Full Paper

AN ANALYSIS OF ELECTRONIC WASTE IN NIGERIAN UNIVERSITY: OBAFEMI AWOLOWO UNIVERSITY AS A CASE STUDY

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ABSTRACT

This paper examines electronic-waste in Nigerian universities by using the Obafemi Awolowo University (OAU), Ile-Ife, as a case study. There is no clear policy on how computers are acquired used and how they are disposed off when they reach their end-of-life. The scenario at OAU can also be applied to other Nigerian universities. It is not only computers but also many types of equipment and research consumables that have become obsolete and constitute serious environmental nuisance to the university community. Most of the wastes contain various types of toxic materials with potential occupational and environmental health hazards to the university community. Computer waste issues are also currently being debated by environmental activists and researchers in technologically developed countries as well. Specific issues considered are disposal methods, storage facilities and waste recycling. A variety of short term and long-term measures to alleviate the e-waste problem were proposed.

Key words: Computer waste, disposal, recycling and storage.

1. INTRODUCTION

The issue of electronic waste is becoming a major concern in most universities in Nigeria. Waste arising from computer systems are perhaps the most challenging. This challenge emanates from the lack of a clear policy on how computers are acquired, use and decommissioned. Hence, the waste generated as a result of the decommissioning of computer hardware becomes a problem as there is usually no, or poorly implemented policy for their management. The focus in this paper relates to computer hardware waste generated in a typical Nigerian tertiary institution environment using the Obafemi Awolowo University (OAU) as a case study.

The Obafemi Awolowo University is well known for being one of the most well planned Universities in black Africa. Her physical and architectural layout bears witness to this. In fact in 1997, the University was declared one of the best ten most beautiful real estates in the world. This may have come about as a result of the aesthetic architectural buildings and the clean and well laid-out landscape. This beautiful landscape, which has brought fame and pride, may soon become history (Odejobi, 2007). More details on this are given below.

The University purchased an IBM 360/370 Mainframe computer system for the University Computer Centre sometimes in late 1970's. That system is now littering the computer buildings (see Plate 1). The PDP 11 computers purchased by the Computer Science and Engineering Department sometimes in the late 1970's is no longer used but littered corridors and laboratories in and around the Computer Buildings. Another example was the IBM AS 400 super-mini computer system purchased by the university for the University Computer Centre sometimes in 1992. That system is now obsolete and is littering the computer building and environment.

Plate 1: University's IBM 360/370
(One will see this junk when approaching the Computer Building from Biological Sciences side)

Sometimes in 1995, some computer systems donated by the Shell Petroleum Development Company were brought into the university. The donation was received with pomp and pageantry. The donation was even covered by the NTA and reported in the news a few days later. In less than two years after the computer systems were received, they have all become obsolete and of no use to anyone. They became junks littering laboratories, corridors, back of buildings, and offices at that time.

At an individual level, consider the computer storage media as an example. More than 25 years ago, i.e. about the early 1990s, the 5.25 inches high density floppy diskettes (or disks in short), were then in vogue. Before the end of 1995, the smaller 3.5 replaced the 5.25 inches disk. The 3.5 inches disk was not only smaller in size, it also had about double the storage capacity and was more reliable than the 5.24 inches. Many of the old 5.25 inches disk were either in filing cabinets wasting away or somewhere in many of the refuse hips around the university campus. In the past 10 years or so, the USB (Universal Serial Bus) flash memory has replaced the 3.5 inches floppy disk. The USB flash is much smaller than the 3.5 inches floppy disk and, if the original one is acquired, it is much faster and more reliable than the floppy disk.

Other computer systems and consumable acquired by the university, units and departments as well as some members of the university community have also suffered similar fate: they have become obsolete. There is a common theme in all the episodes and cases of computer junks cited above. They were all purchased or acquired by the university or a member of the community with the aim of addressing important computing needs. The technology at the time most of these computers were acquired may have been one of the best, but they soon became obsolete due to the rapid technological improvements in the computer industries.

An important feature of all these technologies is that they are getting smaller and cheaper. Therefore, it is economically unwise to retain the older technology. In addition, the older technologies are less reliable when compared with the new technologies. Furthermore, the older technologies are usually not completely compatible with the new technology. For example, they tend to be much slower and some data representations and communication formats are usually not supported by the older technologies or systems.

According to Sakpere *et al.* (2013), e-waste is poorly managed in Obafemi Awolowo University. They collected data through the use of questionnaires and in-depth interviews via a purposive sampling of staff of waste disposal units, dealers, commercial operators and consumers of electronic devices in the university. Data analysis was carried out using the Pearson correlation coefficient and Chi-Square methods.

The study found evidence at the Maintenance and Works Unit of the University where obsolete e-waste and unser-viceable Electrical and Electronic Equipment (EEE) are indiscriminately dumped within the premise. Also broken down e-waste such as photocopiers, computers and printers littered at campus business centres where typing and printing activities take place.

According to Sakpere *et al.* (2013), there is an urgent need for a detailed assessment of the current e-waste disposal practices and their resultant environmental impact. The research by Olufokunbi (2015) was a follow-up on documented research in the literature with a bid to develop a more robust computational model to tackle this problem using automata-based technique and Coloured Petri Nets.

The results of Olufokunbi's data analysis were obtained using R data analysis and modelling tool. The results showed at a 95 percent confidence interval, the computer equipment based on survey data at OAU that will be disposed by 2020 will be 417 units. Compared to the 800 units of computer hardware in circulation in 2014, 50 percent of personal computer (PC) components available will become e-waste. This indicated that PC computers were in high demand at OAU due to their low cost and will be disposed off more rapidly when replaced by new computer equipment. In addition, the results revealed that 57.2 percent of the respondents discarded their e-waste by throwing it into the garbage bin or by dumping it. This implies that they are not aware of the e-waste collection procedure in the campus which agreed with the work of Ogbomo (2012) in Delta State University, Abraka, Nigeria.

Furthermore, the results of the simulated models for three e-waste processes showed that the e-waste dynamics is a forward sequential process in the form of a pipeline meaning that e-waste will continue to accumulate and grow in volume with time as the processes have initial and final states.

2. DATA

This obsoleteness does not affect the computer hardware only. It also affects the computer software. However, because the junks created by the computer software (e.g. email spam) are usually not physical, they are not considered dangerous as the hardware junks.

Although the authors are focusing on computer junk in this write-up, they have also visited several laboratories, in the Faculties of Agriculture, Pharmacy and the Sciences as well as the Dam, Maintenance and Power units of the university. Their findings are that it is not only computers but also many types of equipment and research consumables have become obsolete and constitute serious environmental nuisance to the university community (see Table 1). Other categories of waste e.g. refrigerators, air conditioners, and hand held cellular phones etc. are also present. However, computer and electronic wastes are becoming a difficult problem, with thousands of devices becoming obsolete each year. The main reason for this is that the technology industry is producing faster, better and less expensive equipments at a much faster rate than ever.

The most worrying dimension to this problem is that most of the wastes contain various types of toxic materials with potential occupational and environmental health hazards (Mundada et al., 2004) to the university community.

Table 1: Waste on OAU Campus

Ser. No.	Type of waste	Growth rate /year	Easy of management	Related risk
1	Computer monitor	High	Very difficult	Very High risk
2	Computer printer	Medium	Very difficult	High risk
3.	Keyboard	High	Very difficult	Moderate risk
4.	Typewriter	Low	Difficult	Moderate risk
5.	Old metal furniture	Medium	Difficult	Moderate risk
6.	Household equipment, e.g. Television, Washing machine, etc.	Low	Very difficult	High risk
7.	Computer casing and chassis	Medium	Difficult	Moderate risk
8.	Failed equipment replacement parts	Low	Difficult	High risk
9.	Abandoned vehicle	Very low	Difficult	Moderate risk
10.	Abandoned motor-bike	Very low	Difficult	Low risk
11.	Paper	Very high	Very easy	Very Low risk
12.	Abandoned construction equipment	Medium	Medium difficult	High risk

3. PROBLEM RESOLUTION

On the surface, computer wastes and other junks may look normal and acceptable. However, there are serious consequences for the environment and, by extension, the university community, if this situation is allowed to continue without proper control and management. The issues in the control and management of computer wastes are numerous and diverse. Efforts to address the issues will cut across many disciplines such as computer engineering, environmental design and management, chemistry, chemical engineering, as well as the health sciences. Computer waste issues have been debated by environmental activists and researchers in technologically developed countries as well. The specific issues are addressed as follows.

3.1. Disposal

How does one dispose off these computer wastes? This seems to be a simple problem. For example, the most obvious option, the university can locate a place far away from the university campus, and dispose the computer junks. By doing this, the university will be transferring her responsibility to other people, who may not be in a position to do anything about the waste. The university will then be putting the lives of such people in danger. Hence this is not a responsible option.

3.2. Storage

Another option is to store the junks somewhere on campus, e.g. by digging a hole and burying the junks. Computer and related junks are very difficult and very expensive to store this way for two reasons: (i) space requirements and (ii) related environmental hazards. In the case of space requirement, the amount of space that is required to store computer hardware waste grows exponentially with time. Take the average 14 inches Cathode Ray Tube (CRT) monitor, i.e. the Visual Display Unit (VDU), for example. Its technology is already obsolete. Recently, some of the VDU have been replaced by Liquid-Crystal-Display LCD or the Surface-conducting Electron-emitter Display (SED) (O' Donovan, 2006).

As a rough estimate, assume there are 1000 computer units on the campus. This translates to 1000 VDU. Each VDU will occupy a space of about 14X6X8 cubic inches volume of space. Therefore, there is need for a space of approximately 15,000X6000X8000 cubic inches to store the junks on campus. On a conservative estimate, this volume is enough to fill a medium size lecture hall (e.g. BOOB)! Note that the above estimation does not include disused keyboard, mouse, printers, computer casing, and other peripherals.

Assuming the university has such a space, it is technically unwise to pursue the goal of storing computer waste on campus for another reason: related environmental hazards. The computer waste, particularly those with components made from lead, e.g. your VDU monitor (see Plate 2 and 3), have toxic chemical that can create serious health hazards for the community. In China, for example, research has shown that people exposed to lead and related chemicals emanating from computer waste are more prone to terminal diseases such as cancer (Berger, 2006). The cost of managing each patient exposed to this toxic waste far outreached the profit accruing to the computer industry. The psychological and emotional traumas that accompany such health problems are unquantifiable. Burying or burning these wastes is, therefore, not a wise option.

Plate 2: A disuse CRT monitor already leaking its lead
(This waste is behind the White House, Physics Department)

Plate 3: A high of waste along a staircase in Computer Buildings
(Note that this junk contains many monitors)

Presently at OAU campus, e-waste which is unserviceable is stored in the Board of Survey yard of the Maintenance Unit until such a time it can be auctioned; given out for research, or taken to Tonkere where University refuse are dumped or burnt (Olufokunbi, 2015).

3.3. Recycling

Another option that could be pursued apart from computer junk storage is waste recycling. Some computer consumables, such as toner cartridge can be re-used or recycled. But the number of re-use is limited and the consumables themselves soon become junks. With the exception of printing papers, computer consumables are generally not 100 percent recyclable.

By the authors' conservative estimate, observing the rate at which computer and related wastes were dumped around the university campus, by the year 2020, the university will be dealing, not only with the spiraling volume of computer junks but also serious environmental problems that will accompany the wastes. Factoring in the rapid rates at which computers are becoming obsolete, it will be clear that one cannot wish the problem away. In addition, many of the equipment that are acquired these days are nearing the end of their useful life before being imported into the country. This further aggravates the problem associated with computer wastes and their management. How the university

manages this problem may affect her very survival in the very near future.

4. SUGGESTIONS FOR ADDRESSING THE PROBLEM

At the moment, the authors have been conducting research into the pattern and nature of the computer junks on the OAU campus. The main goal of this paper was to develop (i.e. design and implement) a computational model for the computer and electronic wastes problem with the aim of implementing a simulation system. The simulation system was used to predict the pattern of growth as well as the scale and scope of the wastes (Olufokunbi, 2015). In this paper, the authors have suggested the following tentative ways of addressing the problem:

4.1. Short term

i. The university should accept that the problem of computer and electronic wastes is pertinent.
ii. The university should solicit and accept computer and electronic equipment donations with care and caution: some donations cost the university more than the value of the donated items on the long run (e.g. the Shell donated computer mentioned above).
iii. It is important to take inventory of computer systems in the university (owner, date of manufacture, location, use status, etc.).
iv. Identify and document the location of computers junks/wastes heaps around the campus and take immediate steps to cordon them off.
v. Educate and advice the member of the community on environmental impacts of computer junk/waste.

4.2. Long term

i. Conduct environmental impact assessment of computer and electronic equipment wastes (CEEW) on the OAU campus with the aim to identifying the long-term effect of CEEW on the university community.
ii. Generate/Update the university policy on computer systems acquisition to include the issue of junks and their disposal
iii. Put in place a viable recycling mechanism, e.g. conducting research into how the junks/wastes can be put to fruitful use, development of a cost-effective recycling systems, extraction of components for students' experiments and research, and so forth.
iv. Institute a task-force on computer and electronic wastes management for the university with a mandate to monitor and manage the problem as well as to inform the university community on issues relating to computer waste.

5. CONCLUSION

Computer as well as electronic waste is a problem that must be addressed if the university is to remain a place where the university community can live and work in peace and good health. The rapid rates at which modern computer and electronic equipment are becoming obsolete increase the prospect of the problem of these wastes getting out of control. The short term and long-term approaches to addressing the problem, suggested above, could be a starting point. It is pertinent that action is taken now to alleviate the problem.

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