Course unit: SCS 3101 - Introduction to Computer Systems

Module name/Topic: Ethics in eWaste Management

Contributors: Elisha Abade, Selina Ochukut, Paul Rabala, Charles Katua, Reagan Onditi

Duration 1 hr

Reviewed by: Elisha Abade

Module Description

This module exposes learners to the foundations of responsible management of wastes emanating from broken computer systems and other electronic devices in an accountable and sustainable manner.

Module learning outcomes:

By the end of this lesson, the learner should be able to:

1. Define electronic waste
2. Explain the danger of electronic waste to human health and environment
3. Apply responsible approaches to manage electronic waste.
4. Critique electronic waste management approaches

Topic/Module contents:

1) **Introduction**

Welcome to this lesson in which you will learn more about ethical issues with regards to hardware components of the computer system. In this lesson, you will be exposed to ethical issues that arise with regards to disposal of hardware components of the computer systems.

This far, we have seen the structure and organization of a computer system. Key components of a computer system such as CPU, memory, hard drives, the Input and Output subsystem and other peripherals are made up of electronic substances. Such pieces of hardware can potentially contain hazardous materials such as lead, mercury, cadmium and other toxic substances based on the raw materials used to make them.

These hardware components form a major class of waste items that are found when a computer system gets old or breaks down. It is commonplace to find these components disposed of just as any other garbage albeit with hidden risks. When such components are not properly disposed of, they can contaminate the environment (soil, water and air) thereby posing a serious threat to human health and ecosystems.

The more widespread the use of computer systems becomes, the higher the volume of hardware parts that remain when computer systems get old and are no longer fit for use. Electronic waste (or e-waste in short form) refers to the discarded electronic components of devices such as computers, television sets and peripherals such as keyboards, monitors, disk drives and printers among others.

If these components are not properly disposed of, they can pose a great threat to the environment and cause unimaginable issues to human health and other ecosystems. For example some of the chemicals found in these components have been known to cause harmful effects on human as summarized below:

a) **Beryllium:** this is commonly used in springs, relay connections and computer motherboards. It is known to increase the risk of developing lung cancer.
b) **Brominated flame retardants:** They are used in circuit boards and plastic casings and are known to cause thyroid problems. Additionally, they can impact brain function.

c) **Cadmium:** This is commonly used in laptop batteries, wire insulation, coating for Cathode Ray Tubes (CRTs) and semiconductors as a plastic stabilizer. When ingested or if it gets into the human body in whatever way, it is known to lead to kidney damage, development of lung cancer and/or respiratory illnesses.
d) **Lead:** This compound is used in electrical solder on circuit boards, Cathode Ray Tubes (CRTs) and as stabilizers in PVC formulations. Lead is known to impact brain development in children and can additionally cause kidney damage and respiratory illnesses.
e) **Mercury**: This is mostly used in lights to illuminate flat screen displays and computer batteries. It is known to impact brain development in children, and harm the central nervous system in addition to causing kidney damage.
f) **PVC:** This is used to insulate wires and cables that are found in most of the hardware components of computer systems. When not properly incinerated, they can cause lung disorders.

It is therefore important that as a learner, you are equipped with the relevant skills to ensure that you can handle disposal of obsolete and broken computer systems responsibly, thus ensuring sustainable use of computer systems.

2) Pillars of responsible e-waste Management

It is important that you understand the fundamental tenets of managing wastes that emanate from hardware components of electronic devices. They form the core pillars of e-waste management. There are three core pillars of responsible management of electronic waste, commonly known as the "***three-R's***" of e-waste management. These are *Reduce, Reuse and Recycle*.

a) **Reduce**: This pillar advocates for minimizing generation of electronic waste. It involves encouraging users to adopt the "*buy less, use longer*" strategy to electronic equipment ownership and promoting durable and repairable electronic equipment. Eco-design and developing products that are easier to disassemble, repair and upgrade can help in extending lifespan of electronic equipment and thus reducing the volume of e-waste.

b) **Reuse:** This pillar involves promoting refurbishing and repurposing of electronic devices thereby extending their lifespan and reducing the volume of electronic waste. When properly done, this approach can also promote access to computer systems by the underserved communities without necessarily generating too much electronic waste.
c) **Recycle**: This is the process of converting the wastes into reusable materials. It entails recovering valuable materials from discarded devices while minimizing the environmental impact of raw material extraction. There are certified e-waste recyclers that have put in processes and procedures to ensure that their recycling efforts are friendly to human and environment.

3) Strategies for responsible e-waste Management

Having understood the risks that haphazard disposal of electronic waste pose to the environment, it is important that learners are equipped with strategies that need to be put in place to ensure that electronic waste is handled in a responsible manner. This section highlights some of these strategies:

a) **Fully understand the impact of E-Waste**: It is important for all stakeholders to understand the impact of e-waste on environment and human and wildlife health in order for them to appreciate the need to handle such wastes responsibly. This will ensure proper handling, recycling and disposal of electronic components.
b) **Public Awareness and sensitizations:** It is important to establish channels for sensitizing and creating awareness among the general public on the importance of responsible handling of electronic waste. People need to be informed of the need to minimize acquiring of new devices, refurbishing and repurposing old devices as well as recycling used devices. Such awareness campaigns will serve to enlighten the public on health and environmental impact of e-waste.

   Such initiatives can be implemented through collaboration with educational institutions, community organizations and county governments. Other initiatives would include organizing workshops, recycling drives and e-waste collection events. Such events are important in encouraging active participation and knowledge sharing.

c) **Collaboration and Extended Producer Responsibility (EPR):** Responsible waste management is not a one-party affair. It requires collaboration among the governments, citizens and private sector players such as manufacturers and retailers. This entails establishing and enforcing policies and programs for responsible electronic waste management. One such initiative is Extended Producer Responsibility (EPR). In this approach, manufacturers are held accountable for the entire lifecycle of their products, right from production to end-of-life.

It ensures that manufacturers take responsibility for collecting and recycling e-waste thereby minimizing the negative impacts of electronic wastes.

Since e-waste management is a transnational problem, collaboration efforts extend beyond national borders into the international arena.

d) **Innovative approaches in tracking e-Waste:** Disruptive technologies such as blockchain can be applied in tracking and tracing of e-waste throughout its lifecycle thereby enforcing responsible handling of e-waste. Technology can also improve initiatives such as recycling through application of advanced automated sorting systems and friendly extraction methods.

e) Design for the Environment (DfE): This is a design approach in which the focus is to reduce the overall human health and environmental impact of a product, process, or service, where impacts are considered across its life cycle.

Case Studies:

Assignments /Quizzes:

1. E-waste can be handle in all of the following ways except _____

a) Incineration
b) Landfilling
c) Composting
d) Reuse

2. _____ is a common hazardous substance found in electronic wastes

a) Nitrogen
b) Carbon
c) Potassium
d) Lead

3. Choose a responsible approach to management of electronic waste from hardware components of electronic devices

a) Burning in incinerators
b) Dumping in landfills
c) Reusing and recycling
d) Exporting to developing countries

4. Which of the following describes the greatest faced by developing countries with regards to managing e-waste

a) High cost of e-waste disposal
b) Lack of skilled labour
c) Limited availability of e-waste
d) Lack of awareness and infrastructure

5. Use the following statements to answer the questions that follow:
   i. Like climate change, e-waste is a global problem.
   ii. The increase in use of electronic devices and short lifespan of electronic devices contribute to generation of e-waste

a) Both i and ii are true and ii is a correct explanation of i.
b) Both i and ii are true but ii is not an explanation of i
c) I is true but ii is false
d) I is false but ii is true

6. Light Emitting Diode (LED) technology is used in some hardware components. Which hazardous compound is likely to be found in them?

a) Barium

b) Cobalt
c) Arsenic
d) Cadmium

7. Electron tubes release which hazardous compound to the environment?

a) Barium
b) Cobalt
c) Arsenic
d) Cadmium

8. Lithium-Ion batteries are commonly used in computer systems. Which hazardous elements are found in them?

a) Barium
b) Cobalt
c) Arsenic
d) Cadmium

9. Insulators used in most of the parts of hardware components found in computers release _____ to the environment.

a) Barium
b) Cobalt
c) Arsenic
d) Cadmium

10. Printed Circuit Boards release which hazardous compound to the environment?

a) Barium
b) Copper
c) Arsenic
d) Lead

Answers:

1. c – Composting
2. d – Lead
3. c – Reusing and recycling
4. d – Lack of awareness and infrastructure
5. a – Both i and ii are true and ii is a correct explanation of i.
6. c- Arsenic. NB: Semiconductors, diodes, microwaves, LED's (Light-emitting diodes), solar cells releases arsenic into the environment
7. a – Barium. NB: Electron tubes, filler for plastic and rubber, lubricant additives releases barium into the environment.
8. d – cadmium: Batteries, pigments, solder, alloys, circuit boards, computer batteries, monitor cathode ray tubes (CRT) releases cadmium when handled improperly.
9. b – cobalt : Chrome is released by dyes or pigments, switches, solar panels whereas, insulators release cobalt.
10. d - Lead rechargeable batteries, solar, transistors, lithium batteries, PVC, (polyvinyl chloride) stabilizers, lasers, LED's, thermoelectric elements, and circuit boards releases lead pollutant into environment.

Additional Resources:

1. How e-waste is harming our world: https://www.youtube.com/watch?v=-uyIzKIw0xY
2. What Causes Electronic Waste?: https://www.youtube.com/watch?v=MQLadfsvfLo

References:

1. Arya, S., & Kumar, S. (2023). *Global E-waste Management Strategies and Future Implications, 1st Edition.*
2. Khan, A., Inamuddin, & Asiri, A. M. (2020). *E-waste Recycling and Management*.
3. Majeti Narasimha Vara Prasad & Meththika Vithanage. (2019). *Electronic Waste Management and Treatment Technology, 1st Edition* [Kindle Edition].