*MBJLIS – Middlebelt Journal of Library and Information Science, Vol. 12, 2014*
ISSN: 1596 - 1595
Journal homepage: https://www.mbjlisonline.org/

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

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## ABSTRACT

*Information and Communication Technology (ICT) tools are deployed in academic libraries to acquire process, disseminate and use of information. However, as the ICT tools deteriorate, there emerges an environmental concern called e-waste. This study investigated ICT wastes management systems in academic libraries in Delta State, Nigeria. The survey research design was adopted for the study. The entire population of 14 system librarians was studied. Data were collected with the use of questionnaire and analysed using frequency count. The results show that 941 ICT wastes were generated from 2002 to 2012 in academic libraries in Delta State, ICT wastes were kept in stores, landfilling and reuse as the disposal methods adopted. Also the study found that there was no policy on ICT waste management. The study concluded that ICT wastes were generated in academic libraries without appropriate policy on their proper management. It was recommended that the libraries should develop policies on ICT waste management in line with existing e-waste laws in Nigeria and implement same to ensure healthy and eco-friendly environment.*

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

## Introduction

Information and Communication Technology (ICT) has penetrated every aspect of modern life and is positively affecting human life even in the most remote areas of the developing countries (Babu, Parande & Basha, 2007). According to Aina (2004) "ICT is concern with the technology used in handling, acquiring, processing, storing and disseminating information." The use of information and communication technology in information handling and processing in academic libraries has risen because of the increase workload involved in coping with information explosion and its management for effective use. Over the years

ISSN: 1596 - 1595
Journal homepage: https://www.mbjlisonline.org/

managers of academic libraries have acquired ICT tools for improved information management and quality service delivery to their teeming users. However, the ever growing demand and rapid change of these technologies and deterioration have paved the way for an environmental concern in academic libraries and their institutions called "Electronic or ICT waste".

Electronic waste means unwanted electrical or electronic appliances that have been discarded by their original users (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. They may include computers, laptops, monitors, mice, keyboards, typewriters, scanners, printers, cables, modem, servers, and UPS. This waste contains hazardous substances such as lead and cadmium which pose threat to the health of human and the environment if not properly managed (Ramachandra & Varghese, 2004). Therefore, electronic waste management is the measure taken by individuals, institutions, organizations, libraries, industries etc to recycle discarded/unwanted left over electronics/ICT equipment that contain materials that could be recovered and reuse for new product development.

Academic libraries are 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 treat ICT waste in an appropriate, eco-friendly and ethical ways in libraries. Consequently, the study investigated information and communication technology waste management systems in academic libraries in Delta State, Nigeria.

**Purpose of the Study**

The main purpose of this study is to investigate ICT waste management methods in academic libraries from 2002 to 2012 in Delta State, Nigeria. Specifically it investigated the categories of ICT waste in academic libraries, volume, storage and disposal methods, policies on ICT waste management and environmental consequences.

**Research Questions**

The study provided answers to the following questions:

1. What are the categories of ICT- waste generated in academic libraries from 2002 to 2012 in Delta State?
2. What is the quantity of ICT- waste generated in academic libraries?
3. What are the ICT- waste storage methods used in academic libraries?
4. What are the ICT-waste disposal methods used in academic libraries?
5. Are there policies on ICT-waste management in academic libraries?
6. What are the environmental consequences of ICT- waste in academic libraries?
7. What are the problems militating against proper storage and disposal of ICT-waste in academic libraries?

**Review of Related Literature**

Electronic waste is also referred to as e-waste, e-scrap or ICT-waste. According to United Nation Environment Programme (2007) as cited in National Environment Management Authority, Kenya (NEMA, 2011) the term e-waste "is a generic term encompassing various

ISSN: 1596 - 1595
Journal homepage: https://www.mbjlisonline.org/

forms of electrical and electronic equipment that are old, end-of-life electronic appliances, or have ceased to be of any 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, the categorization of e-waste varies from country to country. For instance, while the European Union (EU) has 10 categories, North America recognizes Information and Communication Technologies (ICT) products and television. The differences in types notwithstanding, experts and interest groups have provided acceptable estimates. In a study Eneh and Agunwamba (2011), noted that "about 50 million tons of e-waste are generated worldwide each year and increasing at a rate of 3.5% per year". Complementing the above statistics Technavio (2012) in a study on global electronic waste management market 2011-2015 reported that "the global e-waste management market has been forecast to increase at a compound annual growth rate (CAGR) of 17.6% over the next five years, rising to reach 93.5 million tons by 2016".

The quantity of ICT waste generated in some countries is known. For instance, Monika and Jugal (2012) opined that in India, the total waste generated by obsolete or broken down electrical and electronic equipment was estimated at 146,000 tons in the year 2005**.** In Nigeria, an estimated 500 containers of second-hand computer related electronic equipment of various conditions enter the country each month. Most of it end up in Lagos (computer village) Ikeja and each contain about 800 computers and monitors which amount to about 400,000 arriving each month, (Osibanjo & Nnorom, 2007). However, Ogungbuyi, Nnorom, Osibanjo and Schluep (2012) are of the view that in Nigeria "approximately 1.1 million tonnes of Electrical and Electronic Equipment (EEE) become obsolete each year. Only around 440,000 tonnes ends 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 is not known. However, Kim (2007) observed that "the total amount of ICT waste generated in libraries and archives increase as a result of digital preservation activities and changes in technology."

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 recovers prior to disposal. Consumers store their old electronic believing that it still has value (Ogbomo, Obuh, & Ibolo, 2012). STEP (2013) noted that "an estimated 4,300 tons of non-functioning computers, television, mobile phones and refrigerators are stored in households and businesses in Ethiopia". Also, Ogungbuyi et al. (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.

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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) reuse 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 should begin with policy formulation to organize and coordinate the activities of stakeholders in order to achieve sustainable environment.

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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 put in place some policies that will help to address ICT waste to achieve a clean environment. The policies, according Amachree (2013) are:

1 Environmental Impact Assessment Act Cap E12
2 Harmful Waste (Special Criminal Provisions) Act Cap HI, 1988 and updated in 2004
3 The National Environmental (Sanitation and Waste Control) Regulation 2009
4 Guide for Importer of Used Electrical and Electronic Equipment (UEEE)
5 The National Environmental (Electrical/Electronic Sector) Regulation 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". And 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 if not properly managed 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 ICT 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 et al. 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 problems militating against proper storage and disposal of ICT waste as it is evidenced by some environmental groups such as the Basel Action Network (BAN) and Greenpeace. Ogbomo et al. (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 the country is not pushing enough. Consequently, this may lead to neglect, lack of knowledge 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

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leads to e-waste being stockpiled at homes, offices and repair shops and lack of formal training in e-waste management. While, Fagbohun (2011) 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, recovery and disposal.

**Methodology**

The survey type of research design was used for this study. The population for the study is 14 and consists of heads of the e-library in the various academic libraries in Delta State. See Table 1. The entire population was studied but only 12 successfully completed the instrument. The questionnaire was used to collect data. It contained items on categories and quantity of ICT waste generated in academic libraries, storage, disposal policies, environmental consequences, and challenges of ICT waste management systems. Data were analyzed using frequency count.

*Table 1: Academic Institutions in Delta State*

| S/N | Academic Institutions |
|---|---|
| 1 | Delta State University, Abraka |
| 2 | Novena University, Amai |
| 3 | Western Delta University, Oghara |
| 4 | Federal University of Petroleum Resources, Effurun |
| 5 | College of Education (Technical), Asaba |
| 6 | Delta State Polytechnic, Oghara |
| 7 | Delta State Polytechnic, Ozoro |
| 8 | Delta State Polytechnic, Ogwashi-Uku |
| 9 | College of Education, Warri |
| 10 | College of Education, Agbor |
| 11 | College of Physical and Health Education, Mosoga |
| 12 | Petroleum Training Institute, Effurun |
| 13 | Delta State School of Marine Technology, Burutu |
| 14 | School of Health Technology, Ofuoma |

MBJLIS – Middlebelt Journal of Library and Information Science, Vol. 12, 2014
ISSN: 1596 - 1595
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**Results and Discussion**

Figure 1: Gender distribution of respondents

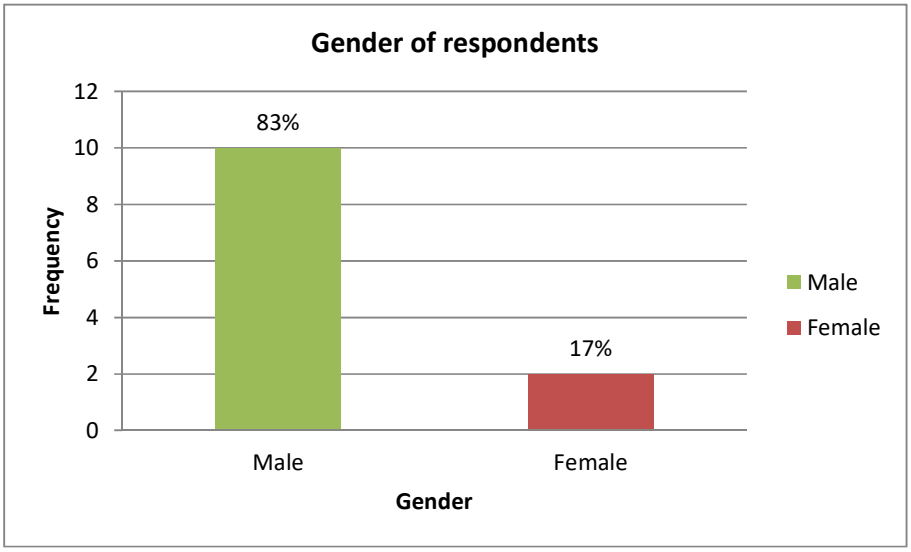


Figure 1 shows the gender of respondents. Male accounted for 10 (83%) while female accounted for 2(17%). Male constituted the highest respondents in this study.

Research question 1: What are the categories of ICT waste generated in academic libraries from 2002 to 2012 in Delta State?

*Table 2: Categories of ICT waste in academic libraries in Delta State*

| ICT | Frequency | Percentage |
|---|---|---|
| Computer | 12 | 100 |
| Keyboard | 12 | 100 |
| Mouse | 12 | 100 |
| Photocopier | 12 | 100 |
| Typewriter | 12 | 100 |
| Scanner | 12 | 100 |
| Printer | 12 | 100 |
| Monitor | 12 | 100 |
| Modem | 12 | 100 |
| Audio and video recorder/player | 4 | 33 |
| UPS | 12 | 100 |
| Projector | 6 | 50 |
| Television | 2 | 17 |

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| | | |
|---|---|---|
| Stabilizer | 12 | 100 |

The results in Table 2 show the types of ICT waste generated in academic libraries from 2002 to 2012 in Delta state. They are computer, keyboard, mouse, photocopier, scanner, monitor, printer, television and stabilizer. In addition the respondents noted that cables, batteries, speakers and chargers were included among the categories of ICT wastes generated in academic libraries. The results are in line with Kim (2007) and Wooddell (2008) who categorized ICT waste generated in libraries as computer, printer, photocopier, scanner, audio/video recorder/player, cable, telephones, CD and DVDs modem and digital camera, etc and anything digital that is no longer in use.

Research question 2: What is the quantity of ICT waste generated from 2002 to 2012 in your library? The quantity of ICT waste generated from 2002 to 2012 in academic libraries is shown in Table 3.

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

| ICT waste | Quantity |
|---|---|
| Computer | 210 |
| Keyboard | 167 |
| Mouse | 158 |
| Photocopier | 17 |
| Typewriter | 10 |
| Scanner | 12 |
| Printer | 22 |
| Monitor | 180 |
| Modem | 6 |
| Audio and video recorder/player | 26 |
| UPS | 28 |
| Projector | 34 |
| Television | 11 |
| Stabilizer | 60 |
| Total | 941 |

The quantity of ICT waste generated in academic libraries from 2002 to 2012 in Delta State was 941. Computers (210) and monitor (180) constituted the highest volume of ICT wastes in academic libraries. This finding is in line with Robinson (2009) who opined that electronic computers which have an average of three year lifespan comprise a greater proportion of waste from electrical and electronic equipment.

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

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*Table 4: ICT waste storage methods*

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

The results showed that 12 (100%) of the respondents indicated that ICT waste were kept in a store, while 10(837%) of the respondents indicated that ICT wastes were kept within the library offices. These findings is in agreement with that of Ogungbuyi et al. (2012) who 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".

Research question 4: What are the ICT waste disposal methods used in academic libraries in Delta State? The disposal methods used by academic libraries in Delta State are reported in Table 5

*Table 5: ICT waste disposal methods*

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

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

Research question 5: Are there policies/measures for ICT-waste management in academic libraries? Policies/measures in place to manage ICT waste in academic libraries in Delta State are shown in Table 6

*Table 6: Policies/measures for managing ICT waste*

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

All respondents indicated that there are no standard guide, collection programme and workshop to sensitize and educate staff of the libraries on ICT waste management. This

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finding is at variance with the National Environmental Standards and Regulation Enforcement Agency (NESREA) who 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". This situation may be so because librarians lack awareness of ICT waste management and that the higher institutions in which academic libraries existed do not have policies on ICT waste management.

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

*Table 7: Environmental consequences of ICT waste in libraries*

| Environmental consequences | Frequency | Percentage |
|---|---|---|
| Physical injury | 10 | 83 |
| Skin disorder | 0 | 0 |
| Occupy space | 12 | 100 |
| Disorganizes offices in the library | 12 | 83 |
| Interference with regulatory hormones | 0 | 0 |
| Leaching toxin into soil, air and water | 0 | 0 |

Occupy space 12(100%), disorganizes offices in the library 12(100%) and physical injury 10(83%) are the consequences of ICT waste in academic libraries. Therefore, ICT waste negatively impacted the academic libraries physical environment and the health of librarians. This result is in line with Osuagwu and Ikerionwu (2010) who found 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 considered as the consequences of ICT waste in academic libraries in Delta State, Nigeria. This situation is so because librarians are not directly involved in recycling of e-waste.

Research question 7: What are the problems militating against proper storage and disposal of ICT waste in academic libraries?
The problems of managing ICT waste in academic libraries are presented in Table 8.

*Table 8: Problems of ICT waste in libraries*

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

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Inadequate fund 12(100%), no policy on ICT waste 12(100%), neglect (100%) and no awareness 12(100%) are the problems militating against proper management of ICT waste in academic libraries in Delta State. This is in agreement with National Environment Management Authority (NEMA) Kenya, (2011), who identified one of the weaknesses of e-waste management as lack of awareness of the need for the e-waste management system and the National Environmental Standards and Regulation Enforcement Agency (NESREA) (2009) who observed 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". 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 (neglect) on the imported ICT waste even though Nigeria has a national import ban for hazardous waste. This could be as a result of neglect and lack of finance.

**Conclusion and Recommendations**

Academic libraries in Delta State contributed to the growing menace of ICT waste in Nigeria due to lack of policy on ICT waste to guide academic librarians on proper management of ICT waste to achieve sustainable environment. As a result of the findings, the following recommendations were made to deal with inadequate management of ICT waste in academic libraries in Delta State.

1. Academic librarians should develop ICT waste policy in line with existing regulations.
2. Create awareness and conduct sensitization campaigns among academic librarians on proper ICT waste management on a sustainable basis.
3. The ICT directorate of the various higher institutions should liaise with academic libraries to ensure that ICT waste is collected and kept in appropriate storage pending disposal

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