

Impacts Assessment of Electronic Wastes Menace on Environment: The Biu Community Case, Nigeria

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Abstract

Carefree disposal of electronic wastes on Biu environment over time, have reached alarming rate. Probably, most users of electronics appliances in the community were not aware that, when damaged appliances are improperly handled, they have the tendency of being source of silent, but serious environmental problems. However, they might be aware, but likely resolved to be nonchalant in the face of such challenges. This research therefore, assessed the impacts of the e-wastes menace in the community; given their aggravating challenges that seems difficult to surmount. To unfold more to these, sites where the community e-wastes are dumped were identified; and the challenges they pose to such environment examined. Others include, guidelines put in place for safeguarding the environment against the menace; as well as their adherences were also examined. Primary and secondary data were used in forms of questionnaires, field investigations, measurement, interview and empirical literatures review to source data. Whereas, the research population comprised of electronic appliances repairers; and homes, institutions, offices and commercial outfits in the community presumed as active users of the appliances are considered as households. Yamane (1967) statistical formula for sample size determinant was use to sample 38 repairers and 338 households from 142,644 population of Biu that served respondents. The data obtained were analyzed using SPSS version 20, and the results presented on tables and charts using percentages. From the results, 36.8% of the respondents attributed the reason why the community leaves malfunctioned electronic appliances with the repairers unclaimed to lack of spare-parts to fix them. To 26%, high cost of available spare-parts is the reason. When these appliances are left in the shops, 31.6% of them become reservoir of parts for other appliances that have the guarantee of collection when repaired. When they become junks, 29.9% of the respondents saw them as nuisance, eyesore and deprived such areas aesthetic. Blockage of waterways was observed by 23.4% respondents. Whilst, despite the impacts of these e-wastes, only 34.2% of the repairers understood they contained toxic materials. Lead has 23.7% acknowledgement, Mercury and Cadmium 15.8% each, while Brominates flame retardant 10.5%. Given these findings, the research uncovered that, in Biu community, critical environmental issues posed by e-wastes are unfortunately down-played. In effect, they are conveniently allowing run-off, winds, storm-water and human actions to easily transport their toxic elements into unprotected farms, playground, assembly areas and streams, posing slow, but eventual deleterious effects.

Keywords: *Electronic appliance, Electronic repairer, E-waste, community, Impact*

Introduction

Unabated disposal of electronic wastes (e-wastes) on environment over time, have reached alarming rate particularly in urban areas of developing countries (World Bank Report, 2022). Probably such actions are exhibited given that, most users of electronics appliances in those environments are not aware that damaged or faulty mobile phones, refrigerators, televisions, laptops, pressing iron, hot plates, washing machines, and plugs, among others, when improperly handled, could be sources of silent, but serious environmental problems. However, they might be aware, but have resolved to be nonchalant on such challenges (Mohammed, 2024). Wastes in whatever form, are directly linked to human consumption patterns, and use of technological items. The rate at which they are generated around the world therefore, were observed to be exponential (World Bank Report, 2022). In 2020 for instance, 2.24 billion tons of solid wastes were reported to have been generated across the world; which amounted to 0.79kg per person, per day footprint. In comparison to their challenges, developing countries are more severely affected by these menaces, than those in developed countries. This is due to poor governance issues on waste management, that resulted in over 90% of their wastes being poorly handled (3S Media Report, 2021; World Bank Report, 2022).

Evidently, aggressive transformations of human development, over the recent decades have been associated with significant increase in use of technology, particularly in areas of communication. As computers and mobile phones are continually manufactured with new improvement (Mauk and Metz, 2011). These rapid innovations and replacements, serves as drivers, fueling increase in e-wastes generation that in most cases, defiled effective collections and disposal of their scraps when they reached their end-of-life (European Commission Report, 2010). Furthermore, in many developing countries, the situation is compounded by lack of good infrastructure for disposal of the e-wastes. Others are non-implementation of existing environmental sanitation laws, irregular and unplanned dumping of wastes, insufficient capital to run e-wastes management process. Inclusive also, shows lack of advanced technology for effective handling of e-wastes which become overwhelming to surmount (Momodu, 2017). Consequently, widespread environmental damage became glaring landmark in those areas, as these wastes could contain hazardous materials like lead, mercury and *hexavalent* chromium. Large number of them also have the presence of cathode ray tubes (CRTs), capacitors, relays, batteries, liquid crystal displays (LCDs), cartridges, selenium drums and electrolytes which are toxic to humans and the environment (Devi, 2004).

E-wastes therefore, are generally electric and electronic equipment that no longer satisfy their original purpose due to exhaustion of their utility value overtime, suffers sudden damage, or have attained end-of-life circle (United Kingdom Environmental Agency, 2012). In Biu urban, *which this study deliberately phrased as Biu Community due to its indigenous homogeneity*; humans and e-wastes relationship, have taken center-stage, given their generation and pronounced carefree disposal within settled enclave over the resent years. This observation could be attributed the rapid developmental transformation stride of the community from its agrarian state, to more sophistication as witnessed in the establishment of Nigerian Army University, Schools of Health, the existing Collage of Education, and other institutions of learning, alongside the presence Army Cantonment. These traits gave it exponential developmental identity in population and infrastructure in multifaceted areas that attract inflows of people and numerous activities (Mohammed, 2024). Among others, bustling

activities in the community are therefore kept alive with the use of large number of electrical and electronic appliances that become necessary in social interactions, educational pursuits, trading, security networking, comfort at homes and offices. Interestingly however, obvious periodic malfunctioning, and eventual damage, or end-of-life attainment of these appliances are experienced; thereby giving rise to e-wastes generation as the aftermath of usage. This study therefore, was motivated to assess the impacts of these e-wastes disposal on the environment of this community.

Statement of the Problem

Increasing human population is observed to be an indicator for creating various detrimental environmental and health challenges across settled areas; due to continuous wastes generation and their poor management. With the rapid urbanization of Biu therefore, various kinds of wastes are generated daily as parts of the transformation; but haphazardly disposed within people's habitable environment. E-wastes are among these wastes menace aggravating the challenges that seems to have not been given proper attention; whilst they keep accumulating. This become pronounced, given the population's insatiable use of electrical and electronic equipment in satisfying its daily life style. However, this formed of electronic engagement in daily lives is observed to be directly proportional to the e-wastes volume continually generated. As a result, they have formed significant environmental menace in the community given their continuous tear-and-wear, and end-of-life syndrome associated with usage. In view of this, the research examined how this category of wastes managed in the community, that pave ways for ascertaining environmental challenges associated with the actions and the wastes.

Aim and objectives

The research assessed impacts of e-wastes menace on the environment of Biu community; with the view to ascertain their levels of detrimental environmental challenges, and proposed mitigating measures. The objectives identified sites where electronic appliances considered as wastes are continually disposed in with the community; and examined the challenges these disposed e-wastes are posing to such environment. It also examined laws or guidelines put in place for safeguarding the environment against e-wastes handling, and the levels of adherence in the community.

Scope

The research was conducted in Biu community focusing on attributes mainly consisting of electronic items which are considered to have reached their end-of-life and discarded within environment where people who disposed them, assumed appropriate. E-wastes appliances examined included: lanterns, mobile phone, refrigerator, televisions, sound system/radios, washing/cleaning machines, and electrical cooking appliances. Others are, decoder, pressing iron, bulbs, electrical and toys/games among and other electronic devices. Thus, the research covered households, electronic repairing workshops, public drainages, open-fields, wastes dump sites, offices, wastes collection sites, stores, and worship buildings.

Literature Review

Environmental nuisance of electronic wastes

Electronic wastes come from electrical or electronic appliances which have exhausted their usefulness and discarded in wastes stream or kept without definitive uses. Government and

private sectors therefore, were observed to account for 70% of this category of wastes; whereas households generate 15%, and manufacturing 15%. Computers and their components specifically, are the bulk, as they contribute about 70% of the e-waste; followed by mobile phones 12%, electrical equipment 8%, medical equipment 7%, and household appliances 3%. The rapid increase in technology and innovation are responsible for this build-up of wastes, leaving societies with the burden of how to dispose them (Chatterjee, 2017; Manish and Chakraborty, 2019; Patel, 2021).

Even with the estimated 40 million metric tons of the electronic wastes produced globally each year; however, only 13% are recycled especially in developing countries (McAllister, 2013). Exposure to these unattended e-wastes therefore, could be life threatening as their toxicity are capable of causing DNA damage, cancer, cardiovascular disease, and spontaneous abortion in women due to the composition of the wastes that mostly falls under hazardous category (Okunola, Yetunde and Bakare, 2021). Iron and steel for instance, constitutes about 50% of the wastes, plastics 21%, non-ferrous metals 13% and other constituents 16% (Okunola, *et al.*, 2021). The presence of elements like lead, mercury, arsenic, cadmium, selenium, hexavalent chromium, and flame retardants beyond threshold quantities also, made the e-wastes more hazardous, which when improperly handle and disposed on the environment, can create damaging nuisance (Hindu, 2009).

E-wastes control policies

To curtail the excesses of manhandling e-wastes and protect the environment from their damaging impacts, governments across the globe have taken some measures; though, adherence to those measures seems to be the problem (Mohammed, 2024). For instance, besides Bamako Convention (1998) which is a treaty of African nations prohibiting importation of hazardous wastes into member countries, Basel Convention, also known as Basel Action Network (1989) in Basel Convention Report, (1991) on control of trans-boundary movements of hazardous wastes for disposal came into limelight. These convention and treaty, among other things, creates awareness on long term effects of improper disposal of hazardous wastes by industrialized countries in close proximities to some developing countries; and enacted regulations in form of costs on defaulters to discourage such actions (Basel Convention, 2011).

Domestically, it was desperation to flee strict the laws in home countries, that led to seemingly free illegal trade in electronic wastes across international borders by developed countries, through enticement of the developing nations. Given that, Basel Convention swung into action in 1992 as pan-global international agreement to reduce such movement of hazardous wastes from the industrialized nations to developing nations. The aim was to ensure environmental responsibility of wastes by those country originating the e-wastes; so as to encourage reduction in volume and toxicity of wastes through the treaty (Basel Convention, 2011). In so doing, the Convention agreement focused on global producers of e-wastes and their recyclers alike. Essentially, countries signatories to the BAN Convention are obliged to ensure that e-wastes generation and other hazardous wastes are reduced to the barest minimum, and they should also develop effective and sufficient disposal facilities within their control environment. However, United States has over time seems not willing in adherence to the agreement by not ratifying the treaty (Puckett, Byster, Westervelt, Gutierrez, Davis, Hussain, 2002).

The Bamako Convention in its swing equally prohibited importation of any hazardous wastes African countries through negotiation at the Organization of African Unity in Mali, in 1991

and enforced the agreement in 1998 after realizing the affluent nations were still exporting their toxic wastes to Africa due to failure of the Basel Convention. Nigeria ratified this Convention in May 24, 2004 (Organization of African Unity, 1991). For effective adherence therefore, the federal government promulgated harmful wastes decree that provides legal framework for effective control on disposal of toxic and hazardous wastes in any part of the country through creation of Federal Environmental Protection Agency in 1988. To further strengthen the agency, National Policy on Environment was developed as working document for the preservation and protection of the country's environment (Muhammed, 2013). However, there are no direct laws prohibiting importation of electronic wastes in the guise of second-hand appliances into the country; neither are there laws to determine the quality and standards of these appliances on importations (Benedicta, 2012 in Mohammed, 2024).

Study Area

Biu in brief: Biu, is a major community in southern Borno senatorial district, Nigeria; and traditionally spelt and pronounced: *Viu*. This community, possessed high significant prominence as cultural renaissance city of the *Pabur-Bura people*, their provincial commercial hub, and capital of a local government area dated to 1918. First as a kingdom, it was founded by a personage of mythic proportion called *Yamta-ra-walla*. A legendary believed to have possessed super-human qualities and a dare-devil hero whose root was embedded in the history of royal family of Kanem-Borno Empire. But was forced to migrate due to Kingship tussle in 1535 (Bukar, 2015 pp.21, 54). Out of the Empire with his loyalists, *Yamta-ra-walla* moved south, to the land of *Bura people*, where he first settled at *Dlimbur*, neighbouring *Mirnga*, *Diwar* and *Buratai*. Through conquests of these villages and more of the *Bura land*, his people mixed with the indigenous people, and "*Mpabur*" became a new set of people who learned to speak similar language with the *Bura* (Bukar, 2015 pp.47, 57). With the establishment of the kingdom, the royal palace which stood as the administrative headquarters however, experienced several changes in locations. This was due to threat of wars, plagues, or the need for better site to produce more food. Whenever any of such necessities happened, hunters were sent out to scout for new site bearing in mind its safety, suitability for agriculture and easy access to water supply. The present location of Biu on a plateau was found to be exceptionally suitable till date (Bukar, 2015. Pp.69, 109).

Its location and population: Biu community, is located on rich agricultural diverse land on a plateau that has its highest point at *Wida-Hill*, measured about 821m (2693ft) asl; whilst its lowest points is as low as 271m (890ft) asl. Generally, the mean elevation of this unique plateau is 626m (2057.7ft) asl (Kparmwang, Esu and Chude,1994; Bukar, 2015); and located between Latitude 10⁰35'30" – 10⁰39'30"N and Longitude 12⁰8'0" - 12⁰14'0"E (Google Earth Pro4 in: Bala, 2024). As at year 2020, its population was put at 124,038 people (Aliyu, Kolo and Chutiyami, 2020), and as at in 2023, the approximate population stood as 142,644 people, based on 5% national annual growth rate (NAGR). This population however, is unevenly distributed among the 5 major and 23 sub-wards that formed the community. Thus: *Dugja* (*Bakin kasuwa, Batilti, Bayan tasha, Brikuthi, Tabra-fulani, Tabra tsahuyam, Zara-mirnga*); *Galdimara-kenken* (*As-rock, Galdimare, Galdimare-kirgal, Jugol, Kampala, Low-cost housing estate, Nasarawa*); *Sulumthla* (*Gardina, Tashan-danfulani, Zara-kwara*) *Yawi* (*Bulachivi, Filin-jirgi, Tse-tse*); and *Zara-wuyaku* (*Kogu, Mbulamel, Zara-wuyaku*)

(Mohammed, 2024) as shown in Figure 1. The rich history and prominence of this community was responsible for attracting its rapid transformation to what is witnessed today.

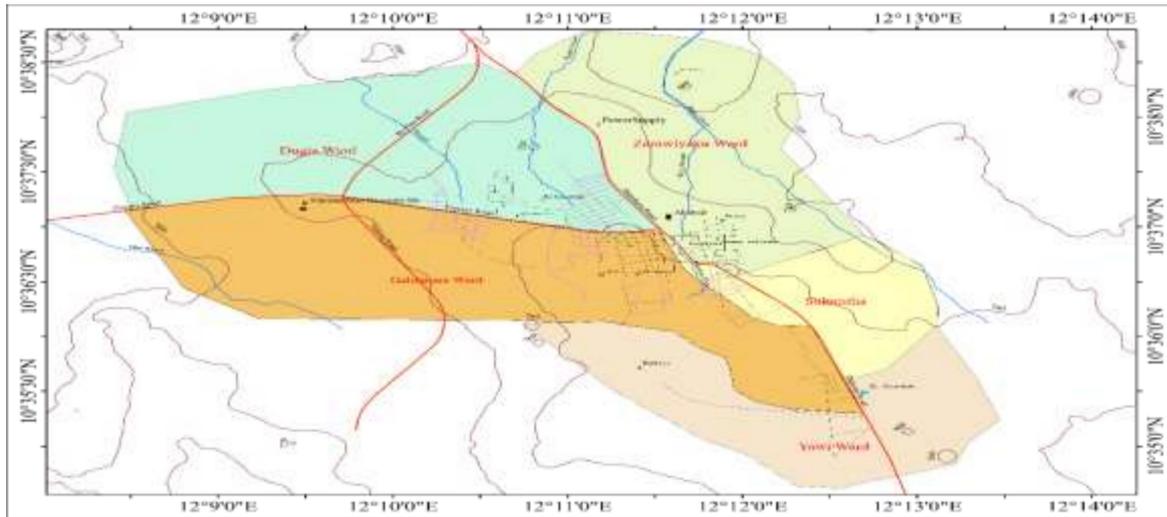


Figure 1: Biu urban and its major wards

Source: Google Earth Pro4 in: Bala, (2024)

Methodology

Primary and secondary data were used in this research; as questionnaires, field investigations, measurement, and interview aid in sourcing data. Information were also obtained from empirical literatures on electronic wastes challenges. The research population therefore, comprised of electronic appliance repairers, homes, institutions, offices and commercial outfits within the community presumed to be in active use of electronic appliance in day-to-day activities. For easy and compact assessment, home, institutions, offices and commercial outfits were summed up as households. Thus, classified the respondents as either: *repairers* or *households*. Yamane (1967) statistical formula for sample size determinant with specific level of precision and confidence was used to sample the respondents for the purpose of questionnaire and interview administration as given below:

Table 1 Biu community’s main wards, from
which sample respondents (size) were drawn

Main wards	Population projections	
	2020	2023
Dugja	31,317	36,015
Galdimare	19,021	21,874
Sulumthla	25,749	29,613
Yawi	19,923	22,911

Zarawutaku 28,028 32,231
 Total population 124,038 142,644

Note:

Population estimate for 2020 (Alhaji, Kolo and Chutiyami, 2020)

Population estimate for 2023 (Projection from Alhaji, *et al.*, 2020)

Population projection was based on 5% National Annual Growth Rate (NAGR)

$$n = \frac{N}{1 + N(e)^2}$$

Where:

n = sample size (?)

N = population size (142644)

e = level of precision (expressed as a proportion, such as 0.05 for a 5% margin of error)

l = Constant

$$n = \frac{142644}{1 + 142644(0.05)^2}$$

$$n = \frac{142644}{1 + 142644(0.0025)}$$

$$n = \frac{142644}{357.61}$$

n = 399

Questionnaires issued to respondents in households and electronic appliances repairing shops in the 5 wards were 399; using the Yamane (1967) samples determinants, given as:

$$\frac{n399}{N}$$

Where, N = Total population of Biu community (142644), and n = individual major ward population size from which samples were drawn (Tables 1 and 2):

Table 2 Sampled population of wards

Dugja	Galdimare	Sulumtha	Yawi	Zara-wuyaku
n399	n399	n399	n399	n399

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N	N	N	N	N		
36015(399)	21874(399)	29613(399)	22911(399)	32231(399)		
142644	142644	142644	142644	142644	142644	
14369985	8727726	11815587	9141489	12860169		
142644	142644	142644	142644	142644	142644	
= 101	= 61	= 83	= 64	= 90		

Samples determinates based on 2023 population estimate at 5% NAGR

Non-Probability sampling technique based on stratification of the entire 22 sub-wards at interval selection was used to pick 13 sub-wards, from which 3 electronic appliance repairing workshops were randomly selected, 1 respondent each was issued questionnaire in the sampled workshop. That gave a total of 39 sampled respondents from the entire electronic repairers' shop in the community (Table 3). These workshops were sampled given their activities in repairing either *white goods* (refrigerators, air conditioners, fans, washing machines and their like); or engage in repairing *brown goods* (mobile phones, televisions, computers, printers, radios and other similar electrical appliances). For the households, given their individual population of the wards, the Yamane (1967) formula determined the number of the sampled respondents for each major ward as given in Tables 1 and 2. The sampled frame obtained for each ward was sampled randomly from its sub-ward.

Table 3 Sampling procedure based on major and sub-wards in the community

Dugja		Galdimare-Kenken		Sulumtha				
<i>Sub-wards</i>	<i>Shops</i>	<i>Resp</i>	<i>Sub-wards</i>	<i>Shops</i>	<i>Resp</i>	<i>Sub-wards</i>	<i>Shops</i>	<i>Resp</i>
Bakin-kasuwa	*	3	As-rock	*	3	Gardina	*	3
Batiltil			Galdimare-kirgil			Tashan-danfulani		
Bayan-tasha	*	3	Jugol	*	3	Zara-kwara	*	3
Brikuthi			Kampala			- Respondent from Ers = 6		
Tabra-fulani	*	3	Low-cost	*	3	- Respondents from Hh = 83		
Tabra-tsahuyam			Nasarawa					
Zara-mirnga	*	3	- Respondents from Ers = 9					
- Respondents from Ers = 12			- Respondents from Hh = 61					

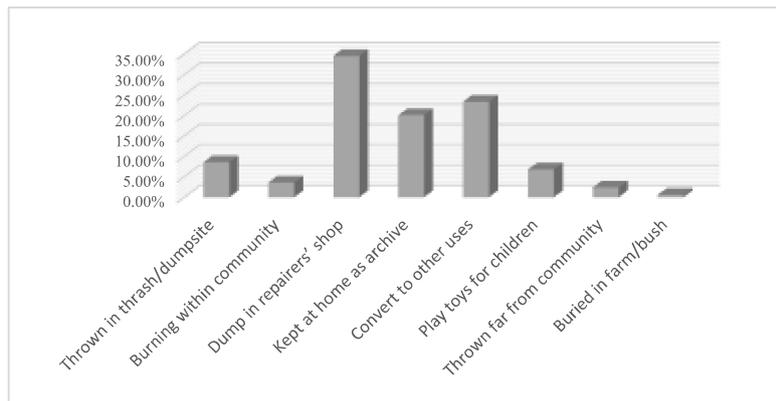


Figure 4: Treatments the community gives to electronic appliances when not serviceable

$n = 338$

$\% = 100$

Source: Field survey, (2024)

Various electrical and electronics appliances in their huge number, are subjected to use by the community to make life comfortable, communicate easily, entertain and solve some demands. However, as indicated in Figure 3, bulbs with 16.3% user capacity proved to be the most use appliances in the community. This may be due to its function in providing light as necessity in the community. So irrespective of social class, provision of light is seen as necessity. Mobile phones usage which could be view as both necessity and luxury items, are also found abundantly (15.7%) among the population. The likely high-level engagement of these electronic appliances may not be unconnected with the quest to follow the trend of technological transformation of society that facilitate communications and other networking easy, using portable mobile phones.

Fans are also significantly utilized in the community, given the 13% user response. This might've been necessary consequent of location of the community in the northern Nigeria where weather is harsh most parts of the year, and fans become vital appliance of necessity also to facilitates ventilations and cooling effects of rooms; rather than, view as appliances of luxury among the people irrespective of social class. Whilst the least use appliances in the community are washing and cleaning machines with 1.2%. These appliances and their spare parts as affirmed by the respondents are not commonly traded in the community, and couple with the high electricity tariff, most of the people do not acquaint themselves with them. Generally, the implications of using these appliances whether massively, selectively or few, have the high tendency of developing faults, get damage, wears-off or malfunction over time; with many becoming unserviceable. As a result, they are giving different treatment to either revive their functionality, or kept without making efforts to repair them or discard; which over time, they become e-wastes.

Giving the varied treatments of the malfunctioned electronic appliances, or when at their end-of-life, as revealed in the same Figure 4, dumping them with the repairers at the workshop was found to be the common resort among the population with 34.6%. In so doing, the appliance may be repaired; while in some case, repairing some of these appliances come with challenges that hampered success. As a result, they gradually turn to e-wastes in those workshops. In many

households, offices and even the workshops, the malfunctioned electronic appliances are commonly converted to other uses (23.4%) such as, cabinet, handy storage closet, seats and ladders. Whereas in some case, the broken-down appliances were kept at home to form part of the family archives (20.1%); being that, they have become non-serviceable, or too expensive to repair. Consequently, they are kept for long time, with some eventually outdated their fashion era, and becoming e-wastes at home. Burning of these electronic appliances with 0.65% is the rarest form of treatment practice in the community; likely because of the value attached to them even at the state of their un-repairability, or bearing the hope that, someday they could be repair; but eventually remain at that state as potential e-wastes. However, whichever treatment given to end-of-life electronic appliance, its aging comes along with deterioration of its component parts, which are made of harmful substances. Their gradual eroding incidentally into the environmental components like air, water and land therefore, may be slow, but with obvious detrimental challenges on human health and other organisms as posited by Okunola, *et al.* (2021).

Reasons why faulty or end-of-life electronic appliances are left with repairers unclaimed

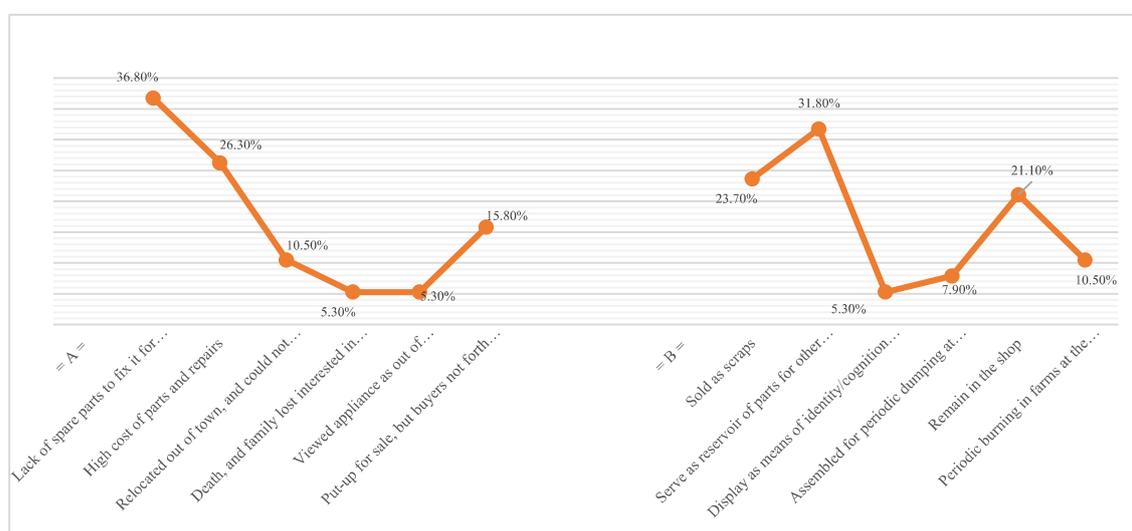


Figure 5

=A= Why customers leave their electronic appliance in the repairers' shops unclaimed

=B= Treatments the repairers give to electronic appliances viewed as wastes or kept for too long in their workshops

$n = 38$

$\% = 100$

Source: Field survey, (2024)

Reasons were advanced to why populace in the community leaves their malfunctioned electronic appliances specifically with the repairers in their workshop for long period of time unclaimed. As shown on Figure 5=*A*= therefore, lack of spare parts to fix the appliances when they were already taken to the workshops was the most common challenges with 36.8%. Though Biu is a fast-developing community, however, it is still not sufficient in terms of technological market that deals in engineering materials spare parts, and outstanding electronic engineering. This makes it challenging in some cases to achieve desire results when it comes

to effective repairs. As a result, some appliances suffer from lack of replaceable parts, or try-and-error replacement, that end up in ultimate damage. Some of these spare parts, even when available, due to logistics and other economic cost of bringing them to Biu, made them very costly beyond the ability of many owners of faulty appliances to pay as indicated by 26.3% responses. This most times left them with no choice, but to delay the repairing period which in most cases never come. Leaving the appliances by the owners at the repairers' workshops due to their out-of-fashion brands, or outdated models also, may not be deliberate. But highly likely necessitated by the length of periods those appliances stayed in the workshops unclaimed; and the aggressive new innovations of their likes make them vintage. These expositions which formed the list in such category (5.3%) shows the owners might've lost interest in repairing and claiming them back; thereby, makes repairers workshops their easy dump sites.

Additionally, as the electronic appliances were left by their owners at the workshops for length of time unclaimed, and without sign of coming for them at the periods deem reasonable (maybe 6 months – 1 year, 1 year – 2 years or > 2 years) by the technicians, the fate of each of the appliances is decided based on prevailing exigencies that presented themselves at the workshops. As shown on the Figure 5=*B*= also, most of those electronic appliances (31.6%) normally, after the expiration of their waiting periods end-up serving as reservoir of parts for other appliances that have the guarantee of collection when repaired. Some are sold as scraps is indicated by 23.7% treatment values. Whereas significant number (21.1%) of these appliances remain in the workshop unclaimed; not thrown away, and not tempered-with. It is therefore of note that, however the treatments of the unclaimed or poor functional condition of the appliance in the workshop, the obvious challenges are mount of potential e-wastes with complex and difficult management strategy being encouraged, and the environment at the damaging receiving end as confirmed by United Kingdom Environmental Agency (2012).

Impacts of the e-wastes on environment and knowledge on harmful substances contained therein

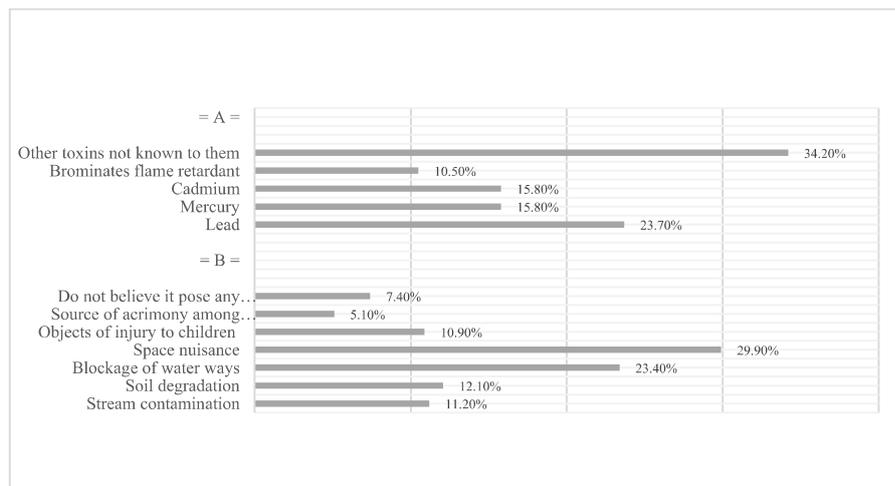


Figure 6

=*A*= Repairers knowledge on toxicity of e-wastes on the environment (n = 38)

=*B*= Community's concern on e-wastes impacts on their environment (n = 338)

% = 100

Source: Field survey, (2024)

The community attested to the fact that, electronic wastes pose significant measures of inconvenience to both humans and the recipient environment. This is as revealed in Figure 6=B=, by 29.9% responses that saw their presence on the immediate environment as great nuisance, eyesore and deprived such areas aesthetic values. Blockage of waterways was observed by 23.4% respondents as the problem associated with the disposed e-wastes. This occurrence, as encouraged, unfortunately, are among the major reasons why the community's drainage network spills wastes water. Given that, the blockages limit easy flow of drained water, as a result, creating lots of inconveniences in the neighborhoods. Although, the accumulations of unserviceable electronic appliances and those unclaimed are the least in terms of observation (5.1%), yet, they are source of concern. As most of these repairers shares spaces in blocks of shops they occupied with other traders, trading in other commodities, and in most cases, with households and offices. In view of the nature of their wares which require and occupy spaces therefore, these appliances by commission or omission tend to occupy spaces not formally designated for the single repairs shop, so in many cases, creates problems. Among these problems, are the tendencies of acrimony among the neighbors.

Similarly, stream contamination and soil degradation combined constitute 23.3% observations of impacts of the disposed e-wastes on the environment. These environmental issues are critical indicators on how poorly managed e-wastes, impact on the environment. This is because, *Dugja, Daura, Wambaya* and *Whu streams* which these wastes are washed into, substantially serve complementary water need of some community for bathing, and washing, among other uses especially in raining season. Soil affected in some areas also, are farms, or playground. Their likely contamination with particles of the e-wastes, could means, a likelihood that, they may incidentally be absorb into human body; even as only 7.4% of the respondents believed e-wastes are environmental problems. E-wastes general, contained toxic substances like lead, mercury, *hexavalent* chromium, cathode ray tubes (CRTs), capacitors, relays, batteries, liquid crystal displays (LCDs), cartridges, selenium drums and electrolytes, among others; which are harmful to environment and organisms when improperly managed (Devi, 2004 in Mohammed, 2024).

Working in workshops that repairs these electronic appliances, or living at close proximity with those shops could facilitate direct contact with their deteriorating challenges. As disposal of the damaged appliance in people's habitation neighborhoods, could also means, exposure to their harmful potential. Acknowledging the presence of toxic ingredients as components in the appliances revealed Figure 6=A= therefore, shows 34.2% of the repairers understood that, the appliances contained toxic materials, though they could not identify those materials. However, Lead was acknowledged as one of the most toxic substance affirmed by 23.7% of the repairers/technicians. Whilst knowledge on the presence of Mercury and Cadmium has 15.8% each; and Brominates flame retardant with 10.5%. With this overwhelming understanding of the presence of various harmful substances in the electronic appliances whether identified or not, one wonder why the repairers are still active participant in poor management of the e-wastes within community's settled areas. Given that, these substances possess the tendencies of leaching to contaminate soil and ground water; and if burned, they emit toxic fumes into the air that can harm health. Inhaling their particles also through breathing or wind action, could cause health effects, though may be slow, but possess the potential of eventual damaging capacity (Udhayakumar, 2021).

Awareness of laws or guidelines on electronic wastes management

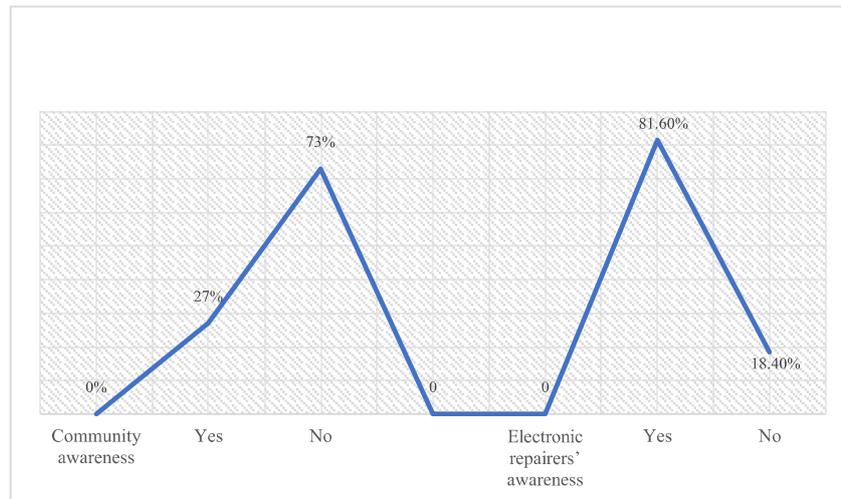


Figure 7

Community awareness ($n = 338$)

Electronic repairers' awareness ($n = 38$)

% = 100

Source: Field survey, (2024)

Plausibly, electronic appliances have overtime becomes man best companion for entertainment, communication, education, trade, security and luxury. However, the problems with them is when they've reached their end-of-life and need to part ways with their owners. That is, the issue lays with how to discard them in such a way that, their toxic components may pose minimum or no impacts on the environment. Bedeviled with these problem, laws and guidelines were enacted to guide how the resultant e-wastes should to be dispose on the environment. However, over time, it seems the bottleneck remain whether communities are properly informed, guided, monitored on those laws and guidelines; and punishment reserved for outright defaulters. As shown on Figure 7 therefore, 73% of the community, aside the electronic repairers were not aware of any guidelines or law to that effects. Only 27% are aware. With this high percentage of ignorance, one could imagine their actions on handling their e-wastes. Even 27% respondents that claimed to be aware of the law/guidelines, adherence was observed to be non-issue to them. This is because, such knowledge seems to have not been built in their conscience; as well as there is no feasible actors responsible for such enforcement in the community.

Critical are the electronic repairers; whom though, lots of them seems to possessed some levels of understanding of the needful as regard handling of e-wastes, yet, failed to use such knowledge; instead shared almost the same faulty principles with the rest of the community. As shown in the Figure 7 for instance, electronic repairers constituting 81.6% confirmed to having appreciable knowledge of the existence of law as regard protecting the environment against poor handling of e-wastes. Only 18.4% claimed to be ignorance of such laws or guidelines. But to what importance is the awareness, if the adherence level is grossly poor. This is as, these technicians go about doing their business without following the set guidelines; going by their public dismantling of electronic appliances and displaying them carefree under

all-weather conditions without protection, or throwing them in spaces they deem fit; without consciousness of the impacts, they may cause on that environment. When on display outside the shops, flash flood or strong wind usually drag some of these e-wastes potential appliances or their component and littered them in the neighborhoods. As result, the neighborhoods immediately become vulnerable to toxic substance they contained. Some of them are also transported to nearby shallow surface water bodies, low-level-edge-wells, or formed constituent parts of pollutants in stagnant water in streets. This become nuisance which easily come into contact with people especially children who play around. In general term, seeking knowledge on how to handle e-wastes and adhere to those rules even without being coerce are important in safeguarding the environment against their menace. This is, as their harm can cause silent, but various life-threatening consequences, such as DNA damage, cancer, and cardiovascular disease among other ills as revealed by Okunola, *et al.* (2021).

Impacts review and mitigating measures of the e-wastes on environment

E-waste is found to be associated with soil contamination when improperly disposed particularly in open spaces; as they contained harmful substances like lead, mercury, cadmium, and arsenic that easily leached. When improperly discarded, the toxins disrupt soil essential microorganisms and reduce agricultural productivity. In environment where e-wastes are frequently dumped or recycled in unsafe conditions, the soil is observed to be saturated with heavy metals, leading to long-term environmental challenges (Robinson, 2009). E-wastes also have the ability to easily leach into ground or surface water and contaminate them. These pollutants, particularly heavy metals are highly toxic and persist in the environment for long periods, causing extensive damage to organisms in the ecosystems. Mercury, for instance, bioaccumulates in food chain in fish, posing serious health risks to both aquatic life and humans who consume them (Brigden, Labunska, Santillo, and Johnston, 2005).

E-wastes also, when incinerated or openly burnt, either for destruction or for recovery of valuable metals like copper and gold, emits toxic chemicals. Burning of their plastic covers equally emits dioxins and furans among others, which contribute to air pollution capable of causing respiratory issues, cancer, and other health problems in humans. Environmental challenges like acid rain and climate change therefore, are observed to be associated with release of carbon dioxide and other greenhouse gases caused by e-waste poor handling (Sepúlveda, , Schluep, Renaud, Streicher, Kuehr, Hagelüken and Gerecke, 2010). Moreover, the category electronic appliances which contained valuable metals were found to lost them when they are discarded instead of being recycled. That means, the action will impose more strain on the need to continue extracting new ones to make-up for the lost due to the non-recycling efforts. So if such is allow to persist due to poor management, that could intensify significant environmental impacts through habitat destruction, soil erosion, and water contamination (Widmer, Oswald-Krapf, Sinha-Khetriwal, Schnellmann and Böni, 2005).

Effective strategies therefore, are essentially required to be adopted particularly in Bui community for mitigating the environmental challenges of e-wastes improperly disposed continually. The producer responsibility initiatives, put in place by the European Union's Waste Electrical and Electronic Equipment (WEEE) and Extended Producer Responsibility (EPR) could go a long way handling the problems. Given that, the initiative implies that, manufacturers of electronic appliance be mandated by local government authority to include as part their sales rules, the *take-back* electronic appliances at their end-of-life from the

community. This should be at minimum cost for replacement with new one at cost price. The returned mal-functioned appliances are to be return to the manufacturers. This in turn, will encourage companies to design electronics that are easier to repair, highly qualitative, as well as promotes sustainable production practices (European Union Report 2012).

Effective policy frameworks capable of ensuring e-wastes are managed responsibly as enshrined in laws like that of the Basel Convention can help in arresting the shipping of end-of-life electronic appliances in the guise of second-hand to Nigeria where they've become hazardous junks within space of short time (Secretariat of the Basel Convention, 2021). In term of import of electronic appliances, Nigeria through enforceable legislation at the state and local government levels therefore, must insist on those design manufactured with longer lifespans using eco-friendly materials, that will be easier to repair, and with resultant insignificant e-wastes at their end-of-life (Dell Technologies, 2021 in: Robinson, 2009).

Conclusion

Electronic wastes are evidently threatening the environment, given their impact on air and water quality, degrade soil and reduce environmental aesthetic values, due to their bulky, harmfulness and non-biodegradable nature. These potent unfavorable conditions to both living and non-living components of the environments. As their potential substances like zinc, lead, mercury, copper, cadmium and many other toxicants takes longtime without decomposing. Biu community therefore, is without doubt severely affected by this menace; even as many of its populace are ignorant of the silent, but obvious impacts e-wastes are posing on their wellbeing and environment. Failure in appreciating these challenges by both the community and the local government authority, could be view as the *laissez-faire* attitude contributing to non-designating safe area(s) where the community e-wastes should be disposed with minimal environmental impacts. Other factor could be attributed to lack of presence of private or nongovernmental organization that own recycling plants where most of the community e-wastes can be recycle. This in turn, left the people to dispose e-wastes alongside other wastes using their discretions, and with carefree attitude, without scolding from authorities. The availability of guidelines on e-wastes handling as provided by the Federal government however, was mere theoretical, and without effect, as there was no mechanism for enforcement, talk-less of punitive measures against defaulters. Against this, the community will likely continue to suffer this form of environmental problem occasioned by action of poor management of e-wastes on its environment.

About the research

This research epistemology (what is known to be true) exposed e-wastes generation to be on the increase in almost every human society, and Biu sprawling community inclusive. The increase in its e-wastes was attributed to multifaceted usage of electronic appliances on daily social, religion, economic, educational and recreational activities that surged with the establishment of its institutions. Its doxology (what is believed to be true) therefore, was based on the findings which established that, given the quality and quantity electronic appliances in use in the community, their end-of-life syndrome become faster in almost the same proportion with their replacement's tendencies. In effect, the consequences are leading to generation of huge e-wastes menace difficult to control within the community despite their perceived environmental and health challenges.

Contributions to existing knowledge

The research uncovered that, not-well-developed communities in urban-clique of Nigeria, also generate and disposed significantly high amount of e-wastes within human habitation areas which are poorly managed. Some of these wastes however, are ignorantly viewed as archives for beautification that portrayed class-superiority which possessed no harm potentials. It equally unfolded critical environmental issues posed by e-wastes in such communities, which are unfortunately down-played. In effect, agents such as run-off, winds, storm-water and human action easily transport their toxic elements in huge volume into unprotected all-important-streams that serves as daily complementary sources of water for domestic, agricultural and other activities. Some of the environment housing e-wastes also, are farms, playground or assembly areas which have direct contact with human at their vulnerable state. Furthermore, reality on government negligence by non-inclusion of smaller urban, and rural communities in effective education capable of informing and guiding the locals on laws and guidelines on safe environmental and wastes management was equally established. This made it certain why most locals, act on instincts on what is right individually as regard managing e-wastes; which proved grossly poor and potentially deleterious to the environment.

Authors' contributions in the research

This research was conducted in collaboration of its four authors. Thus: *Mshelia* designed the research performed statistical analysis, and write the manuscripts; *Badawi* developed the first draft of the research manuscript; whilst *Mohammed* performed data and information collection. whilst *Dibal* reviewed literature that guided the research. All these authors have read and endorsed the final manuscript; as well as declared no conflicting interest.

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