Sokoto Journal of Geographical Studies (SJGS)

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Prof. I. M. Dankani

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ASSESSMENT OF ELECTRONIC WASTE GENERATION AND MANAGEMENT PRACTICE IN GUSAU, ZAMFARA STATE

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Abstract *https://doi.org/10.65760/sjgs.v3.i1.11*

Electronic waste generation and management have become significant environmental concerns, particularly in developing countries, due to increasing technological adoption and high consumption of electronic devices. This study assessed e-waste generation and management practices in Gusau metropolis. The study identified the common types of electronic waste found in Gusau City and the prevailing disposal options by individuals for electronic waste in Gusau City. The study categorized e-waste into five types: small, large, entertainment, ICT, and lighting equipment. The study employed systematic sampling to select 400 households and purposive sampling to select 16 technicians. Data were analyzed using descriptive statistics (frequency, mean, percentage). Findings revealed that lighting equipment accounted for 54% due to its short lifespan. The disposal methods were largely informal, with 44% of households stockpiling old electronics and 47% of technicians relying on general waste disposal. The study recommends policy interventions through the enforcement of structured e-waste management regulations, including segregation, safe collection, and formal recycling systems in Gusau metropolis. In addition, public awareness campaigns should be implemented to educate households and technicians on the environmental and health risks of improper e-waste disposal. Promote sustainable management practices and formal recycling facilities in order to mitigate environmental hazards in the study area.

Keywords: *Electronic, Waste, Generation, Management and Practice.*

Introduction

Electronic waste is a general term used for all types of disposed or abandoned electrical and electronic equipment, including toys, leisure, sports, and recreation gear that is powered by electricity, office computers, entertainment and consumer electronics, lighting equipment, and appliances for home and office use (Ajekwene *et al.,* 2022). According to Kitila *et al*. (2018), e-waste is any electronic material that has been disposed of, including working and broken equipment tossed in the garbage. These are sometimes hazardous since the toxic chemicals that innately percolate from the buried metals are very harmful to living organisms and their environment (Fiore et al., 2019). Electronic waste is one of the fastest-growing solid waste streams around the world today. According to the European Union (EU), e-waste is growing at a rate of 3% to 5% per annum or approximately three times faster than other individual waste streams in the solid waste sector (Kumar *et al.,* 2019). Electronic waste is a growing concern around the world due to technological advancements. The industry has moved toward greater automation, which has increased the use of electronic equipment. According to the United Nations Environmental Programme (UNEP, 2020), the Basel Convention was developed to control the transboundary movement of hazardous electronic waste. It was developed to stop

deliberate dumping of hazardous waste from wealthy to developing nations for economic gain, and these factors have led to the increment of e-waste generation in Africa.

Ledwada & Sosibo (2017) found out that the leading countries in electronic waste generation in Africa are Egypt with 0.37 million tones, followed by South Africa at 0.35 million tones and the third highest is Nigeria with 0.22 million tones. According to Andeobu, Wibowo & Grandhi (2021), there is a significant increase to 0.42 million tones. This concern of e-waste is proportionally growing with the amount of e-waste generated, since it contains toxic compounds that could influence health and environmental aspects.

The unlawful export of electronic waste by affluent nations worsens the issue of electronic waste in developing nations. Informal e-waste recyclers are highly common in developing nations due to a lack of recycling facilities, weak legislation, and a lack of awareness, giving way to an increased demand for new electronic devices or equipment in developing countries like Nigeria; this has led to the increment of e-waste generation in our environment (Miyamoto and Kobayashi, 2020). The ineffectiveness of electronic waste management and the user's knowledge about the rising dangers of e-waste in our environment remain unsolved. This study can lead to a better understanding of dealing with the behaviour perception about e-waste disposal and deliberate importation of used electronic devices by developed nations to our dear nation as their means of disposing of their electronic waste materials. Therefore, this paper aim to assess electronic waste generation and management practice in Gusau City and further reiterate the concern of e-waste increase raised by the EU, UN, WHO and UNEP.

Electronic materials have become very important to people's lives, so that we cannot do without it, these electronic gadgets serve as a means of income for businesses and a means of communication that we use in our daily life; they are mostly found in our homes and offices. However, it can also become a health nightmare when it reaches the end of its use; it contains heavy metals such as lead and mercury, which would have significant adverse effects on human health and the environment if disposed of indiscriminately. Lack of formal recycling centres in developing countries gives room for informal recyclers to mitigate the volume of e-waste generated, but their mode of operation and storage practice has created more harm in our local environment, based on the extraction of metals, e.g. copper, through burning causes unpleasant smell, which expose the residence to bad air moisture (Li and Achal, 2020).

Furthermore, the open storage practice of local recyclers emits heavy metals into the soil through running water; some of these metals sink into the soil and destroy the ecosystem in the environment. Refuse dumping and open burning of e-waste materials by individuals, technicians and local recyclers in our immediate environment shows a weakness in government policy. Illegal disposal practices of e-waste by the residents show there is a lack of awareness program by the Government toward it citizen, and coupled with a lack of formal recycling centres, has led to indiscriminate dumping of e-waste material on landfills, causing fatal disease to local recyclers and the ecological balance of the environment (Maphoza, 2021). Therefore, this study is designed to assess the electronic waste generation and management practices in Gusau City and suggest the best approach that will safeguard people's health and reduce environmental risk.

Theoretical Framework and Literature Review

Consumer Theory and Its Application to E-Waste Generation

Consumer theory, a key concept in microeconomics, explains how individuals make purchasing and consumption decisions based on income, preferences, and the goal of maximizing satisfaction or utility. Its application to electronic waste (e-waste) generation helps explain how consumer behaviour drives both demand for electronic products and the patterns of their disposal (Islam *et al*., 2021). In the context of electronics, choices are shaped by technological

advancement, social influence, and income levels. Many consumers replace functional devices with newer models due to diminishing satisfaction from older products, a behaviour intensified by globalization and exposure to modern consumption trends (Rasheed *et al*., 2022). In developing countries like Nigeria, limited income leads many to buy second-hand electronics, which, though cost-effective, quickly become waste due to short lifespans. Poor awareness and inadequate disposal facilities further worsen the e-waste problem. From a policy standpoint, consumer theory highlights the need to address behavioural factors through education, incentives for recycling, and regulatory frameworks like extended producer responsibility to promote sustainable consumption and safe disposal practices (Islam *et al*., 2021).

Literature Review

E-Waste Generation Across the Globe

The quantities of e-waste generated across the globe were approximately 53.6 million tons in 2019 (Kumar, Holuszko & Espinosa, 2017; Rene *et al.,* 2021). E-waste is projected to increase by 33% in the next decade due to the increase in the use of modern electronic and electrical equipment (Rene *et al*., 2021). The rapid advancement in information technology, frequent release of new devices, reduced cost of appliances, and the shorter lifecycle of electronic products have contributed to the increase in consumption and creation of e-waste. In a study by Kumar *et al*. (2017) conducted in four continents to quantify e-waste as reflected in Figure 2.1, Asia was the highest generator (18.2 million tons), followed by Europe (12.3 million tons), America (11.3 million tons) and the lowest generator was Africa (2.2 million tons).

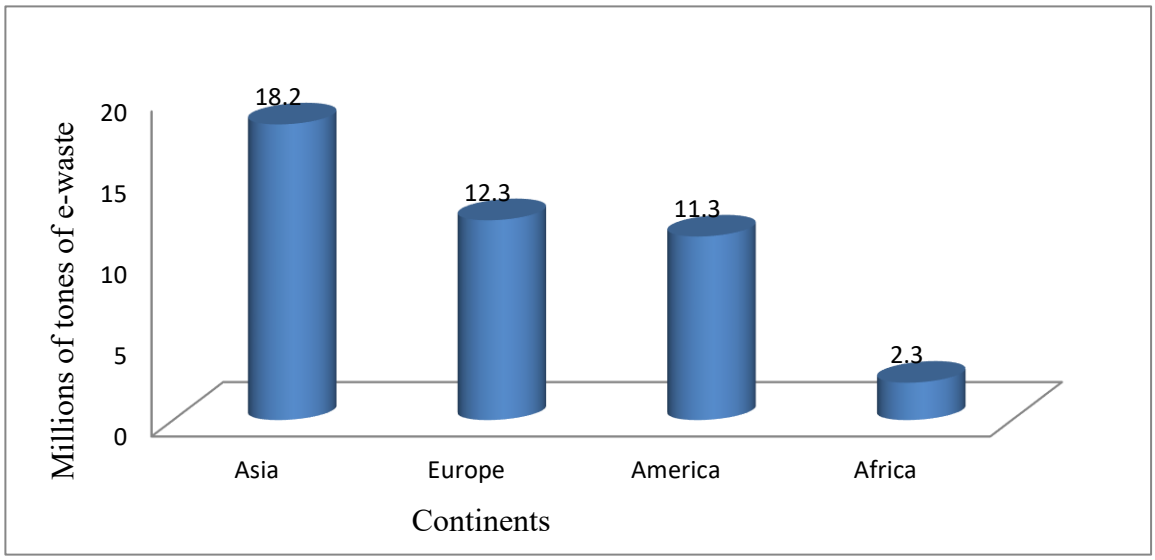

Figure 1: E-waste Generation Across the World
Source: Kumar, Haron & Radam (2018)

Technological Advancements and Obsolescence

Technological advancement is one of the major drivers of e-waste generation in Nigeria. As new technologies arise, older devices become obsolete, encouraging consumers to abandon functional products in favour of newer models. The rapid growth of technological innovation in electronic devices, such as smartphones, televisions, and computers, has resulted in shorter product lifespans. In many scenarios, electronic products that are still functional are replaced simply because of the availability of newer or more advanced models (Issah *et al*., 2022).

The lifespan of electronic products has shortened considerably in recent years due to design choices, market dynamics, and technological innovations. The majority of recent electronic devices are intentionally designed with limited durability to encourage more frequent replacements and drive continuous consumer demand for newer models (Andeobu *et al.* 2021).

Economic Factors and Importation of Used Electronics

Economics play a crucial role in e-waste generation in Nigeria. The country's growing middle class has led to an increase in the demand for electronic products. As the purchasing power of Nigerians improves, more people can afford consumer electronics such as smartphones, televisions, and computers. However, the increase in consumption is not accompanied by proper waste management and recycling practices, leading to an increase in e-waste (Shad *et al* 2020).

Another significant cause of e-waste generation in Nigeria is the inadequate recycling and disposal infrastructure. Nigeria lacks sufficient facilities for the proper collection, sorting, and recycling of e-waste, which results in the improper handling of electronic waste. E-waste is often sent to landfills or simply dumped in open spaces, contributing to environmental pollution.

E-Waste Types

According to Schmidt (2016) majority of e-waste comes from excess materials during the production of electronic equipment and broken equipment. The European Union (2017) classifies e-waste into categories. Examples of e-waste from each category are presented below**:**

Large Household Appliances

Large household appliances are essential electrical devices used in homes. These appliances include: air conditioners, which regulate indoor temperatures, microwaves, which quickly heat food, washing machines, which automate the process of washing clothes, and refrigerators, which are crucial for preserving perishable food items for long-term storage (Govender, 2019).

Small Household Appliances

These appliances are essential for performing everyday tasks at home, enhancing convenience, efficiency, and quality of life. They also serve various functions, from food preparation to personal care and cleaning. Kitchen appliances like kettles, toasters, coffee machines, and fryers simplify meal preparation, while grinders and blenders assist in processing ingredients (Zhong *et al.* 2022).

Information Technology and Telecommunication Equipment

These are electronic devices that facilitate communication, data processing, and information exchange. Examples of such equipment include computers, laptops, and servers, which are very important for processing data and supporting digital operations. Mobile phones and smartphones serve as primary communication tools, offering voice, text, and internet services. Networking devices such as routers, modems, and switches enable internet connectivity and data transfer (Oke & Potgieter, 2024).

Lighting Equipment

Lighting equipment are devices that provide illumination in homes, businesses, and outdoor spaces, e.g., incandescent, fluorescent, and LED light bulbs, each with varying energy efficiencies and lifespans. Fluorescent tubes are usually used in office spaces and commercial

environments, while LED lights are becoming increasingly popular due to their energy efficiency and longer lifespan. Street lights and outdoor lighting systems, such as floodlights and garden lamps, are used to illuminate public areas and outdoor spaces (Baldé *et al.* 2019).

Entertaining Equipment

These are devices designed for ease and media consumption, e.g., Audio equipment (speakers and home theatre systems), which improve the audio-visual experience. Television sets, gaming consoles, and DVD players provide entertainment through media consumption, while digital streaming devices such as smart TVs and set-top boxes permit access to a variety of content. Portable music players, projectors, and gaming accessories like controllers and Virtual Reality (VR) headsets are also popular (Baldé *et al*., 2021).

TABLE 1: SOURCE OF E-WASTE, AVERAGE MASS AND LIFESPAN

S/N	Electronic Equipment	Mass (Kg)	Estimated Lifespan
1.	Air Conditioner	35	12
2.	Cell phone	0.1	4.7
3.	Desktop Computer	15	6
4.	Dish Washer	30	10
5.	DVD player	5	6
6.	Fax Machine	3	5
7.	Flat panel Television (TV)	12	7.4
8.	Food Mixer	1	5
9.	Freezer	35	10
10.	Hair dryer	0.5	6
11.	Iron	1	3
12.	Kettle	0.6	3
13.	Laptop	2.3	5.5
14.	Microwave	15	7
15.	Photocopier	60	10
16.	Radio	2	10
17.	Smartphone	0.3	2
18.	Smartphone	0.3	4.6
19.	Tablet	0.7	5.1
20.	Telephone	0.3	5
21.	Television Cathode-ray tube	30	5
22.	Toaster	1	5
23.	Tumble Dryer	35	10
24.	Vacuum Cleaner	10	10
25.	Washing Machine	65	8

Source: Gaidajis *et al.* (2010); Godihal (2024)

E-waste Management in Nigeria

Nigeria waste management is governed by the National Environmental (Electrical/Electronic Sector) Regulations Act, 2011and Federal Environmental Protection Agency (FEPA) Act of 1988: also known as the Waste Act. The Waste Act prescribes requirements for management of waste from classification, storage, import, export, treatment that applies to both generators of waste as well as managers of waste (e.g. landfill sites).

The Waste act is also supplemented by additional standards such as the Waste Management Activities and Licensing Regulations which prescribes activities requiring waste management licenses; the Norms and Standards for Waste Management prescribes acceptable practices for storing waste; the Waste Classification and Management Regulations prescribe procedures for analyzing and classifying waste; and Norms and Standards for Assessment and Disposal of Waste to Landfill guides suitable disposal facilities for waste (FEPA 1998),(FEPA 2007).

Nigeria signifies one of the largest booming economies in Africa in recent years, which witness high volume of e-waste generated among its citizens, due to greater connectivity. According to the *Global E-Waste Monitor 2020* report, Nigeria is one of the largest producers of e-waste in Africa, contributing significantly to the continent's e-waste burden (Andeobu *et al*., 2021) In precise, the importation of second-hand electronics, which includes; mobile phones, computers, and televisions, is a key factor that worsens the e-waste problem in Nigeria (Baldé *et al.,* 2019).

Policies on Hazardous E-waste at the International Level

From a scientific point of view, e-waste is no doubt a hazard to both the environment and humans; socially speaking, it is plainly inhumane to introduce materials embedded in e-waste into communities just for the sake of making quick money and avoiding responsibilities. From a legal standpoint, however, the issue has become murky and is dependent on how seriously a government intends to deal with the hazards and their effects. Domestically, e-waste regulations exist in countries. Internationally, besides the Bamako Convention, which is a treaty of African nations prohibiting the importation of any hazardous waste (including radioactive waste), the Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal, also known as BAN (Basel Action Network), seems to be the only internationally recognized body in charge of hazardous waste management.

National Policies on E-Waste: Nigeria

In relation to the illegal dumping of toxic wastes occasioned in 1987 in Koko, former Bendel State, the Nigerian Government publicized the Harmful Wastes Decree. This decree provides the legal framework for effective control of the disposal of toxic and hazardous waste into any environment within the boundaries of Nigeria. This gave birth to the creation of a regulatory body, the Federal Environmental Protection Agency (FEPA) in 1988. FEPA is responsible for protecting and developing the Nigerian environment. To facilitate this process, a National Policy on the Environment was developed, thus making it a standard working document for the preservation and protection of the Nigerian environment. Administratively, States and Local Government Councils established their own environmental regulatory bodies for the purpose of maintaining good environmental quality as it applies to their particular terrain (NESREA, 2011).

The EIA Decree No. 86 of 1992 is an additional document with the aim of protecting the Nigerian environment. It is, however, particularly directed at regulating the industrialization process as regards the environment. By this Decree, no industrial plan/development/activity falling under the FEPA's mandatory list can be executed without prior consideration of the environmental consequences of such a proposed action, in the form of an environmental impact assessment (Federal Republic of Nigeria, 1992).

Study Area

Gusau town is the headquarters of Gusau Local Government Area (LGA) and the capital city of Zamfara State, Nigeria. The town is located along Zaria – Sokoto road and it is placed between latitude $12^0 – 13^1$ to $12^{11} – 18^0$ N and longitude $6^0 – 29^1$ to $6^{11} – 45^0$ E (Chubado, *et al*. 2022), Gusau is bordered in the east by Kotorkoshi, in the north by Birnin Magaji, in the west by Dansadau, this favorable location has contributed to the growth of commercial activities of the town. Gusau town covers an area of approximately 3469 square kilometers (Umar, 2015). According to 2006 census, Gusau Local Government had estimated population of 383,712 and at 2019 projected population of 421,4882. with Gusau town having 214,685 populations (Umar, 2015) and 4,439 Households (Matrix 2018). The inhabitants are made up of Hausa and Fulani among others; and predominantly inhabited by Muslim. (Okorhi 2017).

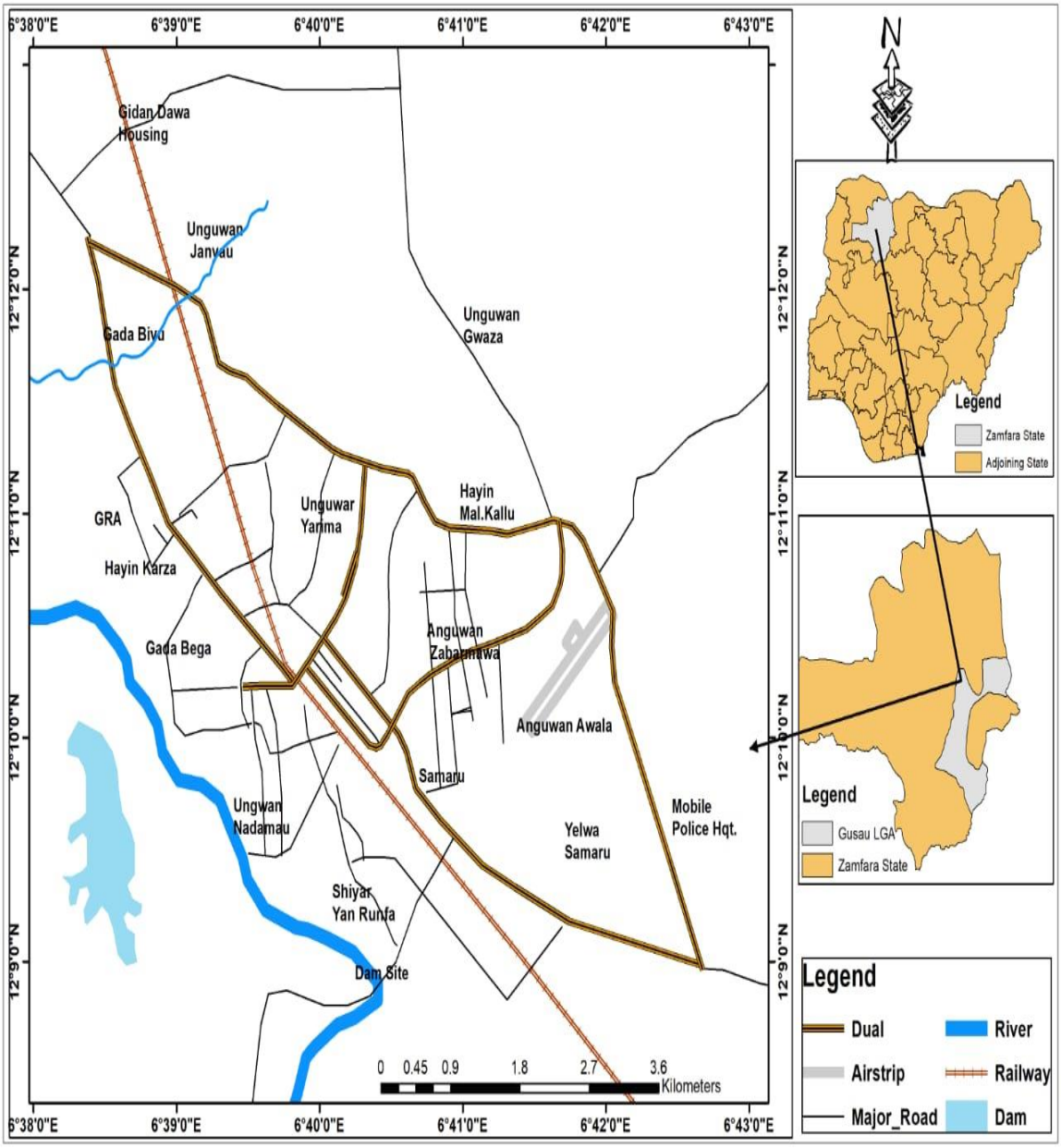

Figure 2: The Study Area

Materials and Methods

This study employed a descriptive survey design aimed at systematically collecting and analyzing data to describe the nature of electronic waste (e-waste) generation and management practices in Gusau city. According to Gall and Borg (2007), survey design allows researchers to gather data from a representative sample through questionnaires, enabling generalization to the wider population.

Both primary and secondary data sources were utilized. Primary data were collected using structured questionnaires administered to households, technicians, and informal recyclers to assess types and management practices of e-waste. Secondary data were obtained from relevant literature, including journals, reports, textbooks, conference papers, and online publications.

The study adopted a systematic random sampling technique, using a sampling frame of 4,439 households in Gusau metropolis (Matrix, 2018). The metropolis was divided into 16 residential areas, which constituted the primary sampling units. These residential areas were subsequently grouped into four wards (Tudun Wada, Sabon-Gari, Galadima, and Madawaki). Moreover, 16 technician were selected purposively; TaroYamane's (1967) formula was used to determine the sample size of 400 households; the sample was proportionately allocated to the selected wards, with Tudun Wada accounting for 43% (172 households), Sabon-Gari 26% (104 households), Madawaki 21% (84 households), and Galadima 10% (40 households). Within each residential area, systematic sampling was applied by selecting every 8th household after a random starting point to ensure representativeness and minimize sampling bias.

Results and Discussions

Types of Electronic Waste Generated in Gusau City

Electronic waste is fast becoming a very important waste stream, both in terms of quantity and toxicity, in Nigerian cities. The importation of outdated and end-of-life electrical and electronic equipment is the major source in Nigeria Street. The main source of e-waste in Gusau City is from the following: ICT (broken laptop computers, desktop, printer, tablet, telephone and smartphones), lighting appliance (florescent lamp, bulb and touch light), Entertaining equipment (obsolete TV, led screen, audio system, stereo system), Large appliance (deep freezer, Washing Machine, Air condtion) and small households' appliances such as kitchen appliances as shown in Plate 1.

Plate 1: Example of E-waste Materials from Lighting, Large Appliances and Entertaining Equipment in Sabon-Gari Ward

The results in Table 2 show that 54% of participants in households mentioned electronic waste derived from lighting equipment as the highest, this is mainly due to its short life span and how frequently it is used, since the majority of houses can do without bulb light for visualization. Waste from ICT equipment comprises of 21%, followed by waste from entertainment equipment, which comprises of 9%, lastly; waste derived from large electronic appliances and small electronic appliances are used for domestic and personal care, which consist of 3% and 14%, respectively, due to their long-life span. Cheng and Li (2021), in their study on e-waste generation in Beijing, China, discovered that lighting equipment accounts for 78% of e-waste generated in every household at every 2 years, due to its lifespan and patterns of usages among the residents. Thus, Asante *et al*. (2019) is of view 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 Gusau City where the population is fast increasing on daily basis because of its proximity to urban growth.

TABLE 2: TYPE OF ELECTRONIC WASTE GENERATED

S/N	Types of e-waste	Frequency	Percentage
1.	Small Appliances	54	14
2.	Entertainment equipment	35	9
3.	Large equipment	11	3
4.	Lighting Equipment	212	54
5.	Information/Communication	82	21
	Total	**394**	**100**

Source: Field Survey, 2024

E-Waste Management Practice in Gusau City

Figure 3 shows that 90% of households store their e-waste indoors due to factors such as limited outdoor space, the perceived economic value of electronic devices, fear of theft, and the absence of designated disposal points while 65% of technicians prefer indoor storage to ensure equipment security and maintain organization, while 35% opt for outdoor storage. The storage practice by the households and technicians clearly shows the absence of recycling centres, the improper handling of harmful substances associated with e-waste often result to secondary pollution. A proper recycling method will lead to a reduction in the amount of heavy metals released to the environment.

The result shows that there is no proper management strategy for the electronic waste generated in Gusau City. The management of e-waste generated is entirely left to the producer of such waste. There are no organized recycling centres for e-waste, except local recyclers (mai bola), who go around to collect these electronic and electrical products from open dumpsites or various workshops or households. Their mode of dismantling metals does not consider safety health, open burning of metals which is one of their daily activities, emit unpleasant smell into the environments causing air pollution, furthermore some of these metals (Lead, iron, Zinc) sink into the soil and pollute the underground water, which has an adverse effect on human health when consumed (Bichi, 2013).

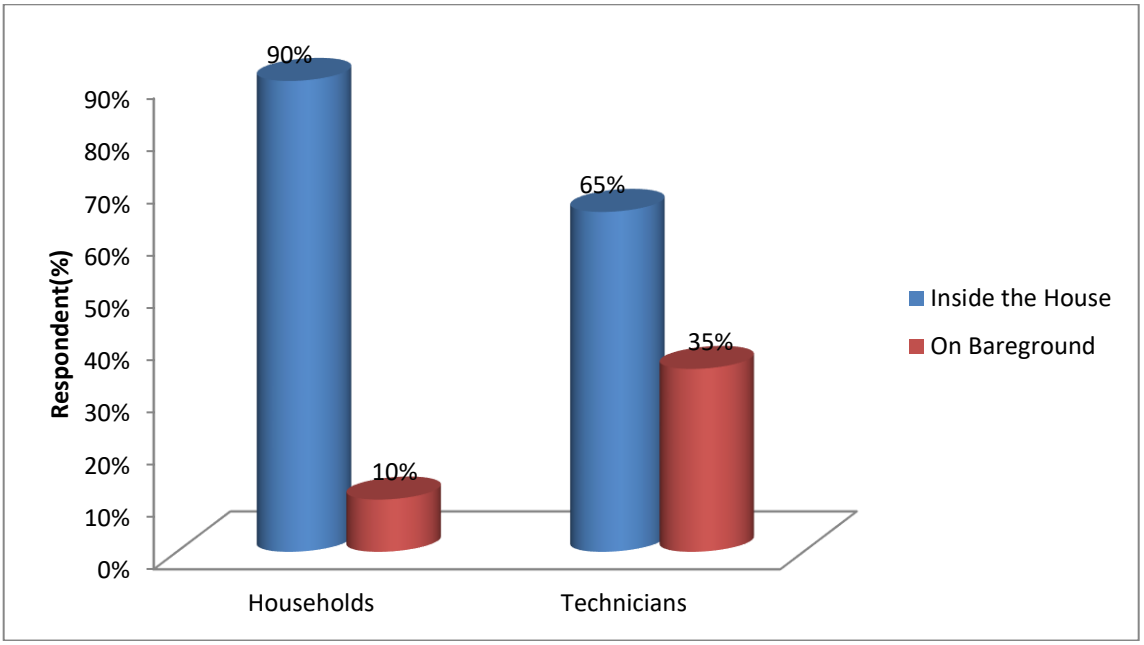

Figure 3: Electronic Waste Storage Practices

It was observed from the study that some of the e-wastes are carelessly dumped on waste collection centres and even burnt in some dumpsites without considering environmental effects. Achieving an environmentally friendly practice requires a cost-effective and scientific method of recycling. Due to its toxic nature, it poses a threat to the environment if disposed of indiscriminately. Figure 3 highlights the differences in e-waste disposal practices between households and technicians. Households predominantly engage in unregulated stockpiling of electronic materials (44%) and open dumping (20%) as their primary disposal methods. In contrast, technicians make minimal use of unregulated stockpiling (6%) due to limited space but rely heavily on general waste disposal (47%) and open burning (31%).

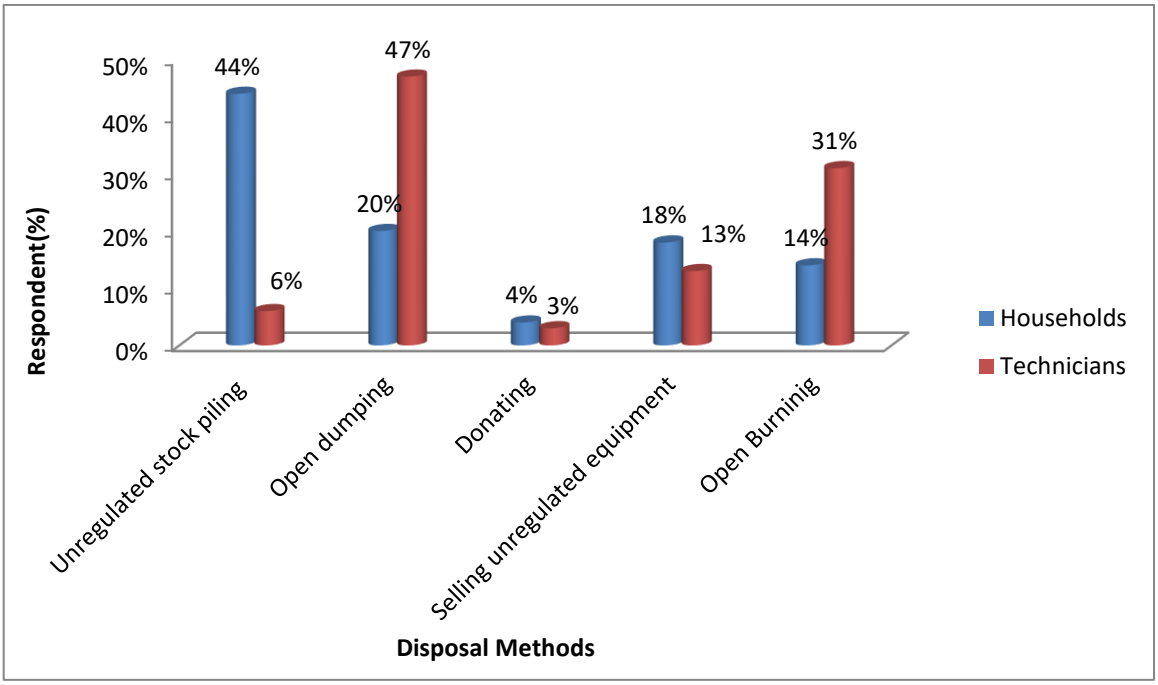

Figure 4: Electronic Waste Disposal Option by the Respondents

Based on this study, open burning and open dumping are common disposal methods adopted by households and technicians' shop, it shows that e-waste management in Gusau is very poor and needs urgent attention. Butu *et al*. (2013) and Butu (2015) observe that most developing nations are fast becoming an e-waste destination, because most second-hand electronics, standard and recycled electronics from developed nations, like China, Germany, the U.S.A., Indian another Europeans countries find booming markets in these countries and are patronized mostly by low-income population, who have low level of environmental awareness. As a result of these, most refuse dumpsite comprises of large amount of e-waste deposited, such as broken screens, panels, wires scrab etc. An example of an unhealthy disposal practice is shown in plate 2.

Plate 2: Open Burning and Open Dumping at an Illegal Collection Site Opposite Babeji Plaza, Sabongari Ward

Conclusion and Recommendations

Based on the findings of this study, it is concluded that there is a significant challenge in electronic waste generation and management practice in Gusau City, due to population growth, with a lack of sound solid waste management strategies, which have worsened the problem of e-waste management. Lighting equipment and ICT devices were the most dominant types of e-waste, due to their high usage, consumer behaviour patterns and short lifespan. This factor has led to improper disposal methods, whereby the majority of respondents in households dispose of their broken appliances through open dumping and unregulated stockpiling. Whereas the majority of the technicians disposed of their waste through burning and dumping at an illegal collection point. Notably, this action has posed severe environmental and health risks, leading to soil contamination, water contamination and air pollution.

Based on the results of the study, the following recommendations for better e- waste management methods are put forward:

1. The government should prioritize education campaigns for the public, recyclers and manufacturers to raise awareness on the e-waste management challenge.
2. Zamfara State Environmental Protection Agency (ZEPA) should enforce strict regulations to control illegal e-waste disposal practices by discouraging harmful practices such as open burning and open dumping.
3. Public awareness should be conducted to educate citizens about the dangers of improper e-waste disposal and the benefits of responsible recycling by the Zamfara state environmental protection agency
4. The government should establish e-waste collection centres across Gusau and incentivize citizens to properly dispose of their old electronics by offering trade-in programs or discounts.

By implementing these recommendations on e-waste management, environmental and health hazards will be reduced in other to protect public well-being and the ecosystem.

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