INFORMATION AND COMMUNICATION TECHNOLOGY WASTE MANAGEMENT SYSTEMS IN ACADEMIC LIBRARIES IN DELTA STATE, NIGERIA

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Abstract

This study investigated ICT wastes management systems in academic libraries in Delta State, Nigeria. Specifically, the study examined the categories of ICT waste in academic libraries, quantities generated, storage and disposal methods, policies on ICT waste management and environmental effects. The survey research design was adopted for the study. The population of the study was 14 system librarians and all 14 librarians constituted the sample for the study. Data were collected with the use of questionnaire and analysed using frequency. The study found that 1,111 ICT wastes were produced in academic libraries in Delta State, from 2008-2018. ICT wastes were kept in stores and library offices, landfilling and reuse were the disposal methods adopted by the libraries. Also, it was established that there was no policy on ICT waste management in academic libraries. The study concluded that academic libraries produced ICT wastes without appropriate policy on their proper management. It was recommended that the academic librarians should liaise with tertiary institution administrators develop policy on ICT waste management for implementation in academic libraries to ensure healthy and eco-friendly library space and environment.

Keywords: e-waste, ICT waste, academic libraries, e-waste management, Nigeria.

Introduction

Information and Communication Technology (ICT) has penetrated every aspect of modern life and is positively affecting humans even in the most remote areas of the developing countries (Babu, Parande & Basha, 2007). According to Aina (2004:301) "ICT is concerned with the technology used in handling, acquiring, processing, storing and disseminating information."

The use of ICT in information handling and processing in academic libraries has risen because of the increase workload involved in coping with information explosion, its management and the need to disseminate information to users. Over the years managers of academic libraries had acquired ICT tools for improved information management and quality service delivery to their teeming users. Librarians in academic libraries have used ICT tools such as computers, servers and printers to acquire, process, organize, store, disseminate and use information. However, increasing demand and rapid change of these technologies and their deterioration have paved the way for an environmental concern in academic libraries and their institutions called "Electronic waste or ICT waste".

Electronic waste, e-waste or ICT waste refers to all items of electrical and electronic equipment and their parts that have been discarded by its owner as waste without the intent of re-use (STEP, 2014). This means unwanted electrical or electronic appliances that are considered not useful (Pondicherry Pollution Control Committee, 2006). ICT waste generation in libraries may be seen as all electrical and electronic devices that have deteriorated and can no longer serve its users' needs. They may include computers, laptops, monitors, mice, keyboards, typewriters, scanners, printers, cables, modem, servers, and UPS. The waste contains hazardous substances such as lead and cadmium which pose threat to human health and the environment if not properly managed (Ramachandra & Varghese, 2004). Therefore, electronic waste management is the measure taken by individuals, institutions, organizations, libraries, industries e.t.c. to recycle discarded/unwanted electronics/ICT equipment to be reuse for new product development.

Academic libraries are gradually facing the challenge of accumulated ICT waste whose handling and disposal have not been adequately addressed in developing countries like Nigeria. Librarians should consider how to manage e-waste in an appropriate, eco-friendly and ethical ways in libraries, with the hope to ensure minimal generation, prevent indiscriminate dumping, promote recycling and create jobs in the re-use sectors (Balde, Forti, Gray, Kuehr & Stegmann 2017). Therefore, the results of this study, will guide heads of academic libraries to design ICT waste policy aimed at effectively controlling the generation, collection, storage and disposal of e-waste in their libraries.

Objectives of the Study

The general objective of this study was to investigate ICT waste management methods in academic libraries in Delta State, Nigeria. Specifically, the study investigated the categories of ICT waste in academic libraries, quantity generated, storage and disposal methods, policies on ICT waste management and environmental effects.

Research Questions

To achieve the objectives, the study provided answers to the following questions:

- 1. What are the categories of ICT waste produced in academic libraries in Delta State from 2008-2018?
- 2. What is the quantity of ICT waste produced in academic libraries?
- 3. What are the ICT waste storage methods used in academic libraries?
- 4. What are the ICT waste disposal methods practiced in academic libraries?
- 5. What are the institutional policies on ICT waste management in academic libraries?
- 6. What are the environmental effects of ICT waste in academic libraries?
- 7. What are the challenges to proper storage and disposal of ICT waste in academic libraries?

Review of Related Literature

ICT wastes are tools that have been abandoned and are of no value to their owners. They could be reused, resold, salvaged, recycled or disposed. Examples of electronic waste are computers, laptops, scanners, printers, photocopiers, televisions, servers, radio and mobile phones. Solving The E-Waste Problem (STEP) (2013) observed that "because so much of the world's e-waste is unaccounted for, it is difficult to quantify e-waste volume." Also, compounding the challenge of actual volume of e-waste is the fact that categorising e-waste varies from country to country. While the European Union (EU) has 10 categories, North America recognizes Information and Communication Technologies (ICT) products and television. However, experts and interest groups have provided acceptable estimates of e-waste generated throughout the world. Forte, Balde, Kuehr and Bel (2020:23), reported that "in 2019, approximately 53.6 million metric tons of e-waste... it is estimated that the amount of e-waste generated will exceed 75 MT. in 2030. The global quantity of e-waste is increasing at an alarming rate of almost 2 MT per year." Out of the global volume of e-waste, China is the highest producer, followed by United States, India and Japan (Tiseo, 2020).

The quantity of ICT waste produced in some countries is known. For instance, Shrimathi, Krishnamoothy and Dharshini (2019: 2627) stated "the e-waste production of India at the end of 2018 is 3.3 million MT." In Nigeria, Ogungbuyi, Nnorom, Osibanjo and Schluep (2012) are of the view that "approximately 1.1 million tonnes of Electrical and Electronic Equipment (EEE) become obsolete each year. Only around 440,000 tonnes end up as e-waste". It is worthy of note that computers with an average lifespan of 3years comprise a large chunk of e-waste (Robinson, 2009). The volume of ICT-waste generated in libraries, archives and information centers could be ascertained through empirical studies. Kim (2007) opined that "the total amount of ICT waste generated in libraries and archives increase as a result of digital preservation activities and changes in technology." Kiplagat, Odero and Buigutt (2017: 237), in a study on e-waste management at Egerton University Library, Kenya, found that "the high amount of discarded equipment has led to the generation of e-waste in the library." Furthermore, the authors found that "the library has a substantial amount of e-waste in its store that has accumulated over time." (p. 237).

ICT waste is stored so that it can be disposed off after it accumulates to a considerable extent. Hence, The Environmental Association for Universities and Colleges (2011) advised that "to store ICT-waste you must ensure it is stored securely so that it does not get damaged, preventing reuse or treatment." ICT waste is often stored for purposes such as repair, reuse, recycling and recover prior to disposal. Kiplagat, Odero and Buigutt (2017: 236) found that "most Departments, library among them, still prefer keeping all their obsolete and out – of – use electronic equipment in their stores." . Solving The E-Waste Problems (STEP) (2013) noted that "an estimated 4,300 tons of nonfunctioning computers, television, mobile phones and refrigerators are stored in households and businesses in Ethiopia". Also, Ogungbuyi, Nnorom, Osibanjo and Schluep (2012), stated that "The current practice of e-waste management varies, 80% stores and 20% donates while 60% of government ministries and institutions store obsolete computers within their premises for about 2 years before disposing them through auctioning or donation". According to California Integrated Waste Management Board (CLWMB, 2004) "three quarters of all the electronics generated in most places, remain stockpiled in a closet or storage space."

When ICT-wastes are improperly discarded, they can be associated with health risks and environmental pollution. In Nigeria e-wastes are often disposed together with general wastes in an indiscriminate manner in undesignated places. Agencies responsible for municipal waste management are also in charge of ICT-waste disposal. There are eco-friendly methods of disposing ICT-waste. According to Pondichery Pollution Control Committee (2006), ICT-waste is dispose through the various disposal alternatives such as landfilling, incineration, product reuse and recycling.

In landfilling, trenches are made on the flat surface. Soil is excavated from the trenches and waste material is buried in it, which is covered by a thick layer of soil. Lagos State Environmental Protection Agency (2011) noted that "an estimated 53,600 metric tons of e-waste are dumped annually at Lagos State landfills which include 860,000 computers, 530,000 printers, 900,000 monitors and 480,000 television sets'. The environmental risk from landfilling of ICT waste cannot be neglected. Lead and cadmium can leach into soil and ground water leading to ground water pollution. Landfills are also prone to uncontrolled fires, which can release toxic fumes into the air and may cause air pollution. Therefore, landfilling does not appear to be an environmentally sound management method for ICT-waste (Pondicherry Pollution Control Committee, 2006).

Incineration is a waste treatment technology that involves the combustion of organic materials or substances. The act of burning something completely, reducing it to ashes thereby releasing toxic smoke into the atmosphere. A major problem with this method according to Curran (1990) is that "many incinerator units contribute to air pollution by spewing carbon monoxide, hydrocarbons and particular matter into the air."

Recycling is a process of dismantling separating fractions and recovering materials from e-waste. Recycling also involves the removal of different parts of ICT waste containing dangerous substances. It helps conserve raw materials and energy that manufacturers would otherwise use to make new products. The study by Ogunbuyi et al. (2012) showed that between 46, 276 to 1, 347,840 tonnes of e-waste are recycled annually in Nigeria.

Reuse according to Pondicherry Pollution Control Committee (2006) "constitutes direct second hand use or use after slight modification to the original functioning equipment." It is commonly used for electronic equipment like computers, cell phone, copier, scanner, printer etc. The United States Electronic Management Agency (2010), opined that "reusing ICT waste in the first place is usually preferable to any waste management option including recycling." The United States Electronic Management Agency further stated that reuse extend the lives of valuable products and keep them off the waste management system for a longer time.

In Nigeria, the volume of ICT waste generated has become one of the national challenges to be addressed. Thus, the growing challenge of ICT waste requires development of policies, regulations, legislations and international standards to address the issue and guide the collection, disposal and recycling activities. Charting a regulatory roadmap for the rising e-waste problem is the best

manner of solving the problem of e-waste and its hazards. Therefore, effective and efficient management of ICT waste problem in Nigeria and academic libraries should begin with policy formulation to organize and coordinate the activities of stakeholders in order to achieve good health and sustainable environment.

Nigeria has ratified the Basel Convention in March, 1991, made amendment to the Basel Convention in May, 2004, and a signatory to the Bamako Convention in December, 2008. At the national level, Nigeria has some policies that will help to address ICT waste in order achieve a clean environment. The policies according Amachree (2013) are: Environmental Impact Assessment Act Cap E12, Harmful Waste (Special Criminal Provisions) Act Cap HI, 1988 and updated in 2004, The National Environmental (Sanitation and Waste Control) Regulation 2009, Guide for Importer of Used Electrical and Electronic Equipment (UEEE) and The National Environmental (Electrical/Electronic Sector) Regulation 0f 2011.

Other efforts made by Nigeria to stem the tide of rising ICT waste include national and international conferences and workshops to sensitize, educate and create awareness on the management of ICT waste. For instance, the National Environmental Standards and Regulation Enforcement Agency (NESREA) organized the international conference on e-waste control in July, 2009, at Abuja. Participants observed among other concerns that "there is a general lack of awareness among the citizens in developing countries on the hazards and negative impacts of improper management of e-wastes". It was recommended that "there is need to mount a robust public awareness and education campaigns, including the development and integration of e-waste management into school curricular, involving Governments at all levels".

ICT wastes contain hazardous and toxic substances which may be released into the environment thereby posing environmental and human health risks (Lagos State Environmental Protection Agency, 2011). ICT waste management activities such as landfilling and incineration impacted negatively on the resident, by affecting the air, water and soil. ICT wastes that are landfilled produced contaminated leachates which eventually pollute the groundwater. Ramachandra and Varghese (2004) noted that "acids and sludge obtain from melting computer chips, if disposed on the ground causes acidification of soil". Incineration of electrical and electronic waste may lead to emitting toxic fumes and gases thereby polluting the surrounding air.

Dumping of ICT waste in any environment occupies space, disorganizes the environment and has negative health consequences such as leaching toxin into the soil, air and ground water which later is absorbed by crops, animals and human body systems causing physical injury, skin disorder, interference with regulatory hormones and pollution (Osuagwu & Ikenonwu, 2010 as cited by Ogbomo, Obuh & Ibolo, (2012). Complementing the above, Koloseni and Shimba (2012) observed that the effects of e-waste to human health and well being include: respiratory problems, oxidative stress, DNA damage and the possibility of causing cancer.

There are several challenges in the collection, storage and disposal of ICT waste as reported by environmental groups such as the Basel Action Network (BAN) and Greenpeace. Ogbomo, Obuh

and Ibolo, (2012) noted that "the Nigerian government seems not to keep adequate record or statistics on imported and internally generated ICT wastes." Though, Nigeria has national policies on e-waste however, policies are not enough. The implementations are very critical and that is where Nigeria is not pushing enough. Consequently, this may lead to neglect, lack of awareness about ICT waste, and weak administrative bodies. In Kenya, the National Environment Management Authority (NEMA), (2011), identified "the weaknesses of e-waste management as lack of coordinated approach across the ministries to deal with e-waste, lack of awareness of the need for the e-waste management system, lack of collection system leads to e-waste being stockpiled at homes, offices and repair shops and lack of formal training in e-waste management." While, Fagbohun (2011:6) identified the challenges of e-wastes in Nigeria to include "relax/weak/insufficient enforcement of existing laws, lack of awareness of the risk/potential harmful effects associated with e-waste, coupled with lack of technical capacity for environmentally sound management and lack of inadequate infrastructure for collection, recycling and recovery."

Methodology

The survey type of research design was used for this study. The population for the study was 14 and consisted of heads of the e-library in the various academic libraries in Delta State. (See Table 1). The questionnaire was used to collect data. It contained items on categories and quantity of ICT waste produced in academic libraries, storage, disposal, policies, environmental effects and challenges of ICT waste management systems. Data were analyzed using frequency.

Table 1: Academic Librariess in Delta State

S/N	Academic Institutions	Year Established
1	Delta State University library, Abraka	1992
2	Novena University library, Amai	2005
3	Western Delta University library, Oghara	2007
4	Federal University of Petroleum Resources library, Effurun	2010
	College of Education (Technical) library, Asaba	1987
	Delta State Polytechnic library, Oghara	2002
	Delta State Polytechnic library, Ozoro	2002
	Delta State Polytechnic library, Ogwashi-Uku	2002
	College of Education library, Warri	1980
10	College of Education library, Agbor	1980
	College of Physical and Health Education library, Mosoga	2002
	Petroleum Training Institute library, Effurun	1973
	Delta State School of Marine Technology library, Burutu	2011
	School of Health Technology library, Ofuoma	1993

Results and Discussion

Figure 1: Gender Distribution of Respondents

Figure 1 shows the gender of respondents. Male accounted for 10 (83%) while female accounted for 2(17%). Male constituted the highest respondents in this study.

Research question 1: What are the categories of ICT waste produced in academic libraries in Delta State from 2008-2018?

Table 2: Categories of ICT Waste in Academic Libraries in Delta State

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ICT	Frequency	Percentage
Computers	12	100
Keyboards	12	100
Mice	12	100
Photocopiers	12	100
Typewriters	12	100
Scanners	12	100
Printers	12	100
Monitors	12	100
Modems	12	100
Audio and video recorders/players	4	33
UPS	12	100
Projectors	6	50
Television Sets	2	17
Stabilizers	12	100

The results in Table 2 show the categories of ICT waste produced in academic libraries in Delta state. Computers, keyboards, mice, photocopiers, scanners, monitors, printers, television sets, stabilizers, modems and UPS were the ICT waste categories in academic libraries in Delta State. The finding is in line with Kiplagat, Odero and Buigutt (2017) that "the library received a consignment of a variety of electronic equipment which included computers, printers, plotters, typewriters, scanners, server among others most of which have reached their end of life." The finding is a testimonial to the fact that academic libraries in Delta State are ICT compliant in information management.

Research question 2: What is the quantity of ICT waste produced in academic library? The quantity of ICT waste produced in academic libraries is shown in Table 3.

Table 3: Quantity of ICT waste in academic libraries in Delta State

Quantity
310
167
251
20
10
12
25
180
6
4
45
10
60
1,111

The results show that 1,111 items were the quantities of ICT waste produced in academic libraries in Delta State. Computers (210) and monitors (180) constituted the highest volume of ICT wastes in academic libraries. This finding corroborates Robinson (2009) who opined that electronic computers which have an average of three years lifespan comprise a greater proportion of waste from electrical and electronic equipment.

Research question 3: What are the ICT waste storage methods practiced in academic libraries? The responses to the question are presented in Table 4.

Table 4: ICT Waste Storage Methods

Storage method	Frequency	Percentage
Kept in a store	12	100
library offices	10	83
Kept on cupboard	2	17
Kept along corridor	4	33

The results show that ICT waste were kept in a store and library offices. These findings were in agreement with that of Ogungbuyi et al. (2012) that "The current practice of e-waste management varies, 80% stores and 20% donates while 60% of government ministries and institutions store obsolete computers within their premises for about 2 years before disposing them through auctioning or donation".

Research question 4: What are the ICT waste disposal methods used in academic libraries?

The disposal methods used by academic libraries are reported in Table 5.

Table 5: ICT Waste Disposal Methods

Disposal methods	Frequency	Percentage 100	
Landfilling	12		
Incineration			
Recycling			
Reuse	10	83	

Table 5 shows methods of disposing ICT waste generated in academic libraries. Landfilling and reuse are the disposal methods used by academic librarians in tertiary institutions in Delta State. Incineration and recycling were not considered as disposal methods. This finding corroborates the United State electronic management agency (2010) that "reusing ICT waste is usually preferable to any other waste management option." This finding also corroborates Pondicherry Pollution Control Committee, (2006) that "landfilling is the most used method of ICT waste disposal."

Research question 5: What are the institutional policies on ICT-waste management in academic libraries?

The institutional policies in place to manage ICT waste in academic libraries in Delta State are shown in Table 6

Table 6: Policies for Managing ICT Waste

Policies	Yes	No
Standard guide	0	12
Collection programme	0	12
Workshop/conference to sensitize and educate staff		12

The results show that there were no policies to guide librarians on ICT waste management in academic libraries in Delta State. This finding agrees with the National Environmental Standards and Regulation Enforcement Agency (2009) that "there is a general lack of awareness among the citizens in developing countries on the hazards and negative impacts of improper management of e-wastes". This situation may be so because librarians may be unaware of ICT waste management laws, and that the higher institutions in which academic libraries exist do not have policies on ICT waste management.

Research question 6: What are the environmental effects of ICT waste in academic libraries? Environmental effects of ICT waste are shown in Table 7.

Table 7: Environmental Effects of ICT Waste in Academic Libraries

Environmental Effects	Frequency	Percentage
Physical injury	10	83
Skin disorder		0
Occupation of office spaces	12	100
Disorganisation of of fices in the library	12	83
Interference with regulatory hormones	0	0
Leaching toxin into soil, air and water	0	0

The results show that occupation of office spaces, disorganisation of offices in the library and physical injury are the effects of ICT waste in academic libraries. The results are in line with Osuagwu and Ikerionwu (2010), that "dumping of ICT waste in any environment occupy space and disorganizes the environment." However, the study revealed that skin disorder, interference with regulatory hormones and leaching toxin into soil, air and water were not found to be effects of ICT waste in academic libraries in Delta State, Nigeria. This situation may be so because librarians were not directly involved in recycling of e-waste.

Research question 7: What are the challenges to proper ICT waste management in academic libraries?

Answers to the question above is presented in Table 8.

Table 8: Challenges to ICT Waste Management in Academic Libraries

Problems	Frequency	Percentage
Inadequate fund	12	100
No policy on ICT waste	12	100
Neglect	12	100
No awareness	12	100

Inadequate fund, no policy on ICT waste, neglect and no awareness were found to be challenges to proper management of ICT waste in academic libraries in Delta State. This is in consonance with National Environment Management Authority (NEMA), Kenya (2011), that "one weakness of e-waste management is lack of awareness of the need for the e-waste management system." Also this result is in line with Basel Action Network (BAN) and Greenpeace (2009), as cited in Ogbomo et al. (2012) that" Nigerian government seems not to keep any type of record or statistics on the imported ICT waste even though Nigeria has a national import ban for hazardous waste." This could be due to neglect and lack of finance.

Conclusion and Recommendations

The types of ICT wastes produced in academic libraries in Delta State were computers, keyboards, mice, photocopiers, scanners, printers and UPS. One thousand one hundred and eleven (1,111) items were the quantities of ICT waste generated in academic libraries, ICT wastes were kept in stores and library offices, there was no policy on ICT waste, and occupation of space and disorganization of offices were the environmental effects. Academic libraries in Delta State contributed to the growing menace of ICT waste in Nigeria due to inadequate institutional policy on ICT waste to guide academic librarians on proper management of ICT waste to achieve sustainable environment. The following recommendations were made to improve on ICT waste management in academic libraries in Delta State.

- 1. Academic librarians should liaise with tertiary institution administrators to develop policy on ICT waste management for implementation in libraries to ensure healthy and eco-friendly library space and environment.
- 2. Head of academic libraries should create awareness among library staff on proper ICT waste management on a sustainable basis.
- 3. The ICT directorate and procurement departments of the various higher institutions should liaise with academic libraries to ensure proper management of ICT waste.

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