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Challenges Facing Disposal of E-Waste in Kenyan Public Universities

Rose Nakhanu Kapukha[1], Samuel Mbuguah[2], Juma Kilwake[3]
[1,2,3] *Kibabii University*

Abstract: This study sought to establish the challenges facing disposal of electronic waste in Kenyan Public Universities. Survey research design was used in the study. The target total population was 385 from two public Universities and one University Constituent College. Through purposive and simple random sampling 110 respondents were selected. The data collection instruments were questionnaires and document review. The data analysis used both descriptive and inferential statistics. The findings of the study indicated that public Universities have major challenges in disposal of electronic waste and there is also lack of proper disposal mechanism. The paper then recommends that universities need to set up a disposal and refurbishing center.

Keywords: Electronic Waste, ICT, Disposal, Refurbishing, Disposal And Refurbishing Centers, Electronic Devices.

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I. INTRODUCTION

Electronic waste (e-waste) is one of the fastest growing solid waste streams around the world today (United Nations Environment Programme (UNEP), 2010). The ICT industry's growing economic activities has found its way into almost all the sectors such as Education, Health, Industrial, Trade and Communication sectors among others (Nnorom & Osibanjo 2008; Mokaya & Njuguna, 2010; Otero & Ismail, 2011; NEMA, 2013). These has led to unprecedented high rates of consumption coupled with enormous growth of ICT electronic devices such as personal computer, mobile phones, tapes, floppy disks, CDs and other devices (Carisma, 2009; Basel Convention, 2011). Other factors like reduction in price of electronic devices has also made affordability and acquisition of new devices easier. These factors has led to high production of waste which comprises run down or end of life ICT devices.

In Kenya, the port of Mombasa on a daily basis receives containers filled with computers and peripherals numbering in the thousands (NEMA, 2012). Some of the devices are procured for business purposes while others come as donations to academic institutions. In Kenya ICT E-waste generated annually includes: 2,800 tonnes from TVs, 2,500 tonnes from personal computers, 500 tonnes from printers and 150 tonnes from mobile phones (Press Release UNEP, 2010). Although there are broad regulations for environmental protection in this country, what is not known is if they are specific to e-Waste. The workshop held by the various stakeholders in ICT sector found out that the uniqueness of e-waste problem is that e-waste is relatively new and its quantities are rapidly growing as technology becomes more common (CCK, 2010).

Maina (2012), in his study, established that, the amount of e-waste generated by Kenyan Universities is increasing at a rate of more than 100% per annum due to the continued increase in the use of computers and other related devices. However, about 40% of the e-waste generated remains in stores for years before disposal due to lack of proper e-waste management systems. The disposal procedure in these institutions is not clearly defined. Studies have been carried out in Kenya, which resulted to the birth of some frameworks, for instance the extended producer responsibility framework, focusing on mobile phone manufacturers' responsibility in end of life management of mobile phones. Communication driven corporate entities such as Safaricom have launched campaigns to raise awareness on electronic waste and implementation of these frameworks to no avail.

1.1 Objective of the Study

The objective of the study was to establish the challenges facing disposal of electronic waste in Kenyan Public Universities **.**

II. RELATED STUDIES

Studies in e-waste management has been done in the followin areas: Rapid growth of electronic waste; Effect of Poor disposal and Recycling and refurbishment of electronic waste

2.1 Rapid growth of electronic waste

Technological advances in electronic data management and communications have spurred economic growth and improved people's lives in countless ways (Kumar , Singh, Prasad, & Yadav, 2013). However, the increased production and consumption of electronic devices has led to a rapid growth in e-waste. The rapid changes in computer technology and emergence of new electronic gadgets have intensified the problem. For example, between 2000 and 2005, the Organisation for Economic Co-operation and Development (OECD) in its ICT growth report noted a 22% growth in Information and Communications Technology (ICT) in China. Furthermore, China was the 6th largest ICT market in 2006, after the US, Japan, Germany, UK and France. This is astounding when one considers that just ten years ago, under 1% of China's population owned a computer (Electronic Takeback Coalition, 2014).

The rapid growth in the high rate of obsolescence of ICT devices is due to the technological advancement as devices reaches its end of life, disposal challenges arise. When devices no longer satisfies the initial user's needs, it should not be assumed that it is in poor operational condition or has become obsolete. Instead, it may be possible to extend its life through use for the same purposes by other users. Or, it can be reused (in part or whole) for other purposes. Or, the materials contained within it can be recovered and recycled. Computers, monitors, televisions and other electronic devices should not be disposed of with regular garbage; in fact, this is illegal in some states such as California. Functioning electronics can be sold or donated thereby prolonging their useful life. Nonfunctioning electronics that cannot be repaired should be recycled by an organization qualified to do so. (CalRecycle, 2013).

2.2 Effect of Poor disposal

Electronic products contain materials that render them hazardous, depending on their condition and density. E-toxic components in computers could be summarized as circuit boards containing heavy metals like lead & cadmium; batteries containing cadmium; cathode ray tubes with lead oxide & barium; brominated flame-retardants used on printed circuit boards, cables and plastic casing; poly vinyl chloride (PVC) coated copper cables and plastic computer casings that release highly toxic dioxins & furans when burnt to recover valuable metals; mercury switches; mercury in flat screens; poly chlorinated biphenyl's (PCB's) present in older capacitors; transformers; among others. When improperly disposed of, this can be associated with health risks and toxic environmental pollution from toxic compounds found in most computers and monitors (Calrecycle, 2013). Many of these products should be reused, refurbished, or recycled in an environmentally sound manner so that they are less harmful to the ecosystem.

Poorly disposed electronic waste (e-waste) can result in severe health and environmental hazards due to highly toxic substances, such as lead and mercury. Only a few governments, like that of California, has levied the fee for the recycling of e-waste. The law covers only the CRT monitors. The fee is based on the size of the monitor and the cost of recycling. Slowly, there are ideas coming up from across the globe regarding recycling and disposing off the e-waste (Munyua, 2010).

2.3 Recycling and refurbishment of electronic waste

According to United States Environmental Protection Agency (USEPA), 2011 recycling is the process of collecting and processing materials that would otherwise be thrown away as trash and turning them into new products. On the other hand refurbishment is the distribution of products, usually electronics and electricals, that have been previously returned to a manufacturer or vendor for various reasons. Refurbished products are normally tested for functionality and defects before they are sold. They are repaired by the original manufacturer and resold. Recycling helps reduce the amount of waste sent to landfills and incinerators. Electronic devices contain a variety of materials, including metals that can be recovered for recycling and these saves resources because new metals don't have to be mined (Sonoma County Waste Management Agency, 2014). Recycling is the best way to deal with e-waste due to toxicity and persistence of the constituents.

III. RESEARCH DESIGN

Survey research design was used in this study. This design enabled the researcher to gather data from a large population within a short time and limited funding to establish the challenges facing disposal of electronic waste in Kenyan Public Universities (Mugenda & Mugenda, 2003). A survey design provided a quantitative or numeric description of trends, attitudes or opinions of public university population towards management of ICT electronic waste by studying a sample of public universities population (Creswell, 2011). This research also employed this design to collect both qualitative and quantitative data for both primary and secondary data.

Primary data was obtained by use of questionnaires while the internet, journals and books were used to collect secondary data.

3.1 Research site

The geographical location of this research study was Kenya. The study was carried out in universities in Kenya. Kenyan Public Universities were purposively selected as a study site since these Universities are established and maintained or assisted out of Public fund (CUE, 2013). Moreover, they were established through institutional Acts of the Parliament under the Universities Act, 2012 which provides for the development of the university education, the establishment, accreditation and governance of universities. These universities also utilize a wide range ICT products. Public universities also have larger number of staff as compared to the private universities (Kipkebut, 2010) and are the leading institutions of higher education that the government relies on to devise solutions on emerging challenges such as electronic waste (JKUAT, 2013).

3.2 Target Population and Sample size

The target population for this study was all staff from the administrative, ICT, procurement and stores cadre from the three public universities. Purposive sampling procedure was used since it enabled the researcher to select cases that were likely to be information rich with respect to the purpose of the study. Respondents were drawn from the following universities: Masinde Muliro University of Science and Technology, Multimedia University of Kenya and Machakos University College. The target population was 370.

The sample size determination, for this study was based on Nassiuma, 2000, formula for calculating the minimum sample size required.

The sample size was arrived at using the following formula:

$$n = \frac{NC2}{C2 + (N-1)e2}$$

Note: n=sample size;
N=population size;
C=Coefficient of variation which is 21%≤ C≤ 30%;
e=margin of error which is fixed between 2-5%

Nassiuma, (2000) asserts that in most surveys or experiments, a coefficient of variation in the range of 21%≤ C≤ 30% and a standard error in the range 2%≤ e ≤ 5% is usually acceptable. The study used a coefficient variation of 25% and a standard error of 2%. 25% coefficient of variation was used to ensure that the sample was wide enough to justify the results being generalized for the Kenyan Public Universities. Higher coefficients of variation was not used to avoid very large samples due to limitation of research funds and time. The lower limit for coefficient of variation and standard error was selected so as to ensure low variability in the sample and minimize the degree of error. Therefore, the sample size of respondents was:

$$\frac{370\,(0.25)^2}{(0.25)^2 + (370\text{-}1)0.02^2}$$

$$= \frac{370 * 0.0625}{0.0625+0.1476}$$

$$= \frac{23.125}{0.2101}$$

Sample size =110

3.4 Data collection Procedure

Questionnaires were used as instruments for data collection. They were developed based on the specific research objectives. Questionnaires were administered to the administrators, ICT staff and the procurement staff. This enabled the researcher to collect primary data and solicit information on ICT e-waste and its disposal;. Secondary data was also obtained from literature sources or data collected by other people for some other purposes. Secondary data was collected through review of published literature such as journal articles, published theses and textbooks. These sources were reviewed to give insight in the search for primary information.

3.4 Data Analysis

After data collection, information was structured and put in order for easier and effective communication. Editing, coding and tabulation was carried out. The data was organized and analyzed using descriptive statistics and inferential statistics. Descriptive statistics was computed to obtain a general understanding of the Universities and respondents' characteristics such as tenure, gender and department among others using mean, mode, median and analysis of variance. This data was analysed by use of descritive and inferential statistics.

IV. RESULTS AND DISCUSSION

This section presents the result an offers a discussion of the same.

4.1 Demographic data

This section of the study presents a brief background information about the respondents in terms of their academic institution, departments, and length of time in they have been in those institution.

4.1.1 Response Rate

A total of 110 respondents were sampled for this study. Questionnaires were administered to the sampled respondents. A total of 81 filled questionnaires were collected translating to 74%. This response rate complies with Babbie (2004) who asserts that return rates of 50% are acceptable to analyze and publish, 60% is good and 70% is very good. This response rate indicates a reasonable representation of the sample and of the entire population.

4.1.2 Distribution of Respondents in the Three Universities of study

The table 1 indicates the distribution of respondents across the three Universities:

Table 1: Analysis by University

Respondents university	Frequency	Percent
MMUST	38	47.5
Multimedia	18	22.5
Machakos	24	30.0
Total	80	100

In these study, 47.5% of the respondents were from Masinde Muliro University of Science and Technology (MMUST), 30% were from Machakos University College and Multimedia University of Kenya had 18%. From the table, none of the university had an overwhelming percentage in response. The response is well balanced across the three Universities implying that the results of the study cuts across all these Universities and it's a true reflection of management of electronic waste in Kenyan Public Universities.

4.2 Findings of the role of Disposal on management of Electronic waste

The study sought to find out the influence of disposal on the management of electronic waste. The results are as indicated in table 2:

Table 2: Findings on disposal on management of Electronic Waste

STATEMENT	SA	A	N	D	SD
	%	%	%	%	%
There are so many malfunctioning ICT devices in our stores/offices	21.1	44.7	23.7	5.3	5.3
Our institution has a proper infrastructure and resources for environmentally sound management of ICT electronic waste	7.5	18.8	3.8	57.5	12.5
Ours institution returns back the end of life products to the producers	2.7	5.4	29.7	54.1	8.1
Our institution has active links with the manufactures of ICT devices for the sake of managing the devices that are no longer in use	2.7	18.9	27.0	45.9	5.4
I personally understand the impact of irresponsible disposal of ICT electronic devices	25.0	11.1	8.3	50.0	5.6
Some of our ICT devices are taken for recycling or refurbishing	2.1	19.4	55.0	11.1	5.6
We have undergone training on e-waste disposal measures	17.6	11.8	11.0	29.4	40.2
Our institution has a policy and regulatory framework in place to ensure proper disposal of our obsolete ICT devices	5.7	20.0	11.4	51.4	11.4
We have proper disposal mechanisms of ICT devices to be followed to	2.9	17.1	25.7	42.9	11.4

protect the environment					
Our institution has responsible recycling and reuse practices	15.8	14.4	4.0	36.8	25.9
In our institution we are practising green product lifecycle management	2.1	2.6	40.0	15.8	39.5

4.2.1 Descriptive analysis

On average, most of the respondents (65.8%) agreed there were a lot of malfunctioning devices in the stores. A higher percentage (70%) said that their institutions lack a proper infrastructure and resources for environmentally sound management of ICT electronic waste. 62.2% of the respondents agreed that their institutions lack a take back system where the end of life products are taken back to the producers while 29.7% are not aware of the take back system. The study further sought to find out if the institutions have any active links with manufacturers of the ICT devices for the sake of disposal, 51.3% disagreed, 21.6% agreed while 27.0% are not aware. This complies with studies carried by UNEP (2009), E-waste workshop (2010) and NEMA (2013).

A high percentage of the respondents (55.6%) do not understand the impact of irresponsible disposal of ICT devices. 55.0% were not aware whether obsolete devices were taken for recycling or refurbishing. Majority of the respondents (69.6%)) disagreed that they had not been trained on e-waste disposal measures. While 62.7% disagreed that they had responsible recycling and reuse practices.

4.2.2 Analysis by Inferential statistics

This section discusses the results from inferential statistics. The study used pearson moment of correlation to analyze and determine whether there are significant differences between the independent variables which is disposal and the dependent variable manegement of E-waste.

Relationship between the disposal of electronic waste and Management of Electronic Waste

Table 3: Correlation Matrix

		Management of E-waste	Disposal(X)
Management of E-waste	Pearson Correlation	1	.613**
	Sig. (2-tailed)		.000
	N	80	80
Disposal(X4)	Pearson Correlation	.613**	1
	Sig. (2-tailed)	.000	
	N	80	80

From the correlation analysis disposal had a positive and a significant relationship with the dependent variable (management of E-waste) ($r=0.613$, $p<0.001$) at 0.01 level of significance. This findings concur with the literature that shows the lack of proper disposal mechanism. It is evident from the literature, electronic waste is processed in informal sectors which is harmful to the individual and the environment. The methods employed for disposing e-waste included dropping off old IT technology at garbage collection point, storing in offices room, selling scrap, donation and re-use, selling to staff, friends, family or Public, take back schemes and extended producer responsibility. The implication of these methods used is that e-waste generation is likely to increase downstream as a result of channeling e-waste to end users and recyclers (Munyugi, 2010; Maina, 2012).

From the study, institutions are facing major challenge on the disposal of no longer useful ICT devices due to: lack of proper infrastructure; lack of proper disposal mechanisms; institutions also lack a take back system where the end of life products are taken back to the producers; these institutions do not have any active links with manufacturers of the ICT devices for the sake of disposal.

Finding of the study also indicated that majority of the staff do not understand the impact of irresponsible disposal of ICT devices; Institutions also lack personnel who are knowledgeable on proper disposal of the ICT that will not be harmful to the the health and environment.

It is also evident from the findings that other challenges facing the Universities in the disposal of electronic waste include lack of awareness by staff, lack of proper policy and legislative framework governing disposal of these waste. University disposal policies have not addressed disposal of electronic waste adequately since its a new form of waste and they lack appropriate mechanism of handling it.

V. CONCLUSION AND RECOMMENDATION

Disposal have a positive and significant effect on the management of e-waste. From the findings of the study there exists a lot of malfunctioning devices in the stores of the universities. The study also indicates that universities lack of proper infrastructure and policies to guide disposal of obsolete devices. It was also noted that public universities face challenges in regards to disposal of electronic waste.

Since disposal has a great influence on the management of electronic waste. The study recommends setting up disposal centers in every town to deal with the rapid growth of e-waste. There is also need for formulation of policies and guidelines to govern disposal of these. The study also suggests the need for financial support and proper infrastructure for managing the disposed devices. There is also need to empower recycling centers in terms of human capacity, funds and technology.

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