Institutional E-Waste Management: Comparison of Practices at two Tertiary Institutions in Nigeria

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Abstract—Electronic waste (e-waste) comprises of waste from information and communication technology (ICT) equipment, devices and materials as well as others such as refrigerators, televisions, and air conditioners. Particularly, e-waste handling has become a major issue in recent times due to the increasing number of computer and wireless telephone users. Mostly, in developing countries, e-waste are usually improperly disposed of by burying, burning, employing unconventional or unsafe recycling methods and in the extreme, by doing nothing – simply storing the unusable e-waste away. Having recognized that large institutions are major consumers of electronic products, this paper presents a study of e-waste management practices at two institutions in Nigeria that were established in the 70's. They were selected for their age in the expectation that electronic products would have been purchased and disposed over the past 30 years or more. A questionnaire was used to obtain data from departments in the institutions and the data collected analyzed using descriptive statistics and the chi-square test at the 0.05 level of significance. The findings from the study are presented as a comparison of both institutions and recommendations are made towards the green disposal of e-waste in the institutions.

Keywords/Index Terms—e-waste, EEE, green disposal, ICT waste, WEEE.

Introduction

The terms, electronic waste (e-waste) and waste electronic and electrical equipment (WEEE) are used interchangeably (Deathe et al., 2008; Monika, 2010; Schoenung, 2005) to describe almost any household or business item with circuitry or electrical components with power or battery supply that has or could enter the waste stream (Man et al., 2013; Wang et al, 2013). E-waste includes information and communication technology (ICT) equipment, home electrical appliances, audio and video products, and all of their peripherals (Bandyopadhyay, 2008). A comprehensive listing of equipment and appliances that are considered electronic or electrical have been provided by the European Union (UNEP, 2007; Shah & Shaikh, 2008). E-waste is a generic term encompassing various forms of electrical and electronic equipment (EEE) that are old, end-of-life electronic appliances and have ceased to be of any value to their owners (Bandyopadhyay, 2008).

It is well documented that e-waste is the fastest growing segment of municipal solid waste world-wide, with the United States, Western Europe, China, Japan, and Australia being the major (Deathe et al., 2008; Monika, 2010). Of note is that most of the waste was from large businesses and institutions (USEPA, n.d.). Countries in Africa are also contributing to the stream of e-waste particularly because most ICT acquisition and ownership of large and small household appliances such as air-conditioners and refrigerators, depends more on second-hand or refurbished electrical and electronic equipment which are usually imported without confirmatory testing for functionality (Osibanjo & Nnorom, 2007). Indeed many West African re-use markets prefer refrigerators and televisions from European countries because of compatibility with power formats and broadcasting systems (Ogungbuyi et al., 2012).

Financial constraints have been flagged as a major factor in the trade in second-hand electronic goods in the African region (Fagbohun, 2011). For instance, in 2009 trade in second-hand Blackberries was reported to be booming in Lagos, Nigeria, with prices ranging between $25 and $65 (Leyden, 2009). The fact that information products generally have short life cycles (three to six years) (United States Agency for Natural Resources, 2004) with personal computers dropping to two years by 2005 (Oteng-Ababio, 2010). This means that the contribution of ICT products to the waste stream is significant.

Aginam (2008) reported that dumping of e-waste into the African markets, especially Nigeria, continued despite measures put in place by regulatory authorities such as the Standards Organization of Nigeria and the Computer Professionals Registration Council of Nigeria. Other countries where heavy dumping of e-waste occurs include China and Ghana (Aginam, 2008) as well as India **(**Needhidasan et al**.,** 2014) and Kenya (Onderi, 2011).

Electronic and electrical equipment (EEE) become e-waste as a result of obsolescence due to advancement in technology, changes in fashion, style and status, and nearing the end of the product's useful life (Needhidasan et al., 2014; Ramachandra & Saira, 2004; Schwarzer et al., 2005). There are two ways that e-waste is handled at the end-of-life phase. It is either disposed of improperly and in an unsafe manner or it is done safely for environmental sustainability and good health. Improper ways of disposing e-waste include the following:

- Land-filling (i.e. burying)

which can cause environmental and health hazards arising from mercury, cadmium, lead, etc, leaching into the soil and groundwater (Ramachandra & Saira, 2004; Chen et al., 2011).

- Incineration (i.e. burning) which can cause emission of toxic fumes and gases, thereby polluting the surrounding air. Also leads to ozone depletion by the release of gases such as polychlorinated biphenyls (Waema & Mureithi, 2011).
- Dumping i.e. shipping from industrialised countries to developing countries which was quite commonplace in the late 1980's (Osibanjo & Nnorom, 2007).
- Recycling by unconventional or unsafe recycling methods to produce useable equipment or extract economically viable components such as gold, silver, platinum and palladium (Alake & Ighalo, 2012; Needhidasan et al. 2014; Oresanya, 2011).
- Storage (a 'do nothing approach') which is common where there are no policies to guide the disposal of e-waste (Ramachandra & Saira, 2004).

International outrage following indiscriminate dumping of waste, including e-waste, by the developed nations led to the drafting and adoption of the Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal, usually known simply as the Basel Convention (http://www.basel.int). The Convention was opened for signature on 22 March 1989, and entered into force on 05 May 1992. Nigeria signed up in 1990, Kenya in 2000, and Ghana in 2003, amongst others. The Convention provides assistance and guidelines on legal and technical issues, gathers statistical data, and conducts training on the proper management of hazardous waste (Sthiannopkao & Wong, 2013).

Green disposal is advocated as the best way of disposing e-waste. It emanates from green computing which has the goals of reducing the use of hazardous materials, maximizing energy efficiency during the product's lifetime, and promoting the recyclability or biodegradability of defunct products and factory waste (Bossuet, 2014). Green information technologies and systems refer to initiatives and programs that directly or indirectly address environmental sustainability in organizations (Jenkin et al., 2011). To promote green disposal of e-waste, Ramachandra and Saira (2004) advocate that management of e-waste should begin at the point of generation by minimizing the waste and practising sustainable product design. They propose waste minimization strategies that revolve

around inventory management, production-process modification, volume reduction, and recovery and reuse. Sustainable product design, according to them, should include rethinking the product design, use of renewable materials and energy, and use of non-renewable materials that are safer.

Improving final disposal is also advocated through setting strict guidelines for landfill management and building disposal capacities by the establishment of a system of national treatment facilities. In this regard, countries like the United Kingdom have reported significant reductions in the amount of waste sent to landfill (down by over a third since 2001), while households recycled over 38% of their waste in 2010 compared to only 9% in 2000 and recycling from green waste went up 13% in the last decade (The Green IT Review, 2010).

According to Ramachandra and Saira (2004) there are roles to be played by government, industries and citizens in promoting green disposal of e-waste. They suggest that governments should provide an adequate system of laws, controls and administrative procedures for hazardous waste management and educate e-waste generators on reuse/recycling options. On the role of industries, adoption of waste minimization techniques, which will make a significant reduction in the quantity of e-waste generated and thereby lessen the impact on the environment in addition to manufacturers, distributors, and retailers undertaking the responsibility of recycling/disposing of their own products. Furthermore, citizens are advised to donate EEE for reuse, taking care that such items are in working condition; never to dispose e-waste with garbage and other household wastes, but rather to take them to a designated collection point; and to opt for those with green manufacturing policies while buying electronic products.

Statement of Problem

Ramachandra and Saira (2004) reported that an estimated 75% of electronic items are stored due to uncertainty of how to manage it and they stay unattended in houses, offices, warehouses etc. until they are mixed with household wastes, which are finally disposed of at landfills. Osibanjo and Nnorom (2007) highlight the challenges facing the developing countries in e-waste management as an absence of infrastructure for appropriate waste management, an absence of legislation dealing specifically with e-waste, and an absence of any framework for end-of-life product take-back or implementation of extended producer responsibility. The result is an e-waste problem for

a country like Nigeria where formal equipment take-back, re-use and disposal structures are missing.

When the e-waste is not properly disposed, the toxic substances such as lead and mercury, present in components of EEE can be harmful to humans and other organisms (Yousif, 2009). For example, lead which is used in batteries, solders, as alloying element for machining metals, and printed circuit boards are very toxic to aquatic organisms and to humans. Also, mercury, which is used in in thermostats, sensors, relays and switches which is toxic by inhalation can damage the central nervous system and kidneys in humans in addition to long term effects in the aquatic environment. As a result, it is important to have empirical evidence of what is being done with e-waste in Nigeria. The study by Alake and Aghalo (2012) focused on Alaba International Market, Badagry road, Lagos, which is a major in-let for electronic products (especially second hand electronic goods) in Nigeria, and examined e-waste disposal practice by electronic repair technicians, domestic electronic goods consumers and some distributors of electronic products. While the study gives information on how e-waste is managed in relation to a major EEE market in Nigeria, it does not provide any insight into corporate use and disposal of EEE.

Objective of the Study

To get ready for formal e-waste management in Nigeria, the type and amount of e-waste being generated by different stakeholders must be ascertained in addition to identifying how disposal is presently being handled. In recognition of the fact that large institutions greatly contribute to the growing stream of e-waste[8] this study sought to determine the type and magnitude of e-waste being generated by large institutions as well as to identify e-waste management practices at the institutions. The contribution of academic institutions to the e-waste problem was recognised by Iyer (2014), hence the study of attitude towards e-waste collection and safe management in lection in academic institutions in Bangalore. Specifically, the sub-objectives are to:

1. Compare the amount of selected EEE acquired by the study institutions from 2008-2011
2. Quantify selected EEE at the study institutions that are not in working condition
3. Identify the source of acquired EEE by the institutions
4. Identify e-waste disposal practices at the institutions
5. Make recommendations for green disposal of EEE

where necessary.

As a preliminary study, the scope was limited to a study of two of the oldest tertiary institutions in Kwara State, Nigeria – the University of Ilorin (Unilorin) and the Kwara State Polytechnic (Kwara Poly), focusing only on the academic departments.

Policies and Practices that Promote Green Disposal of E-Waste

At the international level, the Basel Convention focuses on the control of trans-boundary movements of hazardous wastes and their disposal. Regional policies are also influenced by non-governmental bodies. For example, the Council of European Professional Informatics Societies (CEPIS) works at promoting the ideas of Green ICT among its members in order to contribute to the environment's protection (CEPIS, 2012). At the country level, such policies or guidelines usually outline the responsibilities and roles of government, industries, and consumers (organizations and citizens).

In Nigeria, institutional and legal frameworks to regulate e-waste management in the country include the establishment of the National Environmental Standards and Regulations Enforcement Agency (NESREA), in 2007, replacing the Federal Environmental Protection Agency Act Cap F 10 LFN 2004. Nigeria signed up on the Bamako Convention in 2008. Nigeria also has a Ministry of Environment at both the Federal level and at the State level. Although, plans have been underway for a National Policy on e-waste such a policy is yet to be released. Nevertheless, a memorandum of understanding was brokered between NESREA, the Standards Organization of Nigeria, the Consumer Protection Council and the Alaba International Market Amalgamated Traders Association (Alaba being a major trading centre for electronic equipment in Lagos, Nigeria), to fight e-waste and piracy (Fagbohun, 2011).

Ramachandra and Saira (2004) propose the following things governments should do to promote green disposal of ICT waste - Government should provide an adequate system of laws, controls and administrative procedures for hazardous waste management , come up with a comprehensive law that provides e-waste regulation and management and proper disposal of hazardous wastes, establish an agency that is responsible for waste management, encourage beneficial reuse of e-waste and encourage business activities that use e-waste, set up programs to promote recycling among citizens and businesses, and educate e-waste generators on reuse/recycling options.

They recommend that industries that generate waste should take responsibility for it; all personnel involved in handling e-waste in industries including those at the policy, management, control and operational levels, should be properly qualified and trained; companies should adopt waste minimization techniques, which will make a significant reduction in the quantity of e-waste generated and thereby lessen the impact on the environment; manufacturers, distributors, and retailers should undertake the responsibility of recycling/disposal of their own products; manufacturers must be responsible for educating consumers and the general public regarding the potential threat to public health and the environment posed by their products. Furthermore, they recommend that consumers should donate EEE for reuse - but care should be taken while donating such items i.e. the items should be in working condition; e-wastes should never be disposed with garbage and other household wastes – take to a designated collection point; and while buying electronic products opt for those with green manufacturing policies.

Methodology

The tertiary institutions selected for this study were founded in 1973 (Kwara Poly) and 1975 (Unilorin) respectively. They are both located in the city of Ilorin in Kwara State, in the north-central zone of Nigeria. Academic activities at the Kwara Poly are carried out through 26 departments aggregated under five (5) institutes – Basic and Applied Sciences, Finance and Management Studies, Environmental Sciences, Information and Communication Technology, and Technology. Unilorin on the other hand has 81 academic departments clustered under 12 faculties. The faculties are: Agriculture, Arts, Basic Medical Sciences, Business and Social Sciences, Clinical Sciences, Communication and Information Sciences, Education, Engineering and Technology, Law, Pharmaceutical Sciences, Science and Veterinary Medicine.

Since the study was an institutional one, all 26 academic departments at Kwara Poly were selected as well as departments from closely related faculties at Unilorin. The related faculties at Unilorin were: Business and Social Sciences (six departments), Communication and Information Sciences (five departments), Engineering and Technology (seven departments) and Science (nine departments). This gave a total of 27 departments to be sampled at Unilorin. The Stores department at both institutions was visited for additional information on methods of e-waste disposal.

In developing the data collection

instrument, the first task was to determine what EEE were of interest in a large institution while still having a manageable list to deal with in the study. Starting with the list used in a national e-waste management study in Kenya (Waema & Mureithi, 2011) and using a combination of consumer electronics lists classified as information products by the US Agency for Natural Resources (2004) and the European Union list of equipment and appliances (UNEP, 2007) the 13-item list for the EEE used for this study was generated. Life expectancy for some products was as low as 2 years with some others reaching 15 years (Jackson, 2007; United States Agency for Natural Resources, 2004).

TABLE 1: ELECTRONIC AND ELECTRICAL EQUIPMENT CONSIDERED IN THE STUDY WITH THE LIFE EXPECTANCY

S/No.	Electronic/Electrical equipment	Life Expectancy (in years) †	Life Expectancy (in years) ‡
1.	Desktop computers	3 to 6	
2.	Laptop/Notebook computers		2.5
3.	Monitors (CRTs)	6 to 7	
4.	Flat screens (VCDs)	13 to 15	
5.	Printers	3 to 5	
6.	Mobile phones		2
7.	Radio sets	3 to 15	
8.	Televisions	13 to 15	
9.	Fridges		9 to 13
10.	Air conditioners		10 to 15
11.	Photocopiers		4
12.	Fax Machines	3 to 6	
13.	Uninterrupted Power Supply (UPS)		6

† Source: US Agency for Natural Resources (2004, p.4). Electronic Waste Management in Vermont. Available at http://www.anr.state.vt.us/dec/wastediv/recycling/pubs/Electronics_Legislative_Report_gl.pdf

‡ Source: "Study of Life Expectancy of Home Components", National Association of Home Builders/Bank of America Home Equity, February, 2007, p.7

The structured questionnaire developed for collecting the data had six main items as follows:

1. What year was this Department established?
2. How many items of the following types do you have in your department in working condition and also the number not in use. A column for items in working condition and another column for bad or obsolete items was provided. The aim of this question was to determine the quantities on ground.
3. How many items of the following types did your department purchase in the last four years? A column was provided for each year between 2011 and 2008, starting with 2011. This item was included to provide an estimate of recent acquisitions which could be compared to the numbers on

ground.

4. Where do you usually acquire indicated equipment from?
5. Do you keep inventory of the equipment you discard or store?
6. Kindly use the table below to indicate what you do with items that you do not use anymore. Four options were given in addition to 'Others. Please specify'. The options were A – Store away in the department or unit, B – Throw away with other waste, C – Send them to the Stores department, D – Disassemble to reuse some parts to repair others, and E – Others. Please specify.

The developed instrument was pre-tested before administering the final version. Copies of the questionnaire were distributed to the selected departments with several follow-up visits thereafter. Several departments were unable to provide the required information either because the records were unreachable or due to unwillingness to complete the questionnaire. Of the 26 departments targeted at Kwara Poly, 16 completed the questionnaire while 16 out of the 27 at Unilorin also did, giving a return rate of 62 percent and 59 percent respectively. The data collected was analysed using frequency distributions, summations and the Chi-Square statistic to test for independence. When necessary, further computation such as finding the proportion of available equipment that was not in working condition was undertaken.

Results and discussion

Analysis of the data collected, revealed that the proportion of equipment that were not in working condition were generally low across all departments sampled except at Unilorin where a high proportion of desktop computers (38%) and photocopiers (24%) were not in working condition (Table 2). The equipment with the highest out of order proportion at Kwara Poly was the photocopying machine (17%).

Furthermore, the deduction could be made that most of the equipment found in the departments were purchased between 2008 and 2011, simply by comparing the total purchases during that period (Table 3) with the numbers found in the department (Table 2). This raises the question – if most of the departments in the study were established at least 20 years ago, what has happened to the e-waste generated from equipment end-of-life? Further esults are also presented in Table 4 and Table 5

TABLE 2: NUMBER OF EQUIPMENT IN WORKING OR NOT IN WORKING CONDITION AT THE SAMPLED DEPARTMENTS

S/No.	Equipment	Kwara Polytechnic			University of Ilorin		
		No. in working condition (A)	No. not in use (B)	Percent (%) not in working condition†	No. in working condition (A)	No. not in use (B)	Percent (%) not in working condition†
1	Desktop computers	67	4	5.6	29	18	38.3
2	Laptop/Notebook computers	20	1	4.8	42	0	0.0
3	Monitors (CRTs)	20	0	0.0	66	5	7.0
4	Flat screens (VCDs)	49	0	0.0	60	1	1.6
5	Printers	24	2	7.7	39	5	11.4
6	Mobile phones	37	0	0.0	3	0	0.0
7	Radio sets	10	1	9.1	3	0	0.0
8	Televisions	26	0	0.0	28	3	9.7
9	Fridges	39	1	2.5	17	3	15.0
10	Air conditioners	39	1	2.5	138	11	7.4
11	Photocopiers	5	1	16.7	16	5	23.8
12	Fax Machines	2	0	0.0	0	0	0.0
13	UPS	60	4	6.3	116	11	8.7

TABLE 3: ITEMS ACQUIRED IN FOUR YEARS (2008 – 2010) BY THE DEPARTMENTS SAMPLED

S/No	Equipment	No. bought by sampled departments in Kwara Polytechnic					No. bought by sampled departments in University of Ilorin				
		Year 2008	Year 2009	Year 2010	Year 2011	Total	Year 2008	Year 2009	Year 2010	Year 2011	Total
1	Desktop computers	4	29	5	23	61	6	9	7	3	25
2	Laptop/Notebook computers	3	1	10	8	22	7	3	86	1	97
3	Monitors (CRTs)	6	4	4	1	15	3	5	56		64
4	Flat screens (VCDs)	1	23	1	22	47		4	52	3	59
5	Printers	6	3	7	7	23	6	5	5	6	22
6	Mobile phones	16	5		16	37				2	2
7	Radio sets	5	1	1	5	12			1	3	4
8	Televisions	2	3	3	2	10	4	2	12	1	19
9	Fridges	10	4	1	3	18	3	2	4	3	12
10	Air conditioners	5	4	3	2	14	10	37	37	24	108
11	Photocopiers	2	1		2	5	2	2	7	2	13
12	Fax Machines		1			1		1		1	2
13	UPS	7	1	4	44	56	1	4	81	2	88

TABLE 4: SOURCE OF ACQUIRED EQUIPMENT IN SAMPLED DEPARTMENTS

S/No.	Source of equipment	Kwara Polytechnic		University of Ilorin	
		N	%	N	%
1	Retail outlet or store	11	64.1	12	66.7
2	General distributor	3	16.7	6	33.3
3	Leased	0	0.0	0	0.0
4	Formal second-hand market	1	5.6	0	0.0
5	Informal second-hand market	1	5.6	0	0.0
6	Others	2	11.1	0	0.0
	Total percent		100.0		100.0

TABLE 5: NUMBER OF DEPARTMENTS OUT OF 16 DEPARTMENTS AT EACH INSTITUTION SELECTING AN INDICATED METHOD OF E-WASTE DISPOSAL

S/No.	Equipment	Kwara Polytechnic					University of Ilorin				
		A	B	C	D	E	A	B	C	D	E
		Store away in the dept./unit	Throw away with other waste - discard	Send them to the Stores department	Disassemble to reuse some parts to repair others	Others	Store away in the dept./unit	Throw away with other waste - discard	Send them to the Stores department	Disassemble to reuse some parts to repair others	Others
1	Desktop computers	1		6	1		7		7		
2	Laptop/Notebook computers	1		3			2		2		
3	Monitors (CRTs)			4			5		4		
4	Flat screens (VCDs)			3			3		1		
5	Printers	2		6			7		3		
6	Mobile phones			1	1		3				
7	Radio sets	3		2			2				
8	Televisions	1		3			4		1		
9	Fridges	2		3			5		2		
10	Air conditioners	3		2			4		3		
11	Photocopiers	3		2	1		4		2		
12	Fax Machines			2			3				
13	UPS	3		2			6		1		

Two major sources for acquisition of electronic and electrical equipment were identified as (i) purchase from a retail outlet or store and (ii) purchase from a general distributor. At both organisations more than 60% of the distributors (33%). On the other hand, while 64% of the departments sampled at Kwara Poly sourced electronic equipment from retail outlets or stores, 17% sourced from general distributors while one department each indicated sourcing equipment from the formal and informal second-hand market. Of the two departments at the Kwara Poly that indicated 'Others' as source of equipment (Table 4) one indicated a supply source as being from the school store while the other indicated the Education Trust Fund (ETF) departments sampled reported obtaining electronic equipment from retail outlets or stores (Table 4). At Unilorin, equipment was sourced from either retail outlets or stores (67%) or from general Intervention as a source.

It was also established that there were two main disposal methods used by the departments sampled at the University of Ilorin. These were to either store the unused equipment away in the department or send them to the Stores department (Table 5). These were the disposal modes most used also at Kwara Poly, except that a few departments indicated disassembling the equipment in order to reuse parts therein to repair desktops, mobile phones and photocopiers. However, fewer

departments at Kwara Poly kept out of use equipment at their departments than did departments at Unilorin as shown in Table 5.

On the question of whether a department kept records of discarded e-waste, very few responses were obtained, most of which was 'No'. The large proportion of no responses to this data item further re-affirms the finding that at both institutions, e-waste is rarely discarded at the departmental level (Table 6), and shows adherence to due process in fixed-assets management.

TABLE 6: RESPONSE TO KEEPING INVENTORY OF DISCARDED ITEMS

Keep inventory of discarded items	Kwara Polytechnic		University of Ilorin		Chi-square	df	p
	n	%	n	%			
Yes	0	0.0	1	6.3	1.293	2	0.524
No	4	25.0	5	31.3			
No response	12	75.0	10	62.5			
Total	16	100.0	16	100.0			

The Chi-square statistic (1.293 with calculated probability of 0.524) obtained from the cross-tabulation of responses to whether inventory of discarded items were kept (Table 6) suggests that at the 0.05 level of significance, institution was not a factor in whether or not a department would keep records of discarded equipment.

To the question on whether the department kept an inventory of stored out of use items, the proportion of departments that answered 'Yes' was 44% for Kwara Poly and 63% for Unilorin (Table 7). From the Chi-square statistic of 1.348 with calculated probability of 0.510 (Table 7), it was inferred that institution was not a factor in whether or not a department would keep records of stored out of use items.

TABLE 7: RESPONSE TO KEEPING INVENTORY OF STORED ITEMS

Keep inventory of stored out of use items	Kwara Polytechnic		University of Ilorin		Chi-square	df	p
	n	%	n	%			
Yes	7	43.8	10	62.5	1.348	2	0.510
No	2	12.5	2	12.5			
No response	7	43.8	4	25.0			
Total	16	100	16	100			

At the Stores department of the Kwara Polytechnic, it was gathered that after receiving goods from departments across the polytechnic, an attempt was usually made to reuse some parts to repair others. This was the case for desktop computers, laptops, monitors (CRTs), flat screens (VCDs) and printers. Televisions, refrigerators, air conditioners, photocopiers, fax machines and UPS were also for this purpose. In addition to reuse for other repairs, the Polytechnic periodically auctioned electronic equipment at its end of life. Nevertheless, most of the e-waste still remained in the warehouse of the Stores department.

On the other hand, at the University of Ilorin Stores department, e-waste was disposed of in the following ways –

(a) Moved to another department or unit within the university that can still use the equipment
(b) Sold to the university staff at reduced price
(c) Donated
(d) Sold to other organisations/ firms as second hand equipment
(e) Auction the equipment.
(f) Recommending items for final disposal was done at the University of Ilorin through a 'Board of Survey' constituted by university management.

Just as in the case of Kwara Poly, it was also found that despite the efforts at discarding the e-waste, most of it still remained stored in the various warehouses of the Stores department at Unilorin.

Conclusions & Recommendations

Several conclusions can be reached as a result of this study. One is that most of the out of use electronic and electrical equipment (e-waste) still remained stored at the Stores department of both institutions which provides a pointer to answering the question earlier posed – what has happened to all the e-waste generated since inception of both institutions? The answer may be that most of the e-waste generated can

largely be found in the warehouses of the Stores departments – a 'do nothing approach' suggesting the need for a policy to guide real disposal that leads to emptying the warehouses. Furthermore, the findings suggest that improvements in inventory management are required at both institutions because not all departments in the sample kept records of out of use equipment.

There are lessons on maintenance of electronic and electrical equipment (EEE) that can be drawn from the findings. For instance, the lower proportion of EEE not in working condition that was found at Kwara Poly may be linked to the practice of dissembling to reuse some parts to repair others, and may be especially so for desktop computers. This is a type of waste minimisation. The University of Ilorin should consider adopting and institutionalising this technique as part of the disposal approaches to be explored by the Stores department. In practical terms, the Stores department could work with the University's Equipment Maintenance Centre to achieve this.

Another conclusion reached from the study is that the dominant source for acquiring EEE at both institutions is from retail outlets and stores. This has implications for green disposal as retailers in Nigeria are not known to offer reuse or recycling options. It is best if both institutions identify general distributors that offer reuse, recycle or disposal options. In the long run, using such distributors would reduce purchase costs and free up space in the Stores departments.

For future work, a study that focuses on the Stores department of public institutions and organisations is suggested since most of the e-waste generated would end there. Extending the study to cover other types of large organisations and individual consumers is also suggested.

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