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Computer E-Waste Disposal Management Approaches and Their Implications on Human Health and The Environment in Nairobi City County, Kenya

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Abstract

Computer e-waste, one of the greatest challenges of the urban solid waste, has potential negative effects on environmental and human health. This study examined computer e-waste disposal management approaches in 38 institutions, 156 households and 30 private companies and their implications on human health and the environment. Questionnaires, interviews and observation guides were used to collect data. The findings revealed that public auction, certified waste collections, storage by institutions, private companies and households, respectively, are the main disposal management approaches. All the approaches used had potential negative environmental and human health effects. The key drivers of the disposal management approaches were identified as resource value, cultural, age at purchase of new computer, stakeholders' attitude, technology update and obsolesce, high cost of repairs, research and development and end-of-life. Purchase of cathode ray tube (CRT) display monitors by public institutions and private companies was decreasing; liquid crystal display (LCD) monitors and laptops were increasing; and households purchased and retained CRTs and laptops. Lack of a disposal management system contributed to unsustainable e-waste disposal management. The study recommends involvement of public-private-partnerships and establishment of a sustainable computer e-waste disposal management system consisting of residential and commercial neighbourhood E-waste Drop-Off Points, E-waste Recycling Centre and Ward Literacy Centres to utilize recycled products. This will include formulation of a zero e-waste policy that will provide for the establishment of a County Computer E-Waste Management Authority. The authority will spearhead implementation of the zero e-waste policy.

Keywords: Computer e-waste, Disposal management approaches, Disposal management system, Human health and environmental effects, Public-private-partnerships, Zero e-waste policy.

INTRODUCTION

Computer electronic waste is the swiftest growing urban solid waste stream in the world (Step Initiative, 2014). It is a human health and environmental threat in urban areas because of the hazardous nature of its contents. The enormous computer e-waste generated at end of life (ITU, 2013) creates a major disposal management challenge especially in the low-income countries of the world. However, information on how these countries are disposing of the e-waste and potential effects of the different approaches on human and environmental health is lacking.

The main objective of this study was to identify the computer e-waste disposal management approaches by public institutions, private companies and households and their potential effects on human health and environmental quality in the Nairobi City County (NCC), in Kenya.

THEORY

One of the objectives of sustainable computer e-waste disposal management is to enhance the quality of human health and the environment of the urban populace. According to Tietenberg (2010), high disposable incomes, many years in school, and household size play a significant role in increased demand for improved environmental goods and services. The writer expounds on access to information, regarding the costs and

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benefits of improved quality of human health, the need for a clean environment and the number of people in a household playing an essential role in the willingness to pay for the collection of the computer e-waste for enhanced disposal management.

According to Kalana (2010); Oteng-Ababio (2012), the public and private sector stored the computer e-waste in the premises awaiting instructions for their disposal from elsewhere. Apart from the potential effects on human health and the environment, disposal of computer e-waste has liabilities related to what the product is composed of. For example, public institutions are exposed to the risk of unwanted data exposure if private client data or information was not properly removed from hard drives when disposing of computer e-waste. Likewise, software license intrusion may result when institutions discard technology. Failure to remove data from hard drives before disposal means any software found on the computer could be retrieved and utilized or sold off, thereby infringing on the software companies' licensing agreements.

Hossain (2010) noted that more computers are shipped to low-income countries such as Kenya, without testing for functionality (Osibanjo et al., 2007). In most cases, these are disassembled unprofessionally hence have potential to harm the residents, pollute soils, air and water sources. Although most of these countries have established human health and environmental management statutes and related regulations, their capacity to treat e-waste remains low. The consignments are hence re-labeled and re-directed as charity provided computers to clear them at the customs and deliver it to the buyers who are readily waiting for their arrival at a low-income country.

While exporting of second-hand computers is legal in many low-income countries, it is banned in the international and regional treaties and also in the legislations of many nations. The Basel Action Network (BAN), the Silicon Valley, Toxics Coalition, Toxics Link, among others reveal that only computer reprocessing practices in Africa, India and China are toxic to the environment.

Williams (2003); Hischier (2005) observed that encouraging the market for used computers extends their lifespan and delays the e-waste to the landfill. Hence, when the computers become obsolete, users have three main choices for their equipment; namely store it, throw into the County Solid Waste stream or pass it on to a second user. Williams (2003) noted that public institutions and private companies hardly installed used computers. Most of the re-used computers are finally disposed of by small companies (40%) and households (60%) who had bought them through auctions (Williams, 2003).

The computer e-waste disposal management is often practiced by the institutions and private companies (Kalana, 2010), but it is at the household level where the waste from computers is of great concern. The household mostly stores the obsolete computers for a while for perceived value, either for the emotional or physical connection before it is discarded.

Williams et al. (2008); Arora (2008) noted that usually the acquisition of new computer products is led by the desire to purchase new hard and software, rather than repair, but not due to breakage. The writers report that it is because of the declining lifespan of computers that more are purchased.

The disposal management practices for computer e-waste, in Kenya, vary depending on the user. Once computers attain the end-of-life, they are stored at homes or offices, sold as second-hand, donated to schools, friends or neighbours who could otherwise not afford the cost of new computers (Mureithi et al., 2008). It is noted that few consumers took their used computers for reprocessing or disassemble for reuse. The study further noted that with 1,210.4 tonnes of computer e-waste discarded off on the secondary market and an estimated 1,640 tonnes of new computers entering into the market each year, the outflow to refurbishing market was lower compared to the new acquisitions. This clearly indicates that it was possible that a substantial amount of stored computer e-waste was stored by consumers with limited level of awareness on the risks of improper disposal management practices of the e-waste,

especially if it is broken down.

According to Lis (1993), increasing public demands for environmental transparency has increased the cost of traditional disposal or treatment methods and sitting of new landfills has over time become exceedingly challenging and expensive. The potential burden for computer e-waste discharges has also increased with the formulation and increased uptake of the cradle-to-grave solid waste legislation. A vast body of literature has highlighted lack of proper infrastructure, lack of or weak regulatory enforcement, unclear legislation, lack of waste minimization audit reports, low pressure from environmental NGOs or justice groups, insufficient information, and lack of financial resources as key foundation stones for successful e-waste disposal management system (Satvir, 2016).

RESEARCH METHODS

Cross sectional research design was used in the study. This design is best suited for studies aimed at finding out the prevalence of a phenomenon, situation, problem, attitude or issue, by examining a cross-section of the population for obtaining an overall picture as it stands at the time of the study (Lindell et al., 2001).

The target population for the study consisted of different categories of computer users. This included public and private universities, government ministries, research and regulatory institutions, private companies and households. Both formal and informal municipal waste disposal sites were also surveyed.

Various sampling techniques were used in selecting the respondents from the different categories of users. Procurement in government is carried out in the same way for the same products for all ministries therefore, any ministry could have been sampled for the study. Government ministries were classified in two categories, those directly related to policy and regulation of the ICT and others. Purposive sampling was used to select ministries that were rich in the information related to the subject of study (Creswell, 2005). Purposive sampling was used to sample the Ministries in charge of science and technology, ICT, health and environment. Sampling of Research Institutes considered different mandates such as research on animals, crops, crime, humans, policy and industrial sub-sectors.

The households sampled were from among the officers occupying government-owned houses because they are well organised into high, medium and low-income categories. From the pilot study, it was observed that generally, the lower cadre of government officers did not own computers. This category was therefore left out of the study. The medium and high-level government households formed the sampling frame for this target population. The private companies listed in the Nairobi Securities Exchange formed the sampling frame for this target population.

Dandora dumpsite, the only official waste disposal management site for the county solid waste stream, was included in the study. The Waste Electrical and Electronic Equipment (WEEE) Centre, the temporary waste disposal stations, called 'yard shops' in the terminology of Oyake-Ombis (2015), located within the proximity of the Dandora dumpsite were also included in the study. Three e-waste scavengers were also included to capture their experience with the e-waste disposal management.

Based on the recommendation by Bell (1993) and Mugenda and Mugenda (2003) that one-third is a reasonable representation of the target population, a sample size of 30% was drawn from each of the household clusters and private companies. A total of 38 public and private institutions, 30 private companies and 156 high and middle-level income households were sampled. The Dandora dumpsite, the WEEE Centre, three-yard shop operators and three scavengers were also interviewed as detailed in **Table 1**.

To ensure a high response rate, face-to-face interview schedules were used for data collection from the key informants and semi-structured questionnaires for public institutions, private companies and households. For key informants and private companies, the top management

TABLE 1: Institutions, private companies, disposal sites and households sampled

Data source	Type of sample	Frequency	Sample	Proportion
Institutions	Public universities	3	3	1.3
	Private universities	17	6	2.7
	Government ministries	18	7	3.1
	Research institutions	11	9	4.0
	Private companies	67	30	13.4
Key policy makers and regulators	MENR	1	1	0.5
	MoH	1	1	0.5
	NCC	1	1	0.5
	CA	1	1	0.5
	NEMA	1	1	0.5
Households	High income	264	79	35.3
	Middle income	257	77	34.4
Disposal sites	Official county disposal site (Dandora)	1	1	0.5
	Temporary collection sites	3	3	1.3
	Scavengers/Pickers	3	3	1.3
	WEEE Centre	1	1	0.5
	Grand total	-	**224**	**100**

Source: Researcher 2018

employees were interviewed to ensure sufficient coverage of institutional policies and practices. Data on households was collected through face-to-face interviews where respondents were accessible. Where respondents were not accessible, the questionnaire was left in the home for filling by the head of household or spouse and then collected later by the research assistants.

The information collected was on the type of e-waste disposal management approaches, knowledge on levels of awareness of the staff on the impact of computer e-waste disposal management approaches on human health and the environment, knowledge of existing legislation and policies, and enforcement and degree of compliance. Checklist aided observations were also used for the disposal sites that consisted of the WEEE Centre, scavengers and yard shop operators. The data were analyzed using IBM Statistical Package for Social Sciences (SPSS) Version 21.

RESULTS

Computer E-Waste Disposal Management Approaches

The respondents from public institutions, businesses, households and disposal sites were asked about the approach they had employed for the computer e-waste disposal management that no longer deemed useful to them. The results from the respondents are as indicated in **Table 2**.

The study observed that public institutions store (100%) their computer components and accessories for about one year before the government agency in charge of disposal provides directives on their behalf. It was also observed

TABLE 2: Computer e-waste disposal management approaches employed by different actors

Disposal management approaches	Respondents (%)		
	Households	Institutions	Private companies
Auctions	-	75	-
Stored in the premises	44.9	(100)	-
Throw away with urban solid waste	27.2	20	-
Donated	10.9	5	47
Sold out as second-hand material	8.8	-	-
Sold to recycling plant/collectors	8.2	-	50
Lease out	-	-	5

Source: Researcher 2018

that 75% of all computer e-waste from institutions is sold through auctions, 20% thrown away with other county solid wastes and 5% is donated mainly to other public institutions such as technical institutions. The main disposal management approach by the private sector includes donations to staff (47%) and selling to e-waste collectors (50%). The WEEE Centre was found to refurbish imported computer e-waste and donate them to schools through Computer for Schools Kenya (CFSK) while 10% is recycled. Open-air burning was practiced by the waste collectors.

Table 2 indicates that storing computer e-waste in their premises was the most common practice among households (44.9%), followed by throwing it away with other urban solid waste (27.2%). Other disposal options practiced by households included donation (10.9%), sold as second hand (8.8%) and sold directly to a recycling plant.

Exposure to human health risk of computer e-waste by types of computers

The type of computers found in institutions, companies and households were examined as a further pointer to the risk of e-waste disposal management approaches. The respondents were asked to rate on a Liker-type scale of: 1-most common, 2-second common, and 3-least common with CRTs (traditional monitors), LCDs (flat screens) and laptops. The response enlisted was as summarized in **Figure 1**.

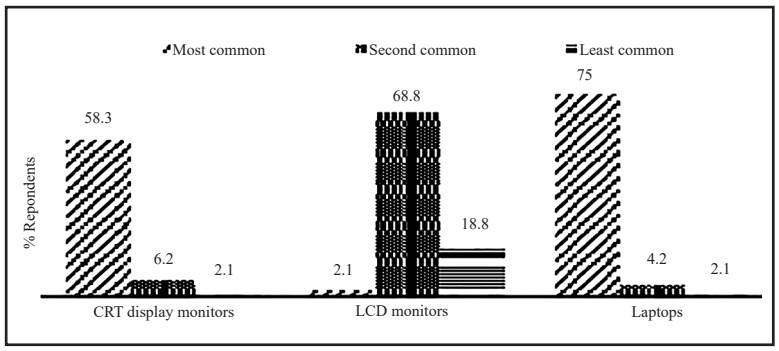

FIGURE 1
Use rating for types of computers available in Institutions
Source: Field survey 2016

Equally, results presented in **Figure 1** were reflected in the responses to the question which sought to enlist the type and the average number of computers purchased in the institution per year. The responses to the question of this variable were as presented in **Figure 2**.

Figure 2 indicates that most institutions (including private companies) prefer the use of LCDs (85.4%) or laptops (91.6%) to CRTs (33.4%). Most of those who responded to the question (56.4%) said that there was at least one laptop in the house. Another 19.2% reported that there was a desktop computer with a CRT display monitor in the house while 6.4% reported that they had one with an LCD monitor (**Figure 3**).

For effective disposal of e-waste, computer users were asked where they obtain them from. The responses to this question were as presented in **Table 3**.

TABLE 3: Common source of computers for Institutions

Source	Frequency	Percent
Direct import of international brand	1	2.2
International brand retail outlets	43	93.4
Local assembler with no own brand / refurbished	1	2.2
Other sources	1	2.2
Total	**46**	**100.0**

Source: Researcher 2018

From **Table 3**, nearly 90% of the institutions and private companies bought computers from international brand retail outlets. Other sources for institutions with relatively less favour were the direct import of international brand (2.2%) and local assembler with no own brand/refurbishes (2.2%). Similarly, most of the respondents from

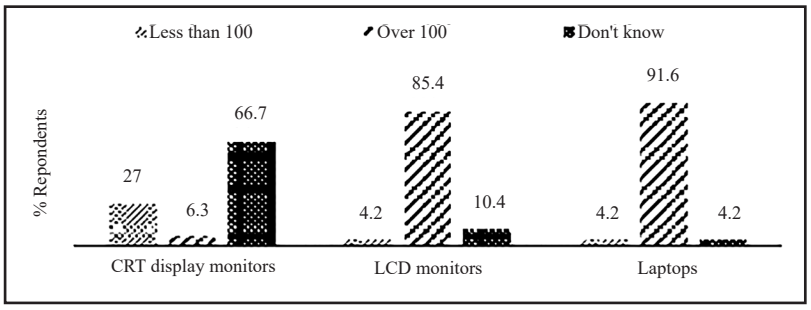

FIGURE 2
Average type of computers purchased in Institutions per year
Source: Field survey 2016

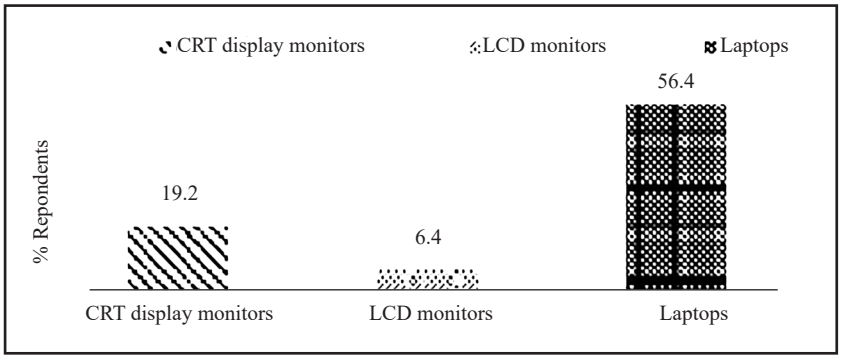

FIGURE 3
Type of computers in the household at the time of the study
Source: Field survey 2016

households (70%) reported that the computer in their house had been purchased (**Figure 4**). Those who reported having acquired the computer by way of donation were only 3%. However, over one-quarter (27%) did not disclose the source of the computer in their household, a scenario which raises the possibility that ownership through purchase is not the only option for attaining ownership of a computer.

Condition of computer currently in the household at the time of receipt

Respondents were asked about the condition the computer used within their household was in at the time it was received. Of the 114 who responded to this question, only 4% reported that it was 'second-hand but in usable condition'. An overwhelming majority (96%) of households reported that the computer they had was 'new' at the time they received it.

Reasons for institutions warranty considerations on purchases

Another question that sought to map out human health and environmental aspects as the underlying springboards for consideration of warranty period were examined and responses enlisted are summarized in **Table 4**.

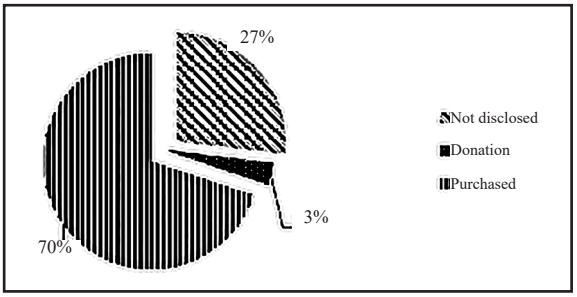

FIGURE 4
Source of computers present in the households
Source: Field survey 2016

As the analysis revealed, none of the respondents reported environmental nor human health as a consideration of the value attached to the warranty periods. The four who responded considered maintenance and replacement cost. The economic cost, therefore, was the most outstanding underlying value attachment considerations presented in the responses.

More particularly, three response options were provided against a question that sought to enlist the views of respondents about what would be the responsibility of computer technology users in the disposal management of computer e-waste. These options were:- postponing the purchase of new computers when those in use are still able to serve; pay for waste disposal levies during the purchases; and engage in the separation of computer e-waste from urban solid waste and channel them to recycling plants (**Figure 5**).

Drivers of Computer E-Waste Disposal Management Approaches

The factors that stimulate the desire to dispose of computer e-waste were assessed in relation to two parameters: the type of technology application favoured; and attainment of the computer's end-of-life cycle. On the technology front, respondents from institutions were asked about the average age of computers purchased in their respective institutions. The responses to this question were as presented in **Figure 6**.

As **Figure 6** indicates, most of the respondents (60%) reported that the average age of computers

TABLE 4: Reasons for Institutions' warranty considerations on purchases

Reasons	Frequency	Percent
Maintenance and replacement cost	4	57.14
No response	3	42.86
Environmental/Human health aspects	0	0
Total	7	**100**

Source: Researcher 2018

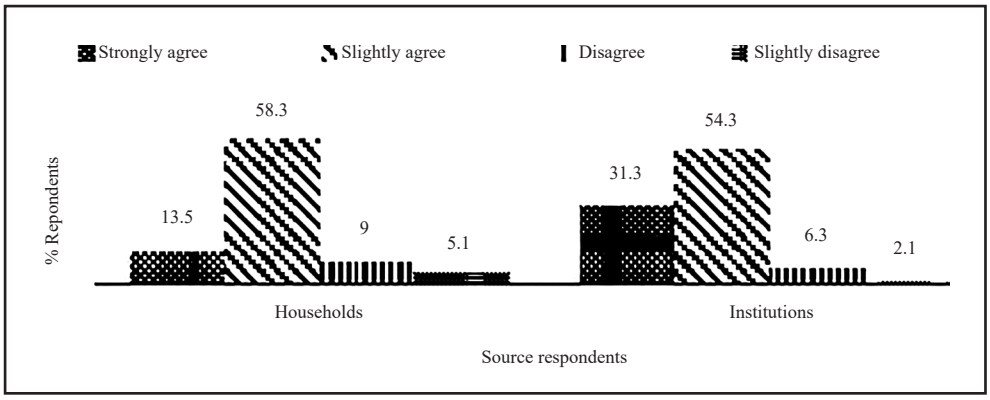

FIGURE 5
User responsibility preferences for computer e-waste disposal management approaches
Source: Field survey 2016

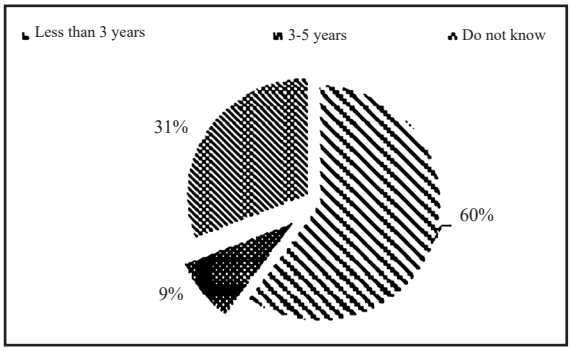

FIGURE 6
Average age of computers purchased by Institutions
Source: Field survey 2016

purchased in their institutions was less than 3 years. Other respondents (9%) reported that it was between 3 and 5 years. Some (31%) of the respondents did not have answers about the appropriate average age of computers purchased by their institutions.

Both **Figures 6** and **7** attest to the likelihood that age at purchase and duration is a crucial driver of the decision for the disposal of computer e-waste by many users.

Respondents were provided with a set of options for which a decision to dispose of computers would be based within their respective institutions. These conditions were: when broken down and not repairable; when broken down but repairable; and when in excellent condition, functioning, but technologically out of date. They were granted the liberty to indicate if they 'can't remember exactly' the underlying reason for the disposal decision. Their responses were presented in **Figure 8**.

Figure 8 indicates that nearly half of the respondents reported that breaking down of computers was a common cause for disposal, albeit in a repairable state. However, the technologically obsolete consideration as disposal driver was much higher (66.7%). To further assess technological transition as a determinant of decision for the disposal, households were asked about the type of computers they had discarded from the house over the past five years. They were also granted the liberty to indicate if they 'can't remember exactly' the underlying reason for the disposal decision. The response to this question is as presented in **Figure 9**.

From **Figure 9**, the number of households in which computers had been discarded was highest for the CRTs (55.2%), followed by the LCDs (37.9%), and least for the laptops (33.4%). Although with a much smaller magnitude, households that reported that they had not disposed of laptops over the past five years before the time of the study was highest for CRTs (5.1%) than for LCDs (1.9%). Examination of responses to questionnaires from the households to the question which sought to enlist the major reason for the reported disposal is presented in **Figure 10** (n=58). The major reason for the disposal of computers from households is the high repair cost compared to a new one (65%).

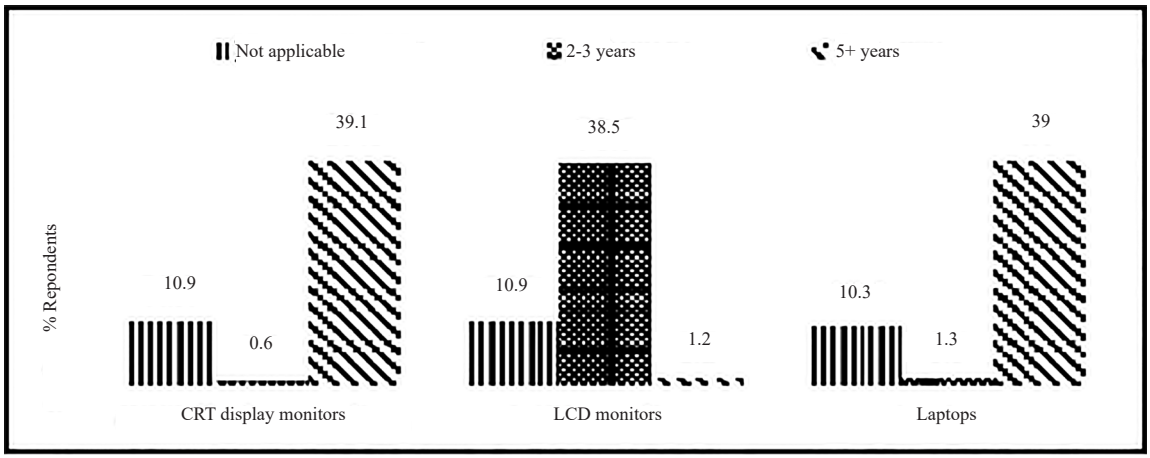

FIGURE 7
Duration newly acquired computers were used in household before replacement
Source: Field survey 2016

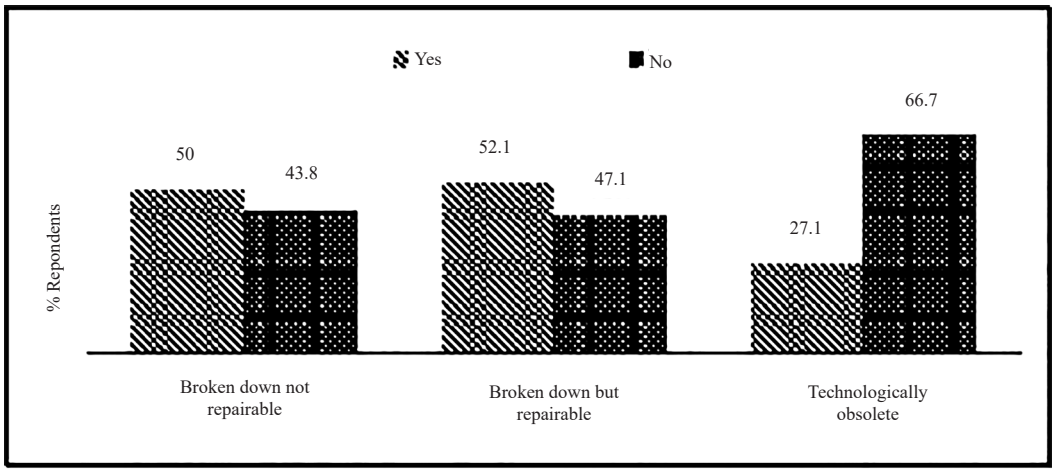

FIGURE 8
Conditions that trigger decision to dispose of computer e-waste in Institutions
Source: Field survey 2016

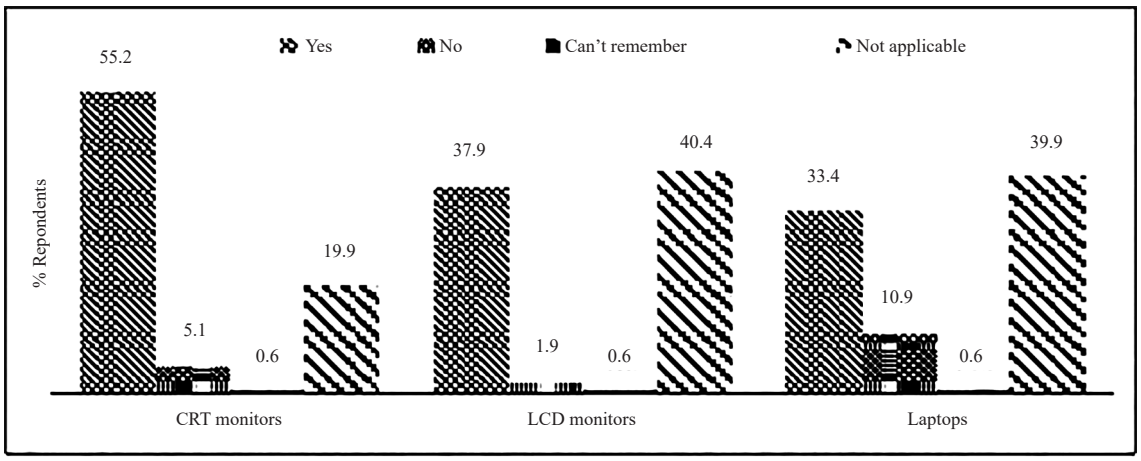

FIGURE 9
Type of computers discarded from households over the past five years
Source: Field survey 2016

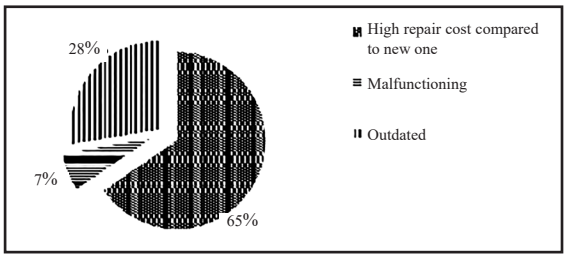

FIGURE 10
Major reasons used for computer discarded from households
Source: Field survey 2016

Sustainability of Computer E-Waste Disposal Management Approaches

The study observed that all the computer e-waste disposal management approaches practiced by the different actors have potential negative effects on human health and the environment and hence they are unsustainable (**Table 5**). According to Herat (2007); Wath et al. (2010), lack of end-of-life disposal management options, capacity, legislations, commitments, increasing volumes of computers, rapid technology obsolescence, and socio-economic issues, have resulted in the unsustainable disposal management of the computer e-waste. A sustainable computer e-waste disposal management system will, therefore, require the implementation of a zero-e-waste policy.

DISCUSSION

Computer e-waste disposal management approaches employed by different actors

The study established that all types of computers are being used by institutions and private companies. The most purchased computers are the laptops and the LCDs, while the CRTs are still being used at the institutions. It is evident that the CRTs are being phased out and are fast being replaced by the LCDs. The main form of computer e-waste

TABLE 5: Implications of computer e-waste disposal management approaches on human health and the environment

Disposal management approaches	Implications
Auction	• This disposal management approach has no direct effects on human health and the environment. • However, it has potential negative impact on human health and the environment if it ends up in the hands of pickers/scavengers who dismantle them with no protective gear.
Recycling by the e-waste pickers / scavengers	• Disordering of boards, chemical striping of chips and gold -plated components (UNEP, 2013) has the following effects on human health and the environment. **Human health** • Cuts from glass and plastics. • Acid contact with eyes and skin resulting in permanent injury and death (Davis, 2006; Reena, et al., 2011). • Inhalation of tin, lead (pb), brominated dioxin, beryllium, cadmium (Cd) and mercury (Hg), phosphorous, respiratory irritation or inhalation of acid fumes resulting in problems or permanent injury. • Direct exposure through skin contact or ingestion of hazardous components. **Environmental impacts** • Acidification and pollution of soils by heavy metals. • Pollution of both surface and groundwater sources. • Air pollution.
Throw into urban solid waste stream	Weathering of CRTs in the landfill releases toxic chemicals (Hg), Cd, Pb, BFRs, Zinc (Zn) etc. that have the potential to:

	• Pollute the air, surface and underground water sources and soils (Njoroge, 2007; Panwar et al., 2018). • Broken plastics cause physical injuries and inhalation/ingestion of chemical components may lead to Hg and Pb poisoning.
Donated	• This disposal management approach has no effects on human health and environment. • However, it extends end-of-life, but after use, the computer e-waste may break down, may become unserviceable, may be thrown away, or may be stored in premises.
Sold to NEMA e-waste collectors/Lease out	• This approach has no effects on human health and environment. However, it is not clear how these collectors dispose of the computer e-waste.
Storage	• This disposal management approach has no effects on human health and the environment if computer e-waste is not broken down. • However, it fails to provide the computer e-waste to the recycling facility.
Sold as 2nd hand material	• The computer e-waste may be reused, recycled, or refurbished after purchase. • This approach has potential to negatively impact on human health and the environment if it is recycled by the e-waste pickers who do not use protective gear. • The end-of-life of the computer e-waste is however extended when it is re-used and refurbished.
Sold to recycling facility (WEEE Centre)	• This approach has no negative impacts on human health and environment since the facility uses the Best Available Technology (BAT) and best environmental practices. • The non-recyclable materials are exported to countries with appropriate recycling facilities.
Refurbish	• This extends end-of-life of the computers, but finally, it may end up being disposed of in an environmentally unsound manner.
Open air burning	• Burning of polyvinyl chloride (PVC) forms dioxins which has the following human health and environmental risks. **Human health risks** • Exposure to dioxins and furans can lead to inhalation, ingestion and skin absorption. • Exposure to high levels can lead to severe skin disease, darkening of the skin, and altered liver function. • Exposure to lead, beryllium and tin can lead to damage of the immune, nervous and endocrine systems and impaired reproductive functions (SVTC, 2002; Huo et al, 2007; Annamalai, 2015; Alam, 2016). • Pollution of air by brominated dioxins, heavy metals and hydrocarbons • Toxic fallout affects the health of workers and their families. **Environmental risks** • High temperatures concentrate the metals in fly ash. • Toxic fall out affects the urban environment. • Intoxication of dumpsite near the residential areas. • Contamination of air by heavy dioxins and heavy metals and hydrocarbons.
Urban mining	Recovering and recycling of computer e-waste from dumpsite may have potential negative effects to human health and the environment. However, it can also reduce:- • Burden on mining industry. • Global demand for virgin materials. • Greenhouse gas (GHG) emissions. and • Conflicts (e.g. Democratic Republic of Congo).

Source: Reconstructed from Deng et al. 2006; Wath et al. 2010; Kumar et al. 2017

disposal management approach for households was storage in premises while institutions and private companies often stored in the offices until directions to dispose of are given (Nengimana et al., 2011; Kalana, 2010; Oteng-Ababio, 2012; Tiep et al., 2015; Bandhopadhyay, 2010; GOK, 2015). When the decision is finally given, it is mainly by auction.

CONCLUSION

The study concludes that institutions store their computer e-waste in the offices until directives are given to dispose the waste off mainly through public auctions. The private companies dispose of their computer e-waste to NEMA certified e-waste collectors while others dispose of their e-waste to vendors through leasing. Storage on the premises was identified as the major computer e-waste disposal management approach by households. The households are unwilling to dispose of their computer e-waste because they do not know how and where to dispose of it and mainly store their unused or broken-down computers for a while before they are resold, donated or thrown away with other urban solid wastes.

The computer e-waste disposal management approaches in the informal sites is recycling using rudimentary tools and open burning without any regard to potential effects on human health and environmental degradation of the urban area. The computers with LCDs and laptops are preferred compared to computers with CRTs. The research, therefore, concludes that the old riskier technologies are being replaced by new technologies. The respondents from the households also preferred to purchase new computers because it was cheaper than repairing the old ones.

Sale of computer e-waste through public auctions provides an avenue for the informal sector and household respondents to purchase the used computers at a low cost. The study concludes that huge volumes of computer e-waste are still stored on the premises due to lack of information on how and where to dispose of it. This should be a great concern because it is a potential threat to human health and the environment if it is not disposed of in an environmentally sound manner. It is also not clear how the certified e-waste collectors and lease vendors dispose of their computer e-waste. The study concludes that all the computer e-waste disposal management approaches practiced by the institutions, private companies, and the households are a risk to human health and the environment, and they are therefore unsustainable.

The study also concludes that the average age of computers purchased by institutions and the duration newly acquired computers were used in the household before replacement are drivers of computer e-waste disposal management approaches. Technological obsolescence is the main trigger of the decision to dispose of computer e-waste in the institutions.

RECOMMENDATIONS

The study recommends the establishment of a sustainable computer e-waste disposal management system. It will consist of Computer E-waste Drop Off Points (CEDOPs) in residential and commercial neighbourhoods; a County Computer E-Waste Recycling Centre (CEREC) and Ward Computer Literacy Centres (WCLCs) in all Wards to utilize some of the refurbished computers. The system will require formulation of a zero e-waste policy. To enhance efficiency and effectiveness of e-waste management, there is need for establishment of a County E-Waste Management Authority (CEDMA) to coordinate the whole value chain. The Authority will have the mandate to implement the zero e-waste policy in Nairobi City County. Processing, sorting, reuse, refurbishing, and recycling will be done at CEREC and the WCLCs will absorb some of the recycled products for community computer literacy capacity building. Since most of the computer products are purchased from large foreign companies, any un-recyclable computer e-waste would be exported to foreign countries for recycling using BAT and environmentally sound practices. The NCC should also engage in public-private-partnerships in order to build a strong and environmentally sound computer e-waste disposal management system. Meanwhile, there is a need to follow up on what the certified computer e-waste collectors and vendors do with the computer e-waste to confirm the safety of the final disposal management approach adopted. Effective implementation of the zero e-waste management system will result in computer e-waste disposal

management sustainability in the Nairobi City County.

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