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CAUSES, IMPACT AND MANAGEMENT OF ELECTRONIC WASTES: CASE STUDY OF SOME NIGERIAN COMMUNITIES

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ABSTRACT

Electronic waste (E-waste) is a relatively new and emerging municipal waste in Nigeria. As much as 400, 000 units of used electronic equipment arrive through the Lagos port into Nigeria each month. A large percentage of these imported equipment are completely unserviceable, thus contributing to waste load in the country. E-wastes are leading sources of heavy metal contamination in the environment when improperly managed. The current study examines the reasons for the upsurge in demand for electronics in waste. Information regarding factors that contribute to the generation of e-wastes was gathered through the administration of a structured questionnaire to sections of Ogun State, Nigeria. Findings from the study show that young people between the ages of 15 - 35 are responsible for the highest demand for electronics in the country. It was also shown that the national policy on e-wastes management (especially with respect to enforcement), is still in its formative stages and that public health is highly vulnerable to the effects of e-wastes.

Keywords: e-waste, policy management, public health.

INTRODUCTION

Advancements in technology has helped to shrink the world into a global village. The need for humans to communicate and make work easier has increased the demand for communication accessories such as computers, mobile phones, tablets, batteries, televisions, radios and several other related electronic devices (Okunola *et al*., 2012). In addition, demand for other home devices such as electric bulbs, pressing iron, washing machines, microwave ovens and gas cookers which are meant to improve the standard of living are constantly on the rise. With use and population growth, however, come waste products (Omole and Isiorho, 2011). Presently, electrical and electronic waste (e-waste) is emerging as the fastest growing waste stream all over the world (Nnorom and Osibanjo, 2008). In the past twenty years, the global production and demand for electrical and electronic gadgets has been on the rise. This has been attributed to a proportionate increase in the market acceptability and request for these products in developing countries (Lundgren, 2012; Okunola *et al*., 2012).

Of the 20 to 50 million tons generated annually, it is estimated that 75% to 80% is shipped to countries in Asia and Africa for "recycling" and disposal (Okunola *et al*., 2012). Also, Okunola *et al*., (2012) estimated that about 400,000 units of used computer units are imported into Nigeria through the Lagos ports. In addition, a 2010 estimate showed that the ratio of new and used electrical and electronic equipment (EEE) which were imported into the country were at par (Ogugbuyi *et. al*., 2012). It was further estimated that the volume of EEE imports could subsequently have increased to 69% (Ogugbuyi, 2012).

Due to their composition, e-wastes are often comprised of toxic substances having the capacity to adversely impact on both the environment and public health (Alabi and Bakare, 2011; Liu *et al*., 2011; Okunola *et al*., 2012). E-wastes contain toxic heavy metals such as nickel, mercury, lead, and cadmium, which in sufficient doses could cause health problems and environmental pollution concerns (Nnorom and Osibanjo, 2008; UNEP, 2007). Surface water bodies and plants could serve as sinks for these metals (Omole and Isiorho, 2011). Ultimately, the metals could be ingested by humans and animals when they consume polluted water and plants (Liu *et al*., 2011). When these toxic metals are ingested, it could lead to health problems such as blood poisoning, breakdown of central nervous system, kidney problems as well as vital organ failures, especially in children (Liu *et al*., 2011; Okunola *et al*., 2011).

The compositions of e-waste are generally diverse and fall under hazardous and non-hazardous categories. Generally, they contain ferrous and non-ferrous metals, glass, plastics, wood and plywood, concrete, ceramics, printed circuit boards, rubber and other items (Wang *et al*., 2011; Song *et al*., 2012). The cathode ray tubes (CRTs) which are found in some monitors and television are composed of as much as 8% lead by weight (Nnorom and Osibanjo, 2008; Li *et al*., 2006). This amounts to about 2–4 kg of lead each (Nnorom and Osibanjo, 2008). The CRTs in computers create disposal problems because of their increasing magnitude in waste streams and their role as major sources of certain metals such as lead, mercury, cadmium and beryllium. In addition, electrical and electronic products contain polymers, polychlorinated biphenyls and brominated

flame retardant which are commonly found in municipal solid waste (MSW) (Musson *et al*., 2000; Lee *et al*., 2000).

Mobile phones which is also becoming a predominant e-waste in Nigeria contains more than 50 different components, these include base metals (copper, tin), Special metals (cobalt, indium, antimony) and precious metals (silver, gold, palladium) (Osibanjo, 2009; Kasper *et al*., 2011, Scharnhorst *et al*., 2005). The most common metal component in use in EEE is copper (9g), while the most common precious metals in increasing order are palladium (9mg), gold (24mg) and silver (about 250mg) (Hagelüken and Corti, 2010). The lithium-ion battery found in mobile phones contains about 3.5 grams of cobalt (Xiadong *et al*., 2011). Steel and iron constitutes about 50% of the waste, plastics 21%, non-ferrous metals 13% and other constituents (Pinto, 2008). Some electronic components of and the pollutants associated with them are summarized in Table-1. The potential occurrence of elements such as lead, cadmium, selenium, arsenic, mercury, hexavalent chromium and flame retardants beyond allowable quantities makes e-waste dangerous in nature. Upon disposal, they cause pollution as a result of their toxic nature. Therefore, the current study aims at assessing the e-waste situation in Ogun State, Nigeria. This is done with the intention of determining the cause of high e-waste volumes as well as possible impacts such wastes are having on the environment and public health.

Table-1. Examples of electrical and electronic components and associated pollutants.

Electrical and electronic equipment	Pollutants
Computers	lead, mercury, cadmium and beryllium
Batteries (disposable, rechargeable, and lithium)	Cadmium, Cobalt, Lead, Lithium, Mercury, Nickel, Silver and Zinc
Mobile Phones	Lithium, copper, tin, cobalt, indium, antimony, silver, gold, and palladium
Photocopiers	Mercury, Selenium
Mobile Phones	Lithium
Circuit boards	Silver, Lead, copper, cadmium, Brominated flame-proofing agent, PCBs (polychlorinated biphenyls) and Arsenic
LED (light emitting diodes)	Arsenic
CRT (cathode ray tubes)	Cadmium, Lead
LCD (liquid crystal displays)	Mercury

Source: (Nnorom and Osibanjo, 2009; Janz and Bilitewski, 2008)

METHOD AND MATERIALS

Study area

The survey was carried out in Abeokuta and Ado-Odo/Ota Local Government Areas (LGA) of Ogun State, Nigeria (Figure-1). The study locations were selected because Abeokuta (composed of two separate LGAs) is the administrative capital of the State while Ado-Odo-Ota municipality is the most populated LGA in Ogun State, as well as the host to about five Universities, several primary and high schools, as well as industries (Omole and Isiorho, 2011; Omole, 2011). Ado-Odo-Ota LGA has a land mass of 878 km² and an estimated population of 669, 886 as at 2013 (using the 2006 official census and a population growth rate of 3.5%) (FRN, 2007). It is headquartered at Ota (or Otta) at 6°41′00″N 3°41′00″E to the north of the Area, having 450 towns, villages and settlements. Adodo-Ota borders on metropolitan Lagos. Other towns and cities include Ado-Odo, Agbara, Igbesa, Iju-Ota, Itele, Kooko Ebiye Town, Owode, Sango Ota etc. (Hoiberg and Dale, 2010).

Abeokuta is located at the east bank of the Ogun River 48 miles (77 km) north of Lagos by railway, or 81 miles (130 km) by water (Omole, 2011). Abeokuta (comprising two LGAs) had an estimated population of 573, 540 as at 2013 (using the 2006 official census and a population growth rate of 3.5 %) (FRN, 2007).

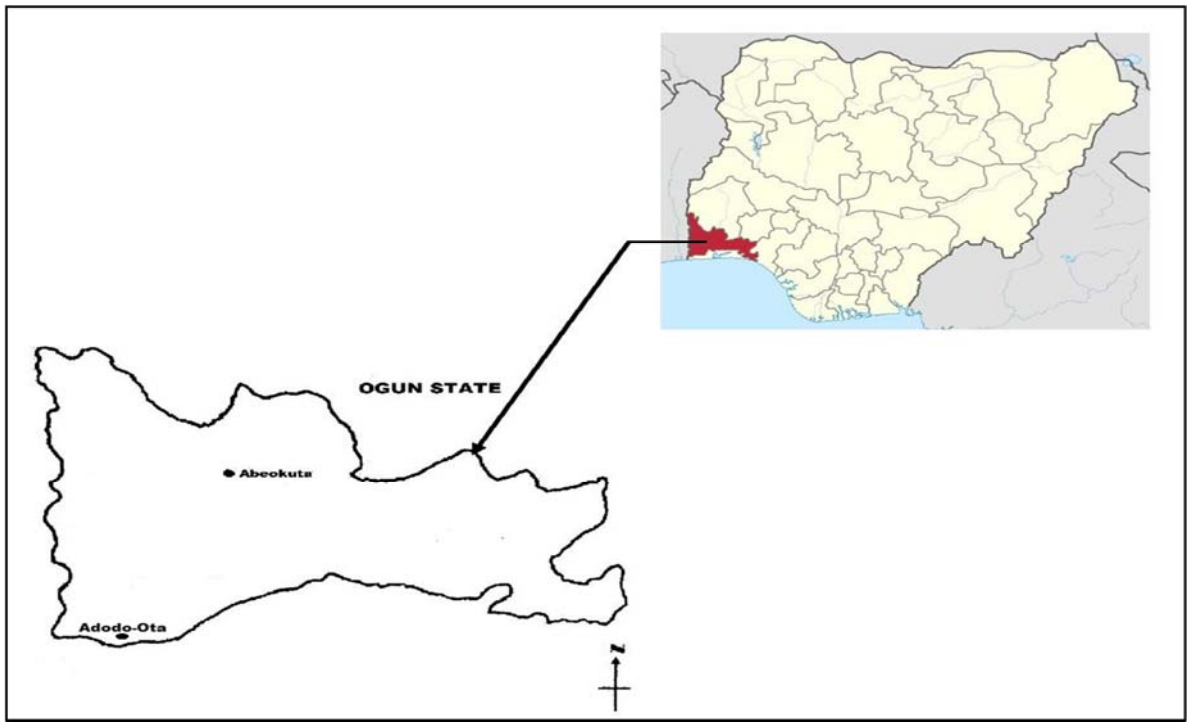

Figure-1. Map showing study area.

Questionnaire application

The research adopted an empirical survey that made use of well-structured questionnaires to obtain information on the recent trends in e-waste. In addition, In-depth interviews were conducted to access the opinion of residents, workers in workplaces and institution of higher learning in Ota and Abeokuta, Ogun State. Emphasis was placed on obtaining information on the average duration of use of EEE bought, economic status of the users, motivation for having more than one EEE, employment status of the consumer and the level of environmental and health risk involved with illegal disposal of e-waste. The questionnaires adopted both multiple choice questions (MCQ) and German objective kinds of questions which allowed respondents to express individual views which may not be listed in the MCQ. A total of 500 questionnaires were administered. Each contained 29 queries on EEE. A total of 464 questionnaires were returned for analysis, thus providing 92.8% return rate. The demography showed that 254 male and 210 female responded to the questionnaire.

RESULTS AND DISCUSSIONS

Causes of high volumes of E-waste

Age range

In this study, three age ranges were adopted. Those between the ages of 0 -14 were classified as children and adolescents who are not expected to have regular jobs. Persons within the age range of 15-34 were considered as young adults and working class people while those above 35 years of age were considered middle age to older people. Those within the 0-14, 15-34, and >35 age ranges constitute 41.8 %, 35.6% and 22.6% of total National population respectively (NPC, 2010; NPC, 2007). The analysis showed that respondents between the ages of 15 – 35 years place higher demand for EEE than the other age groups (Figure. 2). The top three popularly acquired EEE among this age group are cell phones and related accessories for communication purposes, television and video players for entertainment purposes and pressing iron for fashion purposes. Thus, the dual factors of high population distribution of the 15-34 age range as well as the fact that persons within the age range are more economically buoyant than the 0-14 age range (who are considered to be of school age) supports the high propensity for the acquisition of EEE among the former age range.

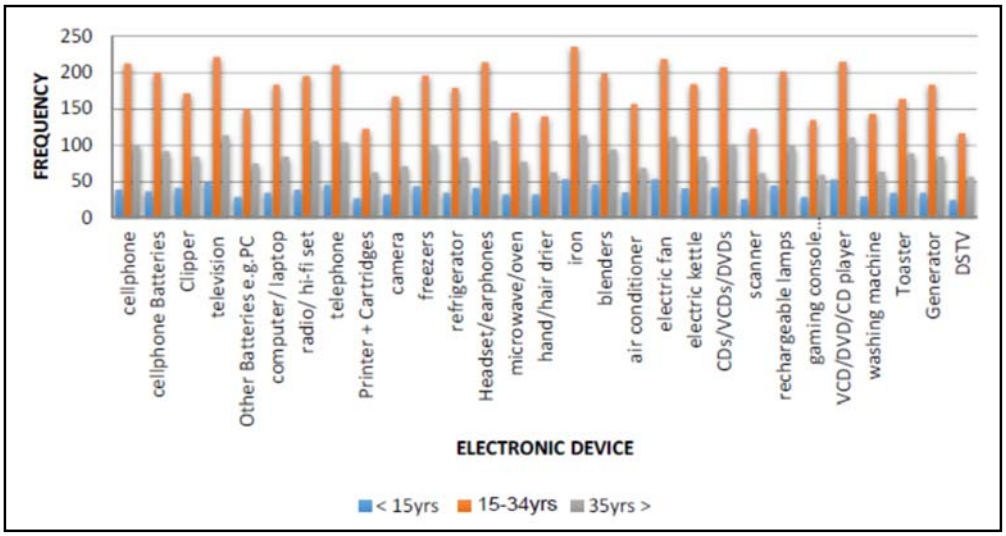

Figure-2. Age range of EEE consumers.

Economic status

Subsequent to the analysis of data on age range, the category of employment of the respondents was determined. All respondents were categorized as students, working class, un-employed or retired. The paradox presented by this data is the fact that students purchased more EEEs than persons within the working class (Figure-3). Although the exact reason for this phenomenon was not clear, it can be extrapolated from the data in Figures 2 and 3 that the students (> 15 years of age) are in tertiary institutions and therefore have passive incomes in the form of stipends from their parents. Much of this passive income could have been diverted in procuring EEEs. Persons in the working class, however, possibly have much more responsibilities than students and are therefore less likely to be impulsive in acquiring EEEs. Figure-3 also showed that un-employed and retired adults were less disposed to acquire EEEs, possibly due to limited incomes. Thus, it can be deduced that the economic status of the respondents play an important role in determining the demand and subsequent influx of EEE into the country.

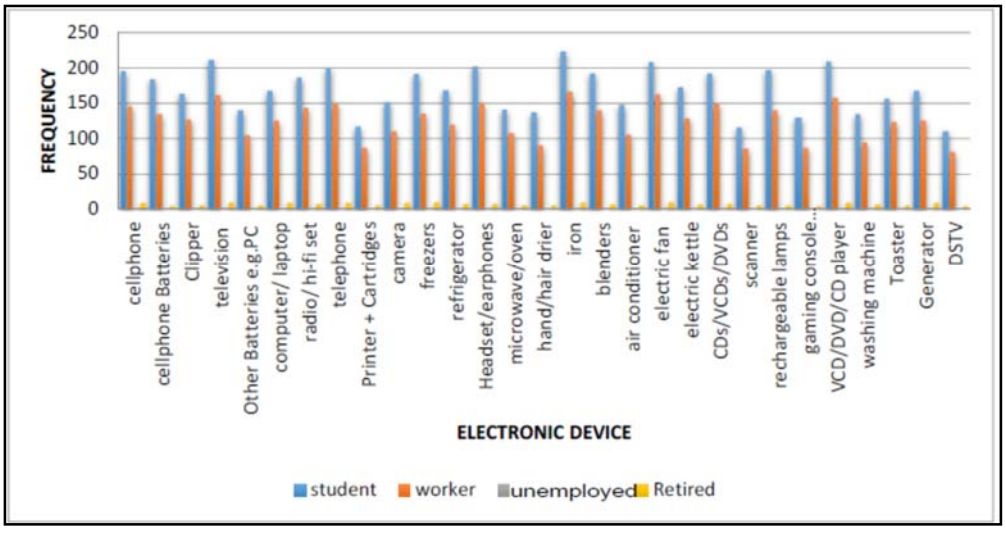

Figure-3. Economic status of respondents.

Motivation for purchase

Based on availability and level of sophistication of EEE function, the opinion of respondents was sought to know which of the options was more responsible for buyers to make purchases. The role of availability and functionality was used as a tool to assess respondents on what spurs them to purchase EEE. The research showed that irrespective of the physical state and durability of the EEEs, respondents tend to view EEE functions as a reason for procurement, than durability (Figure-4). This goes further to confirm the assertion by Nnorom and Osibanjo (2008) that the production of newer models of EEEs is a major cause of e-wastes generation.

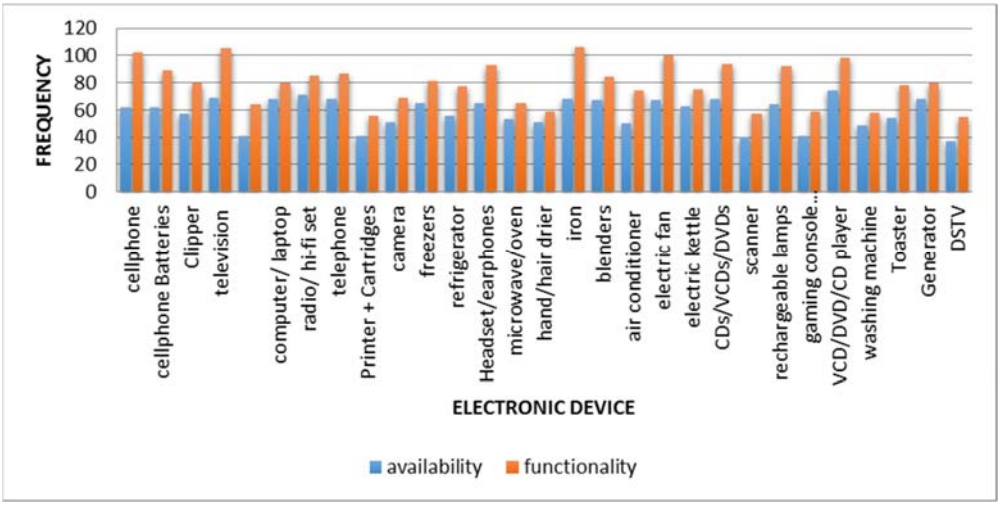

Figure-4. Motivation of respondents based on availability or functionality.

As an example, newer models of mobile phones have been designed to possess the same or even better functions than older computers (David, 2011). This has led to stiff competition among mobile phone manufacturers in their quest to maintain the leading edge in technology in a highly competitive market (Jamie and Martin, 2006). Figure-5 further shows that affordability is the more dominant reason for procuring EEEs than durability. This information could encourage manufacturers to sacrifice durability for low cost but high function gadgets. Ultimately, this could lead to the proliferation of more products that reach the end of their useful life faster, thereby turning out e-wastes at a faster rate.

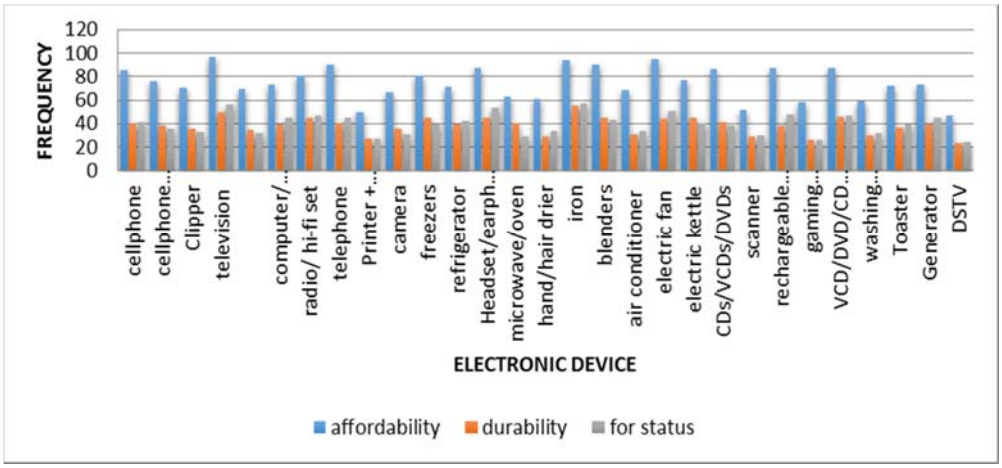

Figure-5. Motivation of respondents with respect to affordability, durability and status.

Assessment of public awareness of associated risks

Public awareness of health risk

The questionnaire sought information on persons that were aware that improperly discarded EEEs could cause health risk. Those that were aware picked 'yes' while those that were ignorant of this picked 'no'. As shown (Figure-6), more persons were unaware of the risks posed to public health by improperly discarded EEEs. This shows that lot of public enlightenment has to be done to increase public awareness to health risks posed by unwanted EEEs. Users need to be educated on the presence of heavy metals in their EEE, the potential damages to health and the benefits that can be derived from a controlled and well managed e-waste system. The effect of e-waste can be reduced to a minimum when there is adequate awareness on the health risk arising from the improper disposal of EEE.

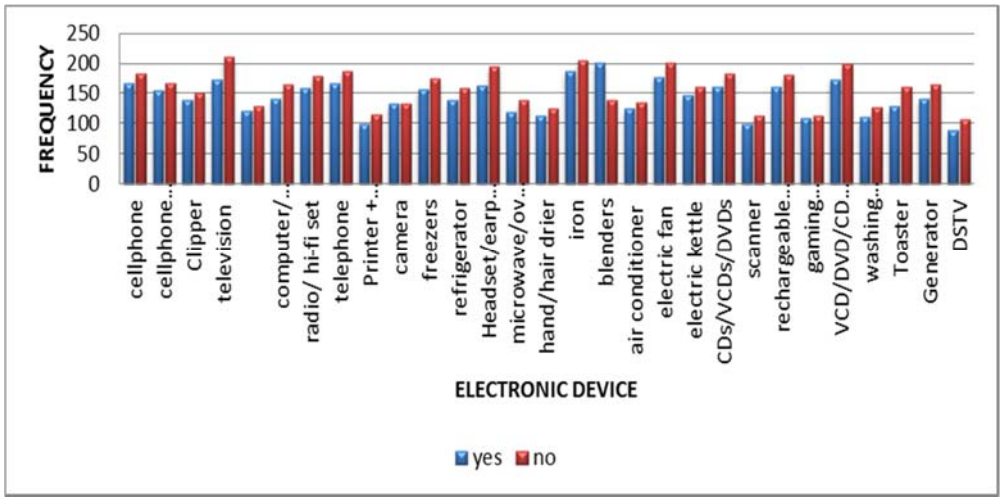

Figure-6. Level of health risk awareness associating with EEE by respondents.

Environmental hazard awareness

Similarly, the questionnaire sought information on persons that were aware that improperly discarded EEEs could cause pollution in the environment. Those that were aware picked 'yes' while those that were ignorant of this picked 'no'. The result of the responses is presented in Figure-7.

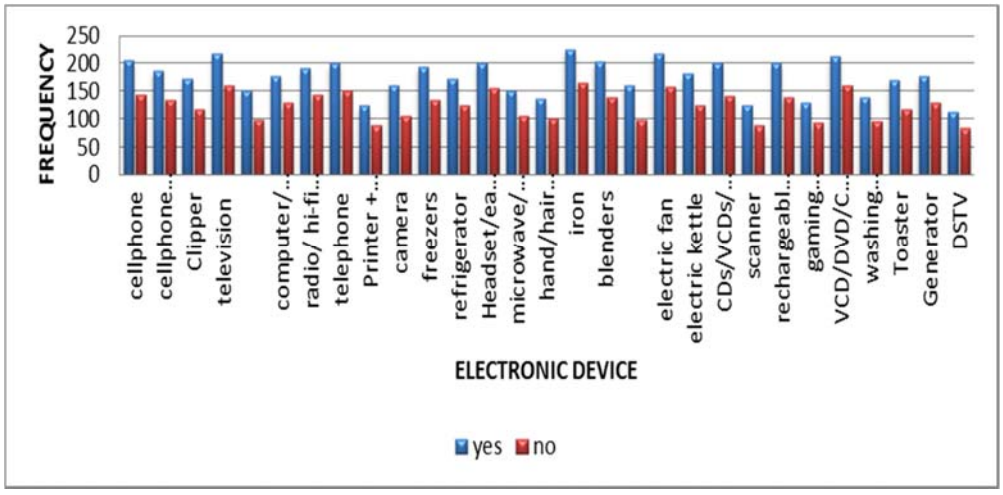

Figure-7. Level of environmental risk awareness associating with EEE by respondents.

Although a larger percentage of the respondents were aware that improperly discarded EEEs could pose environmental hazards, it could also be observed that a relatively large percentage of the respondents were ignorant of this fact. It is important, therefore, that there is a need to increase the level of public awareness with respect to risks posed by used EEEs. Both the public and private sectors could contribute in terms of sensitization programs, in order to reduce cases of adverse health and environmental problems that arise from e-waste related cases.

Management practices

Developing countries (Nigeria inclusive) lack well-established system for separation, collection, storage, transportation and disposal of e-waste as well as adequate enforcement and monitoring of regulations to hazardous e-waste (Mundada *et. al*., 2004; Longe *et al*, 2010; Agunwamba *et al*., 2013). Laxity is experienced in the enforcement of existing laws that oversees general waste management. State-of-the-art facilities and efficient technological methods for e-waste are not common in developing countries (Nnorom and Osibanjo, 2008; Nnorom and Osibanjo, 2009). As a result, low-ends management options are used to manage e-waste. These options include disposal in open dumps, backyard recycling and disposal into surface water bodies (Puckett, 2005; Omole and Isiorho, 2011; Agunwamba *et al*., 2013; Omole and Isiorho, 2014). In addition, there is no integrated framework as regards to the management and monitoring of hazardous and toxic materials and waste in developing countries. Inadequate funding is also a factor that has limited the management efficacy of hazardous waste and this has culminated in slow sustainable development (Omole and Ndambuki, 2014; Agunwamba *et al*., 2013). Nigeria is yet to experience a push-up in the recycling procedure associated with e-waste, so open dumping of materials tend to be preferred solution. This process promotes environmental pollution thereby exposing millions to the hazards involved (Omole and Isiorho, 2011; Okunola *et al*., 2012). Improved management options are required to eradicate e-waste from being indiscriminately disposed together with municipal solid wastes in Nigeria.

CONCLUSION AND RECOMMENDATIONS

Considering demand and utilization of EEE as shown in this study, it could be inferred that e-waste streams will continue to be on the rise if the identified causative factors are not addressed. The Standards Organization of Nigeria (SON), which is the governmental agency responsible for imported products into Nigeria, should pay attention to the strict monitoring and regulation of EEEs coming into the country. Electrical and Electronic products should be clearly labelled with respect to the useful life and the hazardous components of the products. This provides necessary information capable of helping prospective buyers make better and informed decisions regarding procurement and disposal of EEEs at the end of their useful life. Furthermore, the country's manufacturing sector should be encouraged at all levels to invest in the recovery, recycle and re-use of EEE components in order to reduce the volume of e-waste. Finally, all stakeholders should be made aware of the respective responsibilities in adhering to laid-down policies for the effective management of e-wastes. The S.O.N., as well as other environmental agencies such as the Ogun State Environmental Protection Agency (OGEPA) and the Municipal Waste management authorities should be adequately empowered and equipped to enforce all related policies and laws effectively.

Government plays an important role in developing recycling capabilities in Nigeria. Incentives could also be provided to attract private sector partners who would set up state-of-art recycling facilities in Nigeria. This would create job opportunities for many people and take the financial pressure off the State budget (Thomas, 2003). Also, the State government should embark on public awareness campaigns. This will educate end-users on the possible hazards to health and the environment. Furthermore, manufacturers may consider a strategy for e-waste reduction by offering to buy-back the product at the end of its useful life. This concept is already being practiced by the Lagos State Waste management Authority (LAWMA) in retrieving e-waste (Jijoho-Ogun, 2011). LAWMA offers a brand new computer system for every five waste computer systems. The goal is to take the hazard away from the public through incentives. Manufacturers and retailers should be encouraged to adopt this system. Manufacturers and merchant should take adequate responsibility to cater for the convenient disposal of the used product when brought back by an end user. This can be done by having tie-ups with dealers/retailers for the buy-back schemes. If possible, collection or disposal centres can be built for the customers other than the already available dealer locations. Consumers have an important role to play in the disposal of e-waste. Community involvement corresponding to attitudinal approach should be encouraged. The disposal of e-wastes in combination with domestic or municipal must be discouraged through special collection programs as espoused in the buy-back scheme.

E-wastes can be avoided from the beginning through sustainable product design and waste minimization techniques. Where possible, biodegradable components should be used. Also, durable product brands with extended battery life could be encouraged through tax holidays and national awards.

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