges identified are lack of convenient collection points, consumer willingness to participate pegged on incentives, competition for material resources by repairers and lack of consumer awareness on the scheme. The opportunities can be summed up as the existence of EoL mobile phones that are stored at home, the opportune time for intervention as there is no backyard recycling, the availability of usage of existing infrastructure and the competitive edge over other producers. In answering this research question in-depth interviews were conducted with the various stakeholders. The stakeholder issues can be summarized as follows: the consumers need incentives so as to participate in the collection scheme and most of the consumers were not aware of the existence of the scheme. The scavengers' expressed concern on regulation of waste management as they viewed this as a way of excluding them from the formalized system.

7.2 Recommendations

7.2.1 Recommendation for policy makers

Comprehensive studies on e-waste status in Kenya

In light of the findings, discussions and gaps identified in the current system, there is need to conduct a national study to determine the status of e-waste in the country. The study will also develop an inventory of the different e-waste in the country. This study will then provide the basis for the formulation of a strategy to handle e-waste. On the issue of lack of data on imports of EEE into the country, there is need for a compilation of available data on the EEE imports and maintaining of credible data base on the imports and flows of EEE. This calls for a comprehensive national strategy on e-waste that will extensively address the management of the various e-waste issues in the country, the importation of second hand e-products and the donations.

Adoption and implementation of EPR

E-waste is an emerging waste stream that is inadequately addressed in the existing regulations. In order to fill the gaps identified in the existing policies, institutional and regulatory mechanisms in addressing e-waste there is need to incorporate EPR into Kenyan environmental legislation and regulations. The Waste Management Regulation (2006)

addresses various components of waste management ranging from solid waste, hazardous waste, industrial waste, pesticides and toxic substances, biomedical waste and radioactive substance management but does not take cognisance of e-waste as an explicit waste stream or category. The interviewees from the NEMA pointed out that e-waste is presumably covered under chemical waste and hazardous waste. The stakeholders did not link e-waste with the two categories; the term e-waste does not feature anywhere in this regulation. This calls for the clarification of the regulation or inclusion of e-waste as a waste category in the regulation. This can also be done by developing a legislation/regulation specifically on e-waste handling the collection, storage, recycling and disposal of e-waste. The regulation can introduce EPR mandating the producers and importers to take responsibility of their products at the EoL, it can also introduce standards, specifications and mandatory labelling of second hand products, donations and refurbished products as a way of keeping track on these products and differentiating them from new products.

Multi-sectoral management of e-waste

E-waste management should adopt a multi-sectoral approach whereby all the relevant sectors and stakeholders' participate in the formulation of the strategy and the management of the e-waste. E-products life cycle from the point of entry into the country till the EoL is regulated by different agencies. For the e-waste management to be comprehensive there is need to adopt a multi-sectoral approach that could include CCK incorporating EoL management in the licences issued or having linkages with NEMA so that waste management fees are collected from the ICT sector and transferred to the regulator in charge of waste management. This brings the idea of abolition of blanket licensing procedure that do not specify the various licence conditions. There is also need to developed Institutional policies on EoL management of EEE.

Regulatory impact assessment

There are various regulations relating to components of waste management in the country. It could be important to conduct a regulatory impact assessment of the various regulations with the aim of streamlining the regulations that address the same issues but under different regulators so as to achieve synergy within and between the regulations and avoid duplication of efforts and waste of tax payers money. For instance the ICT policy has provisions for development of regulations for recycling and disposal facilities by the government but just for the ICT sector. What about the other EEE sectors? The recycling and disposal regulations will be aimed at promoting use of environmentally-friendly IT products to address environment and cost issues. While generally environment affairs are managed under a different docket, such inclusions in policies should form the basis for synergistic inclusion of the relevant plays so as to avoid duplication of regulations that maybe be contradictory in nature and also make them comprehensive.

7.2.2 Recommendations to the manufacturers

Need to review existing system

Discussion on the existing system with the various stakeholders reveals that there is a need for the manufacturer to review the current system in place to accommodate the stakeholders. There is a need for the manufacturer to design a system which provides incentives to consumers to bring back products to the appropriate collection points. The incentives can be used in the beginning of the collection scheme as a way of advertising the scheme and when the scheme is well established the manufacturer can review and determine if there is need for incentives or not.

Stakeholder involvement and level of convenience

The current scheme is heavily run by the customer care centres that are independent of the manufacturer and the customer care centres determine which stakeholders along the life cycle of the e-waste will be involved. The interviews indicate that there is a need to formulate and calculate working relations with the various stakeholders for the collection scheme to be effective and efficient. As the scheme driven by private industries, the manufacturer needs to define the roles of the various actors and determine how the collection scheme will interact with the existing initiatives. The collection scheme should be convenient to the end users thus the need to establish more collection points across the country. A few suggested areas that can have collections points include the supermarkets, schools and community centres.

Awareness and information disseminations

From the interviews conducted it is apparent that the end users are not aware of the existence of the collection scheme by the manufacturer. There is a need for the manufacturer to create awareness on the schemes existence and purpose. The awareness can be created through various channels such as: media advertisement especially the radio as it has a wider coverage, and through the road shows at times conducted buy the manufacturers in advertising new phones. There is a need for the manufacturer to dedicate funds to the promotion of the take-back scheme. The manufacturer could also promote the scheme through schools as a way of reaching a wider population.

7.3 Suggestions for future research

E-waste management is an emerging problem in Kenya just like in the rest of the Sub Sahara Africa existence of little or no data makes it hard to assess the magnitude of the problem. In my view e-waste management is a big grey area that needs detailed and more research in Kenya. The following areas need to be explored further:

The general flows and quantities of e-waste in Kenya, the origin of the e-waste so as to determine the source of the e-waste if it is generated domestically or is it imported. This should be done with the view of identifying the gaps and loop holes that need to be addressed for effective management of e-waste.

There is still a need for further research on the adoption and integration of EPR into national legislation and what impact it would have to the various players and actors in the e-waste scene. In line with this there a is need for detailed exploration on how various e-waste management strategies can be synergised with EPR and developed to aid in e-waste management in Kenya.

Another interesting research would involve looking at the benefits of manufacturer involvement in EoL management of their products as opposed to development of functional recycle markets that are liberalised and open to competition from the existing recycling practises.

Finally research on potential knowledge transfer in relation to e-waste management from Europe to Kenya this can be conducted with the aim of identifying what kind of knowledge exists in the developed countries and how could the knowledge be transferred to the developing countries grappling with the e-waste management. In line with knowledge transfer it would worthy to explore in details the possibility of transfer of the e-products along with the EoL fee from jurisdictions with the provisions to the jurisdictions not covered but are grappling with management of e-waste from the covered jurisdictions

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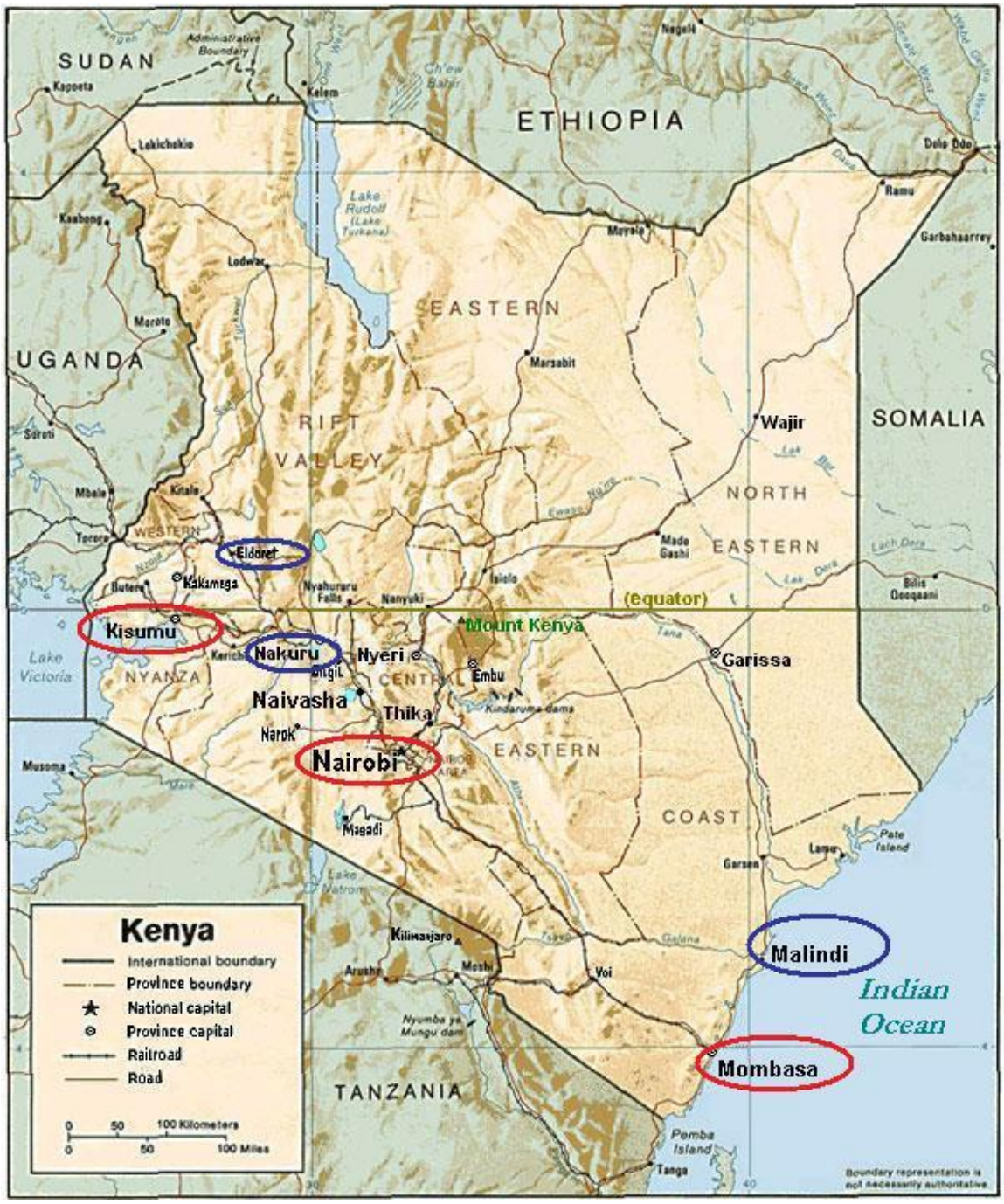
Abbreviations

CCK	Communication Commission of Kenya
CCN	City Council of Nairobi
CFSK	Computers for School Kenya
CR	Collective responsibility
E.A STD	East African Standard News paper
EC	European Commission
EEE	Electrical and Electronic Equipment
EIA	Environmental Impact Assessment
EoL	End of Life
ESM	Environment Sound Management
EPR	Extended Producer Responsibility
EU	European Union
E-waste	Electrical and Electronic waste
GSM	Globally System for Mobile communication
ICT	Information and Communication Technology
ISP	Internet Service provider
KNPC	Kenya National Cleaner Production Centre
Kshs	Kenya Shillings (monetary Unit)
IPR	Individual Producer Responsibility
JICA	Japanese International Aid Agency
KEBS	Kenya Bureau of Standards
Kgs	Kilograms
KPA	Kenya Ports Authority
KRA	Kenya Revenue Authority
MIC	Ministry of Information and Communication
MSW	Municipal Solid Waste
MPPI	Mobile Phone Partnership Initiative
NEMA	National Environment Management Authority
NGOs	Non Governmental Organisations
NWSC	North West Stewardship Council
OECD	Organisation for Economic Development
PPP	Polluter Pays Principle
PRM	Product Recovery Management
PAC	Practical Action Consultancy
PAK	Practical Action Aid Kenya

PVOC	Pre-export Verification of Conformity
SIM	Subscriber Identity Module
SWOT	Strengths Weakness Opportunities and Threat
TV	Television
UNEP	United Nations Environment program
WCED	World Commission on Economic Development
WEEE	Waste Electrical and Electronic Equipment

Appendix 1: Map of Kenya indicating the study areas



The cities circled in red indicate the primary cities of choice to collect data from as they are the three big cities in Kenya while the cities circled by blue are the alternatives cities due to the political situation on the country.

Appendix 2: Materials found in mobile phones

Name of substance	Location in mobile phone	Typical percentage content of mobile phones (including battery and peripherals)
Primary constituents:		(1 per cent and over)
Plastics	Case, circuit board	~40%
Glass, ceramics	LCD screen, chips	~15%
Copper (Cu), compounds	Circuit board, wires, connectors, batteries	~15%
Nickel (Ni), compounds	NiCd or NMH batteries	~10% *
Potassium hydroxide (KOH)	battery, NiCd, NiMH	~5% *
Cobalt(Co)	Lithium-ion Battery	~4% *
Lithium(Li)	Lithium-ion battery	~4% *
Carbon (C)	Batteries	~4%
Aluminium (Al)	Case, frame, batteries	~3% **
Steel, ferrous metal (Fe)	Case, frame, charger, batteries	~3%
Tin (Sn)	Circuit board	~1%
		* Only if these battery types are used, otherwise minor or microconstituent.
		** If aluminium is used in the case, the amount would be much larger, ~20%.
Minor constituents:		(Typically under 1% but over 0.1%)
Bromine (Br)	Circuit board	
Cadmium (Cd)	NiCd battery	
Chromium (Cr)	Case, frame	
Lead (Pb)	Circuit board	
Liquid crystal polymer	LCD screen	
Manganese(Mn)	Circuit board	
Silver (Ag)	Circuit board, keypad	
Tantalum (Ta)	Circuit board	
Titanium (Ti)	Case, frame	
Tungsten (W)	Circuit board	
Zinc (Zn)	Circuit board	

Name of substance	Location in mobile phone	Typical percentage content of mobile phones (including battery and peripherals)
Micro- or trace constituents:		(Typically under 0.1%)
Antimony (Sb)	Case	
Arsenic (As)	Gallium arsenide LED	
Barium (Ba)	Circuit board	
Beryllium (Be)	Connectors	
Bismuth (Bi)	Circuit board	
Calcium (Ca)	Circuit board	
Fluorine (F)	Lithium-ion Battery	
Gallium (Ga)	Gallium arsenide LED	
Gold (Au)	Connectors, circuit board	
Magnesium (Mg)	Circuit board	If Mg is used in the phone case, the amount would be much larger, ~20%
Palladium (Pd)	Circuit board	
Ruthenium (Ru)	Circuit board	
Strontium (Sr)	Circuit board	
Sulphur (S)	Circuit board	
Yttrium (Y)	Circuit board	
Zirconium (Zr)	Circuit board	

Appendix 3: The ten categories of WEEE as defined By the European Union Directive 2002/96/EC

- Large household appliances (refrigerators/freezers, washing machines, dishwashers).
- Small household appliances (toasters, coffee makers, irons, hairdryers).
- Information technology and telecommunications equipment (personal computers, telephones, mobile phones, laptops, printers, scanners, photocopiers).
- Consumer equipment (televisions, stereo equipment, electric toothbrushes, transistor radios).
- Lighting equipment (fluorescent lamps).
- Electrical and electronic tools (handheld drills, saws, screwdrivers).
- Toys (Playstation, Gameboy, etc.).
- Medical equipment systems (with the exception of all implanted and infected products).
- Monitoring and control instruments.
- Automatic dispensers.