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E-Waste Generation and Management Practices in Aba Metropolis, Abia State: Implications for Sustainable Environmental Management"

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Abstract
This study investigates e-waste generation and management practices in tertiary institutions in Aba, Abia State, highlighting the growing challenge of electronic waste in educational environments. Despite the increasing presence of e-waste, awareness and proper management remain limited, leading to environmental risks and missed opportunities for resource recovery. The study addresses the research gap in understanding institutional e-waste management in Aba metropolis. Using a retrospective survey, primary data were collected through questionnaires to assess stakeholder knowledge and practices regarding e-waste in three institutions: Abia State Polytechnic, Temple Gate Polytechnic, and the College of Health Technology. A total of 40 respondents, selected for their direct involvement in e-waste activities, provided insights into local practices. The study's objectives include identifying the types and quantities of e-waste generated, assessing current handling methods, and exploring the reasons for e-waste retention and disposal. Descriptive statistics, including tables and charts, were used to present the data. The findings reveal that electrical and electronics tools are the most common type of e-waste (50%), followed by monitoring instruments (25%). The majority of respondents prefer selling e-waste to scrap dealers (77.5%), with storing e-waste as a secondary option (15%). The primary reason for e-waste generation is the desire for new features (45%), while the lack of proper disposal methods is the main reason for holding onto e-waste (47.5%). This study highlights the need for enhanced awareness and improved e-waste management systems in tertiary institutions. The findings have implications for policymakers and educational administrators, emphasizing the importance of developing sustainable e-waste management strategies, fostering recycling initiatives, and encouraging responsible disposal to mitigate environmental harm and promote resource recovery.

Keywords: *E-waste management, Tertiary institutions, Recycling practices, Environmental sustainability, Disposal methods*

1.0 INTRODUCTION

The accelerated proliferation of electronic waste (e-waste) presents a pressing global environmental and public health concern, primarily propelled by technological innovations and the pervasive utilization of electronic devices. As societies progressively depend on technological

advancements, the quantity of obsolete or non-operational electronics escalates at an alarming rate. Disposed devices, which encompass a range of items from domestic appliances to intricate industrial equipment, harbor deleterious substances such as lead, mercury, cadmium, and brominated flame retardants. When inadequately managed, these hazardous materials have the potential to pollute soil, water, and air, resulting in substantial health repercussions for humans, including neurological disorders and respiratory ailments (Grant *et al.,* 2013). Consequently, the implementation of effective e-waste management strategies is imperative for fostering environmental sustainability and safeguarding public health, particularly in areas characterized by inadequate infrastructure and regulatory frameworks. The magnitude of e-waste production on a global scale is profoundly concerning. As reported by the Global E-waste Monitor 2020, an estimated 53.6 million metric tonnes (Mt) of e-waste were produced worldwide in 2019, with an anticipated annual growth rate ranging from 3% to 4% (Forti *et al.,* 2020). Notwithstanding the escalating volume, a mere 17.4% of global e-waste is appropriately collected and recycled, leaving the overwhelming majority to be processed through informal or hazardous methodologies. E-waste is systematically classified into six primary categories: temperature exchange equipment (e.g., refrigerators), screens (e.g., televisions), lamps, large equipment (e.g., washing machines), and small equipment (e.g., microwaves), and small IT equipment (e.g., mobile phones) (Baldé *et al.,* 2017). When disposed of improperly, these devices can emit toxic chemicals and heavy metals, which can have enduring adverse effects on ecosystems and human health. In developing nations such as Nigeria, the e-waste crisis is particularly pronounced due to a confluence of factors. Nigeria contributes a significant portion of Africa's e-waste, attributable to its extensive population, rapidly expanding technology market, and the influx of second-hand electronic products from developed countries (Maes *et al.,* 2022). The nation confronts distinct challenges, including insufficient infrastructure for formal e-waste recycling, enforcement of environmental regulations, and a substantial informal sector that manages e-waste through perilous practices. Informal workers frequently resort to rudimentary methods, such as open burning and acid leaching, to extract precious metals like copper and gold from discarded electronics. These practices constitute grave health hazards for workers and result in widespread environmental degradation (Andeobu *et al.,* 2021). Hazardous substances such as lead, mercury, and cadmium can leach into adjacent environments, contaminating soil and water sources, thereby posing long-term health risks to surrounding communities. Aba Metropolis, an industrial center in southeastern Nigeria, epitomizes the escalating e-waste dilemma in the urban areas of the country. The swift urbanization and industrial development of Aba have culminated in heightened consumption of electronic devices, thereby leading to a corresponding surge in e-waste generation. Nonetheless, the lack of formal e-waste management frameworks within the city has facilitated the emergence of informal disposal practices, such as open dumping and unregulated recycling operations. These practices present significant environmental and public health dangers, particularly within low-income neighborhoods where informal e-waste recycling activities are predominantly concentrated (Bankole *et al.,* 2023). The hazardous chemicals found in discarded electronics can leach into the environment, contaminating local ecosystems and endangering human health. While the majority of scholarly investigations concerning e-waste management in Nigeria concentrate on metropolitan areas such as Lagos and Abuja, lesser urban locales like Aba have not been sufficiently examined. Lagos has attracted considerable scholarly attention as one of the preeminent e-waste hubs in West Africa, receiving substantial quantities of second-hand

electronics from Europe and North America (Abogunrin-Olafisoye and Adeyi 2025). Research conducted in Lagos has meticulously documented the profound environmental and health ramifications associated with informal e-waste recycling practices. Nevertheless, there exists a paucity of academic inquiry focused on smaller yet pivotal urban centers such as Aba, notwithstanding its significance as a regional industrial nucleus. There is a dearth of understanding regarding the magnitude of Aba's e-waste challenge, the efficacy of current management strategies, or the particular environmental and public health repercussions of informal e-waste recycling within the city. This deficiency in empirical research underscores the imperative for a thorough analysis of Aba's e-waste ecosystem, concentrating on generation rates, disposal methodologies, and the consequences of informal recycling. The environmental and health hazards associated with inadequate e-waste disposal are extensively documented in the academic literature. Toxic substances present in e-waste, including lead and mercury, have the potential to induce enduring contamination of ecological systems. Lead, a prevalent constituent in electronic devices, can leach into soil and water supplies, resulting in neurological impairments and developmental challenges in children exposed to contaminated environments (Grant *et al.*, 2013). Mercury, frequently located in batteries and lighting apparatus, can bioaccumulate within aquatic ecosystems, leading to extensive contamination and posing significant health risks to communities that depend on fish as a dietary staple (Bankole *et al.*, 2023). Informal recycling techniques, such as open burning, exacerbate air pollution by emitting toxic fumes and particulate matter, thereby further jeopardizing public health. In response to the escalating challenges posed by e-waste, numerous nations have enacted effective policies aimed at mitigating environmental risks. Extended Producer Responsibility (EPR) frameworks, for instance, hold manufacturers accountable for the entire lifecycle of their products, encompassing production through to disposal. EPR has proven successful in countries such as Germany, Japan, and Switzerland, where recycling initiatives have markedly curtailed e-waste volumes (Brown *et al.*, 2023). In contrast, the e-waste management policies within Nigeria remain inadequately developed. Although the National Environmental (Electrical/Electronic Sector) Regulations were instituted in 2011 to govern e-waste generation and disposal, enforcement mechanisms are weak, allowing the informal sector to persist as the predominant actor in e-waste management (Ghulam and Abushammala 2023). In Aba Metropolis, there exists an immediate necessity for more robust regulatory frameworks, enhanced public consciousness, and the establishment of formal recycling infrastructures to effectively address the burgeoning e-waste dilemma. This study seeks to evaluate the current levels of e-waste generation in Aba, assess existing disposal practices, and investigate the environmental and health implications arising from informal e-waste recycling activities. By scrutinizing local contexts and identifying principal sources of e-waste, this research will augment the expanding corpus of literature on sustainable e-waste management in Nigeria and proffer recommendations for the enhancement of e-waste practices in alignment with international standards. As Nigeria contends with the environmental and public health challenges posed by e-waste, municipalities such as Aba must prioritize sustainable waste management strategies to safeguard ecosystems and public health.

2.0 MATERIALS AND METHODS

2.1 The Study Area:

Aba is a metropolis in the southeast of Nigeria and the commercial center of Abia State. Aba lies between Latitudes 5.1326N and 5.0518N and Longitudes 7.307E and 7.4047 E. Abia State is bounded on the East by Akwa Ibom State, and Cross River, Imo State to the West, Enugu State and Ebonyi State to the North and Rivers State to the South. Aba has a land mass area of 72 square Kilometres (Km²). Aba, located in Abia State, Nigeria, has a tropical monsoon climate (Am) with significant rainfall from March to October, peaking in June/July and September/October. The area was once covered by tropical rainforest, but urbanization has reduced the natural vegetation to secondary forests and farmlands. The region's flat terrain, part of the coastal plain, is prone to flooding due to poor drainage, while its geology, dominated by sedimentary rocks, supports groundwater resources. The Aba River plays a vital role in the area's hydrology, contributing to both water supply and drainage. Aba North, Aba South, and Obingwa have a well-developed road network, though electricity is unreliable, leading to widespread generator use. Water supply mainly relies on boreholes. Educational institutions like Abia State Polytechnic and several healthcare facilities serve the area. Major markets include Ariaria International Market, Ekeoha Market, and Cemetery Road Market, attracting traders across West Africa. Agriculture, focused on cassava, maize, and yams, is significant, with farmers involved in cassava and maize farming and uses urban farming to supplement their income (Okoro *et al.*, 2018).

Fig 1: Map of Nigeria showing Abia State and the study area

2.2 Methods:

The study employed a retrospective survey method. Primary data on e-waste generation and management practices were collected from tertiary institutions in Aba, Abia State. The data were obtained through questionnaires, which assessed stakeholder knowledge and practices. The questionnaire data revealed gaps in e-waste generation and management. A purpose decision was made to limit the institutional heads that manages electronics.

Table 1: Targeted Respondents

Respondent	**Questionnaire Administered**
Abia State Polytechnic	20
Temple Gate Polytechnic	10
Abia State College of Health	10
Total	**40**

Respondents were selected from three Tertiary Institutions (Abia State Polytechnic, Temple Gate Polytechnic, and College of Health Technology)**:** 20 respondents from Abia State Polytechnic, 10 from Temple Gate Polytechnic, and 10 from the College of Health Technology were selected for their academic perspectives on e-waste and its environmental effects. These respondents were chosen based on their direct involvement in e-waste activities, ensuring reliable and relevant data for the study. Descriptive statistics (tables, bar charts, and graphs) and survey were used to assess the status of e-waste generation and management practices. This helped identify local trends and awareness regarding e-waste handling.

3.0 RESULT AND DISCUSSION

Table 2: Demographic Characteristics of the Respondents in the Market and the Institutions

Institutions	**Frequency**	**Percent**
Abia State Polytechnic	20	50
Temple Gate Polytechnic	10	25
Abia State College of Health	10	25
Total	**40**	**100**
Sex		
Male	31	77.5
Female	9	22.5
Total	**40**	**100**
Marital Status		
Single	15	37.5
Married	23	57.5
Divorced	2	5
Total	**40**	**100**
Level of Education		
FSLC/SSCE	2	5

Diploma/NCE	4	10
HND/Degree	10	25
Masters/PhD	24	60
Total	**40**	**100**

Abia State Polytechnic contributes 50% of the institutional respondents, while Temple Gate Polytechnic and Abia State College of Health contribute 25% each. Males dominate at 77.5%, while females represent 22.5%. A majority (57.5%) of respondents is married, with 37.5% single, and 5% divorced, showing a slightly older or more established demographic. 60% of respondents hold a Masters/PhD. Only 5% have FSLC/SSCE, and 10% have a Diploma/NCE, showing a clear concentration of higher education in this group.

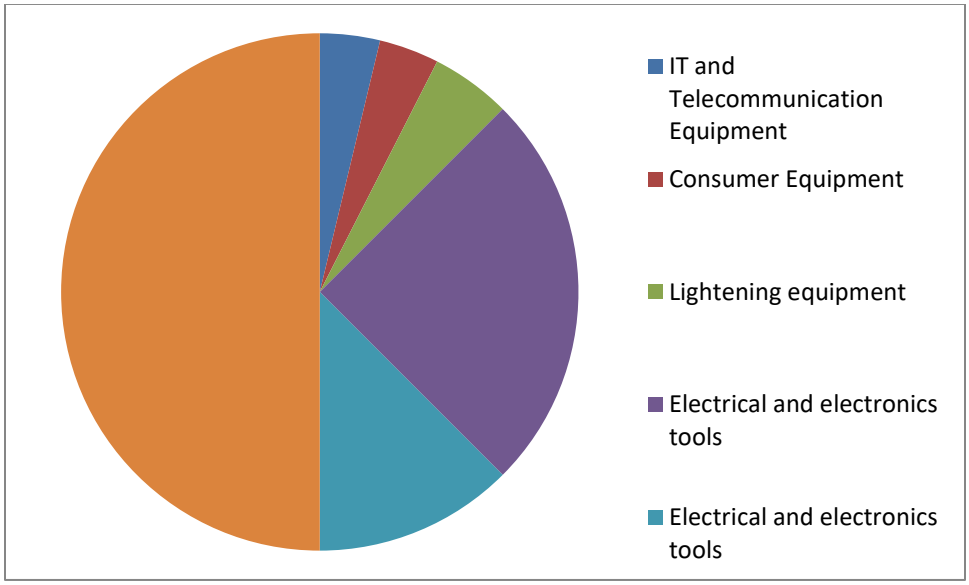

Fig. 2: Types of E-waste dominantly generated/stored in Institutions in Aba

Figure 2 illustrates the distribution of e-waste types based on frequency and valid percent. Electrical and electronics tools rank 1st, with 20 occurrences (50%). Monitoring and controlling instruments rank 2nd with 10 occurrences (25%). Lighting equipment ranks 3rd with 4 occurrences (10%). Both IT and telecommunication equipment and consumer equipment rank last, 4th, with 3 occurrences each (7.5%).

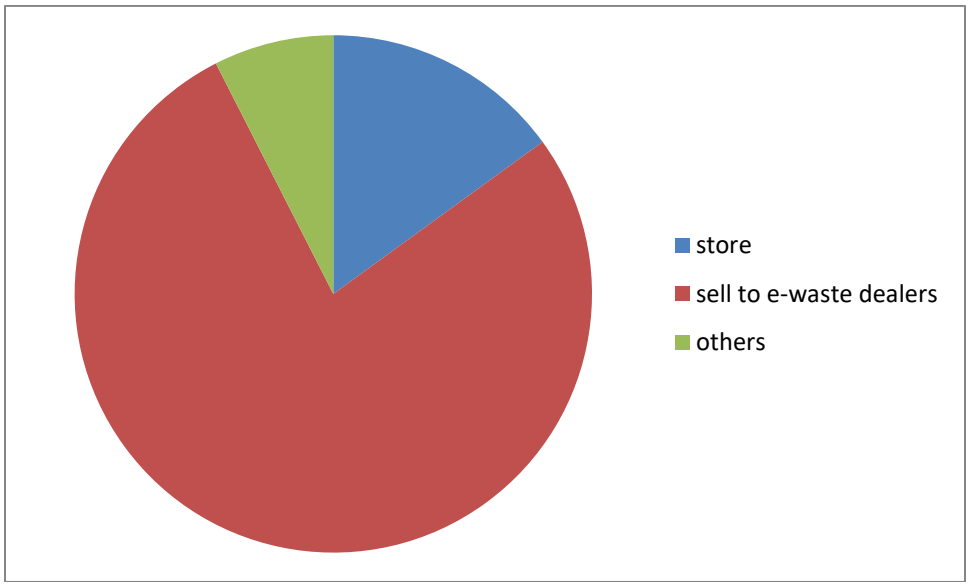

Fig. 3: How do you typically handle outdated or unused electronic equipment

Figure 3 presents the options for handling e-waste based on frequency and valid percent. Selling to scrap dealers or e-waste businesses ranks 1st, with 31 responses (77.5%). Storing the e-waste ranks 2nd, with 6 responses (15.0%). The "others" category ranks 3rd and last, with 3 responses (7.5%). The "others" option encompasses alternative methods including disposal through informal channels or personal reuse of e-waste materials.

Table 3: Why does your institution replace old electronic equipment

Reasons	Frequency	Percent	Rank
Too slow	8	20.0	3rd
Wanting newer technology/design	5	12.5	4th
Wanting features not available on old electronic equipment	18	45.0	1st
Wanting additional equipment	9	22.5	2nd
Total	40	100.0	

Table 3 listed reasons for e-waste generation based on frequency and rank. The top reason (1st) is "wanting features not available on old electronic equipment," with 18 responses (45.0%). "Wanting additional equipment" ranks 2nd, with 9 responses (22.5%), while "too slow" ranks 3rd, with 8 responses (20.0%). The last (4th) reason is "wanting newer technology/design," with 5 responses (12.5%).

Table 4: Major reasons for storing old and unused Electronic Equipment in your Institution

Options	Frequency	Valid Percent	Rank	Cumulative Percent
We don't consider it appropriate to throw it in garbage	10	25.0	2nd	25.0
We don't know what to do with it	3	7.5	4th	32.5
We want to donate/sell it	2	5.0	5th	37.5
We have not upgraded/repaired it	6	15.0	3rd	52.5
We have not found good disposal methods or recycler	19	47.5	1st	100.0
Total	40	100.0		

Table 4 outlined the reasons for holding onto e-waste. The top reason (1st) is "we have not found good disposal methods or recycler," with 19 responses (47.5%). Ranking 2nd, with 10 responses (25.0%), is "we don't consider it appropriate to throw it in garbage." "We have not upgraded/repaired it" ranks 3rd, with 6 responses (15.0%). "We don't know what to do with it" ranks 4th, with 3 responses (7.5%). The last (5th) reason is "we want to donate/sell it," with 2 responses (5.0%).

Table 5: What do you do to unserviceable/irreparable Electronic Equipment

Options	Frequency	Valid Percent	Rank	Cumulative Percent
Store	6	15.0	2nd	15.0
Sell to scrap dealer/E-waste business	26	65.0	1st	80.0
Throw them to other institutions and organizations	3	7.5	4th	87.5
Give them back to the company for servicing	5	12.5	3rd	100.0
Total	40	100.0		

Table 5 listed methods of e-waste disposal based on frequency and rank. The top method (1st) is "Sell to scrap dealer/E-waste business," with 26 responses (65.0%). "Store" ranks 2nd, with 6 responses (15.0%), while "Give them back to the company for servicing" ranks 3rd, with 5 responses (12.5%). The last method (4th) is "Throw them to other institutions and organizations," with 3 responses (7.5%). In this table, an "others" category is present, which includes methods like storing (2nd), giving them back to the company for servicing (3rd), and throwing them to other institutions (last).

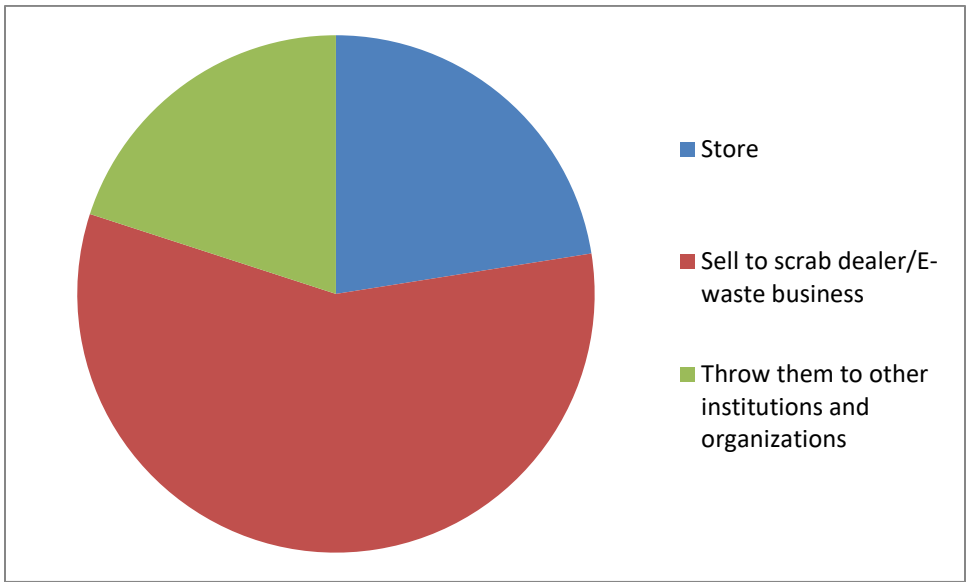

Fig. 4: What do you do to the broken Electronic Equipment

Figure 4 shows the methods of e-waste disposal based on frequency and rank. The top method (1st) is "Sell to scrap dealer/E-waste business," with 23 responses (57.5%). "Store" ranks 2nd, with 9 responses (22.5%), while "Throw them to other institutions and organizations" ranks 3rd, with 8 responses (20.0%). There is no "others" category in this table, as all methods of e-waste disposal are explicitly listed. The cumulative percentage reaches 100.0%, indicating that all methods have been accounted for in the responses.

The study findings show that Institutions within Aba predominantly generate or store electrical and electronics tools (50%) and monitoring/control instruments (25%). This distribution reflects a higher prevalence of industrial and operational equipment in institutional settings, which is consistent with findings from other studies in Nigeria where institutions often handle more complex and high-value e-waste (Abalansa *et al.*, 2021). A significant majority of institutions (77.5%) sell their old electronic equipment to scrap dealers or e-waste businesses, reflecting a common practice of resource recovery through resale or recycling. This is in line with studies showing that institutions in Nigeria often prefer to sell outdated equipment due to limited internal disposal options (Dey *et al.*, 2023). The predominant reason for replacing equipment is the need for features not available on older models (45%). This reflects a trend towards technological advancement and modernization. Studies have similarly found that institutions often replace equipment to keep up with technological progress and improve operational efficiency (Tian *et al.*, 2022). The major reason for storing old equipment is the lack of appropriate disposal methods or recyclers (47.5%), which is consistent with findings from other studies indicating that inadequate disposal infrastructure often leads to accumulation of e-waste. The majority of institutions (65%) sell unserviceable equipment to scrap dealers. This practice aligns with the common trend in Nigeria of reselling or recycling e-waste due to limited disposal options (Ogwueleka and Naveen 2021).

Most institutions (57.5%) sell broken equipment to scrap dealers, similar to other practices observed in Nigeria where the resale of broken equipment is common due to economic incentives. Over half of the institutions (52.5%) report having non-functioning products due to lack of manuals

or operational know-how, which highlights challenges in equipment management and utilization. This finding reflects similar challenges faced by institutions in Nigeria, where lack of technical knowledge and documentation can impede effective use of electronic equipment. A majority (57.5%) of institutions did not manage to get their electronic wastes repaired, indicating challenges in maintenance and repair services. This is consistent with findings that repair infrastructure in Nigeria often lacks sufficient support for effective e-waste management (Abogunrin-Olafsoye, and Adeyi, 2025). The practices of selling e-waste to scrap dealers and storing equipment due to inadequate disposal options are common in Southeastern and South-South Nigeria. This reflects a broader regional trend of relying on informal recycling channels due to limited formal waste management infrastructure. The issues related to lack of manuals and repair difficulties are also observed in other studies, highlighting systemic challenges in e-waste management and equipment maintenance (Ghulam, and Abushammala 2023). Institutions often struggle with outdated equipment and insufficient technical support, mirroring broader regional issues

4.0 Conclusion

The study highlights the urgent need for policy interventions to improve e-waste management practices in tertiary institutions. Policymakers should prioritize establishing clear regulatory frameworks to promote proper e-waste disposal, recycling, and reusing, ensuring that stakeholders are well-informed and equipped to handle electronic waste responsibly. Educational institutions must be encouraged to adopt sustainable e-waste management strategies, including collaboration with licensed recyclers and creating awareness campaigns to inform students and staff about the environmental hazards of improper e-waste disposal. Additionally, policies that incentivize the development of recycling infrastructure, encourage producer responsibility, and regulate informal e-waste handling channels are essential. By integrating e-waste management policies into institutional governance, and offering capacity-building programs, authorities can reduce the environmental and health impacts of e-waste, fostering a more sustainable and eco-conscious academic environment. These policies can also contribute to achieving broader national and international environmental sustainability goals.

Declaration of Conflict of Interest: The authors declare that there is no conflict of interest

Data Availability Statement: Data are available upon request from the authors

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