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ASSESSMENT OF ELECTRONIC WASTE MANAGEMENT AND THE ENVIRONMENTAL IMPACT ON KADUNA METROPOLIS, NIGERIA

Abstract:

The development of electrical and electronic industry has led to increase not only in the production of new goods, but also in scraps generation. The rapid movements in electronic industry, e-waste including obsolete and substandard electronic products have become the fastest growing components in the solid waste stream in most Nigerian cities and this waste contained hazardous chemical elements that pose serious environmental threats. The aim of this paper is to assess electronic waste management system and the environmental impacts on Kaduna metropolis. Materials for this study were obtained from structured oral interviews and field observations. Secondary sources of materials were obtained from desk review method. The results of the study showed that e-waste products were generated from the use of electrical equipment such as battery, electrical cables, televisions, cell phones, computer parts and accessories among others. The rate of generation has been exacerbated by increases in population and technological upgrading due to increase in economical well being of Nigerians. The results also showed that the e-wastes are indiscriminately dumped on open spaces in the metropolis. There is also neither characterization of this e-waste non organized recycling, except by local scavengers (yan bolas) that operate backyard recycling by disassembling or open burning of the e-waste to extract materials of immediate values such as cable, plastic, ICs, transistors and metals leaving behind the toxic metals which are potent pollutants. E-wastes are known to contain toxic heavy metals that are linked to major ailments peculiar to humans. The paper therefore recommends strong legislation enforcement on importation of obsolete and substandard electrical and electronic products and a good e-waste handling and recycling strategies that are economical and environmental friendly.

Keywords:

Obsolete, toxic, heavy metals, pollution, management, e-waste, recycling

JEL Classification: A10

Introduction

The uses of electronic and electrical devices have increased in recent time as a result of economic and technological development over some period in Nigeria. The increased usage of the electrical and electronic devices has also caused high volume of electronic waste in Nigerian cities. Electrical and electronic wastes are also known as electronic wastes (e-waste) or waste electrical and electronic equipment (WEEE). The WEEE is obsolete or end of life (EOL) electrical and electronic equipment (Kalana, 2010). There is no universally acceptable definition of e-waste around the world, however e-wastes are electronic materials that are disposed of by end users and include a wide range of products from simple devices to complex goods. E-waste therefore comprises of both white goods such as refrigerators, washing machines, and microwaves and brown goods such as TVs, radios and computers that have reach their ends for their current holders (Kalana, 2010, Khetriwal *et al*., 2007). Atiemo *et al* (2012) observes that every year 20 to 50 million tonnes of waste electrical and electronic equipments are generated worldwide, which pose potential threat to human health and the environment. Waste electrical and electronic equipments can contain many different substances some of which are toxic whereas others have a relatively high market value when extracted.

In Nigeria, most electrical and electronic equipments are imported and many of these electrical and electronic equipments (EEE) are thought to have undergone End of their Life (EOL) before importation. Nigerian has therefore become the destination for a large proportion of e-waste importation from developed countries (Nnorom and Osibanjo, 2008). The main electronic waste in Nigeria and other developing countries are obsolete computers, refrigerators, old tapes recorders, scrap vehicles, used batteries, monitors, television sets, cell phones, children's toys, printers, refrigerators, microwave ovens and any other used electrical or electronic equipment such as energy bulbs, and fluorescence tubes. The use of EEE and the consequent generation of waste materials left after lifetime of these goods have toxic metals that pose serious environmental threat with landscape of cities littered with solid e-waste (Nnorom and Osibanjo, 2008; Chi *et al.*, 2003; Butu and Okoro, 2014; Onwughara *et al.,* 2010).

Sharma (2010) asserts that e-waste is a problem both at the manufacturers end, and at the user level. This is because e-waste such as computers are not designed for recycling and the new computers has most operating in-built which means that the hard discs cannot be upgraded. In Nigeria it has become very difficult to quantify the actual amount of e-wastes importation, because of the high rate of illegal importation which is far above the due process of which these end of life e-wastes are declared as second hand goods. The disposal rate of these wastes stream is accelerating because the global market for electronic is far from saturated and the lifespan of electronic goods is becoming shorter, so that obsolete equipment is increasing (Onwughara *et al.,* 2010). Musson *et al* (2000) and Cui and Forssberg (2013) are of the opinion that e-waste generation, trans-boundary movement and disposal are becoming issues of concern to solid waste management professionals, environmentalists, international agencies and government around the world.

Electronic waste may be toxic in nature since they contain toxic metals such as lead, beryllium, mercury and cadmium which can pose serious human and the environment

threat if not handled or disposed properly (Onwughara *et al.*, 2010). Personal computers (PCs) constitute the second largest component next to cathode ray tubes (CRTs) in the e-waste stream and are growing most rapidly, they also contain the largest amount of printed wiring board (PWB) and electric products (Yadong *et al.,* 2006). PWBs have been known to contain many types of heavy metals and brominated flame – retardants (BFRs) which are toxic to human beings and the environment (Yadong *et al.,* 2006; Veit *et al.,* 2005; Ching-Hwa *et al*., 2004). Cathode ray tubes (CRTs) are used in televisions and computers display screens; they form about two-thirds of the weight of a television or a computer monitor and composed of 85% glass (Fernanda *et al.,* 2005). Onwughara *et al* (2010) posit that televisions and computers CRTs present a disposal problem because of their growing magnitude in the waste stream and their role as a major source of lead in municipal solid waste.

The unsightly heaps of scrap electronic materials that litter most of the streets where their repair workshops are located, and most of the waste collection centres or dumpsites in Nigerian cities generally and Kaduna metropolis in particular have necessitated this study because of the hazardous chemicals including Polycyclic Aromatic Hydrocarbons (PAHs), Polybrominated Diphenyls Ethers (PBDEs), Polychlorinated Dibenzo-P-Dioxins (PCDDs), Polychlorinated Dibenzofurans (PCDFs) and heavy metals such as chromium, lead, cadmium, copper, manganese, arsenic and mercury that are bond in these electronic wastes are known to have caused pollution to air, soil and water bodies within the catchment area. Therefore, the aim of this paper is to assess the generation and the management of e-waste and also to examine the environmental consequences of the e-waste in Kaduna metropolis. The objectives of the study are;

i. To identify and characterize different types of e-wastes generated in Kaduna metropolis.
ii. To identify the major repair workshops or storages and open dumpsites found in the study area.
iii. To assess any health effects arising from contact with these e-wastes.

The Study Area

Kaduna metropolis is located between longitudes 7^0 15’ and 7^0 30’ of the meridian and between latitudes 10^0 15’ and 11^0 15’ of the equator. The city is located about 220km north of the Federal Capital City, Abuja (Akwo, 2014). Kaduna metropolis is the administrative headquarters of the present Kaduna State. It was the administrative headquarters of the then Northern Region and North Central State. The metropolis is made of two Local Government Areas: Kaduna North and Kaduna South and parts of two other Local Government Areas: Chikun in the Southern and Igabi in the Northern parts of the metropolis shown on Figure 1.

Kaduna metropolis represents a major focus and centre of political economic activities. It is the largest city next to Kano city in Northern Nigeria. Kaduna metropolis occupies a very strategic position in terms of its historic role, contemporary political development and economic activities in the region. Consequently, the development in the metropolis invariably has national implications, because of the federal presence, especially military

institutions. The city has attracted different types of industries which had attracted population overtime although most of the industries are now dormant.

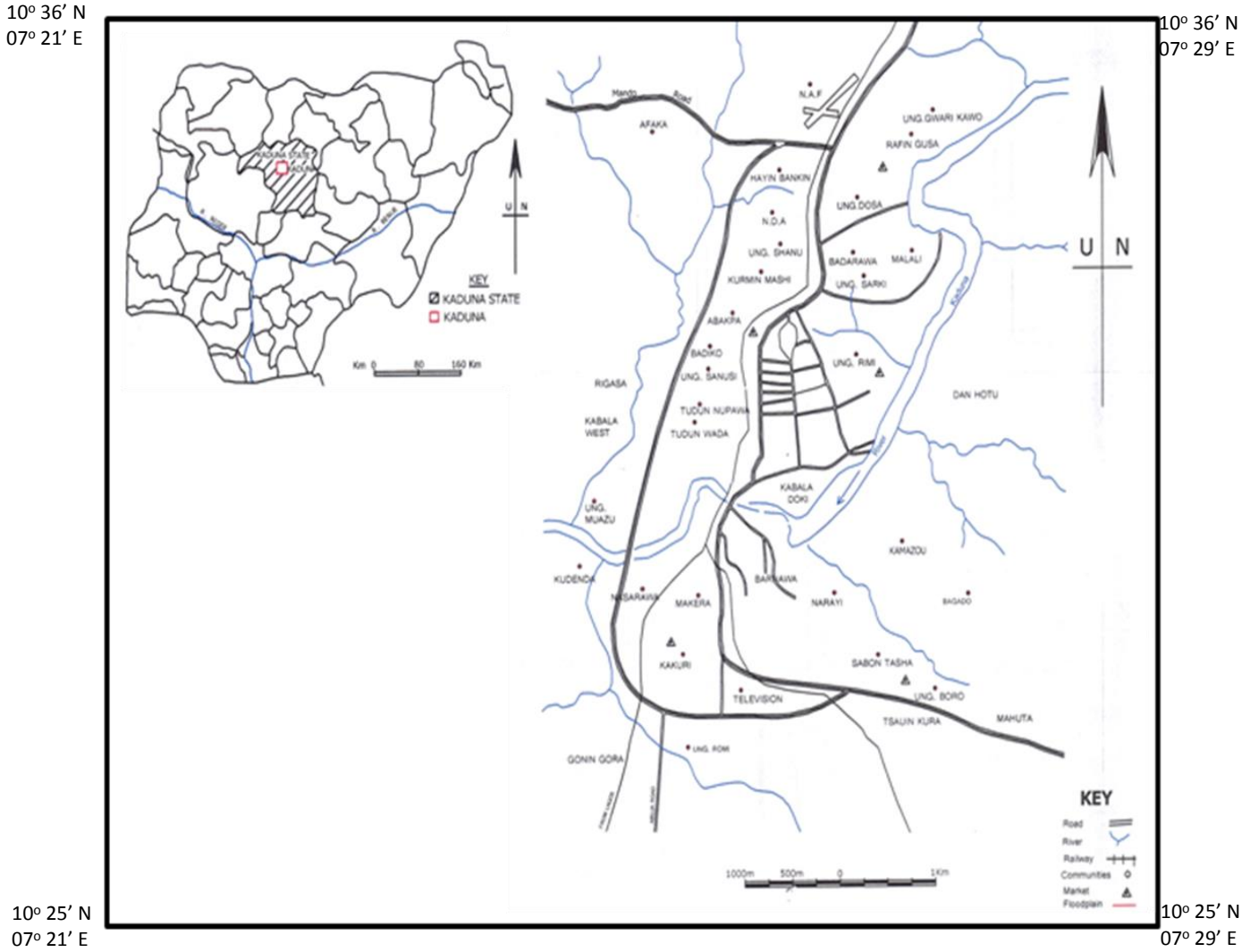

Figure 1: Map of Kaduna metropolis.

Source: Adapted from Oladumi, O.O. (2015)

Materials and Methods

Kadoga *et al* (2013) defined assessment as the process of documenting, usually in measurable terms, knowledge, attitudes and beliefs. They posit that assessment may include observations, inventories, checklists rating scales, performance and portfolio assessment participation, peer and self-evaluation and discussion. Therefore the methodology adopted in the assessment of e-waste management in Kaduna metropolis is a qualitative approach. The qualitative data obtained consisted of primary data generated by carrying out oral interviews and field observations to conduct a holistic and in-depth assessment. The interviews were semi-structured and carried out by using purposive sampling method. The qualitative data was analyzed descriptively.

Results and Discussion

The results of this study is presented and discussed under the following sub-headings:

i. E-waste generation in Kaduna metropolis
ii. E-waste management system in Kaduna metropolis
iii. Environmental effects of the e-waste.

Electronic Waste Generation in Kaduna Metropolis

E-waste is fast becoming very important waste streams both in terms of quantity and toxicity in Nigerian cities. The importation of outdated and end of life electrical and electronic equipment are the major sources of e-waste in Kaduna metropolis and Nigeria as whole. In Kaduna metropolis the disposal rate of e-waste is fast increasing because the global market for electronic goods is getting saturated and the lifespan of the electronic goods is fast becoming shorter and therefore the obsolete electronic equipments are fast increasing and also more people do replace their electrical gadgets.

The main sources of e-waste in Kaduna metropolis are from the following: large household appliances such as refrigerators/freezers and washing machines, small household appliances such as vacuum cleaners and kitchen machines, information technology and telecommunication equipment such as computers, mobile phones, copying machines and printers as shown on Figures 2 and 3. These types of e-wastes are commonly generated along Ibadan Road Kaduna metropolis. Consumer equipment such as televisions, stereo equipment, transistor radios, lighting equipments such as fluorescent lambs and from toys, leisures and sport equipment such as video games are produced in large quantities along Gwandu Road and other parts of Kaduna metropolis. Thus, Kalana (2010) rightly observes that the increase in the end of life electrical and electronic products depends on the economic growth of the country, population, market penetration, technology up gradation and obsolescence rates. Besides that, due to increase in affordability of new products and technological advancements, it is therefore easy to purchase rather than repair outdated equipment (Arora, 2008).

Figure 2: Scraps of e-waste stock by PC and printer repairer ready for discard.

Figure 3: Heap of condemned electronic equipments piled at backyard ready to be discarded.

Kaduna metropolis as any other Nigerian city is heterogeneous in terms of social classification. The population of the high class who prefers to discard than repair electronic products are high so also are the lower social class who depends on even the

second handed imported electronic products which have almost reach their end of life that are commonly found in the city waste streams. Kalana (2010) posits that the disposal of electronic products is fundamentally driven by the production of new ones. Thus, Williams (2005) concludes that the growth in global electronic production will surely result in similar growth in e-waste generation. These arguments therefore justify the high generation of e-waste in most Nigerian cities and Kaduna metropolis in particular.

Waste electrical and electronic equipment (WEEE) generation, trans-boundary migration and disposal systems are becoming notorious issues of concern in Nigeria and other parts of the world. The consumer electronic equipments have fast become essential aspect of human endeavour because of improvement in electronic industry and standard of living over the last two decades. This has therefore led to a great increase in the use of electronic and other electrical equipments which may contain hazardous elements, but have now become part of human life. Volumes of the electrical and electronic products are generated daily in large quantities from our household, the new generation “Computer or GSM Villages” like Makerfi Plaza in Kaduna metropolis and other GSM villages that are commonly found in most Nigerian cities, electronic and mechanical workshops along major streets such as Gwandu Road, the main street leading to Romi, Sabo Tasha, Tudun wada and Kakuri in Kaduna metropolis as shown on Figure 4, 5 and 6.

It is therefore, no doubt that the development of the electronic industry in developed worlds has led to an increase in the production of new goods and as well as in scrap generation and the volume of waste materials left after lifetime of these goods in less developed or developing nations like Nigeria.

Figure 4: Volumes of e-waste mostly obsolete TVs piled up ready for discard by the repairer along Gwandu Road, Kaduna.

Figure 5. Heap of e-waste dumped in a drainage channel along the major road in Romi, Kaduna

Electronic Waste Management in Kaduna Metropolis

The results of the finding reveal that there is no proper management of the e-waste generated in Kaduna metropolis. The management of e-waste generated is entirely left to the producer of such wastes. There is no organized recycling system of the e-waste, except by local scavengers *(yan bola)* who go round to collect these electronic and electrical products from open dumpsites or various workshops or households. The e-waste produced are also not segregated at the source or dumpsites. The composition of the e-waste is heterogeneous, comprising of various materials that are made up of blend of sophisticated chemical elements including hazardous heavy metals as shown on Figure 6.

Figure 6: A mixture of complex e-waste piled up by an electronic repairer and Gwandu Road, Kaduna ready to be discarded on any available waste dump/collection centre.

E-waste are often indiscriminately been dumped on available open ground or space, some even near water channels with total disregard to the environmental consequences of waste especially along Gwandu and Ibadan Roads, Kaduna. In the informal e-waste recycling practices in Nigerian cities and most common in Kaduna metropolis, most of the e-waste is processed in backyards or small workshops by the *yan bolas* using primary method such as local disassembly and most often open burning to extract the immediate needed materials. In this native method of recycling only valuable materials of immediate need such as ICs, cables, plastics, condensers, PWB, CRTs and metals are most often stripped by local disassembling or open burning. Kalana (2010) is of the view that this system poses serious consequences to the surrounding environment and human health and therefore can be replaced by environmentally sound manners. This traditional method of recycling practiced in Kaduna metropolis without proper facilities cannot recover the toxic substances such as heavy metals. The valuable parts of some household electrical and electronic products such as compressors in air conditionals and refrigerators as shown on Figure 7 are separated and sold and the improper treatment of the hazardous substances associated with the e-waste often leaves the problem of secondary pollution behind. The interview with the local scavengers revealed that they earn their daily living from the local recycling practice.

Figure 7: E-waste generated and left carelessly in one of the repair workshops

The quality of recycling method of recovery of the components will indeed lead to minimization of heavy metal release to the environment. It is observed from the study that some of these e-wastes are recklessly dumped in dumpsites or even burnt in some dumpsites without a look at the environmental impacts. To achieve an environmentally friendly practice needs a cost-effective recycling system and total characterization of these wastes which is totally absent in Kaduna metropolis and Nigeria in general. This is because EEE is complex and diverse in terms of the materials and components used. Currently most consumer electronic devices (CEDs) and electrical products end up in open dump collection centres, drainage channels and dumpsites that are often burnt, because there is no segregation mechanism in place.

It is also observed from the study that many consumers do not dispose of unused electronics immediately because they are of the belief that the products may still have value and therefore e-waste management in Kaduna metropolis is very poor and needs an urgent attention. Butu *et al* (2013) observe that most developing nations are fast becoming an e-waste destination because most second handed electronics, substandard and recycled electronics from China, India and other Asian countries find fertile grounds in these countries and are patronized mostly by the low income population who have low level of environmental awareness. As a result of these ugly practices most municipal solid wastes are dominated by large quantities of these e-wastes in Kaduna metropolis and other similar Nigerian cities as shown on Figure 8 and 9.

Figure 8: A heap of complex municipal solid waste containing also e-waste in one of the waste collection centres/dump site in Romi, Kaduna.

Waste management is a vital aspect of environmental regulation. Thus, John *et al* (2010) cited Conneth (1991) that if the future really mattered to us, we would not be talking about waste management. We would be talking about resource management. Nature makes no waste. We make waste: nature makes soil. One creatures waste is another creatures nutrients. Nature recycles everything; or rather it did until we started to put our synthetic materials into the environment. Therefore the waste electrical and electronic equipments that are produced in recent time and exported to Nigeria if properly managed can be Nigeria's nutrients or raw materials as Sharma (2010) rightly states that waste is very valuable raw material located at a wrong place.

Figure 9. E-Waste with municipal solid waste carelessly dumped on opened ground along a major street in Romi, Kaduna.

Environmental Effects of Wastes

E-waste contains several toxic substances that have negative effects on humans and the environment if not properly disposed. Onwughara *et al* (2010) posit that personal computers (PCs) constitute the largest component next to CRTs in the e-waste stream and is growing most rapidly. PCs contain the largest amount of PWB among electronic products (Yadong *et al*, 2006). The printed circuit boards (PCBs) or printed wiring boards (PWB) are parts of WEEE and their composition varied greatly. Veit *et al* (2005) observes that their metal content also varied. PWB are known to contain different types of heavy elements and brominated flame-retardants (BFRs) which are known to be toxic to humans and the environment (Yadong *et al*, 2006; Veit *et al*, 2005; Ching-Hwa *et al*, 2004; Onwughara *et al*, 2010). The phosphur coatings of CRTs, the high lead content in CRT funnel glass, batteries, PWB capacitors and mercury containing parts in PCs are indiscriminately dumped in the area. CRTs in televisions and PCs can contain high level of lead and indeed these televisions and PCs present a disposal problem in Kaduna metropolis because of their growing magnitude in the waste stream and their role as vital

source of lead in heaps of municipal solid waste that dot the city as shown on Figure 8 and 9. Kaduna metropolis is therefore threatened by metal contamination because of large quantity of e-waste that characterized the MSW stream in the city.

The plastic used as insulators or casing in electronic and electrical products have unique properties. The plastics are second largest components in WEEE and make about 30% of the mass of electronic scrap. There is the fear that some of these plastics with flame-retardant can have damaging effect on the environment if not properly disposed off. Some of these plastics even blocked drainage channels thereby preventing free flow of storm water and causing flooding. The major problem in municipal solid waste is the content of toxic substances such as heavy metals, and organic compounds. Onwughara *et al* (2010) and Antrekowitsch *et al* (2007) are of the view that metal combination with halogens in the plastic fraction can form volatile metal halides, and can also have a catalytic effect on the formation of dioxins and furans. WEEE has different toxic chemical substances such as lead, mercury, hexavalent chromium, selenium, cadmium, arsenic and manganese. The specific components that contain hazardous chemicals as stated by Onwughara *et al* (2010) are PWB, CRTs, mercury switches, batteries, sensors and connectors, light generators (e.g. lamps) wires and cable resistors. All these components of WEEE are indiscriminately been dumped on open spaces on many streets and opened dumpsites in Kaduna metropolis and other major cities in Nigeria with grave consequences on the health of the inhabitants and the environment.

The major hazardous chemicals that are contained in these array of e-waste on major streets and dumpsites include cadmium, nickel, zinc, lead and mercury that are contained in accumulators and batteries, selenium, lead and cadmium contained in solders, cadmium, yiterbium, europium, selenium and zinc commonly found in screen coating and gutters, mercury commonly found in mercury switches, thermostats, sensors and discharge lamps, polychlorinated biphenyls found in capacitors, polybrominated biphenyls and polybrominated diphenyl ether that are contained in flame-retardants in PWB, connectors and plastic covers. Chlorine and bromine in halogenated plastics, cadmium, lead, nickel, titanium and arsenic in pigments (Onwughara *et al*, 2010).

Chemical elements especially heavy metals that are contained in electrical and electronic wastes are known to have serious consequences on the surrounding environment and human health. Some of the hazardous effects of heavy metals and other chemical elements from e-waste are; lead which is known to have damage effects to the central and peripheral nervous systems, blood system, kidney and reproductive system in human. Lead is neurotoxin and excessive lead level in the blood system has been linked to learning disabilities, attention deficiency disorder, hyperactivity syndromes and reduced intelligence in children (Carl, 2002). Oladele (2007) is of the view that human exposure to lead from electronic products is more problematic because of poor management and illegitimate recycling in cottage industries in developing countries that have little or no regulatory laws. The local scavengers *(yan bola)* that handle these scraps EEE are highly exposed to lead accumulation in their cells.

Mercury can cause serious damage to several organs in the human body such as the brain and kidney. It has the greatest risk for human even with only short-term exposure to pregnant women, young children and infants (Blazovics *et al*, 2002). Cadmium and its compounds are toxic because of their bioaccumulation nature. Cadmium causes

irreversible effects on human health such as kidney and liver dysfunction, brittle bones; it affects reproduction and survival (Onwughara *et al*, 2010). Low exposure to chromium can irritate the skin and cause ulceration and long exposure to chromium and its compound can cause kidney and liver damage as well as the circulatory system (Butu and Iguisi, 2012).

Silver and silver compounds can have some biological effects to humans such as digestive tract irritation, blue-gray pigmentation of the skin, eyes and mucous membrane known as agryria. Copper and its compounds and atimony and its compounds can also cause serious digestive tract irritation with abdominal pain and vomiting (Butu and Iguisi, 2012). IPCS (2001) is of the view that long term exposure to arsenic is usually related to increase risk of cancer in the skin, lungs, bladder and kidney as well as other skin and kidney damages such as hyperkeratosis and pigmentation changes. Other metals such as nickel, yiterbium, bromine, barium, selenium and titanium that are abound in these e-wastes are also known to have some negative effects on the environment and human health when they accumulate above acceptable limits in the environment. Acu – Cell Nutrition (2012) reports that low intake or exposure to bromine can lead to seizures, insomnia, agitation, irritability and hyperthyroidism and a high dose could lead to drowsiness, fatigue, nausea, vomiting, skin irritation, blurred vision, dizziness, mania, hallucination, increased thirst, hunger, urination, poor memory and hypothyroidism. Yiterbium compounds are known to cause skin and eye irritation and may as well be carcinogenic (Butu and Iguisi, 2012). Most of the local scavengers *(yan bola)* and local EEE repairers confessed that they often have health issues of skin irritation and respiration most of the time, but they have not taken such issues serious. It is therefore dangerous that these toxic elements are likely accumulating in the cells of these people with lethal effect at the long term.

Additional toxic chemical toxic substances in the e-waste are polychlorinated biphyls (PCBs), chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs). These chemical toxicants even in small amount can be potent pollutants and contribute greatly to toxic landfills leachate and vapours such as vaporization of metallic dimethylene mercury in the environment (Balakrishnam *et al*, 2007; Onwughara *et al*, 2010). The backyard burning of these waste electrical and electronic equipments is also responsible for the release of toxic elements such as dioxins and furans to the environment, thereby polluting the atmosphere. The storm runoff also carries leachate (ash, acid or toxic water) into the surrounding streams and finally into the sea thereby affecting the aquatic population. The toxic water (ash) also leached into the soil which contribute greatly to ground water pollution as well as the soils that plants are cultivated on.

Butu and Iguisi (2013) identify several heavy metals such as chromium, antimony and scandium that are most common in household electrical appliances in high concentration in River Kubani sediment and soil along the long profile of the river that have negative effects on the life of humans and other aquatic organisms that depend on the river. River Kaduna is one of the largest river in the catchment area and it disserts Kaduna metropolis into two. Therefore the large quantities of e-waste that is generated in the catchment area and indiscriminately dumped on the surrounding open dumpsites usually end up in this very important river either in the solid state or as leachate (toxic water) thereby polluting the water course, the soil around the river bank that is highly cultivated for market garden

crops and the aquatic life that the population around the city depend on for protein. Heavy metals are known to be non biodegradable, they rather bio-accumulate in cells of living organisms. It is therefore dangerous for continuous exposure to heavy metals through food intake.

Uzoigwe *et al* (2913) detected concentration of iron, cadmium, manganese, lead and chromium in toxic levels in the groundwater in humid tropics of Nigeria that posed serious environmental risk to life. The toxic levels of these heavy metals in the groundwater were routed to anthropogenic activities resulting mainly from indiscriminate dumping of wastes that contained array of materials including these metals. It is therefore suspected that the groundwater in the ancient seat of Northern Nigeria may be getting polluted by heavy metals that emanate from all these dumpsites or dump collection centres in the city and this posed danger to the consumers of the groundwater especially those that depend on shallow wells (hand dug wells).

Butu and Ati (2013) traced the sources of some chemical elements such as europium, manganese, arsenic, zinc and copper into Zaria Dam that is used for domestic purposes to washing of debris that contained these metals from refuse dumpsites that surrounds the dam catchment area. Butu *et al* (2013) observe that most of the electronic and electrical fittings that are commonly seen in most of the refuse dumps in Karu, Nasarawa State contained a lot of heavy metals that are carcinogenic to humans. Heavy metals are non-biodegradable and persistent environmental contaminants which may be deposited on the surface and can be absorbed into the tissues of vegetable and may accumulate in the flood chain with risk to health of animals and humans which are sensitive to metal toxicity (Doherty *et al*, 2012). This therefore implies that Kaduna metropolis environment, Kaduna River, the surrounding *fadama* that are highly cultivated for vegetables and other market garden crops are threatened by possible contamination by heavy metals from e-wastes that are found in major solid waste streams in the metropolis as well as other major cities that generate high volume of e-waste in their waste streams. The consumers of crops loaded with these metals as well as the local scavengers and other people that handle these EEE are exposed to the toxicity of these metals, because these heavy metals keep bio-accumulating in their cells unnoticed with resultant lethal effects over a long period. Heavy metals are known to be carcinogenic and have been associated with etiology of most human ailments.

Conclusion and Recommendations

E-waste generation and management is a serious issue in Nigeria and very precarious in Kaduna metropolis; due to its environmental and human health implications. The study reveals that population growth with lack of solid waste management strategies in place have compounded the problem of e-waste management. The rate of e-waste generation and indiscriminate dumping by the roadsides and on available open dumpsites in mixtures with other municipal solid wastes fall below acceptable standard. The hazardous chemical components of these e-wastes are the major problem in WEEE management because the toxic metals and other chemical substances in these wastes have been identified to be associated with implication in the etiology of human ailments. The generation of this e-waste in the waste stream in Kaduna metropolis is known to be on

fast increase because of the population growth, improved technology and demand for EEE products that result in the increase importation of consumer electronics which have become essential aspect of human life. The development of electronic industry in developed worlds has subsequently led to uncontrolled production of new goods as well as scrap generation in less developed nations like Nigeria. Obsolete and substandard or recycled electronic materials are imported or smuggled into Nigeria from Europe and Asia. These obsolete and substandard electronics have attained their end of life and therefore constitute most of the scrap electronics in Kaduna metropolis and other Nigerian cities

E-waste management in Kaduna metropolis is left in the hands of the producers. There is no organized e-waste segregation or management. E-waste are sorted by local scavengers *(yan bolas)* at the source centres (electronic repair workshops) or at the dumpsites/collection centres who disassembled the e-waste or burn them to extract items of immediate values such as plastics, ICs, transistors or cables, leaving behind the chemical toxic components as potent pollutants. The WEEE is known to contain a lot of toxic chemicals which have adverse effects on the environment and humans. These chemicals are leached into the soil and pollute the groundwater, soil and surface water that the human population in Kaduna city depends on.

To avert these ugly threats on the environment, it is therefore recommended that:

i. People should be orientated to look at these e-wastes as valuable resources for materials and energy recovery and on environmental consequences of dumping this e-waste indiscriminately in open dumps, drainage channels, streams or open burning.
ii. There should be more interaction with developed nation's waste agencies to close up the existing wide gap in order to enhance efficient municipal solid waste management. Such collaborations will open ways for best practices and strategies for effective solid waste management in Nigeria.
iii. There is need for information flow between e-waste producers, generators and waste management agencies. This will facilitate partnership and encourage recycling of the e-waste.
iv. The existing informal recycling of e-waste by scavengers be prohibited and replace with cost effective, and environmentally sound recycling systems that will serve as job opportunity to the growing population.
v. The improper system of e-waste disposal is stopped and waste characterization be encouraged. E-waste to be sorted at the source and packaged separately for disposal or recycling.
vi. It is very important to enhance public awareness regarding the hazardous effects of e-wastes on the environment and public health and therefore government should take the issues of education on the hazards associated with e-waste as paramount.
vii. The government to enforce legislation on the standard of electrical and electronic equipments to be imported into the country. This will reduce the reckless importation of obsolete and substandard products into Nigeria.

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