E-waste Management in Kenya

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Prof Timothy Waema   Muriuki Mureithi

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Glossary of terms

Importers/ assemblers	Importers and/or assemblers of branded and non-branded electrical and electronic equipment.
Collectors	Formal or non-formal bodies that collect e-waste. This may involve procuring bonded computers from government and parastatals, collecting old computers from private sector organisations etc. Includes informal rag-tag collectors.
Consumers	An organisation or individual that uses electrical and electronic equipment and then discards it as waste after the equipment has reached its end-of-life. Note that the end-of-life for a consumer is the functional use of the equipment by that consumer, and may feed into the second-hand market directly or through refurbishers.
Distributors / retailers	Include all bodies selling equipment to the end-consumer, including donated computers.
Downstream vendors	Industries buying fraction (e.g. copper, plastics, metals, gold etc.) produced by the recyclers. Can be national or international.
End-of-life	Refers to the end of the useful life of equipment in a particular environment. The equipment may then be passed onto the second-hand market. This is distinct from lifespan which describes the total functional life of the equipment.
E-waste	Electronic waste (e-waste) refers to electrical or electronic equipment which is waste, including all components, subassemblies and consumables which are part of the product at the time of discarding. It includes computers and entertainment electronics consisting of valuable as well as harmful and toxic components.
Mass flow system	A description and quantification of mass flows and stocks of computers over time defining the system borders.

Recyclers	Organizations dismantling, separating fractions, and recovering material from e-waste after the lifespan of the equipment. This includes plastic, copper, gold etc.
Refurbishers	Refurbishers extend the functional life of equipment. They include the repair and service centres. They often feed into the second-hard market.

Acronyms

ARF   Advance Recycling Fee
CCK   Communications Commission of Kenya
CFSK   Computer for Schools Kenya
CRT   Cathode ray tubes
DSF   Digital Solidarity Fund
EMCA   Environmental Management Co-ordination Act (1999)
EMPA   Swiss Federal Laboratories for Materials Testing and Research
ICTs   Information and communications technologies
ISP   Internet Service Providers
IT/ICT   Information technologies
KEBS   Kenya Bureau of Standards
KRA   Kenya Revenue Authority
LCDs   Liquid crystal display
MENR   Ministry of Environment and Natural Resources
MoIC   Ministry of Information and Communications
MoLG   Ministry of Local Government
MoPHS   Ministry of Public Health and Sanitation
MoTI   Ministry of Trade and Industry
NEMA   National Environmental Management Authority
NGOs   Non-governmental organizations
PCBs   Printed circuit boards
SWICO   Swiss Association for Information and Communications and Organisational Technology

1 Executive Summary

This report presents the findings of a baseline study into electronic waste (e-waste) in Kenya, which was conducted between December 2007 and April 2008 by the Kenya ICT Action Network (KICTAnet). The study was supported by Hewlett Packard (HP), the Swiss Federal Institute for Materials Testing and Research (Empa) and the Global Digital Solidarity Fund (DSF). Through a literature review, a survey, field visits and interviews, as well as a series of stakeholder workshops, this study estimates e-waste flows in Nairobi, and makes national assumptions. It also analyses the policy and legislative context affecting e-waste, and looks at its social, economic and environmental impact, including health and safety issues. The study focuses on IT equipment, such as desktop computers, notebooks, printers and related accessories.

The study suggests that the total e-waste generated from only computers, monitors and printers each year is about 3,000 tons. This amount of e-waste is likely to increase as the importation and use of computers increases in coming years – best illustrated by the higher imports of IT in 2007 compared to previous years, with a growth of over 200%. However, much of the e-waste remains in storage because of a lack of a policy and legislative framework, and the absence of a practical e-waste management system.

Due to cost issues the market for second-hand computers and clones is still high. Nevertheless, the second-hand market is not well developed in part due to a shortage of good stock: around 60% of the equipment given to beneficiaries like schools is beyond refurbishing, and should be directed to the recycling market.

The value of e-waste to the consumer is apparent. A majority of the respondents in the study were aware that some of it could be profitably recycled. To recover this value half of the respondents sold the computers to scrap dealers at 10-20% of their purchase price, while the rest was sold to the second-hand market, include friends, family and colleagues. Consumers, however, were willing to give away the computers as e-waste freely, on condition that there was an acceptable means of disposal and free pick-up services.

The market for recyclers in Kenya is expanding, and with sophistication. Downstream vendors dismantle old technology and re-sell or re-use parts for repair. The emerging market includes students of technical colleges. The market for

downstream vendors in the country has grown with their main source of parts/fractions being refurbishers, followed closely by e-waste recyclers and collectors. Some informal businesses have already been established around recycling operations in areas such as the Kenyatta and Ngara markets and Kijabe Street.

70% of the respondents indicated that they were aware of the environmental hazards caused by discarded electronic equipment. Despite this, only 20% of the respondents had an internal policy governing e-waste management. Of those who did not have a policy, slightly under half planned to have such a policy.

While the Government has recognised the challenges posed by e-waste, the level of preparedness in-terms of policies and regulations is low. For example, the Ministry responsible for environment considers e-waste a matter of concern but does not have a policy to deal with e-waste management. Instead it has developed a concept paper to address what it termed 'a new phenomenon'. In particular it was considering recycling and technology transfer.

Amongst its recommendations, the research proposes that specific policies and regulations on e-waste be developed. These should govern the handling process from collection to final disposal, and licensing of the key actors. A collection system needs to be developed, and a consumer awareness campaign launched. Waste should be sorted at source, and this should be enforced by Local Authorities. Capacity development programmes should be launched in the sector, possibly funded by fees levied on importers of second-hand equipment. Finally, developing an e-waste management system should be a multi-stakeholder process, which includes the participation of civil society.

2 Introduction and background

This baseline study, implemented by the Kenya ICT Action Network (KICTAnet), seeks to provide an opportunity for Kenya to critically review its management of electrical and electronic waste (e-waste) and to work towards a strategy to create the necessary infrastructure and mechanisms to support sustainable and environmentally friendly e-waste management. A key focus is to explore the economic opportunities provided by e-waste and to address concerns arising from its toxic and non-biodegradable components.

The study is supported by three partners:

- Hewlett Packard Corporation (HP)
- Swiss Federal Laboratories for Materials Testing and Research (Empa)
- Global Digital Solidarity Fund (DSF)

HP is a world-leading information technologies (IT) company and was incorporated in 1939, with its corporate headquarters in Palo Alto, California. It has considerable experience in e-waste recycling, having recycled most of its products through a number of schemes in the last 20 years. Empa is a materials science and technology research institution based in Zurich. It falls under the Swiss Federal Institute of Technology (ETH) and specialises in applications research and development. Empa is leading a global e-waste programme which aims at building capacities for e-waste management in developing economies (ewasteguide.info). DSF is an initiative of the African Union, and an outcome of the World Summit on the Information Society (Geneva, 2003). It is based in Geneva, with a mandate to reduce the digital divide by equipping the developing world with the means to access the knowledge society.

This study is part of a programme that includes similar studies being conducted in Morocco and Senegal. A pilot e-waste recycling project was also launched recently in South Africa by the partnership.

KICTAnet is responsible for the implementation of the study in Kenya. KICTAnet was created in October 2004, as part of the Association for Progressive Communication's Catalysing Access to ICTs in Africa (CATIA) project in Kenya, and currently comprises over 50 institutions, organisations and networks concerned with information and communications technologies (ICTs) in Kenya. It is a multi-stakeholder network with members from the private sector, civil society, media, academia and government. For the past year, KICTAnet has acted as a central meeting point and platform for collaboration and activity for various stakeholders interested in greater and more affordable access to ICTs in the country.

KICTAnet proposed a consultative and inclusive process for this study, that brings together a wide stakeholder audience, in order to gain buy-in and support and to ensure the long-term sustainability of the outcomes. The stakeholders in this project include Government at policy legislative and regulatory levels, the private sector, civil society, development partners and the media.

KICTAnet commissioned Prof Timothy Waema and Muriuki Mureithi as consultants to undertake the study.

3 Objectives of study

The general objective of the project is to assess the e-waste landscape in Kenya. Specifically the study aimed to:

- Produce a baseline study on the current state of e-waste in Kenya;
- Map the strengths and weaknesses of the current situation in handling e-waste;
- Develop a roadmap for the way forward as well as recommendations for advocacy efforts;
- Develop and enlarge the network of relevant stakeholders/key players in the existing 'e-waste scene', including the repair/reuse and recycling industry, the Electrical Electronic Equipment (EEE) supply sector, as well as government administration, parastatals and corporate actors; and
- Create awareness of the roadmap through workshop facilitation and media reports as necessary.

4 Scope of study

4.1 Geographical scope

The geographical boundary for the research and data collection with a field study was Nairobi and its environs. This was based on the premise that Nairobi is the heaviest consumer of ICT products and consequently has more challenges related to e-waste management. The data collected and subsequent analysis was used to extrapolate the national e-waste situation and challenges.

4.2 Product scope

The study limited the product scope to IT equipment; specifically personal computers (or desktop PCs), laptops (notebooks), cathode ray tube (CRT) and flat panel monitors, printers, and related computer accessories.

5 Research design and methodology

The project was realized through explorative/formulative research that looked to establish the state of the computer acquisition, use and disposal market in Kenya. A research methodology framework was developed which guided the development of the research tools (see Annex 1). This framework was customized from a generic framework that is used by Empa, and describes the various stakeholders, the indicators for which data needed to be collected and the possible sources of data. The research collected both

quantitative and qualitative data to establish the flow of e-waste and subsequent disposal.

5.1 Data collection methods and research tools

Data were collected through document reviews of policies and laws, interviews with stakeholders, as well as observations by researchers. From the customised methodological framework, research tools were developed. The primary data were obtained through administration of a questionnaire to the respondents. Additionally interviews were conducted with key persons in policy, regulatory and operational areas of the e-waste scene. These tools are annexed.

Three sets of questionnaires and one interview guide were developed and administered. The general questionnaire (see Annex 2) had specific sections relating to each stakeholder: importers, distributors, consumers, collectors, refurbishers, recyclers, vendors and final disposers. A sample of 68 interviewees was selected for face-to-face interviews with representation from all the identified sectors. The sampling was purposive to address the non-homogonous nature of the population. A second questionnaire was used for households located near dumpsites, while the last questionnaire targeted international organisations dealing with e-waste issues. The fourth tool was an interview guide that targeted policy-makers and regulatory agencies. Annex 3 shows the results of the data collected from the policy-makers.

A further source of primary data was observation during site visits to a second-hand market, scrap dealers, repairs shops and dump sites. These were conducted to qualitatively map activities in the area, working conditions, the source and state of old computers and other related e-waste, and the type of customers and their specific interests.

Key sources for secondary data included government documents and similar research conducted in other countries.

5.2 Target population and design of the field study

The e-waste 'universe' in Kenya comprises stakeholders ranging from importers, assemblers, retailers, consumers, refurbishers, recyclers, downstream vendors, and final waste disposers to policy-makers and selected households located near dumpsites. A working list was developed for the research since the licensing framework does not disaggregate ICTs from general trade. This means that no definitive list of stakeholders is available from the Ministry of Trade and Industry (MoTI) or professional associations. The list was developed through the researchers' experience in the ICT market, interviews with key players in computer repair sector, importers, and those buying second-hand computers from government or corporate entities. The yellow pages and national directory were also consulted. The field study targeted 68 respondents from the 10 categories of stakeholders who were purposively sampled.

5.3 Data analysis

Data collected were checked for completeness before being analysed using SPSS Statistics software. This was supplemented by using MS Excel for analysis and illustration.

6 International context of e-waste management

6.1 International drivers and experiences

The fast growth of the ICT sector globally is driven primarily by national initiatives to enhance competitiveness in the global information society. This has lowered the cost of ICTs in many instances, and in many countries, taxation has been reduced or eliminated altogether. In addition, the move towards information society initiatives such as telemedicine, e-government, and e-education calls for the increased acquisition and use of computers, as well as programmes to increase computer penetration. Against the high growth is the high rate of obsolescence of ICTs due to technological change. This means that there is a need to dispose of large quantities of computers. Globally the United Nations Environment Program (UNEP) estimates that up to 50-millions tons of e-waste is generated annually worldwide.

As equipment reaches its end-of-life, disposal challenges arise. While operational appliances do not pose a danger to the user, poorly disposed e-waste can result in severe health and environmental hazards due to highly toxic substances, such as lead and mercury. It is therefore important to arrange for safe disposal of the computers and their components, which includes the right health and safety measures.

As African countries join the global information society, the volume of ICT equipment in these markets continues to grow rapidly. Most e-waste recycling in developing and transition countries is done informally and there is little regulation in place to safeguard the health of those who dismantle the electronic equipment. Additionally, many developing countries have been caught up in a web of global e-waste dumping. This usually goes unnoticed due to the lack of legislation that governs the importation of non-functional, non-reusable and obsolete electronics into the various countries. Kenya is cited as one such e-waste dumping spot.[1]

Responding to safety and health concerns, countries have taken a number of measures. Many European countries banned e-waste from landfills in the 1990s due to the fear that toxic substances will leach and contaminate underground water. In this regard, countries in Europe and Asia have developed a policy framework for e-waste.

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[1]   www.wikipedia.org/wiki/electronic waste

In the United States (US), similar legislation and policies exist at state level, but are not enacted at national level due to stalled efforts in the US Congress.[2]

The key thrust of these efforts is for the manufacturers as well as the consumers to take responsibility for the end-of-life disposal. In some systems, a fee/tax is chargeable at the point of sale to cover the costs of disposal. Switzerland and some other Organisation for Economic Co-operation and Development (OECD) countries have established recycling systems which ensure safe disposal and high collection rates. These are partly financed by an Advance Recycling Fee (ARF) added to the sale price of new appliances, permitting consumers to return end-of-life equipment free of cost. However, consumers have to return them to retail outlets or collection points, from where e-waste is sent to specialised recyclers.

E-waste also provides opportunities. The equipment is dismantled into various parts, some of which are valuable. For instance, circuit boards contain valuable metals, including gold that can be reclaimed. Shredded e-waste fractions are sold to recyclers. According to the Swiss Association for Information & Communications and Organisational Technology (SWICO), up to 80% of the weight of a PC/server is metal and up to 53% of CRT monitors is glass, as illustrated in Table 1. These materials can provide a downstream market for recycled material.

Table 1: Composition of IT equipment

		% of weight						
	Average weight (kg)	Metals	Plastics	Metal-plastics	Cable	Glass	PCBs	Pollutants
CRT monitors	15.87	8	36	2		54		
LCD monitors	5.72	45	21			28	6	
PC/servers	13.39	80	6	1	3		9	1
Laptops	3.51	40	23	13	1	4	11	
Printers	11.70	61	29	5	1	1	3	
Large-scale copiers	90.96	68	13	9	3	2	5	
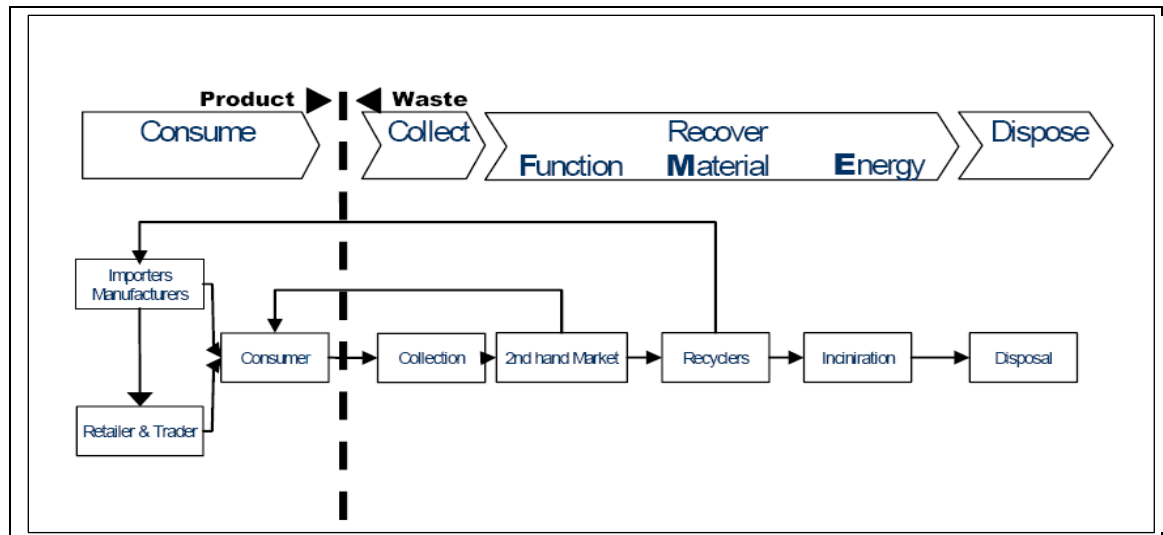
Source: SWICO Activity Report, 2007 (www.swicorecycling.ch)

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[2]   www.wikipedia.org/wiki/electronic_waste

6.2 Generic mass flow

According to Empa, all e-waste systems can be represented through some variation of the generic model shown in Figure 1.

Figure 1: Generic mass flow

Source: Rochat. D; Schluep. M (2007) e-waste country assessment methodology, Empa

The consumer obtains the computer either from an importer or a manufacturer who supplies directly to the market or through a retailer. After the end-of-life of the computer, the disposal process commences. In established e-waste frameworks, a formal or informal collection system exists to collect the computer. This computer may be fed into the second-hand market. The second-hand market seeks to extend the life cycle of the computer by refurbishing it. This may involve changing parts of the computer to make it operational. Once repaired, the computer is sold to a consumer as a second-hand computer and the process is repeated.

When the computer is deemed to be beyond repair, it is dismantled to recover the component material. This material is illustrated in Table 1. In developed markets, the volume of e-waste that can be sold to the downstream market is significant. Incineration can be used for parts of the e-waste with a view to recovering energy.

6.3 International conventions

There are two key international conventions regulating waste management, namely the Basel and Bamako Conventions. The Conventions emphasize that signatories ensure that the generation of hazardous wastes, and other wastes within a country, is reduced to a minimum, taking into account social, technological and economic aspects.

Secondly, where a country exporting the hazardous waste does not have the technical capacity, necessary facilities, or suitable disposal sites to dispose of the waste in question in an environmentally sound and efficient manner, steps must be taken to minimize pollution and its health consequences as far as possible. This also applies to raw material exported for recycling or fraction recovery.

7 National context of e-waste management

7.1 Policy and legislative framework

Kenya is a party to both the Basel and Bamako Conventions. It also participated in Rio de Janeiro in 1992 where it supported the provisions of Agenda 21 amongst other declarations and statements of principle, such as the Rio Declaration on Environment and Development. Agenda 21 is a global plan of action supported by the United Nations which calls for the improvement of environmental information for decision-making.

At policy level, the Ministry responsible for environment – The Ministry of Environment and Natural Resources (MENR) – has promulgated a strategic plan (2006-2010). One of its key functions is the full implementation of the Environmental Management Co-ordination Act (EMCA, 1999). EMCA defines hazardous waste, pollutants and pollution. The strategic plan also emphasises the principle of polluter pays. To achieve this objective, the Ministry's role is to create an enabling environment through policy, legal and regulatory reforms for environmental and natural resources management (MENR, 2006). This enabling environment includes socio-economic development aimed at poverty eradication. From the strategic plan, it is worth pointing out that the Ministry has taken an all-inclusive approach on waste management issues to address all aspects of waste management. The wide scope necessitates that legislation on waste is defined in broad terms. Going forward it would be necessary to develop regulations that focus on specific aspects of waste (e.g. e-waste).

To realise its mandate, the Ministry's core functions are:

- Formulation, analysis, and review of policy on natural resources and environment;
- Monitoring and coordinating research on environmental activities, and enforcing compliance of environmental regulations and guidelines (MENR strategic plan 2006 – 2010).

The Ministry derives its waste management policy framework from EMCA, which requires each individual to safeguard and enhance the environment.

The National Environmental Management Authority (NEMA), created under EMCA, is the regulatory agency in the implementation of all policies and regulations relating to the environment. NEMA

produced its first State of the Environment (SoE) report in 2003, and continues to report on a regular basis. SoE is a reporting standard accepted worldwide as a tool for measuring environmental progress towards sustainable development.

NEMA's role as an agency of government is to provide leadership in pollution control, and waste management guidelines. It acts as the principal instrument of Government in the implementation of all policies relating to the environment. In the NEMA strategic plan 2005-2010, key objectives include universal compliance and enforcement of environmental regulations, developing guidelines and standards and the prosecution of offenders failing to meet the provisions of EMCA. Similarly, the strategic plan allows for the coordination of environmental matters amongst all lead agencies and other stakeholders. NEMA therefore works with the entire spectrum of stakeholders on matters of waste management. It also formulates and regulates policy that governs recyclers, downstream vendors and collectors in the e-waste sector.

In Waste Management Regulations 2006, part II on general provisions provides that "*any person whose activities generate waste shall collect, segregate and dispose or cause to be disposed off such waste in the manner provided for under the Regulations.*" It adds that:

> *[A]ny person whose activities generates waste has an obligation to ensure that such waste is transferred to a person who is licensed to transport and dispose off such waste in a designated waste disposal facility and that any person, whose activities generate waste, should segregate such waste by separating hazardous waste from non-hazardous waste and dispose of such wastes in such facility as is provided for by the relevant Local Authority where the hazardous waste is produced.*

It is clear from the law that individuals and organisations whose activities generate e-waste have an obligation to dispose end-of-life equipment in a manner that takes into account its hazardous components. The law requires e-waste collectors and final disposers to register with NEMA and dispose of the waste at designated facilities.

Section 86 of EMCA, prescribes standards for waste, its classification and analysis, and formulates and advises on standards of disposal methods, such as the handling, storage, transportation, segregation and destruction of waste. Licences are required for the following operations:

- Waste transportation;
- Waste disposal sites;
- Waste treatment plants;
- Cross-boarder transportation of waste.

The Act empowers NEMA to apply in a court of law compelling any individual or organisation to immediately stop the generation, handling, transportation, storage, or disposal of any waste where such activity presents an imminent and substantial danger to public health, the environment or natural resources (EMCA, 1999).

In addition to MENR, which defines national policies, the Local Authorities implement waste management policies, while the Ministry of Public Health and Sanitation (MoPHS) is concerned with health issues. The Local Government Act (Cap. 265) bestows authority on the municipal authorities to deal with waste. In discharging this mandate the local authorities have to take cognisance of the Public Health Act. Under the Public Health Act (1962), it is the duty of every local authority to take all lawful, necessary and reasonably practical measures in maintaining its localities in a clean and sanitary condition (Public Health Act). Therefore, under the two Acts and subsequent by-laws, it is the responsibility of all local authorities to manage waste in their respective jurisdictions.

The ICT policy promulgated by the Ministry of Information and Communications (MoIC) in 2006 is cognisant of e-waste and states that "-- *As a prerequisite for grant or renewal of licences, applicants must demonstrate their readiness to minimize the effects of their infrastructure on the environment. This should include provision of appropriate recycling/disposal facilities for waste that may contain toxic substances.*" While the intention has not been incorporated in ICT regulations to make it binding, the Universal Licensing Framework to be implemented by the CCK from July 1st, 2008 takes a step towards enforcing this statement of intent.

7.1.1 Social legislation

The unemployment rate in Kenya is 14.6% of the economically active population, while the youth unemployment stands at 22.6% (GOK, 2007). The estimated overall poverty incidence is 49.1%, while the population below poverty line stands at 50% (Ibid.). It is evident that the majority of the unemployed are absorbed in the informal sector. Commonly referred to as Jua Kali, the sector covers all small-scale activities that are normally semi-organised, unregulated, use low and simple technologies, and employ few persons. This includes informal businesses working in the fields of waste collection and ICTs. Due to the sector's lack of proper legislation, it is prone to exploitation and poor working environments. Nairobi leads in informal sector job creation, which stood at 1.6 million jobs in 2006 (CBS, 2007).

The prevailing employment policies and their legal framework are contained in various policy documents and Acts of Parliament and foremost enshrined in the Constitution. The Constitution of Kenya provides the protection of the fundamental rights and freedom of the individual: "*no person shall be held in slavery or servitude*". The Trade Unions Act (Cap. 233) provides for establishment of staff associations, employees' and organisations.

In the informal sector, however, due to their unregulated nature and despite being a major source of employment, workers do not have established associations and are not members of trade unions.

Child labour in Kenya, which is defined in the Labour Force Survey conducted by the Central Bureau of Statistics (CBS, 2003) as work undertaken by children aged 5-17 years, which prevents them from attending school, and which is exploitative, hazardous, or inappropriate for their age. Going by this indicator, child labour in Kenya can be estimated at 1.3 million children (CBS, 2003). In its study, CBS did not adduce any form of forced labour. Most working children reported did so to augment their family income. A number of these children find employment in the informal sector as garbage collectors, scavenging at dumpsites for plastics and metals, which they deliver to recyclers. They also were reportedly engaged in dismantling of e-waste at the collectors' premises.

The Investment Programme for the Economic Recovery Strategy (IP-ERS) is the country's medium-term strategy to foster economic growth and reduce poverty. To enhance economic growth, the government envisaged strengthening the macro-economic framework, developing a more responsive fiscal policy stance, and encouraging private sector participation and investment. The IP-ERS laid emphasis on equity and the alleviation of poverty to be attained by investing in human resources (health and education); promoting agriculture, livestock and the environment; and establishing effectively targeted poverty alleviation programmes. In order to address poverty directly, the IP-ERS proposed as priority programmes the establishment of a Social Action Fund, and the development of Arid and Semi Arid (ASAL) areas. The IP-ERS offers a developmental framework in which the grassroots socio-economic impact of e-waste can be managed.

7.2 Environment and energy

Kenya covers a surface area of about 587,000 km^2 out of which 576,000 km^2 is land and 11,000 km^2 is water. This is under constant threat from pollutants resulting from industrial processes that comprises gaseous emissions, obnoxious smells, particulate matter, liquid effluents, solid wastes, heat, and noise. They emanate from agro-processes, chemical and pharmaceutical plants, mining and metallurgical industry, among others (NEMA-SoE, 2003).

In the energy sector, nationally the main sources include firewood, charcoal, grass, kerosene, and electricity. The others are solar, wind, liquefied petroleum gas (LPG) and biogas. Firewood accounts for 87.7% of the energy consumption in the rural population while in the urban population, kerosene accounts for 44.6% followed by charcoal at 30.2%. In Nairobi, kerosene use is at 63.5%, LPG follows at 20.2% and charcoal at 10.5% (CBS, 2007). As illustrated, the energy choices and consumption is posing a danger to the environment. Research has established that e-waste, through combustion, can be a source of energy. From the high volumes of e-waste likely to be generated in the future, it is

imperative to develop a mechanism aimed at safely exploring this potential.

7.3 Economic and development indicators

The Kenyan economy grew at 6.1% in 2006 and 7% in 2007 (CBS, 2008). In particular, there was rapid growth in the transport and communications sector, which recorded growth of 10.6% in the period.

ICTs were a key contributor of this high growth as a result of Government initiatives aimed at making them accessible to citizens. The initiatives include the removal of levies on computers, the launching of an e-government strategy (2004) and the development of a National ICT Policy (2006).

In the education sector e-learning programmes have gained popularity among schools and a number of institutions of higher learning are offering their courses online. Such institutions include Kenyatta University, Strathmore University and Kenya College of Communications Technology. In order to accommodate more students in the e-learning programmes, the institutions have boosted the number of PCs, in addition to other infrastructural requirements. On the other hand, there is a drive by the trainers/instructors to own PCs to enable them to access learning resources at their convenience.

Initiatives driven by companies and institutions to assemble computers locally have increased. The Kenya College of Communications Technology, Strathmore University, and Kenya Christian Industrial Training College have championed these initiatives, enhancing the affordability of PCs. Similarly, a number of companies import and sell second-hand computers.

The prevailing favourable economic conditions have facilitated the rapid acquisition and disposal of computers by institutions and private individuals. At the same time, demographics also impact on the country's projected e-waste volumes. The national population stands at 37.2 million (Economic Review 2007), while the population growth rate is estimated at 2.8%. The median age is 18.6 years (CBS, 2003). The youthful population is more prepared to use computers as a working tool and therefore the rate of acquisition of computers will increase as the youth enter the employment market.

7.4 ICT market

Total tax revenue collected by the central government stood at Ksh 401.5 billion in 2006/7 while the expenditure was Ksh 565.9 billion over the same period (CBS, 2007). One of the key contributors to this revenue collected was the services sector where ICT plays a critical role. Expenditure on ICTs was 11% of GDP in 2006.

There has been substantial growth in national telephone access, especially in the mobile telephony segment. Table 2 shows the growth pattern of both fixed-line and cellular telephony. As at February 2006, there were 5,729,501 subscribers on the cellular networks. In the early years (1998-2002) the cost of handsets and the demand for service were both high. This situation encouraged the mass importation of second-hand handsets, which were comparatively cheaper. However, the sets have a shorter lifespan, and typically either their battery or system unit soon dies out.

Table 2: Telephone services

Year	1998/1999	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004	2004/2005	2005/2006
Month	Jun-99	Jun-00	Jun-01	Jun-02	Jun-03	Jun-04	Jun-05	Feb-06
Mobile subscribers	15,000	180,000	400,000	900,000	1,600,000	2,242,249	4,611,970	5,729,501
Fixed exchange capacity	411,080	444,422	445,822	507,652	508,230	531,442	531,806	513,824
Fixed-line subscriber connections	296,400	313,470	326,282	331,718	328,358	299,225	281,764	286,729
Waiters	116,544	127,169	133,862	108,761	107,938	107,260	85,177	85,177
Total payphones in service	8,184	8,684	9,135	9,618	9,964	9,798	8,967	8,915
Community payphones								19,462

Source: CCK website

In an attempt to make the services available to more customers, service providers have resorted to availing affordable handsets to their customers. Notably, a key player in fixed-line telephony, Telkom Kenya, has recently unveiled code division multiple access (CDMA) handsets to compete with the cellular providers. These developments have contributed to a rapid rise in the importation and use of mobile handsets in the country.

A study carried out by CCK estimated the number of Internet users to be 2.77 million people in 2006/07. Table 3 shows a steady increase in Internet usage in the country.

Table 3: Internet usage

	2000/01	2001/02	2002/03	2003/04	2004/05	20005/06	*2006/07*
Number of licensed ISPs	34	66	72	76	78	51	*51*
Users by ITU (estimates)	100,000	200,000	400,000	1,000,000	1,054,920	1,111,000	*2,770,296 (Internet study)*

Source: CCK website

A number of businesses sell equipment, run cyber-cafés, and mobile phone shops in the informal sector. The sector is unregulated and tends to use simple technologies and employ few people. The ease

of entry and exit into this sector, coupled with the use of low-end technology, makes it an easy avenue for employment creation and small business development (CBS, 2007).

The increase in the number of cyber-cafés and mobile phone outlets in Nairobi is evidence of the rapid growth in the communications sector. The owners of major buildings in the central business district (CBD) are partitioning them into small stalls that house phone shops that provide telephone services. Cyber-cafés are also found in a number of these buildings.

Cyber-cafés operate with five to 100 computers, most of which are second-hand. According to Communications Commission of Kenya (CCK) statistics published on its website (www.cck.go.ke), by 2004/5, 90 cyber-cafés had registered with them, which is an increase of 57% from the previous year. However, the number is insignificant since most do not register with CCK. The phone outlets sell a variety of goods and services, which include handsets both new and used. In 2004/2005, 912 vendors and contractors had registered with CCK. This however is a small fraction of those in the equipment sales business.

Buoyed by the realization that ICTs are a crucial economic enabler, the government is funding a number of initiatives aimed at making ICT available to people. One of such initiative is the Digital Villages Project promoted by the Kenya ICT Board.
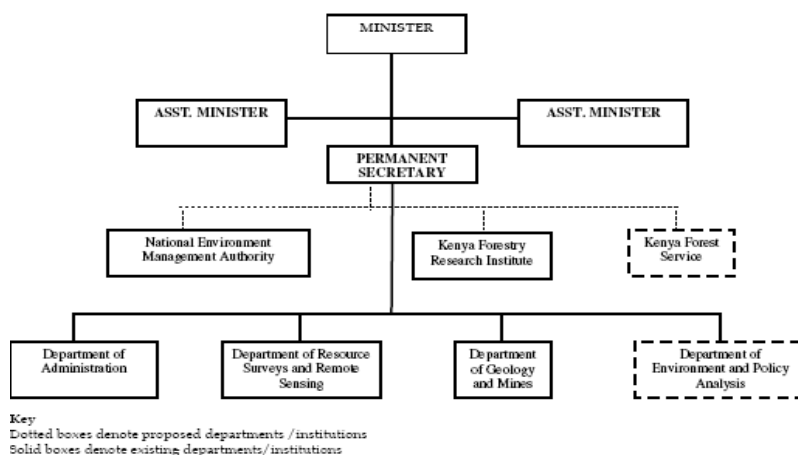
7.5 E-waste governance structure

A brief of the various ministries and parastatals responsible for waste management is given below.

7.5.1 Ministry of Environment and Natural Resources (MENR)

MENR designs policies that govern environmental issues. The ministry has adopted a more participatory approach to waste management that is evidenced in its strategic plan. Enhancement of public-private partnerships is in progress. Figure 2 shows the management structure of the Ministry.

Figure 2: Organizational structure of MENR

Key
Dotted boxes denote proposed departments /institutions
Solid boxes denote existing departments/institutions

7.5.2 Ministry of Public Health and Sanitation (MoPHS)

The Ministry formulates policies that govern waste management. According to the Public Health Act, waste is a nuisance. It gives guidelines to the local authorities on ways and means of dealing with waste. The act also gives local authorities the power to prosecute offenders.

7.5.3 Ministry of Information and Communications (MoIC)

The mandate of the Ministry is to formulate policy on ICT in broad terms. Under the ministry, there are autonomous bodies such as CCK, which is a regulator in the communications sector, and the Kenya ICT Board, which is tasked with promoting Kenya as an ICT hub, as well as availing cheaper internet bandwidth to the Government, universities and the business process outsourcing sector.

7.5.4 Ministry of Trade (MoTI) and the Kenya Bureau of Standards

The Kenya Bureau of Standards is an autonomous body under the MoTI. It runs the pre-export verification of conformity programme (PVoC). The aim is to minimise the risk to Kenya of unsafe and substandard goods from entering Kenya through the execution of conformity assessment activities in the country of export. The Bureau is expected to do pre-shipment inspection of second- hand computers to ensure that they are usable.

7.5.5 Kenya Revenue Authority

The body is charged with the task of revenue collection. It also collects statistics of goods that are imported into the country.

7.5.6 Local Authorities

Under the Public Health Act and Local Government Act, it is within the mandate of local authorities to deal with waste management. In Nairobi, a Council resolution of 1996 created the Department of Environment to focus on waste management (before then, waste management fell under the council's Department of Public Health). It is one of the largest departments in the council with a staff of 6,000. The staff is deployed in various areas of the city for environmental management duties that include cleaning, solid waste management, maintenance and the beautification of parks. Additional responsibilities of the department include:

- Policy formulation;
- Planning of environmental matters including registration of environmental management groups;

- Developing legislation and regulating informal and formal garbage collectors working within the city. (www.nairobicity.org)

Because it is a recent phenomenon, e-waste is not clearly defined in the activities of the department.

8 Findings

From the 68-targeted respondents, 39 responded giving us a response rate of 54.47%. Of the respondents, slightly above half (54.17%) of the institutions were private companies, while NGOs comprised of nearly a fifth (20.83%). Other organizations were government, informal organisations, and selected households. Table 4 below shows the target sample and those interviewed.

Table 4: Target sample and respondents

Category		Target	Respondents
Stakehold ers	ICT importers, suppliers, assemblers and distributors	10	12
	Consumers	8	10 (+1)
	E-waste collectors	6	0
	E-waste refurbishes	7	2
	E-waste recyclers	8	0
	Downstream vendors	8	6
	Final disposers	3	0
Households		8	6
Policy-makers		7	2
Internatio nal bodies		3	1 (-)
Total		**68**	**39**

The respondents indicated their preferences in terms of computer brands and laptops, as shown in the table below.

Table 5: Computer and laptops preferences

Brand of computers (desktop)	Brand of Laptops (notebooks)
IBM	Toshiba
DELL	SONY
HP/Compaq	HP/Compaq
Acer	IBM
Apple	Dell

Notably, of those institutions interviewed, only 17.39% are ISO certified a clear indication that environment management is not an issue that most organisations regard highly. Those that are ISO certified are international organisations.

8.1 Stakeholder analysis
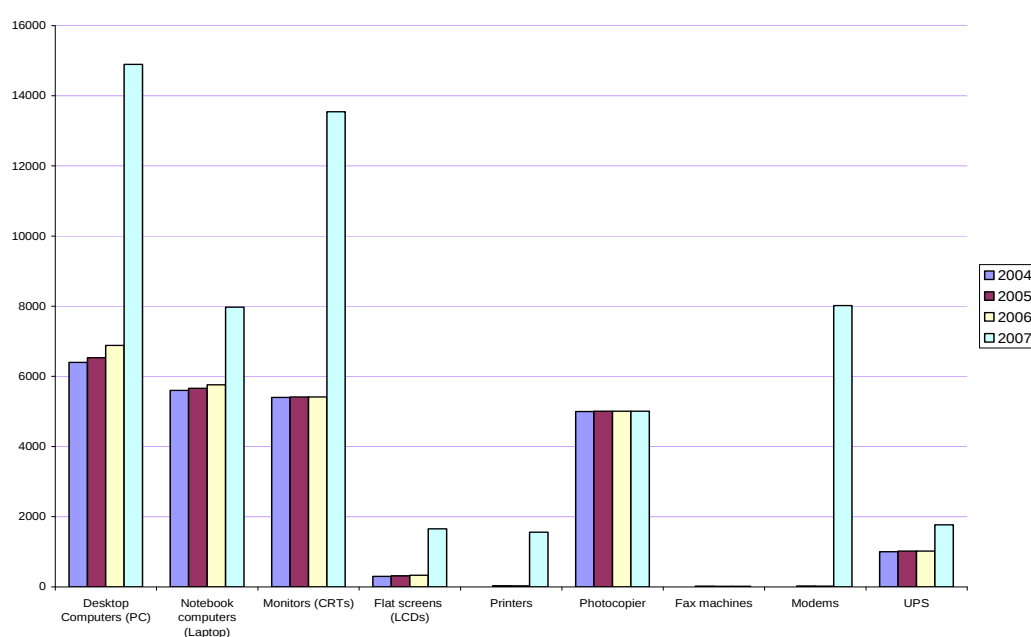
Stakeholders in the value chain were interviewed, and the results are presented below.

8.1.1 Distributors, suppliers and assemblers

All the respondents in this category indicated that they deal with both desktops and laptops, with 83% indicating that they deal with liquid crystal display (LCD) monitors, or flat screens. Over 60% indicated that they deal with printers (75%), modems (66.7%) and uninterruptible power supplies (UPS's) (66.7%). This is an indication that the volume of these categories of equipment is high in the country.

Figure 3 below shows the total amount of ICT equipment imported, assembled, and distributed in the last four years. It shows an increase in demand for ICT equipment and a potential for higher levels of e-waste in the next few years. From the figure, the highest level of import took place in 2007.

Figure 3: Total amount of new ICT equipment imported by the respondents of the field study

Of the importers interviewed, 58.3% indicated that none of their imports were second-hand, while 50% of the respondents indicated that none of their imported or assembled computers are clone, as shown in Figures 4 and 5 respectively.

Figure 4: Sales of second-hand equipment (imported or locally assembled)
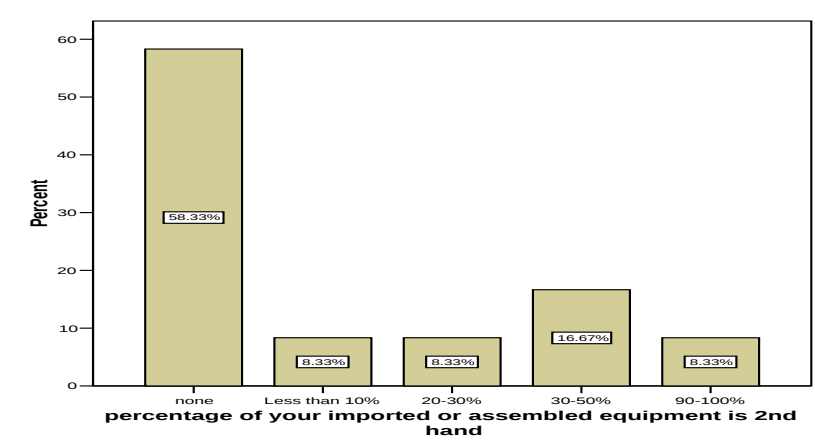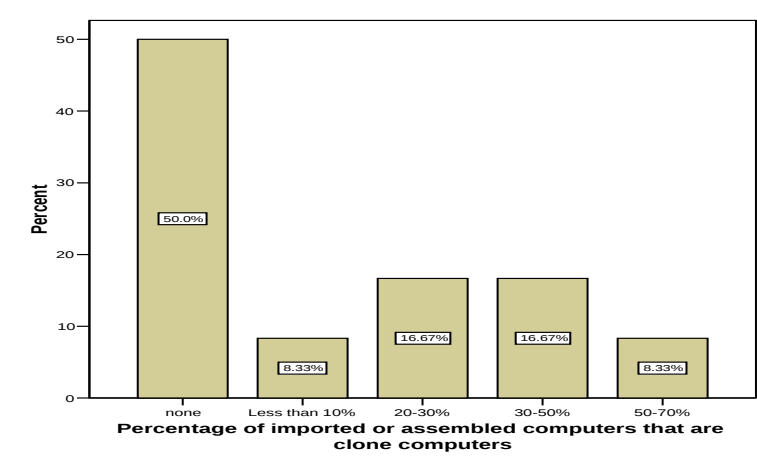
Figure 5: Sales of clone equipment (imported or locally assembled)

The respondents indicated various ways through which the equipment is sold and distributed. 66.7% of indicated that they sell directly to customers, 16.67% sell through appointed distributors, while the rest sell through retail outlets chains.

Of the respondents, only 25% indicated that they have a policy on extended user responsibility. They stated that some of the issues that the policy covers are the trade-in terms, and general terms and conditions that must be met by both user and provider. Finally the importers indicated that the equipment should be valued first and then priced.
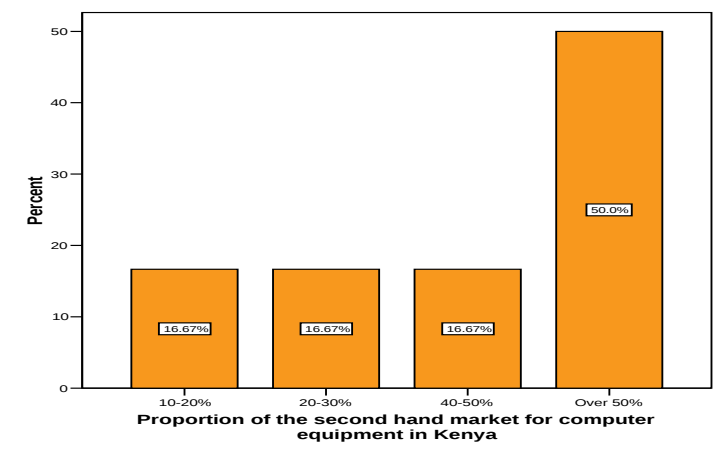
8.1.2 Consumers

Consumers interviewed comprise end-users of the equipment and include government institutions, private institutions and NGOs, among others.

In relation to there being a market for second-hand computers, the results from 50% of the respondents suggest that the market share for second-hand computer equipment in Kenya could be over 50%. Further, the results also suggested that the market share of non-

branded (clone) computers in Kenya is over 50%. Figure 7 below illustrates the situation.

Figure 6: Market penetration of second-hand equipment at consumer level

Once the consumer has used the computer to its end-of-life, the consumer explores mechanisms for disposal.

Table 6 shows the inventory of both new and old equipment from this category of respondents.

Table 6: Total inventory of new and old equipment of the respondents of the field study

Equipment	New	Old	Equipment	New	Old
Desktop computers (PCs)	1,818	222	Telephones	821	204
Notebook computers (Laptops)	1,421	203	Mobile phones	6	0
CRTs	1,657	100	Televisions	32	0
LCDs	1,373	100	Photocopier	65	150
Printers	3,43	201	Fax machines	37	61
Modems	17	70			

From the figures, the current ratio between new and old equipment is very high, with desktop PCs, notebooks, monitors and the flat screens leading the list. The implication is that soon they will get to their end-of-life and will be ready for discarding. As earlier demonstrated, only 25% of the respondents indicated that they had a policy regarding extended user responsibility. This will pose a major challenge when it comes to discarding equipment and final disposal in the next couple of years.
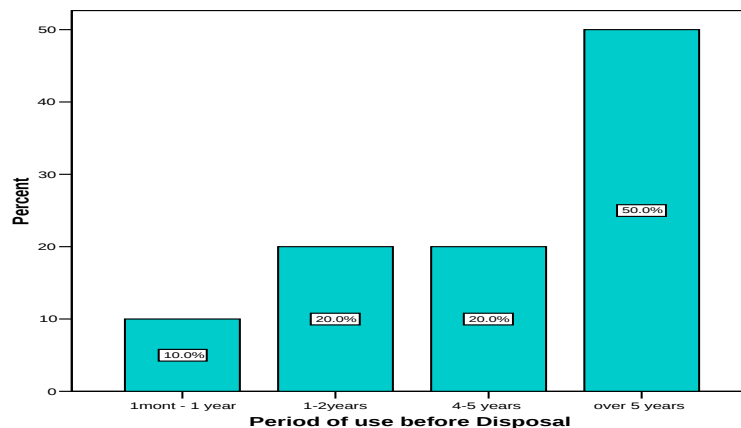
Of the consumer respondents 81.8%, indicated that they purchase their equipment from general distributors, while 54.5% indicated that they purchase from retail outlets or shops. Only 9.1% indicated that they purchase from the formal second-hard market. This is an indication that consumers are purchasing equipment from established operators who *should* be obligated to extend their

responsibility and deploy ways of playing a role in final equipment disposal.

36.4% of the consumer respondents indicated that when the equipment is no longer useful, they store at their own premises. Further, 45.5% indicated that they sell the equipment as second-hand equipment, donate it to schools, or give it to employees, family or friends. Those who either give their equipment to a recycler or disassemble to reuse some parts made a combined percentage of 36.4%. This can be considered the percentage of the equipment that trickles down to the downstream vendors from the consumer level.
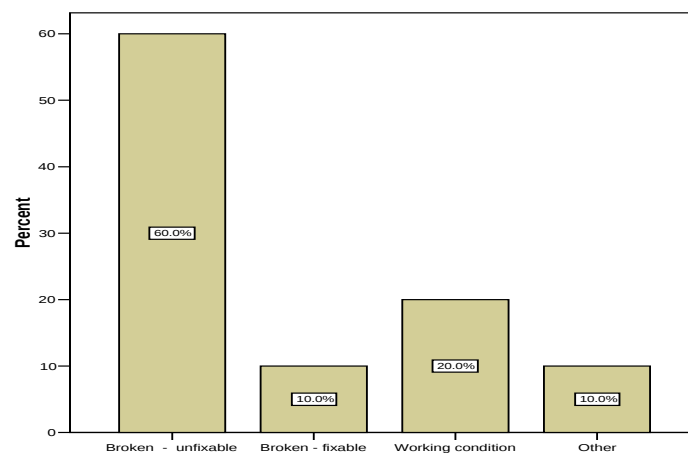
The research noted that 90% of the respondents have discarded ICT accessories of some kind. In particular, 70% have discarded desktop computers and monitors; 50% have discarded notebook computers, printers, telephones, photocopiers, and fax machines; 40% have discarded modems; and 20% have discarded flat screen monitors, mobile phones and televisions. This is an indication of a potentially high accumulation of e-waste. The figure below shows the length of time respondents owned the equipment before they discarded it. Over 50% of the consumers indicated that they kept computers for over five years. Figure 8 illustrates the situation.

Figure 7: Period of use before disposal

Further, 60% indicated that the equipment was in a broken and un-fixable state by the time they discarded it, while 10% indicated that it was in a broken but fixable condition. Only 20% indicated that it was in a working condition. This shows that although 45% of the respondents indicated that they sell their old equipment as second-hand equipment, donate it to schools, or give it to employees or friends, chances are that over 50% of this equipment is in a broken and un-fixable condition, and can be considered e-waste (although some parts of this equipment will be salvaged). Figure 9 illustrates the situation.

The respondents indicated various sources of information on how to dispose of the equipment: this included asset disposal policies, company guidelines and procedures, Government regulations (e.g. government disposal Act which specifies how to dispose of waste), and internal procedures stipulated by management. Others indicated that there is no policy, and most disposal processes are simply cases of dropping off old IT at a garbage collection point, or at the office storeroom. 90% of the respondents indicated that they keep an inventory of the equipment they discard.

81.8% of the respondents indicated that they are aware that some electronic parts may be profitably recycled, as shown in the Figure 10. Further, 42.9% of the respondents indicated that they sold their equipment to the scrap dealers with the knowledge that electronics parts may be recycled profitably, while 71.4% sold to the second-hand market. Others sold to highest bidders in auctions and/or to staff members.

66.7% indicated that they sold at between 10-20% of the equipment original purchase price, while 33.3% indicated that they sold at less than 10% equipment original purchase price as indicated in Figure 9 below.

Figure 9: Market value of end-of-life equipment in relation to its original purchase price
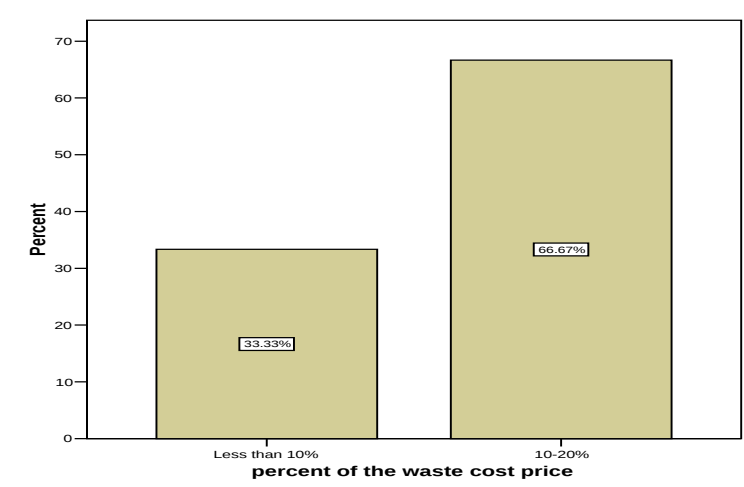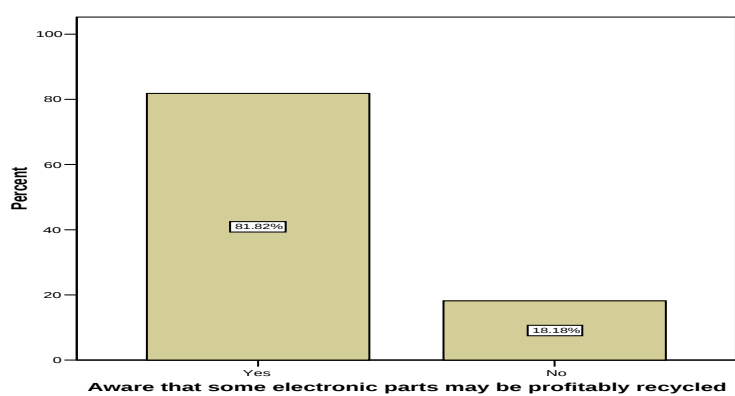
Of the respondents, 27.3% indicated that they were ready to pay for discarded equipment to be collected and recycled, while 72.7% were not ready to pay. Further, 54.55% were aware of companies that collected e-waste for recycling, while 45.45% were not aware. In some instances (44.4%), the company that collects waste picks up the waste at the respondent's doorstep. 55.6% indicated that this does not happen.

Table 7: Modes of discarding old technology

Bond, advertise and sell to the general public	Donation and re-use (e.g. Computer for Schools Kenya)
Sell to general merchants that deal in metal parts and plastics	Store equipment in a room in the building (e.g. office storeroom)
Equipment is dropped at garbage collection points	Give or sell to friends and family

Once discarded, only 18.2% of the respondents were aware of what happens to the equipment while 81.8% had no idea.

8.1.3 E-waste collectors

There is no structured system of e-waste collection, which is often collected as part of general waste.

8.1.4 E-waste refurbishers and recyclers

Refurbishment has been a growing business area in Kenya. Computers for Schools Kenya (CFSK), which is a local NGO dealing in the refurbishment of computers, has established a niche in the sector, including recycling. Material fractions in the form of plastics, ferrous metals and aluminium are easily separated and have found a market mainly in the informal sector, where they are melted and used in the production of agricultural equipment. However, there is no specialised equipment in the country for handling material fractions like copper, printed circuit boards (PCBs), CRT tubes and other hazardous fractions such as lead, mercury and lithium. In the case of CFSK these fractions are currently exported to Europe and Asian countries where there are specialised facilities.

MENR, in its demonstration of commitment to e-waste management, donated Ksh 500,000 to CFSK.

The Department of Environment in the Nairobi City Council (NCC) has registered a number of community-based organisations (CBOs) that compliment their work on waste management. Such organisations are the Kayole Environmental Management Association (KEMA), Mathare Youth Sports Association (MYSA) and the Mukuru Project. International NGOs have been supportive; KEMA, which is engaged in the recycling of plastics to make roofing tiles, among others, have World Vision International, Practical Action and NEMA as its core collaboration team.

8.1.5 Downstream parts and repair market

This sub-sector's main source of material is from e-waste refurbishers (83.3%), followed by e-waste collectors and recyclers, who tally 66.7%. Hardware shops and dumping sites were mentioned as offering the least source material (50%), nevertheless still serving as a viable e-waste stream.

The respondents from these categories were companies formed between 2001 and 2007. This is an indication that it is a new, emerging sub-sector. Of the respondents, 50% are registered legally.

Of the respondents 66.7% indicated that they sell the equipment as parts, while 33.3% said that they used the parts to repair other equipment, as shown in Figure 12. The average revenue from the work was given as Ksh 6000 from 33% of the respondents. The respondents also indicated that their final waste is stored or sold to recyclers, or it is collected by garbage collectors for disposal at the dumpsites at either Dandora or Ngara (behind the market). Amongst other things, they deal with capacitors, transistors, batteries and network cables as common items.

Figure 11: Use of equipment parts

Computer repair business	Dealers in electronic equipment
Individual electronic repairers	Individual customers
Technical colleges and students	Businesses, other vendors and wholesalers
Auto owners and electronic shops	Individuals

8.1.6 Final disposers

Recyclers end up being mostly responsible for final disposal. Unwanted fraction is taken to dumpsites in Dandora or Ngara.

8.1.7 Affected communities: households near dumpsites

The residential areas near Dandora dumpsite observed on our site visit were highly populated with semi-permanent housing. The average income of the residents in the immediate vicinity of the dumpsite is low, some of it earned from waste collection and reclaiming recyclable fraction from the dump, or selling vegetables and food to those working around the dumpsites. All the respondents indicated that they have experienced both positive and negative effects because of waste disposed in the neighbourhood. They indicated that there were fumes emitted from the waste, and that chemical inhalation, and air and water pollution occurred.

The residents felt that companies should be responsible for their own waste and that Government should take a step in implementing better working conditions for collectors and reclaimers, such as providing protective clothes. They further stated that there should be an increase on the number of dumpsites to reduce excess waste at particular sites, or that people living near the current dumpsites should be relocated.

8.1.8 Policy-makers

Two of the respondents interviewed were senior government officers from MENR and MoPHS. While the Ministries have recognised the challenges posed by e-waste, the level of preparedness in terms of policies and regulations is low. This is the case except for the MoIC, which has recognised the potential challenge posed by e-waste and has a clause in its 2006 policy document that specifically addresses the issue. As mentioned the regulator, CCK, is working on enforcement through the Unified Licensing Framework.

While MENR says it is developing a concept paper on e-waste, the Ministry of Local Government (MoLG) is developing a solid waste management policy and the NCC is developing an integrated solid waste management strategy in conjunction with UNEP. Given that NEMA is responsible for promulgating policy guidelines on the disposal of the hazardous waste, the above initiatives demonstrate a non-integrated approach to e-waste management.

The respondents noted that the government has a big role to play in terms of developing a coordinated and structured approach to e-waste management. Annexe 3 contains the full interview reports.

8.2 Social, environmental and economic impacts

The majority of the collection sites, refurbishment centres, and recovery and disposal sites that were visited are located near highly populated areas. Of the respondents with computers, 81.8% indicated that they were aware of the social and environmental consequences of discarded e-waste, while 18.2% were not aware.

Table 9 illustrates the social and environmental consequences that they had noted.

Table 9: Social and environmental consequences of discarded e-waste

Social consequences	Environmental consequences
Affects people's health (e.g. lead poisoning and cancerous mercury can damage human organs)	Causes general environmental damage
Physically hurts people (e.g. cuts, pricks or wounds from discarded waste)	Air pollution, especially when it is burnt
	Pollution by the non-biodegradable equipment
Old batteries and unused toner affect neighbourhood children	Poisoning of the soil and animals
Growth of waste disposal centre has negative effects on children	Blockage of water runoff channels
Loss of appreciation for ICTs	

8.2.1 Social impacts

The research suggested that only about 50% of those working in the e-waste sector had medical cover. From the repair shops visited, most of the staff were seen to be wearing masks and other protective gear. However only 8.3% of the respondents seemed to have undergone thorough training on e-waste management.

The following were the observations made by the researchers. Generally, the staff were found to be exposed to the health and physical risks depicted in Table 11.

Table 10: General observations of health and safety standards

No protective gear for handling equipment	Working unsafely with CRT monitors
Obvious potential for eye damage, back aches and electric shocks	Dangerous objects at the premises (i.e. sharp and heavy computer parts placed in the open)
Many workers in a relatively small shop	Congestion from dust and poor circulation of air generally (e.g. workers in repair sections were in poorly ventilated room)
Lack of dedicated room for storage (congested and shared as office)	Physical risks of falling
Pollution from burning	Certain smells from laser printers that were believed to have a potentially negative health effect

However, in some places, the premises appeared organized and clean.

8.2.2 Environmental impacts

From the interviews, 70% of the respondents indicated that they were aware of the environmental hazards caused by discarded electronic equipment. Further, 73% were aware of the hazardous fractions in e-waste and that they need safe treatment in order to be safely disposed off.

Of the respondents with computers, 90.9% were ready to give away their e-waste free under the following conditions, suggesting an awareness of the environmental impacts of e-waste:

- There were acceptable means of disposal and free pick-up services;
- Proper disposal mechanisms were followed to protect the environment;
- Pick-up services came to premises, and that the waste was crushed before taken away, if possible;

But despite the fact that a high percentage of the respondents are aware of the environmental hazards caused by discarded electronic equipment, only 20% of the respondents have a policy for e-waste management. Of the 80% who do not have a policy on the management of e-waste, only 43.5% were planning to have one. This is a clear indication that the need for e-waste management policy is not yet well understood across all the sectors that formed the sample.

8.2.3 Economic impact

The e-waste sector is an area generating employment both formal and informal. It was noted that on average, vendors are able to make Ksh 6000, which is equivalent to three dollars a day. This is three times more than the World Bank poverty benchmark of a dollar a day.

8.3 Policy considerations

The most important obstacle to proper recycling was identified as a lack of infrastructure and policy within the companies, according to 58% of the respondents. 54% felt that lack of legislation was an obstacle, while the absence of recycling possibilities was rated third by 50% of the respondents. Cost was given the least ranking with 45% of the respondents finding it an obstacle.

The respondents further indicated that a lack of awareness, lack of designated dumping sites, the fact that waste was not separated at source, and a lack of recycling systems have also been obstacles.

Table 10 illustrates the issues that the respondents indicated that they would like to have included in e-waste policy.

Safety and integrity of environment emphasised	e-Waste should be clearly categorized
Proper disposal methods and processes encouraged	Guidelines for disposal developed
Steps taken for e-waste management and recycling should be clear	Roles assignment in the disposal process
Separation at source	Extended user responsibility should be encouraged
Trade-ins with the seller options for recycling or refurbishment encouraged	Sites for disposal created (this could include a centralized managed site, and final disposal sites created at the regional level)
Actions to be taken against those who do not follow the disposal process	Rating of machine at disposal i.e. what is the capability of the machine in terms of efficiency
Age of machine at disposal – at what age should the machine is disposed off e.g. after 2 yrs of use?	

Further, respondents indicated that there should be a policy of zero tolerance on waste in general, that the country's youth should be empowered and given the necessary skills for waste management, that there should be strict government regulations and awareness creation, and that more research should be undertaken to provide alternatives to e-waste management.

Respondents cited various organisations which they suggested should take an active role in the management of e-waste from importation to the point at which it needs to be discarded. The organisations are listed in the roadmap below. From the list, the five most cited were the Government, through the MoIC, MoTI and MENR. Others are NEMA, KEBS, NCC and the Kenya Revenue Authority. Respondents also cited the private sector and civil society.

9 Analysis and interpretation of findings

9.1 Mass flows for the field study

The field study demonstrates that computers enter the Kenyan consumer market in two main ways: firstly, through imports of new and second-hand computers and, secondly, assembly of computers locally to service the local market. A third option is for the consumer to directly import themselves, thereby bypassing the local assembler or computer merchant. Both branded and unbranded computers enter the market through these routes.

To track mass flows of e-waste, the field data was used to construct an idea of the volumes entering the market and supplied to the consumer. Data collected for the period 2004-2007 indicate that a total of 135,385 IT or IT-related units were

imported/assembled. These units are listed in Table 11. Table 11 also indicates the ratio of each unit entering the market against PCs. Using the ratios and applying the weight per unit, the total weight of the various equipment (as presented in Table 11) entering the market per a unit PC is calculated. The value of 100.39kg is used to calculate the mass flows for the stakeholders of the field study.
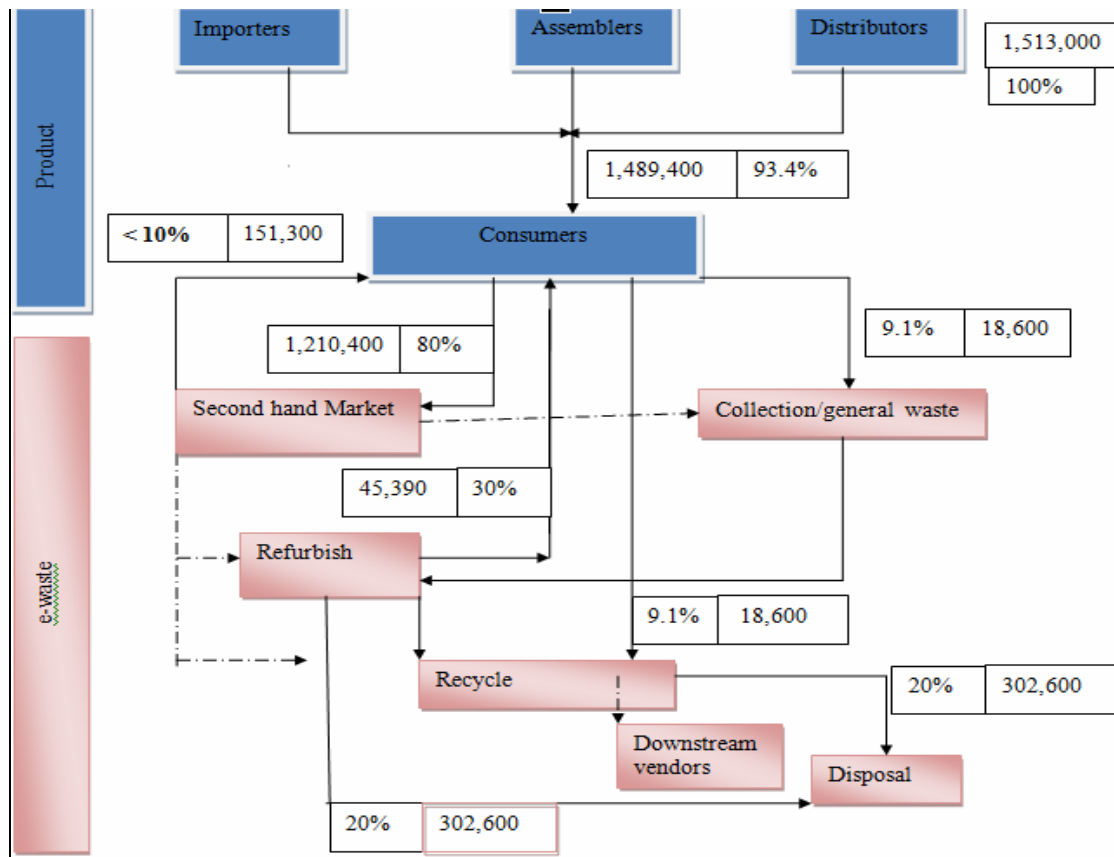
This import/assembled PCs data was compared at distribution level as illustrated in the Table 12, and found to be consistent.

Table 11: Volumes entering the market of the stakeholders of the field study

Equipment imported/ assembled	2007	2006	2005	2004	Total units	Ratio to PC	Wt/unit (kg)	Ratio wt (kg)
Desktop computers (including monitor)	15,130	6,885	6,530	6,400	34,945	1.00	29.26	29.26
Notebook computers	8,288	5,760	5,660	5,600	25,308	0.72	3.51	2.54
Monitors	13,660	5,417	5,415	5,400	29,892	0.86	15.87	13.58
Flat screens	3,775	2,335	2,315	2,300	10,725	0.31	7.72	2.37
Printers	1,455	30	27	0	1,512	0.04	11.7	0.51
Photocopiers	5,010	5,010	5,010	5,000	20,030	0.57	90.96	52.14
Fax machines	13	13	17	0	43	0.00	-	
Modems	8,255	20	25	0	8,300	0.24	-	
UPS	1,790	1,020	1,020	1,000	4,830	0.14	-	
Total	57,376	26,490	26,019	25,700	135,585	3.88		100.39
Equipment supplied/ distributed	2007	2006	2005	2004	Total units	Ratio to PC	Wt/unit (kg)	Ratio wt (kg)
Desktop computers (including monitor)	14,894	6,885	6,530	6,400	34,709	0.99	29.26	29.06
Notebook computers	7,972	5,760	5,660	5,600	24,992	0.72	3.51	2.51
Monitors	13,544	5,417	5,415	5,400	29,776	0.85	15.87	13.52
Flat screens	1,651	335	315	300	2,601	0.07	7.72	0.57
Printers	1,559	30	27	0	1,616	0.05	11.7	0.54
Photocopiers	5,010	5,010	5,010	5,000	20,030	0.57	90.96	52.14
Fax machines	13	13	17	0	43	0.00	-	
Modems	8,019	20	25	0	8,064	0.23	-	
UPS	1,770	1,020	1,020	1,000	4,810	0.14	-	
Total								98.35

The mass flow, based on the 2007 data, is illustrated in Figure 12. It shows that in 2007, 1,513 tons entered the market. However 93.4% of this was supplied to the consumer, suggesting that importers retained a stock of 6.6%. The consumer in addition to receiving 1489.4 tons also received 151.3 tons from the second-hand market.

Anticipating disposal levels poses a significant challenge. From our interviews, we can suggest the following: consumers are likely to dispose 1,210.4 tons to the second-hard market, and 18.6 tons to collectors or as general waste which was sent to refurbishers. The consumer further disposes 18.6 tons directly to recyclers. Refurbishers and recyclers then send 605.2 tons for disposal.

The mass flow diagram suggests that excessive stock is held by the consumer and structures that are not developed enough to handle e-waste disposal, and therefore cause a 'drag' on waste volumes.

There are huge amounts of old technology or e-waste being held by the consumer. The consumer has a total of 1,640 tons comprising of the new equipment and what comes from the second-hand market that could be disposed. While 1,210.4 tons is disposed in the second-hand market, the documented outflow to the refurbishes and the collectors is much lower, suggesting a huge stock is held back by the consumers. In the field interviews, consumers confirmed this position indicating that a lot of the old technology is held in storage due to a lack of clear strategies and processes for disposal. Disposal options vary widely depending on the user. Government and parastatals have to bond the computer and invite competitive tenders for disposal as scrap in line with procurement procedures. This is a slow process and cumbersome. Research revealed that obsolete computers are still in government stores. Private sector corporations often donate the computers as charity

to deserving users. Other institutions dump them in repair shops, which mean repair shops have huge quantities of unusable computers and do not know how to handle the waste. Collector, refurbisher and the recycling infrastructures are generally not developed and therefore the flow down the value chain has much lower volumes. CFSK ships out computer components, such as monitors, to Europe for safe disposal due to a lack of local capacity.

9.2 Mass flows for Kenya

The above model anticipates projected e-waste levels for IT that was sold into the market in 2007. The estimates below are based on the national stock of computers estimated from previous studies across the various sectors, in particular Waema (2007). This includes the Government stock of PCs in use. Companies typically depreciate computers over a three-year period. From this point the computer is amenable for disposal. Field research indicates that most of the disposal takes place after up to five years of use or later. This suggests a disposal rate of the 20% of new stock per year. The research further indicated that the disposal by the first owner usually involves feeding it to the second-hand market. Based on the above, a final disposal rate of 10% is assumed. This means that it is reasonable to estimate of an annual e-waste volume of 2,984.35 tons, as illustrated in Table 13. This is the challenge that e-waste management strategy needs to address.

Table 12: Annual estimate of e-waste in Kenya

Item	Assumptions	Tons of e-waste per year
Overall	850,000 PCs. One printer for every two PCs	
PCs (excluding monitor)	10% discarded every year; waste in one year = 13.39 kg for each PC.	1,138.15
CRT monitors	10% discarded every year; waste in one year = 15.87 kg for each CRT monitor.	1,348.95
Printers	10% discarded every year; waste in one year = 11.7 kg for each printer.	497.25
Total		**2,984.35**

Note: The table gives an estimated volume of e-waste accumulation per year. The estimates are limited to three categories of e-waste equipment namely PCs, CRT monitors and printers.

9.3 Downstream market infrastructure

The resultant downstream market is not fully developed to address both economic opportunities and safety and environmental concerns raised by e-waste. Field research revealed that Kenya does not have the capacity to extract all of the value from e-waste. Local industries, however, have the capacity to recover plastics, ferrous metals and aluminium, and sell the same to various users, including the informal market. On the other hand, the research did not find local industries with the capacity to deal with

copper, precious metals, and CRTs and other hazardous fractions. The extent of local capacity is illustrated in Table 14.

Material Fraction	Recycling in Kenya?	Possible downstream partners
Plastic	Yes	Sold to the informal sector. One major client is an engineer based in Kiambu operating under a company called Femo Works. He has been in the business for 20 years working with metals. Due to high cost, he now uses hard plastic from CFSK which he melts. He uses this to make automotive parts.
Ferrous metals	Yes	Sold to partners in industrial area, who then melt and supplies them to metal and scrap dealers. Most operate informally. They are members of the Kenya Iron and Scrap Metal Association (Kisma)
Aluminium	Yes	Aluminium from computers is also sold to dealers in the industrial area.
Copper	No	There is no capacity to deal with this at the moment. It is shipped out to the UK, and Asian counties such as India, China, Japan and Hong Kong, depending on demand.
Printed wiring boards (precious metals)	No	Currently no capacity in the country. Extraction of metals from the board is complicated due to the level of integration. Partnerships have been established with a company in UK, and Asian countries.
CRT tubes (containing lead, beryllium, phosphor etc.)	No	For some monitors, the motherboard is removed and replaced with a TV motherboard and sold or donated to communities or schools. Irreparable monitors are shipped to Norway in a partnership with FAIR, an international nonprofit NGO based in Norway, where there is guaranteed safe disposal.
Hazardous fraction (mercury in backlights, batteries etc.)	No	There are local companies that buy lead-based batteries and recycle them into new batteries. One such company is a lead batteries production company based in industrial area. Other batteries, such as lithium-based batteries, are shipped out.

Without industries to handle copper, precious metals, CRT tubes and hazardous fractions, dealing with e-waste will continue to be a problem. It is necessary that the development of this capacity is prioritised, since the volume of e-waste will continue increasing and pose an even greater challenge in the future.

In developing a framework to manage e-waste, it is necessary to create awareness of the opportunity it presents. A greater challenge is to create a framework to consolidate e-waste to collection points to make a business case for investment in e-waste handling.

9.4 SWOT analysis

The research established that the current unstructured e-waste management system has both strengths and weaknesses. Some of the

key strengths include that volumes are still at a manageable level; that it generates employment and revenue for a significant number of Kenyans; that MENR has developed a concept paper on e-waste and that MoLG is developing a solid waste management policy; that the NCC is developing an integrated solid waste management strategy in conjunction with UNEP; and that there is significant refurbishment taking place in the country.

In terms of weaknesses, the research noted that the lack of an e-waste management system had led to e-waste being stockpiled at homes, offices and repair shops, and that there was limited national capacity to process e-waste. In addition, the research found that e-waste has environmental consequences such as blocking water run-off channels.

The fact that stakeholders in the e-waste management system are not recognized by the policy and legislative framework has worsened the situation. There is no mechanism to implement good policy intentions such as that of the national ICT policy, essentially crippling these initiatives.

These weaknesses are compounded by the fact that people are not able to afford new ICT equipment and a significant amount of second-hand stock, with a short life span, is finding its way into the country.

The study established that the lack of a policy and regulatory framework and clear mechanisms to separate e-waste from other solid waste has led to final disposal being hazardous, with environmental consequences. A case in point is the possible depletion of the ozone layer, which is a serious threat. Other threats include that e-waste has negative effects on those working in businesses which serve as dumping places for discarded technology. It has the potential to also affect communities living near the dumpsites.

However, not all is lost. E-waste has created employment opportunities, and the informal recycling businesses and those that have been developed around dumpsites can be formalized. It was noted that available funds, such as Constituency Development Fund (CDF), youth and women funds, can be used by small entrepreneurs to improve the lives of the various communities. Other opportunities include the fact that some manufacturers (e.g. Sony Ericsson), suppliers and service providers (e.g. Safaricom) have shown a commitment to take back used equipment, and that stakeholders, in particular consumers, are willing to contribute to e-waste management. Significantly, the Government, through the NCC, has allocated land to CFSK to build a national e-waste recycling centre, and that Safaricom and MENR have been supporting the initiative. Table 15 captures these and other issues.

Table 14: SWOT analysis

Strengths	Weaknesses
- Kenya has taken note of the e-waste challenge and key stakeholders are involved - Currently driven by demand and available volumes - Volumes are at a manageable level - Employment creation and revenue generation - MENR concept paper being developed - MoLG is developing a solid waste management policy - CCK has built e-waste management into licensing conditions - NCC is developing an integrated solid waste management strategy in conjunction with UNEP - Significant level of refurbishment taking place	- Low national priority for e-waste - Lack of coordinated approach across the Ministries to deal with e-waste - Lack of awareness of the need for an e-waste management system - No mechanism to implement the policy intentions (e.g. MoIC policy statement) - Players in e-waste not recognized by the policy and legislative framework - Limited national capacity to process e-waste - Lack of a mechanism to separate e-waste from solid waste - No or limited extended supplier responsibility - Lack of affordability of new IT - Lack of collection systems leads to e-waste being stockpiled at homes, offices and repair shops.
Threats	**Opportunities**
- Dumping by developed nations - Final disposal is hazardous - No regulatory and policy structures to safeguard health, environmental and social consequences of e-waste - Limited capacity of MENR, NEMA and other government agencies to deal with e-waste - Visible environmental impact (e.g. e-waste has environmental consequences such as blocking water runoff channels) - Significant amount of second-hand equipment in the market with short lifespan - Potential political instability	- Willingness by stakeholders to contribute to e-waste management - NCC has allocated land to CFSK to build a national e-waste recycling centre. Others are supportive of this e.g. (Safaricom, MENR) - Employment opportunities - Informal business in recycling and found around dumpsites can be formalized - Capacity in informal businesses can be developed - Some manufacturers (e.g. Sony Ericsson) and suppliers and service providers (e.g. Safaricom) have shown commitment to take back old equipment - E-waste management facilities exist in other countries and these can be leveraged - Funds available that can be used by small entrepreneurs (e.g. CDF, youth and women funds) - ICTs recognized in government's long term plan - vision 2030 as a source of job creation and e-waste issues can ride on that - Stockpiled equipment can be accessed to increase volumes and business case for recycling

10 Conclusions, recommendations and roadmap

10.1 Key conclusions

The following key conclusions can be drawn from the research:

- E-waste is expected to be a huge problem in the future, given the rise in importation in 2007. It is imperative that measures are put in place to address the emerging challenge;
- There is high accumulation of old ICT equipment in homes, offices and repair shops because the owners are not aware of disposal options and whether it has any residual value;
- Knowledge on where to discard e-waste is lacking right from the consumer to the final disposer;
- E-waste management policies are lacking, and there is no legislation to deal properly with the challenge.

10.2 Recommendations

Arising from the conclusions the following recommendations are proposed:

- MENR needs to promulgate a policy and develop specific regulations on e-waste. This should govern the handling process from collection to final disposal, and licensing of key actors including ways they will be supported to ensure safety. Other ministries that need to be engaged are the Ministries responsible for ICTs and MoPHS;
- MENR and related stakeholders need to create awareness of e-waste and the safe handling of e-waste. A key focus should be to create awareness on how to dispose unusable equipment through an organised collection and disposal system;
- Local Authorities should require that e-waste is collected and disposed off separately from solid waste by e-waste collectors. Waste should be sorted at source;
- NEMA should set training standards for personnel handling e-waste to be enforced by the Local Authorities. Awareness and training programmes for staff should be developed and implemented;
- MENR and NEMA should encourage the growth and expansion of recycling capability in Kenya to avoid the high costs of shipping equipment back to Europe that is incurred by organisations pioneering recycling;
- NEMA should establish a mechanism to raise funds for the expensive process of e-waste management. An option is to charge a fee to the suppliers of old equipment or those who want to dispose large volumes of equipment in the country;
- Local Authorities should establish disposal sites far from residential areas due to health concerns;
- MENR should encourage and acknowledge the role of civil society stakeholders in creating awareness and conducting research on e-waste. To this extent KICTAnet and its

partners, as well as CFSK, should be supported in their pioneering work on e-waste.

10.3 E-waste road map

This research demonstrates conclusively the need to establish an e-waste management system with policy, regulatory and operational components. A roadmap is proposed to address the challenges of e-waste as shown in the Table 15.

Table 15: Road map

Issue	Why an issue	Strategy	Responsibility	Time Frame
Policy	- Existing policy framework does not address e-waste management - Disjointed policy initiatives - Needed to deal with negative social and environmental impacts - Possibility of increased dumping	Develop policy framework for e-waste management with various components, such as: - Safe disposal procedures - Extended user responsibility - Extended manufacture responsibility - Dumping consequences - Business opportunities - Separation at source - Addressing useful lifespan of the technology to avoid damping	MENR, MoPHS, MoIC, MoTI, MoLG, Directorate of E-government. Other Significant stakeholders to be involved: - Consumers - Manufactures - Suppliers - NGOs	2008/2009
Legislation	- EMCA does not address e-waste management specifically - Existing regulations do not address e-waste management	Develop regulations for EMCA	NEMA, KEBS with stake-holders	2008/2009
Regulatory framework	- No regulatory framework for e-waste management	- Develop licences for all e-waste operators and actors - Set training standards for personnel handling e-waste to be enforced by the local authority - - Establish safe disposal sites	NEMA, MoLG, MoPHS, Local Authorities	2008/2009
Negative impacts	Negative social and environmental impacts	Establishment of e-waste collection system	NEMA, MENR, MoLG	2008/2009

Issue	Why an issue	Strategy	Responsibility	Time Frame
		Build capacity for stakeholders to handle e-waste	MoTI, Ministry of Labour, MoIC, NEMA, (MoPHS)	2008/2009
		Establishment of infrastructure to handle e-waste	Ministry of Higher Education, Ministry of Science & Technology	2009/2010
		Support for existing and new initiatives	Ministry of Energy (MoE), MoLG, private sector.	Continuous
		Raising awareness on e-waste management at all levels	NEMA, MoLG, Computer Society of Kenya, media, private sector	Continuous
Positive impacts	- Sales of fractions generates income (business opportunity) - Employment opportunities	- Invest in e-waste management - Harness opportunities for increased income generation and job creation	Ministry of Labour, Ministry of Higher Education S&T, KEBS	2009/2010

As a way forward, the research identified three priority areas that need immediate attention, as shown in Table 17.

Table 16: Key priority areas

	Priority Action	Lead Stakeholders	Champion
1	Advocacy/awareness creation	NEMA, KICTAnet, KRA, KEBS, KEPSA,	KICTAnet
2	Amendment of Waste Management Regulations 2006	NEMA, MoPHS, MoLG, MENR	MENR
3	Setting up facilities/processes for e-waste handling	NEMA, CCK, MoPHS, MoLG, MENR, Ministry of Higher Education S&T	MoPHS,

Further, the following actions were deemed necessary:

- Members of parliament should be sensitized and involved in the e-waste management process;
- KICTAnet should facilitate/coordinate meetings and activities on identified priorities areas listed in Table 16;
- Benchmarks from other countries should be used, and information-sharing between countries encouraged;
- E-waste management should be mainstreamed to the government's long term plan - vision 2030.

11 References

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CBS (Central Bureau of Statistics), Economic Survey 2007, Ministry of Planning and National Development, GoK, Nairobi

CCK (Communications Commission of Kenya) 2007, Internet Market analysis report commissioned to Netcom Systems, CCK, Nairobi

GoK (Government of Kenya) 1999; The Environmental Management and Co-Ordination Act, 1999, Ministry of Environment and Natural Resources, GoK, Nairobi

GoK (Government of Kenya) 2003; Kenya Economic Recovery Strategy for Wealth and Employment creation; 2003-2007, GoK, Nairobi

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GoK (Government of Kenya) 2006; Environmental Management and Co-Ordination Regulations, 2006, Ministry of Environment and Natural Resources, GoK, Nairobi

MoIC (Ministry of Information and Communication) 2006 National ICT Policy for Kenya 2006, ROK, Nairobi,

Waema, T. M (2007) Kenya Telecommunications Sector Performance Review: a supply side analysis of policy outcomes, University of Nairobi, Nairobi

Web resources

- CCK, http://www.cck.go.ke
- NCC, http://www.nairobicity.org
- Swiss e-waste guide, http://ewasteguide.info/newsandevents

12 Annexes

12.1 Methodological framework

Stakeholder	Description	Qualitative issues or indicators	Quantitative indicators	Sources of data
Manufacturers and importers	Organizations manufacturing, assembling and/or importing technology (i.e. electronic and electrical goods).	Marketing CSR	Market share for major brands Growth forecasts Annual imports of new equipment Annual imports of second-hand equipment % import vs % domestic % branded vs % clone	Manufacturers Major importers Assemblers IT associations KRA Mobile operators Secondary sources Association of mobile phone dealers
Distributors	Bodies selling technology directly to consumers – vendors, distributors and retailers	Modes of distribution Importance of second-hand market Importance of non-branded market	No. of retail shops Size of formal second-hand market Size of informal second-hand market	Brand EEE suppliers Formal second-hand technology suppliers e.g. CFSK, CAI, Diamond systems Informal second-hand technology suppliers Secondary sources CSK
Consumers	Bodies that consume technology and discard them as waste when they	Modes of consumption Modes of disposal	PCs per 100 inh. E-waste in tons generated	Private (HHs) E-government Large

Stakeholder	Description	Qualitative issues or indicators	Quantitative indicators	Sources of data
	have reached useful end-of-life	Access to new technology Awareness of social & environmental issues	per capita Life span private vs life span corporate % technology in business vs % technology in govt % technology in large enterprises vs % technology in SMEs % technology in homes vs % technology in corporate	enterprises SMEs Secondary sources
Collectors	Bodies that collect e-waste	Formal vs informal collectors Consumer pays or is paid for e-waste Any take back scheme Municipal collectors of waste generally	E-waste collected per inhabitant Persons employed per ton collected No. of employees on e-waste collection	Formal collectors Informal collectors Kimathi Resource Centre
Refurbishers	All the repair units, service centres, etc, that extend the life time of equipments and feed the second hand market	Sector organization Degree of formality (registration, pays taxes, etc.) Interaction with other value-adding players	% of repairable e-waste Revenue per refurbished equipment Lifespan of refurbished equipment Average age of equipments to repair	Service centres Repair shops CFSK Kimathi Resource Centre ALIN business arm

Stakeholder	Description	Qualitative issues or indicators	Quantitative indicators	Sources of data
Recyclers	Organizations dismantling, separating fractions, and recovering material from e-waste	Sector organization (formal/informal) E-waste re-cycling industry? Which fractions produced Disposal of non-valuable fractions	% formal vs % informal Persons/ton employed in re-cycling No. of fractions produced No. of fractions disposed of By-products per ton of e-waste Yearly tons handled by recyclers Gross annual revenue from recycling	Formal recyclers Informal recyclers Secondary sources
Downstream vendors	Industries buying fractions (e.g. copper, plastics, metals, gold, etc.) produced by the recyclers	Industries that use materials from recycling Does material remain in informal market or is re-injected to formal economy What gets exported and in what status	% of raw materials from one ton of e-waste Usage of raw material Revenue per kg of materials sold	Formal vendors Informal vendors
Final disposers	Organizations in charge of final disposal of waste through incineration or landfilling	How is e-waste treated? Formal or informal (dump sites, open burning, etc.) Agencies in charge of solid waste disposal Restrictions on landfill space? Infrastructure	Available landfill volume in Kenya Tons/year of hazardous waste % of e-waste in municipal solid waste (e.g. Dandora)	Formal Informal (e.g. dumping sites, open burning, etc.) Government

Stakeholder	Description	Qualitative issues or indicators	Quantitative indicators	Sources of data
		for hazardous waste?	% formal vs. informal disposal	
Most affected communities	Communities that have – by proximity to collection points, refurbishment / recycling centres or disposal areas – key interests in the development of an e-waste management system, including creating business out of e-waste. This might include interests regarding the sector's economic possibilities or interests in limiting soil, water and air pollution	Serious health risks to the community Quality of jobs compared to local alternatives at the same level of education Positive or negative influence on other social and economic activities	No. of high skilled jobs in e-waste No. of low skilled jobs in e-waste No. of cases of negative health impacts No. of cases of increased health risks (e.g. visible soil or air contamination)	Persons from affected and non-affected communities
Others	Institutions with capacity to support implementation of an e-waste management system	Organizations active in solid waste management Organizations working with informal sectors International funding for e-waste Organizations implementing e-waste management		NGOs International bodies NEMA Ministry of Environment
All		Positive and negative social impacts Positive and negative environmental impacts		All stakeholders

Stakeholder	Description	Qualitative issues or indicators	Quantitative indicators	Sources of data
		Positive and negative economic impacts		

12.2 e-Waste assessment questionnaire

A. General

1. Date: _____   Interviewer:_____
2. Interviewee:_____ Position:_____
3. Name of institution: _____
4. Type of institution:

Government ☐   Private co. ☐   NGO ☐   International ☐   Informal business ☐

Other (Specify) ………………………………………………..

5. Type of stakeholder (Please tick ☑):

Importer	☐	Supplier	☐
Assembler	☐	Distributor	☐
Corporate consumer	☐	Individual consumer	☐
Collector	☐	Refurbisher	☐
Recycler	☐	Downstream vendor	☐
Final disposer	☐		

Other (Specify) ………………………………………………..

6. Address:

P.O. Box	
Code	
Location	
Town	
District	
Province	
Telephone	
E-mail	
Fax	
Web site	

7. Principal activity of the institution _____

8. Number of employees and the age bracket:

	10-20 Yrs	21-30 Yrs	31-40 Yrs	41-50 Yrs	Above 51
Female					
Male					
Total					

9. Is your institution ISO 14001[3] certified?   YES ☐   NO ☐

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[3] ISO 14001 is an internationally accepted standard that sets out how you can go about putting in place an effective Environmental Management System (EMS). The

10. What brand of computers (desktop) do you deal with?
   IBM ☐   Dell ☐   HP/Compaq ☐

   Others (Specify)

   _____

11. What brand of Laptops (notebooks) do you deal with?
   Toshiba ☐   Sony ☐   HP/Compaq ☐
   IBM ☐   Dell ☐

   Others (Specify)

   _____

B. ICT Importers, Suppliers, Assemblers and Distributors

12. Which products do you deal with?
Desktop computers (PC)   ☐   Notebook computers (Laptop) ☐
Monitors (CRTs)   ☐   Printers   ☐
Flat screens (LCDs)   ☐   Photocopier   ☐
Mobile phones   ☐   Fax machines   ☐

Modems   ☐   UPS   ☐

Others, specify
_____

13. How many equipment of the following types did you import or assemble in
   the last four years?

Equipment	2007	2006	2005	2004
Desktop Computers (PC)	_____	_____	_____	
Notebook computers (Laptop)	_____	_____	_____	
Monitors (CRTs)	_____	_____	_____	
Flat screens (LCDs)	_____	_____	_____	
Mobile phones	_____	_____	_____	
Printers	_____	_____	_____	
Photocopier	_____	_____	_____	_____
Fax machines	_____	_____	_____	
Modems	_____	_____	_____	
UPS	_____	_____	_____	_____
Other, specify	_____	_____	_____	

14. How many of the imported or assembled equipment did you supply and
   distribute in the last four years?

Equipment	2007	2006	2005	2004
Desktop Computers (PC)	_____	_____	_____	
Notebook computers (Laptop)	_____	_____	_____	

standard is designed to address the delicate balance between maintaining
profitability and reducing environmental impact

Monitors (CRTs)   _____   _____   _____
_____

Flat screens (LCDs)   _____   _____   _____
_____

Mobile phones   _____   _____   _____
_____

Printers   _____   _____   _____
_____

Photocopier   _____   _____   _____   _____
Fax machines   _____   _____   _____
_____

Modems   _____   _____   _____
_____

UPS   _____   _____   _____   _____
Other, specify   _____   _____   _____
_____

15. What percentage of your imported or assembled equipment is 2nd hand?

None ☐   Less than 10% ☐   10-20% ☐
20-30% ☐   30-50% ☐   50-70% ☐
70-80% ☐   80-90% ☐   90-100% ☐

16. What percentage of your imported or assembled computers are clone computers?

None ☐   Less than 10% ☐   10-20% ☐
20-30% ☐   30-50% ☐   50-70% ☐
70-80% ☐   80-90% ☐   90-100% ☐

17. How do you distribute your computer equipment?

Sell directly to customers ☐   Through appointed distributors ☐
Sell directly to retail outlet chains ☐

Others, specify
_____

18. How many retail outlets sell your computer equipment in Nairobi?
_____

19. What in your view is the proportion of the second hand market for computer equipment in Kenya?

Less than 10% ☐   10-20% ☐   20-30% ☐
30-40% ☐   40-50% ☐   Over 50% ☐

20. What in your view is the proportion of non-branded (clone) market for computer equipment in Kenya?

Less than 10% ☐   10-20% ☐   20-30% ☐
30-40% ☐   40-50% ☐   Over 50% ☐

21. Do you have a policy on Extended User Responsibility (EUR)? (a policy of re-owning /purchasing equipment from consumers after equipment's end-of-life) YES ☐   NO ☐

22. If YES, please explain.

_____
_____

C. Consumer (Government, private institutions, NGOs and individuals)

23.   How many of the following new or second hand equipment do you have?

                                                            New   2nd hand
Computers accessories (including cables, cartridges, mouse, keyboard)
      _____ _____
Desktop computers (PC)
Notebook computers (Laptops)   _____   _____
Monitors (CRTs)   _____   _____
Flat screens (LCDs)   _____   _____
Printers   _____   _____
Telephones   _____   _____
Mobile Phones   _____   _____
Televisions   _____   _____
Photocopier   _____   _____
Fax Machines
Modems   _____   _____
Others, specif   _____   _____

24.   Where did you acquire your equipment from? (Tick 2 of the most common)?

Retail outlet or shop   ☐
General distributor   ☐
Leased   ☐
Formal 2nd hand market   ☐
Informal 2nd hand market   ☐

Others, specify
_____

25.   What do you do with the equipment when it is no longer useful?

Store in own premises   ☐
Sell as 2nd hand equipment   ☐
Throw them away with general waste   ☐
Give them to a recycler   ☐
Donate to family, schools, employees, friends, etc.   ☐
Return to the seller on a buy-back arrangement   ☐
Give back at the store for a reduction on the price of a new equipment   ☐
Disassembled to reuse some parts   ☐

Others, specify
_____

26.   Have you ever discarded any of the following equipment?

Computers accessories (including, cartridges, mouse, and keyboard)
       YES   ☐   NO   ☐Desktop Computers (PC)
               YES   ☐   NO   ☐
Notebook computers (Laptop)   YES   ☐   NO
☐
Monitors (CRTs)   YES   ☐   NO
☐
Flat screens (LCDs)   YES   ☐   NO
☐
Printers   YES   ☐   NO
☐
Telephones   YES   ☐   NO   ☐
Mobile Phones   YES   ☐   NO
☐
Televisions   YES   ☐   NO   ☐
Photocopier   YES   ☐   NO   ☐
Fax Machines   YES   ☐   NO
☐

Modems   YES   ☐   NO
☐
UPSs   YES   ☐   NO   ☐
Others (specify) _____   YES   ☐
            NO   ☐

27.   For how long did you possess the equipment before you discarded (became
      obsolete)?

1 month-1 year   ☐   1-2 years   ☐   2-3 years   ☐
3-4 years   ☐   4-5 years   ☐   Over 5 years   ☐

28.   In what condition was the equipment when you discarded it?

Broken – unfixable   ☐
Broken – fixable   ☐
Working condition   ☐

Other, specify
_____

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

YES   ☐   NO   ☐

28. What is your source of information on how to discard/dispose the equipment?
_____
_____
_____

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

YES   ☐   NO   ☐

31.   If the equipment was sold, who did you sell it to?

The scrap collector   ☐
The 2nd hand market   ☐

Others, specify
_____

32.   Would you be ready to pay for your discarded equipment to be collected and
      recycled?

YES   ☐   NO   ☐

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

YES   ☐   NO   ☐

34.   Does the company (waste collectors) come and pick-up waste at your door?

YES   ☐   NO   ☐

35.   If yes, do they buy the waste from you? At what percent of the cost price?

Less than 10%   ☐   10-20%   ☐   20-30%   ☐
30-40%   ☐   40-50%   ☐   Over 50%   ☐

36.   If no, what process do you use to discard the e-waste equipment?
_____
_____

_____
_____

37.   Are you aware of what happens to the equipment you have discarded?

YES   ☐   NO   ☐

38.   Are you aware of the social and environmental consequences of discarded
      electrical and electronic equipment?

YES   ☐   NO   ☐

39.   What social consequences have you noticed of discarded electrical and
      electronic equipment?

_____
_____

40.   What environmental consequences have you noticed of discarded electrical
      and electronic equipment?

_____
_____

41.   Would you be ready to give away your e-waste for free?

YES   ☐   NO   ☐

42.   If yes, with what conditions? (e.g. pick-up service, guarantee of proper
      disposal, etc.) Provide details
_____
_____
_____

D.   E-waste Collectors

43.   How do you identify the e-waste to be collected?
_____
_____
_____
_____

44.   How do you do the actual e-waste collection?

Pick-up e-waste door to door?   ☐
Have a common collection point   ☐
Pick from garbage disposal gardens   ☐
Send municipal collection lorries   ☐

Others, specify

_____

45.   Under what financial arrangements do you collect e-waste?

Consumer pays   for collection of e-waste   ☐
Purchaser pays   for the e-waste   ☐

Others, specify

_____

44.   Do you separate the general waste from E-waste?

YES   ☐   NO   ☐

46. How many of your staff members are assigned the task of collecting e-waste? _____

47. How many tons of computer waste did you collect in 2007? _____

48. Is the way e-waste is currently collected convenient to you?

YES ☐   NO ☐

49. If no, what can be improved?

_____
_
_____
_
_____
_
_____
_

50. After collecting the e-waste, what do you do with it?

Dismantle and sell as parts   ☐
Repair and sell as 2nd hand (recycle)   ☐
Deposit to a refurbishing firm   ☐

Others, specify
_____

51. Have you and members of your organization undergone any training on E-waste collection and management?

YES ☐   NO ☐

52. On average, how much money do you make per month from E-waste collection?

Less than 15,000 ☐   15,100 – 30,000   ☐   30,100 – 50,000
                 ☐
50,100 – 100,000 ☐   Over 100,000   ☐

E. E-Waste Refurbishers and Recyclers

53. Is the organization formally registered?

YES ☐   NO ☐

54. How many staff do you have? _____

55. Which kind of processes takes place at this site?

Dismantling   ☐   Segregation   ☐   Cable
stripping ☐
Shredding   ☐   Precious metal recovery   ☐
Separating fractions ☐   Recovering material from e-waste
                   ☐

Others, specify
_____

56. Describe how the refurbishing or re-cycling business is organized.
    _____

_____
____

57. Describe the type of interactions (formal or informal) you have with other refurbishers or re-cyclers.

_____
____

_____
____

58. What equipment do you refurbish or recycle? (Tick where appropriate)

Desktop computers (PC)   ☐   Notebook computers (Laptop) ☐
Monitors (CRTs)   ☐   Printers   ☐
Flat screens (LCDs)   ☐   Photocopier   ☐
Mobile phones   ☐   Fax machines   ☐

Printer cartridge refill   ☐   Modem   ☐
UPS   ☐

Others, specify
_____

59. How many tons of e-waste did you collect in 2007? _____

60. What percentage of this was repairable e-waste?

Less than 10%   ☐   10-20%   ☐   20-30%   ☐
30-40%   ☐   40-50%   ☐   Over 50%   ☐

61. What percentage of the e-waste collected is disposed of?

Less than 10%   ☐   10-20%   ☐   20-30%   ☐
30-40%   ☐   40-50%   ☐   Over 50%   ☐

62. What was the average revenue per ton of refurbished or recycled equipment?
    _____

63. What is the average age of refurbished equipment?

1 month-1 year   ☐   1-2 years   ☐   2-3 years   ☐
3-4 years   ☐   4-5 years   ☐   Over 5 years   ☐

64. What main products are produced from the refurbishment or recycling processes?

a). _____
b). _____
c). _____
d). _____
e). _____

65. What protective measures, tools and equipment are given to staff to protect them from potential harmful chemicals and emissions?

Gloves   ☐   Face masks ☐   Overalls uniforms   ☐
Boots (shoes)   ☐

Others, specify
_____

66. What key expertise is needed in the refurbishing or recycling business?

    a).   _____
    b).   _____
    c).   _____

67. How many people are involved in the process?
   _____

68. Visual assessment of the amount of material processed *(kg per year; daily figures come in table input) Photos of site (e.g. overview, storage area)*
   _____
   _____
   _____
   _____

69. What do you do with the materials that are no longer useful?

Dispose off with other rubbish   ☐
Keep in the store   ☐
Burn   ☐

Others, specify
_____

70. Visual assessment of the environment in terms of gas emissions, dirty water etc. *(Condition of the buildings and vegetation around to be noted)*
   _____
   _____
   _____
   _____
71. What should be done to implement proper recycling channels in Kenya?
   _____
   _____
   _____
   _____
   _____
   _____
   _____
   _____
   _____
   _____

On average, how much money do you make per month from E-waste recycling & refurbishing?
Less than 50,000   ☐   50,100 – 100,000   ☐   100,100 – 200,000   ☐
200,100 – 500,000   ☐   500,100 – 1,000,000   ☐   Over 1,000,000   ☐

G.   Downstream Vendors

72. When did you start the E-waste vendor business?
   _____

73. Are you a legally registered business entity (Formal organization)

   YES   ☐   NO   ☐

74. What parts/equipment/gadgets do you deal with?

   Capacitors   ☐   Transistors ☐   Batteries   ☐
   Network cables ☐   Others   ☐

   Others, specify
   _____

75. From where do you get the equipment parts/fractions?_____

E-waste collectors ☐   Hardware shops ☐   E-waste recycler ☐

E-waste refurbisher ☐   Dumping site ☐

Others, specify

_____

76. How do you use the parts/fractions?

Repair broken equipment ☐   Sell them as parts ☐
Make new products ☐

Others, specify

_____

77. List three categories of your clients.

a) _____
b) _____
c) _____

78. On average what is the revenue per kg of materials sold?

_____ _____

79. Where do you dispose the unusable materials?

_____

H. Final Disposers

80. What are the main materials that you dispose off?

Plastic ☐   Metal ☐   Computer screen ☐
Laptop screen ☐   Mouse ☐   Keyboard ☐
Computer cables ☐   Mobile ☐   Telephone headsets ☐
Modems ☐
Others (Specify)

_____
_____
_____
_____

81. Where do you dispose off the material?

Dump sites ☐   Throw away with normal waste ☐
Open burning ☐

Others, specify

_____

82. How many tons do you dispose of in a year?

_____

83. Have you undergone any training on E-waste disposal and management?

YES ☐   NO ☐

84. In your view, does Kenya have infrastructure for hazardous waste disposal?

YES ☐   NO ☐

I. More General Questions

85. What is to your point of view the most important obstacles to proper recycling of electric and electronic equipment in Kenya? (*Rank starting with the most important*)

Costs ☐
Lacking infrastructure and/or policy within your company ☐
Absence of recycling possibilities ☐
Lack of legislation ☐
Other ☐

86. How do you recruit the member of staff?

Advertise through print media ☐   Advertise through electronic media ☐
Referrals by friends ☐   Walk in looking for Jobs ☐
Look for volunteers and pay a fee ☐

Others, specify
_____

87. Are you aware about the environmental hazards caused by discarded electronic equipment?

YES ☐   NO ☐

88. Are you aware that some hazardous fractions in e-waste need a special treatment in order to be safely disposed of?

YES ☐   NO ☐

89. Does your company have a policy for the management of e-waste?

YES ☐   NO ☐

90. If yes, please share a copy with us.
A Copy available for sharing ☐   A Copy not available for sharing ☐

91. If not, does your company plan to adopt a policy of e-waste management?

YES ☐   NO ☐

92. Do workers have the following?

Union ☐   Medical Cover ☐   Flexible working hours ☐
Annual leave ☐

93. What are the key issues you would like included in the policy
_____
_
_____
_
_____
_
_____
_

94. Least five organizations that you think should take an active role in the management of e-waste from importation to the point at which they need to be discarded.

a). _____
b). _____

c). _____
d). _____
e). _____

J. General Observations

95.   What health and physical risks are workers exposed to from observation.
_____
_____
_____
_____

96.   Is it obvious that the workers have undergone/use the following?

Mask and other protective gadgets   ☐   Have undergone training on
e-waste handling   ☐

Others, specify
_____

97.   Describe the geographic setting of major e-waste treatment facilities and
Sites.
_____
_____
_____
_____

98.   Are the collection points, refurbishment, recovery or disposal sites
located in or nearby populate areas or agriculture land?

YES   ☐   NO   ☐

99.   If yes: Describe the socioeconomic set-up of the settlement (economic
basis, typical kind of housing-structure, population density (above / below
local average), distance to e-waste treatment
sites._____
_____
_____
_____

100. What suggestions would you give for proper e-waste management based on
this particular site as the researcher?
_____

12.3 Interview results with e-waste policy-makers

12.3.1   Ministry of Environment and Natural Resources

1. **In your view, how is e-waste situation in Kenya**
   The e-waste programme has not been started; there is a concept paper. Short
   life goods such as TVs, mobile etc. are still finding there way into the
   country.

2. **What effect is e-waste having on your ministry/institution?**
   No direct impact. Accessories are finding there way into the waste stream and
   the treatment of solid waste is not good. Open burning practiced is having a
   negative effect on the environment.

3. **What are some of the opportunities of e-waste?**
   People can do recycling, technology transfer, and disposable materials can
   support other industries e.g. plastic poles.

4. **What are the negative effects of e-waste?**
   The ministry knows that some chemicals are getting into the environment, we do not treat waster properly, and another problem is the aesthetics. Pollution of land and air is a concern.

5. **What actions are being taken to benefit from the opportunities (if any) and minimize the negative effects (if any)?**
   The youth groups are encouraged to focus on e-waste through the CDF, and get more involved. The ministry donated KSh 500,000, which was a show that the government is serious on the matter. The minister has made a statement on the same. The city council is promoting better waste management, for instance by discouraging open burning and encouraging separation of waste at source.

6. **Do you have e-waste management policy in the ministry/institution?**
   No policy, one is being developed.

7. **If no, why is there no e-waste policy and do you see a need for one? If there is, get a copy**
   E-waste is a new phenomenon that is beginning to affect people. We are in the process of developing a policy to deal with it.

8. **What is your general view of e-waste management in Kenya?**
   People have not come to grips with the general problem. The vendors do not have serious problem yet since its on a small scale. It is still treated as solid waste management. Since it does not smell people, do not find it obnoxious.

9. **Should the quality of imported computers and accessories (new & second-hand) be audited and regulated? If yes, by who? (NEMA/CCK/KEBS)**
   Under EMCA, we are not supposed to import end-of-life products. We need a system to monitor waste from source. All the authorities should regulate and NEMA should supervise

10. **Which Ministry/institution should be tasked with the responsibility of coming up with a national e-waste policy.**
    It has to be managed at inter-Ministerial level. There is a role for each: Ministry of Trade, KEBS, NEMA under the Ministry of Environment, and Health in general as well as Public Health.

- **What key issues should the national e-waste policy take into consideration?**
    - The source: some countries have good environmental management programmes for waste, some countries have a history of dumping
    - The amount of refurbishment: some people just replace batteries, some people do real good refurbishment
    - Type of product: some products have a history of longevity,
    - The brand: some companies have indicated commitment (i.e. Sony Ericsson). These should be encouraged.
    - The environmental management policy of the importer

12.3.2   Interview with the Ministry of Health

1. **In your view, how is e-waste situation in Kenya?**
   E-waste is an emerging challenge. Currently, there is no capacity to deal with e-waste. All the e-waste is dumped at Dandora, which is a crude way of doing it. We do realize there is a problem and possible health risks. Alternatives should be explored just as has been done with the transformers which are shipped back to countries of origin, especially Germany where they have the capacity. The Ministry is decommissioning Dandora, and setting up a new facility at Ruai (200 Acres), where they will be controlled as a way forward. There is going to be a transfer section in Kariobangi where there is 30 acres. This is where separation is going to be done. Waste will be compressed to form bales for ease of transportation.

2. **What effect is e-waste having in your ministry/institution?**
   Dust that gathers on the capacitors cause problems health problems. Many Ministries are calling for assistance on internal management.

3. **What are some of the opportunities of e-waste?   What are the negative effects of e-waste?**
   The plastics can be recycled into pellets, the capacitors can be destroyed. There are job opportunities and opportunities technology transfer.   The negative effects include pollution of the environment, land and water. Incineration is done without gas cleaning, leading to air pollution. Polychlorinated biphenyls (PCBs) deplete the ozone layer.

4. **What actions are being taken to benefit from the opportunities (if any) and minimize the negative effects (if any)?**
   In the short-term stockpiling is increasing. In the long-term a controlled station where everything will be sorted out and recycled shall be established. The Ministry is also advising people not to destroy e-waste.

5. **Do you have e-waste management policy in the ministry/institution?**
   There is a waste management plan. The Ministry in collaboration with other stakeholders is in the process of coming up with a policy. The stakeholders include UNEP, Cleanup Production Centre and Moi University.   The ministry is, however, guided by the health care waste management plan and health care waste management policy and guidelines.

6. **If no, why is there no e-waste policy and do you see a need for one?   If there is, get a copy**

7. **What is your general view of e-waste management in Kenya?**
   It is a challenge mainly because we do not have the funding, and technology is an issue. It is an issue that the country can address; it is not out of hand at the moment

8. **Should the quality of imported computers and accessories (new & second-hand) be audited and regulated? If yes, by who? (NEMA/CCK/KEBS)**
   Certainly, because of the lifespan, short life should be discouraged because it is e-waste almost immediately. The government should offer a subsidy. The polluter pays principal applies (KEBS is the standard body who should regulate). In terms of subsidy, it is a KRA/Government subsidy on long-life, high quality electronic equipment.

9. **Which ministry/institution should be tasked with the responsibility of coming up with a national e-waste policy.**
   NEMA is a coordinating body. The Ministry of Health, like the one on medical care, should also play a role.

10. **What key issues should the national e-waste policy take into consideration?**
    - Equipment lifespan and quality
    - Separation at source to capture the e-waste
    - Recycling opportunities
    - Efficiency and effectiveness of the final disposal of e-waste.
    - Depending on the disposal, it should take care of air, water and land pollution.

12.4 Summary of relevant laws

THE ENVIRONMENTAL MANAGEMENT AND CO-ORDINATION ACT, 1999 No 8 of 1999

83.   The Authority may establish additional procedures for the application and grant of any licence under this Act and impose such conditions as it may deem appropriate.

84.   The Authority may, in writing, cancel any emission licence:-

(a) if the holder of the licence contravenes any provisions of this Act or of any regulations made under it;
(b) if the holder fails to comply with any conditions specified in the licence; or
(c) if the Authority considers it in the interest of the environment or in the public interest so to do;

85.   The Authority shall maintain a register of all emission licences issued under this Act. The register shall be a public document and may be inspected at reasonable hours by any person on the payment of a prescribed fee.

86.   The Standards and Enforcement Review Committee shall, in consultation with the relevant lead agencies, recommend to the Authority measures necessary to:-
(1) identify materials and processes that are dangerous to human health and the environment; issue guidelines and prescribe measures for the management of the materials and processes identified under subsection (1);
(2) prescribe standards for waste, their classification and analysis, and formulate and advise on standards of disposal methods and means for such wastes; or
(3) issue regulations for the handling, storage, transportation, segregation and destruction of any waste.

87.   (1) No person shall discharge or dispose of any wastes, whether generated within or outside Kenya, in such manner as to cause pollution to the environment or ill health to any person.
(2) No person shall transport any waste other than –
    (a) in accordance with a valid licence to transport wastes issued by the Authority; and
    (b) to a wastes disposal site established in accordance with a licence issue by the Authority.
(4) No person shall operate a wastes disposal site or plant without a licence issued by the Authority.
(5) Every person whose activities generate wastes shall employ measures essential to minimize wastes through treatment, reclamation and recycling.
(6) Any person who contravenes any provisions of this section shall be guilty of an offence and liable to imprisonment for a term of not more than two years or to a fine of not more than one million shillings or to both such imprisonment and fine.

88.   (1) Any person intending to transport wastes within Kenya, operate a wastes disposal site or plant or to generate hazardous waste, shall prior to transporting the wastes, commencing with the operation of a wastes disposal site or plant or generating hazardous wastes, as the case may be, apply to the Authority in writing for the grant of an appropriate licence.
(2) A licence to operate a waste disposal site or plant may only be granted subject to the payment of the appropriate fee and any other licence that may be required by the relevant Local Authority.
(3) Where the Authority rejects an application made under this section, it shall
 within twenty one days of its decision, notify the applicant of the decision specifying the reasons thereof.

89.   Any person who, at the commencement of this Act, owns or operates a waste disposal site or plant or generated hazardous waste, shall apply to the Authority for a licence under this Part, within six months after the commencement of this Act.

90.   The Authority may apply to a competent court for orders compelling any person to immediately stop the generation, handling, transportation, storage or disposal of any wastes where such generation, handling, transportation, storage or disposal presents an imminent and substantial danger to public health, the environment or natural resources.

91.   (1) The Standards and Enforcement Review Committee shall, in consultation with the relevant lead agencies, recommend to the Authority standard criteria for the classification of hazardous wastes with regard to determining –
      (a) hazardous waste;
      (b) corrosive waste;
      (c) carcinogenic waste;
      (d) flammable waste;
      (e) persistent waste;
      (f) toxic waste;
      (g) explosive waste;
      (h) radioactive waste;
      (i) wastes, reactive otherwise than as described in the forgoing paragraphs of this subsection;
      (j) any other category of waste the Authority may consider necessary.
      (2) The Authority shall, on the recommendation of the Standards and Enforcement Review Committee issue guidelines and regulations for the management of each category of hazardous wastes determined under subsection (1).
      (3) No person shall import into Kenya any hazardous waste falling under any category determined under subsection (1).
      (4) No hazardous waste shall be exported to any country from Kenya without a valid permit granted by the Authority and written consent given by a competent authority of the receiving country.
      (5) No hazardous waste shall be transported within or through Kenya without a valid permit granted by the Authority.
      (6) Any person who contravenes any provision of this section or who withholds, falsifies or otherwise tampers with information relating to trafficking in hazardous or other waste shall be guilty of an offence and liable to imprisonment for a term of not less than two years or to a fine of not less than one million shillings or to both such imprisonment and fine.
      (7) A person found guilty under subsection (6) shall be responsible for the removal of the waste from Kenya and for its safe disposal.

92.   The Minister may, on the advice of the Authority make regulations prescribing the procedure and criteria for –
      (a) classification of toxic and hazardous chemicals and materials in accordance with their toxicity and the hazard they present to the human health and to the environment;
      (b) registration of chemicals and materials;
      (c) labelling of chemicals and materials;
      (d) packaging for chemicals and materials;
      (e) advertising of chemicals and materials;
      (f) control of imports and exports of toxic and hazardous chemicals and materials permitted to be so imported or exported;
      (g) distribution, storage, transportation and handling of chemicals and materials;
      (h) monitoring of the effect of chemicals and their residue on human health and the environment;
      (i) disposal of expired and surplus chemicals and materials; and
      (j) restriction and banning of toxic and hazardous substances and energy.

93.   (1) No person shall discharge any hazardous substance, chemical, oil or mixture containing oil into any waters or any other segments of the environment contrary to the provisions of this Act or any regulations thereunder.
      (2) A person who discharges a hazardous substance, chemical, oil or a mixture containing oil into any waters or other segments of the environment contrary to subsection (1) commits an offence.
      (3) A person convicted of an offence under subsection (2) shall, in addition to any other sentence imposed by the court:-
      (a) pay the cost of the removal of the hazardous substance, chemical, oil or a mixture containing oil including any costs which may be incurred by any Government agency or organ in the restoration of the environment damaged or destroyed as a result of the discharge; and

(b) the costs of third parties in the form of reparation, restoration, restitution or compensation as may be determined by a competent court on application by such third parties.

(4) The owner or operator of a production or storage facility, motor vehicle or vessel from which a discharge occurs contrary to this section shall mitigate the impact of the discharge by –

(a) giving immediate notice of the discharge to the Authority and other relevant Government officers;

(b) immediately beginning clean-up operations using the best available clean-up methods;

(c) complying with such directions as the Authority may, from time to time, prescribe.

(5) Where the owner or operator of a production or storage facility, motor vehicle or vessel has refused, neglected and/or failed to take the mitigation measures prescribed in subsection (4), the Authority may seize the production or storage facility, motor vehicle or vessel.

(6) Where the owner or operator fails to take the necessary measures under subsection (4) after the passage of a reasonable time not exceeding six months in all the circumstances, the Authority may, upon an order of court, dispose of the production or storage facility, motor vehicle or vessel to meet the costs of taking necessary measures under subsection (4) and other remedial and restoration measures.

(7) The Court in convicting a person of an offence under this section shall take into account the measures taken by that person to comply with subsection (4)