

Stakeholders' Role and Sustainability of E-waste management in Kisumu City, Kenya

Amolo Elvis Juma Amolo¹, George G. Wagah, PhD^{2*}, Leah Onyango, PhD^{3*}

¹MA Project Planning and Management Student, Maseno University, Kenya

²Senior Lecturer PhD, Maseno University, School of Planning and Architecture, Kenya

³Senior Lecturer PhD, Maseno University, School of Planning and Architecture, Kenya

*Corresponding author:

Abstract: The increased use of electronic gadgets has proportionately increased the accumulation of e-waste. E-waste is hazardous to the environment and health if not properly managed due to toxic substances contained in them. Currently, E waste in Kisumu is informally managed and it is not known whether the informal management of e-waste is sustainable. The purpose of this study was to assess the role of stakeholders in sustainable e-waste management in Kisumu City, Kenya. The research adopted a descriptive survey design and data collected using questionnaires, interviews, Focus Group Discussions and observation from a sample size of 425 respondents selected through stratified random sampling out of a target population of 148,494 households while analysis involved descriptive statistics. The study concludes that the current e-waste management is not sustainable because the current level of stakeholders' awareness on e-waste management is not adequate, policy formulation and enforcement by relevant government ministries remains weak and investors and NGOs are unwilling to invest in this area due to expensive capital infrastructure and technology inadequacy. The study recommends that NEMA e-waste management guideline 2010 should be enforced to ensure proper reduce, reuse, recycling and disposal besides amendments to Public Health Act (1962), Urban Areas and Cities Act No.13 of 2011 (Cap. 265) to comply with the NEMA guideline. MIC should enforce their requirement for Extended Producer Responsibility on ICT Actors. NEMA and the County Government should offer incentives to interested investors. KEBS should train expertise in forensic audit of hazardous components included in electronic equipments and discourage importation of such substances.

Keywords: Stakeholders' Role, sustainable, E-waste management

I. INTRODUCTION

The growth in electronic equipment production and consumption has been exponential in the last two decades due to urbanization and the growing demand for consumer goods in different regions of the world (Babu *et al.*, 2007); eventually leading to increased volume of e-waste. Financial constraints on acquiring ICT materials in developing regions has led to consumption of second hand products (Nnorom & Odjango, (2007)) besides internal generation or illegal importation of used goods in an attempt to bridge the digital divide.

About 20 to 50 million tones of electronic waste ("e-waste") are generated worldwide every year, much of which has been transported to the developing nations (UNEP 2010). In 2007, Kenya, Morocco and Senegal discarded approximately 17,500

tones of IT e-waste (Hewlett-Packard 2009). South Africa generates 100,000 tons annually (Lombard 2004). In Kenya the total e-waste generated from computers, monitors and printers is about 3,000 tons per year (Mureithi *et al.*, 2008) and likely to increase dramatically as the importation and use of computers increases; a 200% rise was recorded in 2007 (Hewlett-Packard 2009). The e-waste concept came to light as far back as in the 1970s and 1980s following environmental degradation that resulted from hazardous waste imported into developing countries (Shinkuma & Huong, 2009). The Basel Convention on the control of trans-boundary movements of hazardous wastes and their disposal was instituted in 1992 to control the situation. Although "the Basel Convention does not regulate secondhand items and some e-waste scrap" (Shinkuma & Huong, 2009), it has played a role in banning exportation of obsolete products and engineering waste solutions.

E-waste contains toxic substances and creates serious risks to human health and the environment if not handled properly (Chatterjee, 2008; Li *et al.*, 2008). In the e-waste recycling regions, the improvement of disposal systems is the most cost-effective method to reach the objectives of solid-waste management (Brunner & Fellner, 2007) and calls for proper processing and management methods and enactment of timely regulatory and legislative policies. Current technologies are not particularly cost-effective in many developing countries; and many aspects of recycling depend on informal recycling (Babu *et al.*, 2007). Public awareness of the health and environmental threat posed by e-waste is minimal due to failure to provide up-to-date information by the relevant authorities (Brunner & Fellner, 2007). To best protect public health and the environment, policy makers of all developed and developing nations must be willing to fundamentally redesign the approach to e-waste management (Babu *et al.*, 2007). The absence of a policy and legislative framework and a practical management system, means that much e-waste remains in storage or recycled/disposed of in an unsafe and unsustainable manner putting both the recycler and local population at risk (Hewlett-Packard, 2009). Extended Producer Responsibility (EPR) as a policy strategy was first proposed by Thomas Lindqvist in 1988 for a shared responsibility among relevant stakeholders across the product life cycle (Lifset & Lindqvist, (2002); Lindqvist, 2000) and is currently being implemented by Nokia Ltd in Kenya as "a

take-back strategy” (Nokia, 2010). National and local governments ensure effective EPR programmes by raising awareness of programme requirements and establishing mechanisms to help prevent free riding and anti-competitive behavior (OECD, 2001).

The first Medium Term Plan (2008-2012) of Vision 2030 stating the government’s commitment to improve ICT infrastructure as a foundation for a knowledge economy further raises an alarm because to bridge the digital gap there will occur exponential importation of ICT and Telecommunication equipments which will eventually turn into e-waste but the existing legislative Acts and by-laws do not recognize e-waste in specific and the e-waste management systems are informal. Capacity constraints hindering the disposal of e-waste as well as the collection system and recycling infrastructure are the major challenges facing all the East Africa nations. In Kenya a huge quantity of e-waste is handled by the informal (jua kali) sector. In addition, many developing countries have been caught up in the web of global e-waste dumping (Waema & Muriuki, 2008). The major source of e-waste is the disposal of the hardware and electronic items from Government offices, public and private sectors, academic and research institutes and Household consumers (Chatterjee and Krishna, 2009). Many of these products can however be refurbished, reused, or recycled in an environmentally sound manner so that they are less harmful to the ecosystem and public health i.e. to reduce leaching, radiations and emission of toxic gases (William, 2010).

The generation of solid waste in Kisumu is on the increase due to the rising population and high rates of resource consumption while the handling capacity of the council has been exceeded (KARA, SANA & Ilishe Trust, 2007); the legal framework and the Municipal Council By-laws of 2008 on solid waste management, is held captive by inadequate capacity of the county council resulting in illegal dumping on road reserves (Obera & Oyier, 2002). The dumpsite at Kachok on the Kisumu-Ahero Road, 2 km from the town centre, receives unsorted solid waste mixed with toxic e-waste (Carl Bro Report, 2001; Ecoforum, 2001; World Bank, 1995). People from nearby informal settlements use the dumpsite as a source of income, oblivious of the harmful fumes from waste burning and methane fires in it. Only 17% of households in Kisumu have access to private collection and 47% by county council while the rest are just disposed off roadsides (KARA, SANA & Ilishe Trust, 2007).

In general the consumption of secondhand, cloned and refurbished electronic equipments has led to the generation of e-waste even though locally recording has not been done to track the quantities generated per source. On policy issues, Despite NEMA’s development of e-waste management policy guidelines in 2010, the relevant ministries have not amended the necessary Acts and by-laws to comply with the policy guideline i.e. EMCA (1999); Articles 42; 60-70 of the new Constitution; Urban Areas and Cities Act No.13 of 2011 (Cap. 265) and the 2008 city by-laws and Public Health Act (1962) do not specifically address e-waste management since it’s a

recent phenomenon even though currently the council is considering drafting specific by-laws and also engage in public-private partnership. The inexistence of recycling facilities and the unwilling nature of NGOs and the private sector to cooperate with the City Authority in recycling of e-waste due to the huge capital and technology requirements has left the authorities in a limbo. Thus, the study sought to assess the role of stakeholders on e-waste management in Kisumu city. The study aimed to contribute valuable knowledge on sustainable e-waste management policy formulation for a healthy environment in general. Policy amendments for coordination of stakeholders in the management of e-waste in terms of policies and regulations and establish appropriate formal systems of e-waste management practices that observe reduction, reuse, recycling through enforcement of Extended Producer Responsibility. Formal e-waste management would ensure recovery of valuable resources such as gold, silver and aluminum; employment creation both formal and informal; revenue generation to the local authorities through taxation of registered recyclers and refurbishers and improved health and environment. The study also provides a reference and vital information to the databank on sustainable e-waste management for other researchers and development agencies interested on the issue.

II. LITERATURE REVIEW

2.1 Roles of stakeholders on e-waste management

Stakeholders are groups and individuals who have a stake, an interest, in the waste management system in an area (Streicher-porte *et al.*, 2005). Three groups are usually defined as having a stake in waste management: the community, public and private sectors (Wang & Chou, (2009)). To better understand the stakeholder responsibilities in this context it’s wise to understand the underlying issues such as legislative and policy frameworks, administrative responsibility such as Extended Producer Responsibility, technical and financial support at global, regional, national and local areas.

In 2003 European Union implemented two directives i.e., Directive 2002/96/EC on WEEE and Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment (Peralta & Fontanos, 2005). The directives enforce an extended producer responsibility system and encourage reuse, recycling and recovery, and minimizing the environmental impact of e-waste. In addition, EU uses the concept of QWERTY/EE (Quotes for environmentally Weighted Recyclability and Eco-Efficiency) to improve environmental performance of end-of-life products ((Streicher-porte *et al.*, 2005). Europe favors manufacturer-operated take-back systems (Dempsey *et al.*, 2010); however despite all legislative efforts in many developed countries these laws often lack effective implementation. In China, regulations that specifically deal with e-waste are in implementation e.g. the Management Measures for the Prevention of Pollution from Electronic Products regulation that aims at prohibiting the environmentally adverse processing of e-waste and reducing

utilization of hazardous and toxic substances in electronic appliances (Shinkuma & Huong, (2009)); In respect to the local government, they have entirely banned any form of e-waste imports into China from 2000. Similar legislation is active in other developed countries such as Japan, where the Specified Home Appliance Recycling (SHAR) Law holds electronics manufacturers responsible for recycling their products (OECD, 2010). Currently, there is no federal level legislation in the USA, while state level action has recently gained momentum. State-operated take-back appears to be favored in Taiwan and China and some states in the USA (Shinkuma & Huong, 2009).

South Africa currently does not have any dedicated legislation dealing with e-waste and lacks cooperation between national and provincial government since both share the constitutional power over pollution control (<http://ewasteguide.info>). In the East Africa community governments discourage old imports and are working with NGOs to introduce recycling and a take back policy; are signatories to international conventions and protocols that tackle environmental issues (Basel and Bamako) (Wang & Chou, 2009). In Kenya Section 3(1) of Environmental Management and Coordination Act EMCA (1999) and Articles 42; 60-70 of the new Constitution entitles every person to a clean and healthy environment and to safeguard and enhance the environment (Waema and Muriuki, 2008). Kenya subscribes to the Basel Convention to avoid unwittingly becoming an importer of e-waste. Shinkuma & Huong (2009) found that there was no specific government policy on e-waste management except for CCK requirement of applicants to demonstrate their readiness to minimize the effects of their ICT infrastructure on environment, as a prerequisite for grant or renewal of license in ICT sector; But on further analysis its realized that NEMA had developed an e-waste management policy guideline in 2010 which entails collection, sorting, classification, transportation, recycling to disposal (remains dormant).

Some manufacturers for instance Sony Ericsson, Nokia, LG and associated suppliers and service providers are implementing take-back schemes (Waema and Muriuki, 2008). When the Safaricom scheme became operational (2007-2008), it only took back its own obsolete appliances and the scheme has stalled in recent years but is being revitalized (Shinkuma & Huong, 2009). In 2008 the National Environment Management Authority (NEMA) signed a memorandum of understanding with Computer for Schools Kenya (CFSK) which set up a recycling plant in Nairobi which is a good step towards e-waste reduction (Waema and Muriuki, 2008); but currently it's not working. This if properly implemented will generate opportunities such as employment for both the formal and informal workers involved in the recycling process, generate revenue to the government, ensure economic development through extraction of valuable metals such as gold and silver and reduction of toxic substances; and to a greater extent aid in urban poverty reduction.

The involvement of local communities in planning and implementation can play a range of roles (Moreno et al., 1999;

Anschutz, 1996) which can lead to more responsible behavior, increased environmental awareness, and a higher willingness to pay among users of a waste management system thus empowering underprivileged groups in waste management system (Cunningham & Cunningham, (2002)). Actors like community-based organizations (CBOs), non-governmental organizations (NGOs), research institutes and universities should be strengthened to support communities and the informal sector by providing them with training, advocacy, and research, technical or financial assistance (Moreno *et al.*, 1999; Anschutz, 1996). Local governments can create room for local communities and the informal sector by changing legislation and recognizing them as candidates for service contracts (Cunningham & Cunningham, 2002). Besides this, the participation of communities and micro- and small-scale enterprises can generate income and employment in low-income urban areas and thus contribute to the alleviation of urban poverty (Lardinois, 1996). To involve all these groups and to address the constraints they face requires a change in the attitudes of governments (Moreno *et al.*, 1999); and decisions about waste management options should take local resource constraints and concentrate on what is possible in the given context (Davoudi, 2000; Gandy, 1994). Consumers have responsibilities including Critical Awareness and Maintaining a Healthy and Sustainable Environment i.e. a responsibility to buy smart, use right, and manage well and dispose well (Shinkuma & Huong, 2009).

III. METHODOLOGY

The study was conducted through descriptive cross-sectional survey design and data collected using questionnaires, interviews, Focus Group Discussions and observation from a sample size of 425 respondents selected through stratified random sampling out of a target population of 148,494 households while analysis involved descriptive statistics of percentages and cross-tabulation at a significance level of 0.05 to establish the relationship between the variables under investigation. A reliability and validity tests were done amongst 10% of the respondents and a coefficient value of 0.87 obtained. Respondents were drawn from relevant government ministries (MIT, MH, MENR and Ministry of Finance), public and private sector and the household consumers to provide insight into e-waste management practices and prompted recommendations into better practices to ensure clean and healthy habitat. The respondents were drawn from CBD, Industrial Area, Milimani, Migosi, Kibuye, Nyalenda A&B and Manyatta A&B of Kisumu city, Kenya.

IV. FINDINGS AND DISCUSSION

The questionnaire return rate was 87%. The study assessed the role of stakeholders on sustainable e-waste management. The analysis synthesized on various policies and regulations and policy considerations by the consumers on e-waste management: EMCA (1999); Articles 42; 60-70 of the new Constitution; NEMA strategic plan 2006-2010; Public Health Act (1962); ICT policy (2006); Urban Areas and Cities Act No.13 of 2011 (Cap. 265) and by-laws of 2008 on waste

management. Stakeholders in the value chain were interviewed on the articulation of their roles encompassing policy and legislation and policy consideration by the consumers. The stakeholders interviewed included internet

service providers, distributors, consumers, policy regulators and refurbishers/repairers. Qualitative analysis involved thematic clustering and triangulation of results to other findings and results represented in Table 4.1.

4. 1.1 Policy and legislative framework

Table 4.1 Stakeholder Role Analysis

Stakeholders	Role: create an enabling environment through policy, legal and regulatory reforms for environmental and natural resources management through Implementation of EMCA (1999) and Articles 42; 60-70 of the new Constitution. EMCA defines hazardous waste, pollutants and pollution/polluter pays policy. Achievement: Ministry/NEMA has ensured the establishment of Environmental department in all major institutions be it public, private or Non-governmental to track on reduce, reuse and proper disposal of wastes. Challenge: No specific policy and legislation on e-waste; lack of formal recycling infrastructure
Ministry of Environment	Role: NEMA strategic plan 2006-2010, key objectives: universal compliance and enforcement of environmental regulations; developing guidelines, standards and the prosecution of offenders failing to meet the provisions of EMCA; and coordination agencies and stakeholders. Formulates and regulates policy that governs recyclers, vendors and collectors in the e-waste sector. The strategic plan emphasizes the principle of polluter pays. Achievement: Developed e-waste management policy guidelines (2010) from collection to recycling to disposal and areas that concern standardization to trans-boundary movement of hazardous wastes. Challenge: Lack of enforcement.
NEMA	Role: Implementation of Public Health Act (1962) on proper disposal of medical equipments. Achievement: Installation of incinerators. Challenge: Dilapidated incinerators in public hospitals. Public Health Act (1962) does not address e-waste management in specific.
Ministry of Health	Role: Implementation of ICT policy (2006): cognizant of e-waste and states that “CCK should enforce their requirement for environmental management on ICT infrastructure by ICT Actors to ensure implementation of take-back strategy (Extended Producer Responsibility). Achievement: The Universal Licensing Framework implemented by the CCK from 2008 takes a step towards enforcing ICT policy (2006). Challenge: Stakeholders are uncoordinated in the execution and enforcement of the e-waste management.
Ministry of ICT	Role: Implementation of Urban Areas and Cities Act No.13 of 2011 (Cap. 265) and by-laws of 2008 on waste management which is in cognizance of Public Health Act (1962), Licensing recyclers and Providing incentives to investors Achievement: Recognition of e-waste problem Challenge: Lack of specific policies and by laws on e-waste management; inadequate financial and technological infrastructure. Problem underestimation.
Kisumu City Council	Role: Ownership in reduction, re-use, recycle and proper disposal Achievement: Re-use and reduction done. Challenge: Lack of policy and regulatory enforcement by the city council; lack of recycling infrastructure; inadequate information and awareness; lack of designated disposal sites. Little representation at policy formulation.
Consumers	Role: Awareness creation and capital investment Achievement: None Challenge: Unwilling nature of investors and NGOs to invest in this due to expensive capital infrastructure and technology inadequacy.
Investors and NGOs	Role: Extended producer responsibility i.e. Tack back strategy Achievement: Nokia and Safaricom initiated tack back strategy in 2010 but this stalled after 1 year Challenge: Lack of cooperation from equipment holders due to poor mobilization.
Producers, Distributers and ISPs	

At policy level, the Ministry of Environment and Natural Resources (MENR) – has a strategic plan (2006-2010) which is in line with the Basel and Bamako Conventions that control the trans-boundary movement of hazardous waste and inclusion of hazardous components in electronic equipments as a strategy for reduction of which Kenya is a signatory. Similarly Wang and Chou (2009) found that the government of Kenya discourage old imports and is a signatory to international conventions but the enforcement of the conventions remains weak nationally and locally (Waema and Muriuki, 2008).

pollutants and pollution. The strategic plan also emphasizes 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. From the NEMA strategic plan 2006-2010, with key objectives of ensuring universal compliance and enforcement of environmental regulations; developing guidelines, standards that govern recyclers, vendors and collectors in the e-waste sector and the prosecution of offenders failing to meet the provisions of EMCA (1999); and coordination of agencies and stakeholders by emphasizing on the principle of polluter pays, 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 same view was held by Waema and Muriuki (2008) who emphasized that Section 3(1) of

One of Ministry of Environment key function is the full implementation of the Environmental Management Coordination Act (EMCA, 1999) and Articles 42; 60-70 of the new Constitution which entitles every person to a clean and healthy environment. EMCA defines hazardous waste,

Environmental Management and Coordination Act (1999) entitles every person to a clean and healthy environment.

According to the findings enforcing compliance of environmental regulations and guidelines on e-waste within Kisumu city has been minimal since there is the feeling by city authority that the problem has not grown into an alarming state and more so the lack of technological knowhow and legislative by-laws regarding e-waste management. Waema and Muriuki (2008) held similar view that consumers and policy makers think e-waste is a distant issue, hence the need to sensitize the public on the negative effects of e-waste on health and environment and opportunities on proper management (Liu, 2009; Waema & Muriuki, 2008). Dempsey *et al.* (2010) similarly found that despite all legislative efforts in many developed countries these laws often lack effective implementation and based on the study findings it would be prudent to strengthen the implementation capacity.

In the NEMA strategic plan 2006-2010, 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. It also formulates and regulates policy that governs recyclers, downstream vendors and collectors in the e-waste sector. NEMA produced e-waste management policy guidelines in 2010 that govern e-waste management from collection to recycling to disposal and areas that concern standardization to trans-boundary movement of hazardous wastes but this has little impact at the local level since no enforcement is done to control the situation.

The problem is further compounded by the fact that Kenya Bureau of Standards (KEBS) has not adopted advance technology to guard against inclusion of hazardous components in electronic equipments besides corruption at the terminus that has enabled importation of second hand and low quality short life span electronic equipments. Currently Kenya Revenue Authority (KRA) has not developed an integrated revenue collection system on imported secondhand and low quality electronic equipments that can be used to establish a recycling infrastructure to manage the treatment of e-waste. Even though KRA is taking statistics on electronic equipments imported some equipment still find their way into the local market through dubious means at the shipment terminus. The findings are in support of Mureithi *et al.* (2008) argued that, there have been incidents of electrical goods earmarked for transit ending up in the country due to corruption besides incidents of deliberate mislabeling of containers to conceal the true identity of goods leading to substandard electronic products finding their way into the local market. In effort to reduce quantity of secondhand electronics KRA has allowed tax free importation of ICT & Telecom equipments as a means to encourage technology development in the country and acquisition of original brand new equipments to bridge the digital divide but this olive branch has not been extended to other types of electronic

equipments which makes it difficult to find an integrated solution to the entrance of substandard electronic equipments. This incentive by KRA would only be economically viable within a specified time span but not forever.

It is clear from the law that individuals and organizations whose activities generate e-waste have an obligation to dispose end-of life equipment in a manner that takes into account its hazardous components but lack of designated disposal locations by the municipal council jeopardizes the whole scenario. The law requires e-waste collectors and final disposers to register with NEMA and dispose of the waste at designated facilities. The Act empowers NEMA to apply in a court of law compelling any individual or organization 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 and the environment (NEMA, 2010; 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 (MPHS) is concerned with health issues. The Urban Areas and Cities Act No.13 of 2011 (Cap. 265) bestows authority on the municipal authorities to deal with waste. In discharging this mandate the local authorities have to take cognizance 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.

Therefore, under the two Acts and subsequent by-laws of 2008, it is the responsibility of the Municipal council to manage waste in their respective jurisdictions. But because e-waste is a recent phenomenon the City Council of Kisumu has not articulated any specific by-law to address the issue and e-waste is treated just like any other solid waste even though currently the council is considering drafting specific by-laws to address the problem before it grows to unsustainable level based on the information provided by City council director of environment. The Public Health Act (1962) does not address e-waste management in specific but homogeneously address it under solid waste. According to Cunningham and Cunningham (2002) Local governments can create room for local communities and the informal sector by changing legislation and recognizing them as candidates for service contracts while Lardinois (1996) added that the participation of communities and micro- and small-scale enterprises can generate income and employment in low-income urban areas and thus contribute to the alleviation of urban poverty.

The ICT policy promulgated in 2006 is cognizant of e-waste and states that “As a prerequisite for grant or renewal of licenses, 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.” The Universal Licensing Framework implemented by the CCK from 2008 which enforced EPR on dominant market holders according to ICT policy (2006) takes

a step towards enforcing this statement. Generally e-waste management policy has not been integrated into the laws within various ministries and shows clearly how the policy makers (stakeholders) are uncoordinated in the execution and enforcement of the e-waste management guideline provided by NEMA. Waema and Muriuki (2008) argued that the key driver to the rapid generation of e-waste in Kenya is lack of policy enforcement particularly with respect to importation of used electronic equipment and this is in tandem with the research findings.

E-waste is an emerging challenge and all the relevant government ministries except MENR and MIT have not enacted specific e-waste management regulation and are currently using the general guideline on e-waste management from NEMA. Currently, there is no capacity to deal with e-waste. All the e-waste is dumped at Kachok dumpsite which poses possible health risks and environmental pollution (Ozone layer depletion through Polychlorinated biphenyls (PCBs)). On holding a focus group discussion with the respondents from the surrounding immediate settlement revealed that the residents complained of the pollutant smoke emanating from the dumpsite on open burning. A site visit observation to the disposal site at Kachok which is full and overflowing confirmed open burning of e-waste materials. The mixing of the polluter liquids such as mercury and cadmium with underground water is possible as fluorescent bulbs with mercury components and used car battery litters could be spotted.

An interview with Ministry of Public Health officials and hospital management respondents indicated that only three hospitals (New Nyanza General Hospital, District Hospital and Aga Khan Hospital) had incinerators for managing medical equipments but only the one in Agha Khan was in good condition while the rest were in deplorable conditions with no gas cleaners thus polluting air. This is true to the findings by Obera and Oyier (2002) that incineration facilities are limited and where available, they are either broken down or improperly used. Pirrone *et al.* (2001) noted that besides the general advantages of the incineration of wastes such as the hygienic reduction in waste volume to be disposed (Pirrone *et al.*, 2001); it also poses threats due to the release of toxic emissions (dioxins) into the air, water and land (Tibbs, 1999); causing negative environmental and health effects e.g. low sperm counts, Immuno-toxicity, reproductive and developmental effects and cancer (Van Beukering *et al.*, 1999); while the burden of illness can be greater in socially disadvantaged communities (Pirrone *et al.*, 2001).

The stakeholders also identified opportunities associated with properly managed e-waste such as recycling for resource recovery, job creation, revenue generation and technology transfer. E-waste management is facing challenge mainly because there is no funding and recycling technology is low. Some components of the discarded computers, mobile phones, TV sets and even radio sets are made of heavy metals such as mercury, cadmium and chromium which are highly hazardous especially if exposed to fire. The City Council of Kisumu

confirmed that the current situation on e-waste management and policy formulation and enforcement remains weak, not to mention the unwilling nature of investors and NGOs to invest in this area due to expensive capital infrastructure and technology inadequacy. Similarity of the findings are argued by Gao *et al.* (2004); Mou *et al.* (2004) and; Hanapi & Tang (2006) that developing nations do not enforce strictly the environmental laws and therefore end up as alternative disposal destinations for the developed nations. According to Smith and Scott (2005) infrastructure of e-waste recycling is not well-established in Kenya due to high costs of recycling, thus only a very small fraction of e-waste are being refurbished and resold to consumers. Nokia (2010) found out that e-waste collection activities by local governments are still limited because e-waste is commonly viewed as a potentially valuable resource by consumers but in the study case it's the lack of recycling infrastructure that limits proper e-waste management.

4.1.2 Policy considerations

Despite the KRAs lift on importation tariff on ICT & telecom equipments to encourage consumption of brand new equipments and also ensure information society, little has been reflected at the consumer level and surprisingly enough only 11% of the ICT & telecom equipments are brand new (Table 4.5) while the rest are either cloned, second hand or refurbished according to respondents. This was attributed to the fact that this category of equipments were evolving faster with inclusion of additional complex but necessary features. Since original brand new equipments are expensive consumers find it difficult to purchase them frequently, thus resorting to cheap ones to fulfill their digital demands. Respondents (ISP/Distributors/private) attributed lack of policy and regulatory enforcement by the municipal council as provided in the NEMA e-waste management guideline 2010 as an obstacle to proper management of e-waste.

The respondents further indicated that lack of recycling infrastructure, inadequate information and awareness, lack of designated disposal sites and the fact that waste was not being separated at the source are the other obstacles. Further, respondents indicated that there should be an established recycling infrastructure besides a policy of zero tolerance on waste in general, the country's youth be empowered and given the necessary skills for waste management, should be strict government regulations and awareness creation, and more research should be undertaken to provide alternatives to e-waste management. Respondents cited various organizations 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 five most cited were the Government, through the MIC, MTI and MENR. Others are NEMA, KEBS, KCC and KRA. Respondents also cited the private sector (manufacturers and their downstream vendors) and civil society.

The respondents (ISP/Distributors/private/households) also felt less represented at the level of policy formulation and

legislation enforcement process as it was not participatory driven. The involvement of local communities in planning and implementation can play a range of roles (Moreno *et al.*, 1999; Anschutz, 1996): which can lead to more responsible behavior, increased environmental awareness, and a higher willingness to pay among users of a waste management system thus empowering underprivileged groups in waste management system (Cunningham & Cunningham, (2002)). An interview with the service provider Safaricom Ltd in collaboration with Nokia Ltd revealed that they had initiated an Extended Producer Responsibility involving tacking-back old electronic equipments on purchase of new products at a subsidized price but this has not been effective enough as most of the people are reluctant to cooperate. Airtel and others had not initiated the same program but are considering engaging in the business. Waema and Muriuki (2008) similarly indicated that some manufacturers for instance Sony Ericsson, Nokia, LG and associated suppliers and service providers are implementing take-back schemes.

At the same time Shinkuma and Huong (2009) found that when the Safaricom scheme became operational, it only took back its own obsolete appliances. Gao *et al.* (2004) recommended that large companies should purchase the used equipments back from the customers and ensure proper treatment and disposal while Ecroignard (2005) noticed that setting up a system where it's easy to take-back old technology has met resistance due to unwilling nature of big recyclers. The municipal council of Kisumu recognized the complex nature of the waste and mentioned that the cost of establishing a recycling plant was too high and lack of technological knowhow in this area also undermine the development of e-waste management infrastructure. The municipal council is considering partnering with the private sector in order to provide a lasting solution to the growing hazard.

V. CONCLUSION

Even though the government has promulgated various policies and regulations such as: EMCA (1999); Articles 42; 60-70 of the new Constitution; NEMA strategic plan 2006-2010; Public Health Act (1962); ICT policy (2006); Urban Areas and Cities Act No.13 of 2011 (Cap. 265) and by-laws of 2008 on waste management from sorting, collection, transportation to disposal, enforcement compliance is minimal due to the feeling that the problem is not yet alarming and more so, the lack of technological knowhow on handling e-waste. A part from NEMA strategic plan 2010 and ICT policy of 2006 of EPR which recognizes e-waste the rest of the policies do not specifically address e-waste. Generally E-waste management policy has not been integrated into the laws within various ministries and shows clearly how the policy makers are not included in the execution and enforcement of the e-waste management guideline provided by NEMA 2010. The Universal Licensing Framework implemented by the CCK from 2008 which enforced EPR on dominant market holders according to ICT policy (2006) takes a step towards enforcing this statement. Even though EPR was initiated by Safaricom

Ltd in collaboration with Nokia Ltd it stalled due to reluctance on customers to cooperate. Generally the private sector (Investors) and the civil society (NGOs and CBOs) have been unwilling to invest in this area due to expensive capital infrastructure and technology inadequacy. It is clear from the law that individuals and organizations whose activities generate e-waste have an obligation to dispose end-of life equipment in a manner that takes into account its hazardous components but lack of designated disposal sites jeopardizes the whole scenario.

The study concludes that the current level of stakeholder awareness on e waste management is not adequate to make e-waste management sustainable. The unwilling nature of investors and NGOs to invest in this area due to expensive capital infrastructure and technology inadequacy render the management of e-waste unsustainable. E-waste management therefore remains informal leading to resource wastage and minimal health and environmental safety observation, thus it remains unsustainable. Arising from the conclusions the following recommendations are proposed: At policy level; MENR through NEMA should enforce the e-waste management guideline 2010 to ensure proper sorting, collection, recording, reuse, reduce, recycling and disposal and the licensing of investors along this line. The MPHS should amend the Health Act (1962) to include e-waste management and comply with NEMA e-waste management guideline 2010. MIC through CCK should enforce their requirement for environmental management on ICT infrastructure by ICT Actors to ensure implementation of take-back strategy (Extended Producer Responsibility). The County Government should amend Urban Areas and Cities Act No.13 of 2011 (Cap. 265) to incorporate e-waste management. The relevant ministries and related stakeholders need to create awareness of e-waste and its safe handling i.e. dispose unusable equipment through sorting of waste at the source, organized collection and disposal system separately from solid waste by e-waste collectors. NEMA should set training standards for personnel handling e-waste to be enforced by the County Government. Awareness and training programmes for consumers and technicians handling e-waste should be developed and implemented after establishing a recycling facility/infrastructure. Kisumu city council should endear interested investors to establish a formal e-waste recycling infrastructure. KRA should establish a mechanism to raise funds for e-waste management through charging a fee to the suppliers of old equipment or those who want to dispose large volumes of equipment in the city. KEBS should train expertise in forensic audit of hazardous components included in electronic equipments and discourage importation of such substances. MENR should encourage and acknowledge the role of civil society stakeholders in creating awareness and conducting research on e-waste.

REFERENCES

- [1] Babu, B. R., Parande, A. K., & Basha, C., A. (2007): Electrical and electronic waste: a global environmental problem. *Waste Management & Research*, 25(4), 307-318

- [2] Brunner, P. H., & Fellner J. (2007): Setting priorities for waste management strategies in developing countries. *Waste Manage Res* 25:234–240. Washington DC.
- [3] Carl Bro report (2001): Study of the Environmental Situation in Three Urban Centres; New-Delhi India.
- [4] Chatterjee P. (2008): Health costs of recycling. *Br Med J* 337:376–377. Tokyo, Japan.
- [5] Chatterjee, S. & Kumar, K. (2009). Effective electronic waste management and recycling process involving formal and non-formal sectors. *International Journal of Physical Sciences*, 4(13), 893–905.
- [6] Chatterjee S. & Kumar K. (2009). Department of Information Technology, Electronics Niketan, 6, C. G. O. Complex New Delhi-110 003, India.
- [7] Cunningham, W. P., & Cunningham M. A., (2002): Principles of Environmental Science. Graw Hill, New York.
- [8] Davis, G., & Heart, S. (2007): Electronic waste: The local government perspective in Queensland, Australia. *Journal of Resources, Conservation and Recycling*, 52(8-9), 1031–1039
- [9] Gartner Inc. (2007): Worldwide mobile phone sales; Press release 27 February 2007. <http://www.gartner.com/newsroom/id/612207>. Accessed 26 Jul 2014
- [10] Gao Z., Li J., & Zhang H., C. (2004): Electronics and the Environment, IEEE International Symposium pp.234-241. Earthscan, London.
- [11] Hanapi B. M., & Tang B. S., (2006). Selective Liquid-Liquid Extraction of precious metals from semiconductor wastes, Department of Chemical Engineering Faculty of Chemical and Natural Resources Engineering, University of Technology Malaysia. <http://eprints.utm.my/2743/1/72157.pdf>.
- [12] Hewlett-Packard HP, (2010): <http://www.hp.com/hpinfo/abouthp/government/us/ewaste.html>, Accessed June 15, 2010.
- [13] KARA, SANA, and Ilishe Trust, (2007). Citizens' Report Card on Urban Water, Sanitation and Solid Waste Services in Kenya: Summary of Results from Nairobi, Kisumu and Mombasa. Nairobi, Kenya.
- [14] Kathuri, N. J., & Pals, A. D. (1993). Introduction to educational research. Egerton: Egerton University Education Book Series. Kenya
- [15] Kombo D. K., & Tromp D. L. (2006): Proposal and Thesis Writing: Introduction (2006). Nairobi: Paulines Publications Africa.
- [16] Kothari C. (2003). Research methodology, methods and Techniques. New Delhi: Wishu Prakshan.
- [17] Lardinois, I., & Van de Klundert, A. (1999). Integrated sustainable waste management (ISWM). LARDINOIS, I. and FUREDY, C. Source Separation of Household Waste Materials—Analysis of Case Studies from Pakistan, The Philippines, India, Brazil, Argentina and the Netherlands. Gouda, Urban Waste Series, 7.
- [18] Lindqvist, T. (2000): Extended Producer Responsibility in Cleaner Production; the International Institute for Industrial Environmental Economic; Dissertations 2000:2 Sweden Lund University.
- [19] Liu, Q., Li, Q. K., Zhao, H., Li, G., & Fan, Y. F. (2009). The global challenge of electronic waste management. *Environmental science and pollution research international*, 16(3), 248–249. China.
- [20] Moreno, J.A., Rios F.R. & Lardinois I. (1999). Solid waste management in Latin America: the role of micro- and small enterprises and co-operatives. Latin America
- [21] Mou, W., Namara, T. P., Valiquette, C. M., & Rump, B. (2004): Allocentric and egocentric updating of spatial memories. *J Exp Psychol Learn Mem Cogn* 30(1):142–157
- [22] Mugenda, O. M., & Mugenda, A. G., (2003). Research Methods: Quantitative and Qualitative Approaches. Nairobi: Africa Centre for Technology Studies (ACTS press). Nairobi, Kenya
- [23] Municipal Council of Kisumu (2008). Lake Victoria Region City Development Strategy for Improved Urban Environment and Poverty Reduction: Kisumu City Development Strategy 2004-2009 Kisumu, Kenya.
- [24] Nnorom, I. C., & Osibanjo, O. (2008). Electronic waste (e-waste): material flows and management practices in Nigeria. *Waste Manage* 28:1472–1479. Nigeria. [CrossRefGoogle Scholar](https://doi.org/10.1016/j.wasman.2008.05.011).
- [25] Nokia (2010): Nokia Sustainability Report. <http://www.nokia.com/corporate-responsibility/reporting>
- [26] Obera B. and Oyumu M. (2002): Sustainable Solid Waste Management for Kisumu, Kenya in: 28th WEDC Conference Kolkata (Calcutta), India.
- [27] OECD (2002): Working Group on Waste Prevention and Recycling; How to Apply Environmentally Sound Management to Small and Medium Size Enterprises. Washington D.C.
- [28] Peralta, G. L., & Fontanos, P., M. (2006). E-waste issues and measures in the Philippines. *Journal of Material Cycles and Waste Management*, 8(1), 34-39
- [29] Pirrone F. P., & Peralta, G. L. (2006): E-waste issues and measures in the Philippines. *Journal of Material Cycles and Waste Management*, 8(1), 34-39. Philippines.
- [30] Shinkuma, T., & Huong, M., T. (2009): The flow of E-waste material in the Asian region and a reconsideration of international trade policies on E-waste. *Environmental Impact Assessment, Review* 29(1), 25-31
- [31] Smith, T. & Byster, L. (2006). 'The Electronics Production Lifecycle. From Toxics to Sustainability: Getting Off the Toxic Treadmill,' in T. Smith, D. Sonnenfeld & D.N. Pellow (eds), Challenging the Chip, Labour Rights and Environmental Justice in the Global Electronics Industry. Philadelphia: Temple University Press.
- [32] Streicher-Porte, M., Widmer, R., Jain, A., Bader, H. P., Scheidegger, R., & Kytzia, S. (2005): Key drivers of the e-waste recycling system: Assessing and modeling e-waste processing in the informal sector in Delhi. *Environmental Impact Assessment*, 25(5), 472-491
- [33] Tibbs H. (1999): 'Sustainability', Deeper News, Global Business Network, 10:1 E-waste management in South Africa, Kenya and Morocco: Developing a pathway to sustainable systems
- [34] Report commissioned by Hewlett-Packard 2009. St. Gallen, Switzerland.
- [35] United Nations Environment Programme (2009): Recycling – From E-waste to Resources. www.unep.org/PDF/PressReleases/E-Waste_publication_screen_
- [36] Van-de-Kludert, A and Anschutz J., (2001): Integrated Sustainable Waste Management .Gouda Taiwan.
- [37] Waema, T. and Muriuki, M. (2008): E-waste Management in Kenya. Kenya. Nairobi, Kenya.
- [38] Wang, C., & Chou, T. (2009). Personal Computer Waste Management Process in Taiwan via System Dynamics Perspective. International Conference on New Trends in Information and Service Science, pp. 1227-1230
- [39] Williams, E. (2004). 'Energy Intensity of Computer Manufacturing: Hybrid Assessment Combining Process and Economic Input-Output Methods'. United Nation University. Environmental Science Technology, Volume 38. No 22. Tokyo, Japan.
- [40] World Bank (2006, 2004): World Development Indicators; <http://www.worldbank.org/data/wdi2004/index.htm>