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Assessment of the Impact of Extended Producer Responsibility Policy on Electronic Waste Management in Port Harcourt Metropolis, Rivers State, Nigeria

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Abstract: Electronic waste (e-waste) has become one of the fastest-growing waste streams globally due to rapid technological advancement, increased consumption of electrical and electronic equipment, and inadequate end-of-life management practices. This study assessed the impact of the Extended Producer Responsibility (EPR) policy on electronic waste management in Port Harcourt Metropolis, Rivers State, Nigeria. Specifically, the study examined the perceived impacts of the EPR policy on e-waste management, evaluated the implementation of the policy by the National Environmental Standards and Regulations Enforcement Agency (NESREA), and identified the challenges encountered by stakeholders in implementing the policy. A descriptive survey research design was adopted for the study. Data were collected using a structured questionnaire administered to 387 respondents comprising households, business owners, producers, consumers, recyclers, and government officials selected through multistage sampling. Descriptive statistics, including frequency counts and percentages, were used to summarize respondents' perceptions, while independent samples t-test was employed to determine significant differences between respondents who agreed and those who disagreed with the study variables at a 0.05 level of significance. The findings revealed that 53.5% of respondents agreed that the EPR policy has increased awareness of proper e-waste disposal, 57.4% considered the policy an important step towards achieving a circular economy, while only 40.6% believed that government enforcement has effectively reduced informal e-waste dumping. Furthermore, 79.3% agreed that government agencies face limited resources for effective enforcement, and 81.0% identified inadequate funding and infrastructure as major barriers to successful implementation. The t-test results indicated statistically significant differences in respondents' perceptions regarding the impacts of the EPR policy ($t = -24.87$, $p = 0.003$), NESREA's implementation of the policy ($t = -25.61$, $p < 0.001$), and stakeholder challenges ($t = -29.64$, $p = 0.002$). The study concludes that although the EPR policy has positively influenced e-waste management in Port Harcourt Metropolis, its effectiveness is constrained by weak enforcement, inadequate infrastructure, insufficient funding, and poor stakeholder collaboration. The study recommends strengthening NESREA's enforcement capacity, expanding e-waste collection and recycling facilities, increasing public awareness programmes, and promoting stronger collaboration among government agencies, producers, recyclers, and consumers to achieve sustainable e-waste management.

Keywords: *Electronic Waste; Extended Producer Responsibility (EPR); E-Waste Management; NESREA; Recycling; Circular Economy; Environmental Policy.*

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I. INTRODUCTION

Most human activities undertaken towards producing a means of livelihood, often generate waste. Waste generation therefore, is an inevitable practice among human beings. However, the types and quantities of wastes generated vary with respect to the activities being undertaken. Electronic waste is described as all items of an electrical and electronic

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equipment (EEE) and its parts that have been discarded by its owner as waste without the intent of re-use (Step Initiative, 2014). Balde et al., (2017), succinctly described electronic waste as a range of products of circuitry or electrical components with power or battery supply that have no more useful value to its owner. Simply put, e-waste is defined as a waste that emanates from discarded, used, and otherwise unwanted electronic and electrical devices (Hsu et al., 2022).

According to the World Health Organization (2024), electronic waste is one of the fasted growing solid waste streams in the world. In 2022, an estimated 62 million tonnes of e-waste were produced globally. Only 22.3% was documented as formally collected and recycled (Serpe et al., 2025). The rise in the quantity of e-waste being generated globally is due to the increased use of electrical and electronic equipment (EEE) by individuals and organizations towards enhancing living standards and global economic development, respectively. Examples of electrical and electronic equipment used by individuals and households include mobile phones, laptops, computers, printers, air conditioners, fans, washing machines, television sets, refrigerators, ovens, microwaves, radios/DVDs, and many more, while organizations use electrical and electronic equipment for manufacturing, service-oriented activities, transportation, health services (hospitals), security systems, vehicles, electric generators, telecoms, and many more. Also, the increasing production of electrical and electronic equipment is linked to the advent of digital technology, which has consequently promoted the proliferation of digital tools, such as smartphones, social media platforms, and artificial intelligence. This has in turn ushered in a significant paradigm shift in human interactions, information dissemination and general connectivity. This emerging technology has enriched the livelihood of human beings by promoting convenience, speed, and efficiency in workplaces and in daily interactions with one another. The world, therefore, is increasingly becoming digitalized, as every aspect of livelihood is driven by digital technology (Shanmugasundaram and Tamilarasu, 2023).

Digital technology has thus, spurred an increased demand for digital tools due to the value consumers place on them. Manufacturers of various brands of digital tools, which include Samsung, LG, Hisense, Sony, Apple, Nokia, Panasonic, Thermocool, Hewlett Packard (HP), and many more, seem to be competing among themselves by constantly improving on the quality of existing models. Every year newer versions of various models are produced, thereby increasing the propensity for the older models to become obsolete. The obsolete equipment can either be given out to someone in need, kept at home as a monument or discarded as electronic waste.

According to Balde et al., (2017), e-waste encompass the following six categories: (a) temperature exchange equipment: includes refrigerators, freezers, air conditioners and heat pumps; (b) screens, monitors: include televisions, monitors, laptops, notebooks, and tablets; (c) lamps: include fluorescent lamps, high intensity discharge lamps, and LED lamps; (d) large equipment: include washing machines, clothes dryers, dish-washers, electric stoves, large printing machines, copying equipment, and photovoltaic panels; (e) small equipment: include vacuum cleaners, microwaves, ventilation equipment, toasters, electric kettles, electric shavers, scales, calculators, radio sets, video cameras, electrical and electronic toys, small electrical and electronic tools, small medical devices, small monitoring and control instruments; and (f) IT and telecommunication equipment: include mobile phones, global positioning systems (GPS), pocket calculators, routers, personal computers, printers and telephones.

Electronic waste contains complex combinations of toxic substances and recoverable precious minerals. Emission of the toxic substances mixed with soil, air and water could cause harmful effects to the entire biota either directly, through the release of acids, heavy metals, and carcinogenic chemicals or indirectly, through the bio-magnification of heavy metals in food chain (Sthiannopkao and Wong, 2013). When e-wastes are discarded through unconventional methods, such as, burning or acid bath, with an intention to recover some materials of value, the result is the release of dioxins, furans and heavy metals as pollutants into the environment with a consequent negative impact on human health (Sthiannopkao and Wong, 2013). Sometimes, e-wastes are indiscriminately discarded into wastes bins among household wastes and dump sites. This practice of e-waste management process has become outdated in countries where the extended producer responsibility policy has been accentuated, because the policy emphasizes on e-waste take-back for recycling and reuse, thereby ensuring preservation and protection of the environment (Mallick et. al, 2024). The extended producer responsibility approach to e-waste management is an innovative practice that has been embraced by many developed countries. It is driven by appropriate laws that designate responsibilities to stakeholders in the e-waste value chain.

The extended producer responsibility (EPR) policy is an environmental protection strategy that makes manufacturers of electrical and electronic products responsible for the take back of the end-of-life products for recycling and safe disposal (Sthiannopkao & Wong, 2013). This policy was derived from the polluter-pays principle (PPP) (Zhong & Zhao, 2012). By this policy, manufacturers are expected to accept e-wastes from consumers for recycling and safe disposal, thus, shifting the burden of the end-of-life management of e-wastes from municipalities and taxpayers to producers, consistent with the polluter pays principle (Leclerc & Badami, 2019). The goal of the EPR is to reduce wastes streams from post-consumer products; provide a clear and measurable target in terms of prevention, reuse and recycling and production of electrical and electronic equipment with less toxic, but recyclable materials. In developed countries, e-waste management is guided by conventions, directives, and laws to regulate their disposal, mostly based on extended producer responsibility, while developing countries on the other hand, often face difficulties in e-waste management (Osibanjo & Nnorom, 2007).

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The effective implementation of extended producer responsibility policy is the impetus required towards a transition to a circular economy. It also has two primary environmental goals. Firstly, it aims to incentivize producers to design more resource efficient products with lower environmental impacts (often referred to as green design or eco-design), for example in terms of the type or amount of material used. Secondly, it aims to ensure effective end-of-life collection and environmentally-sound treatment of collected waste products, and to create higher rates of reuse and recycling. In this way, EPR schemes can help to address issues related to resource consumption and growing waste generation (Watkins and Gionfra, 2019). Circular economy (CE) is an economic model that is aimed at integrating economic activities and environmental wellbeing in a sustainable way. It places emphasis on the redesign of processes and cycling of materials, which may contribute to more sustainable business models and maximize ecosystem functioning and human wellbeing (Athanasios, 2018). Circular economy also advocates reuse and recycling of e-waste and represents it as a promising sector of prospective interest (Barapatre and Rastogi, 2021).

In the European Union, extended producer responsibility is mandatory within the context of the waste electrical and electronic equipment and batteries. Responsibility for financing collection, recycling, and disposal of the e-waste has been mandated on producers (Gronkvist, 2022). In Switzerland, based on the EPR principle, the financing of collection, utilization and disposal is carried out by charging advanced contributions from customers when buying electrical and electronic equipment, as advanced recycling fee. Manufacturers and importers pay for collection, treatment, recovery and environmentally sound disposal of e-wastes at the point the product is put on market. Retailers and municipal collection points offer free drop-off and take-back of like-for-like (Gupt and Sayah, 2015). In Netherlands, the management of white and brown goods decree, passed in 1998, made Netherlands the first country in Europe to introduce the EPR principle for a wide range of electronic and electrical equipment. The decree made it mandatory for retailers to take back old electrical and electronic goods in exchange for new ones, and manufacturers to accept products from retailers and arrange for transportation and recycling. Municipalities were also required to take products back free of charge (Gupt and Sayah, 2015). In Italy, the extended producer responsibility policy on e-waste was introduced in 2005. Responsibilities for the enforcement of the policy was vested among the three tiers of government, namely: the federal government (ministries of the environment), regional provinces and municipalities. The duties of producers on the EPR policy were handled by 13 producer responsibility organizations (PROs). The PROs collect e-wastes from consumers while the municipalities set up collection points. The policy targets the following categories of e-wastes for recycling: fridges, air conditioners, freezers, washing machines, dishwashers, ovens, television sets, screens, notebooks, phones, luminaires, PV panels, small household appliances, lightbulbs, and all types of bulbs. The financial responsibilities of the EPR policy are shared among distributors, municipalities, and producers (Campbell-Johnston, et. al., 2022).

In France, the EPR principle had existed since 1975, but was applied in a more restricted form. The formal nation-wide application of the EPR commenced in 1992 when the government decided to apply it to tackle the menace of household packaging waste. In the EPR policy, producers often set up the PROs for e-waste collection, treatment or processes and disposal. The national government oversees the operation of the policy by setting operational rules and targets, as well, as arbitrating with all actors. Producers are responsible for financing the EPR scheme by adding an eco-contribution to the selling price of their products, which is visible to consumers. The amount of eco-contribution paid is included in the sales invoice and reflects waste treatment costs once the product becomes e-waste. This contribution is made compulsory by French law. (Campbell-Johnston, et. al., 2022). The United Kingdom's waste electrical and electronic directive 2002/96/EC is aimed at promoting the reuse, recycling and recovery of e-wastes in order to reduce their disposal into landfills. The directive also requires manufacturers or importers to become responsible for the costs of the collection, treatment, re-use and recycling of e-wastes (Calliafas, 2012).

Japan has two separate regulations for recycling of e-waste. They are: law for the promotion of effective utilization of resources (LPUR) and law for the recycling of specified kinds of home appliances (LRHA) (Chung and Murakami-Suzuki, 2008, sited by Gupt and Sahay, 2015). The LPUR covers computers and small sized batteries, while the LRHA covers home appliances like TV, refrigerators, washing machines, etc. In the LPUR system the consumers need not pay any extra recycling cost as the recycling cost is already included in the purchase price. Consumers often dispose their used computers either directly to the manufacturers or through post offices. In the case of the LRHA, consumers are responsible for the cost of transportation as well as e-waste recycling. The law requires the manufacturers to either have their own recycling facilities or outsource it to the commercial recycling companies to fulfil their recycling obligations (Gupt and Sahay, 2015).

In Nigeria, the extended producer responsibility policy is contained in section 11 of the National Environmental (Electrical/Electronic Sector) Regulations, 2011. This regulation mandates every importer, exporter, manufacturer, assembler, distributor and retailer of various brands of electrical electronic equipment to subscribe to an extended producer responsibility programme. The regulation states that it shall be the responsibility of manufacturers, importers, distributors or retailers to take back the end-of-life of electrical and electronic equipment through collection points/centres. Manufacturers and producers of electrical/electronic equipment are also to ensure environmentally sound management of e-wastes from collection points/centres to the National Environmental Standard Regulations and Enforcement Agency's (NESREA) accredited recycling centres. Also, consumers are expected to return their end-of-life electrical/electronic equipment to the

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collection points/centres. The agency responsible for the supervision and enforcement of this policy is NESREA (Ajani and Kunlere, 2019).

Port Harcourt city has been a destination for used electrical and electronic equipment, mainly imported from advanced nations, through the existing ports in the city. Many of the equipment have either expired or near expiration before they were shipped out, thereby increasing the quantum of e-wastes in the city, which has been observed along streets and dumpsites (Konya et al., 2015). The observed indiscriminate disposal of e-wastes in the city has encouraged the operations of informal recycling processes towards the recovery of useful components from the wastes for economic benefits. In a study conducted by Okwu et al, (2022) to assess the menace of informal waste electrical and electronic equipment recycling at MTN phone village, Rumukurushi, Port Harcourt, Nigeria, over 30 informal recyclers were identified at the mobile telephone network village. The study indicated that the informal recyclers lacked knowledge and awareness on e-waste management best practices, but rather, adopted primitive style of practice. Other findings indicated that in addition to causing environmental pollution, the informal recyclers were oblivious of health and safety requirements in the discharge of their duties. They also did not use personal protective equipment, thereby exposing themselves to immense health risks. consideration.

Fig 1 Waste Management in Vienna, Austria: Garbage Bins for Recycling on the Street
Source: Villorejo (2019)

Fig 2 Garbage Sorting Receptacles in a Public Building at Shanghai, China
Source: Huang et al. (2022)

II. MATERIALS AND METHOD

➢ *Area of Study*

- *Location*

Port Harcourt metropolis is defined by a broad area contained in the city master plan of 2008 referred to as Greater Port Harcourt City (Ede, 2014). The city (Figure 1.1) is located in Rivers State (Figure 1.2), an aspect of Nigeria. Port Harcourt is the capital of Rivers State. The city lies between latitudes 4° 42' and 4° 55'N and between longitudes 6°53' and 7° 08'E. At the east of Port Harcourt Local Government is bounded by Emohua Local Government Area while at the west is Eleme Local Government Area and at the North is Obio/Akpor Local Government Area and South is Okirika Local Government Area. The Port Harcourt Urban Area (Port Harcourt metropolis) is made up of Port Harcourt city itself and parts of Obio/Akpo Local Government Area (Ogbonna *et al*., 2007). Important communities situated within the metropolis include Azuabie Town, Abuloma, Agip, Amadi-Ama, Borokiri, Bundu-Ama, D-line, Diobu (mile 1,2,3) Old and New GRA, Ogbunabali, Elekahia, Nkpolu Oroworukwo, Nkpogu, Rumukalagbor, Eagle Island, Alakahia, Atali, Elimgbu, Woji, Rumuokwuta, Rumueme, Choba, Rumumasi, Elelenwo, Eligbam, Omagwa, Rumuokoro and Rumukurusi.

- *Climate*

Port Harcourt metropolis features a tropical monsoon climate with lengthy and heavy rainy seasons and very short dry seasons. Only the months of December and January truly qualifies as dry season months in the city. The harmattan, which climatically influences many cities in West Africa, is less pronounced in Port Harcourt. Port Harcourt's heaviest precipitation occurs during September with an average of 367 mm of rain. December on average is the driest month of the year; with an average rainfall of 20 mm. Temperatures throughout the year in the city is relatively constant, showing little variation throughout the course of the year. Average temperatures are typically between 25 °C-28 °C in the city (The Weather Network, 2014).

- *Geology and Topography*

The principal restraint to the development of Port Harcourt is the Bonny River and vast deltaic swamp area to the South of the town. On the east and west flanks of the city, meandering creeks further restricts the city's physical structure. Port Harcourt thus lies on the low lying coastal plain with a mean elevation of about 60 feet (18m). The northern coastal plain terrace consists of dry land, but the southern lower Delta plain terrace consists of small, isolated islands of firm ground in the vast delta area which is continuously being restructured by strong tidal and flood currents (Oyegun and Adeyemo, 1999).

- *Vegetation*

The vegetation of Port Harcourt is consistently nourished with high rainfall and moderate temperature, which provides favorable condition for the growth of varieties of trees like mahogany, obeche, afara and abundance of oil palm trees and several other species of economically valuable trees

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such as raffia palm, shrubs, ferns, and floating grasses. The major feature of the vegetation of the area is its distinctive three-layer canopy characteristics with the topmost canopy reaching a height of 35-40m, second layer within the range of 25-30m forming interlocking canopy which normally prevents the penetration to the ground surface land. The third layer is about I0m.

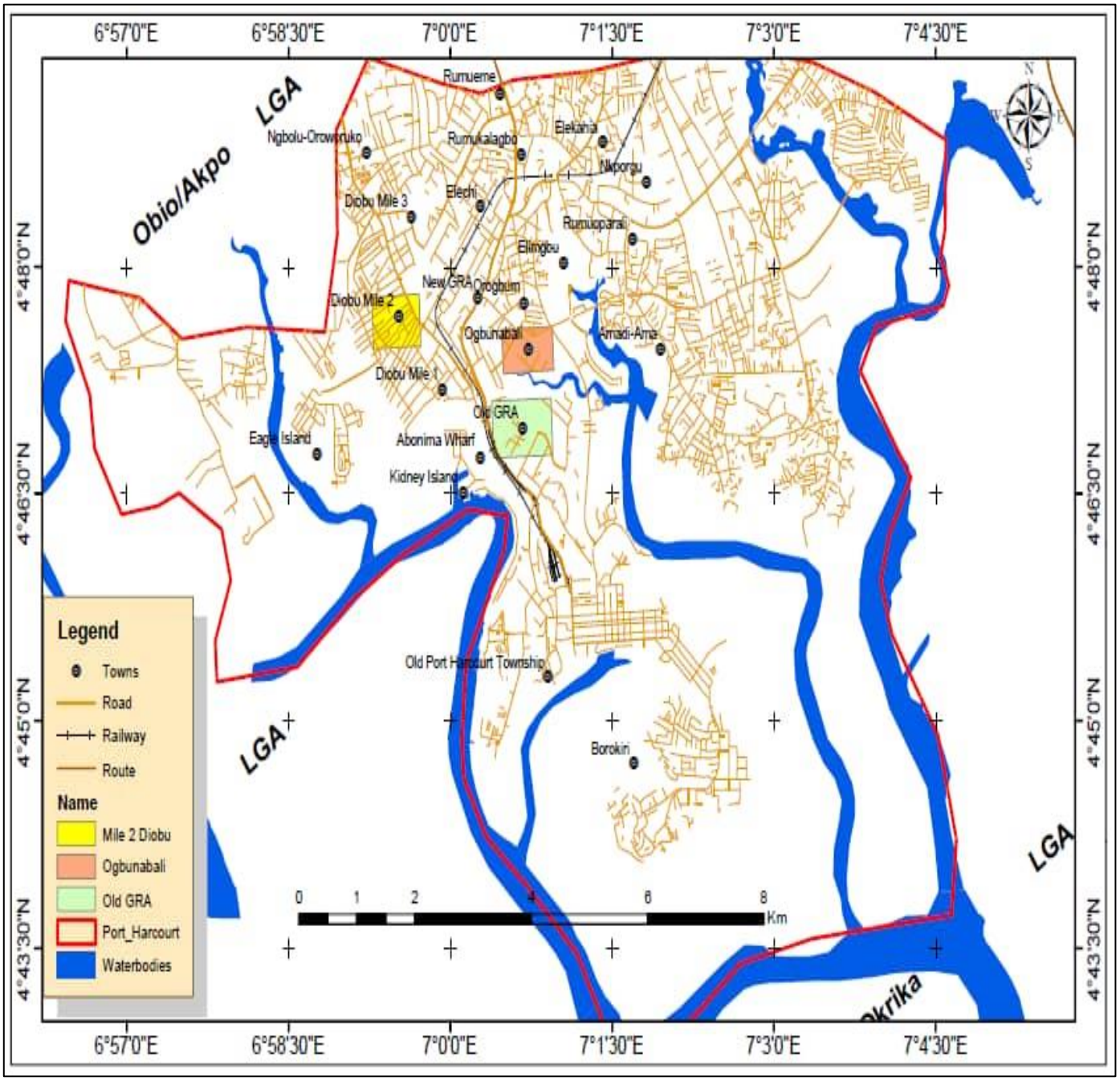

Fig 3 Port Harcourt
Source: Adapted from Nigerian Administrative Map Shapefile

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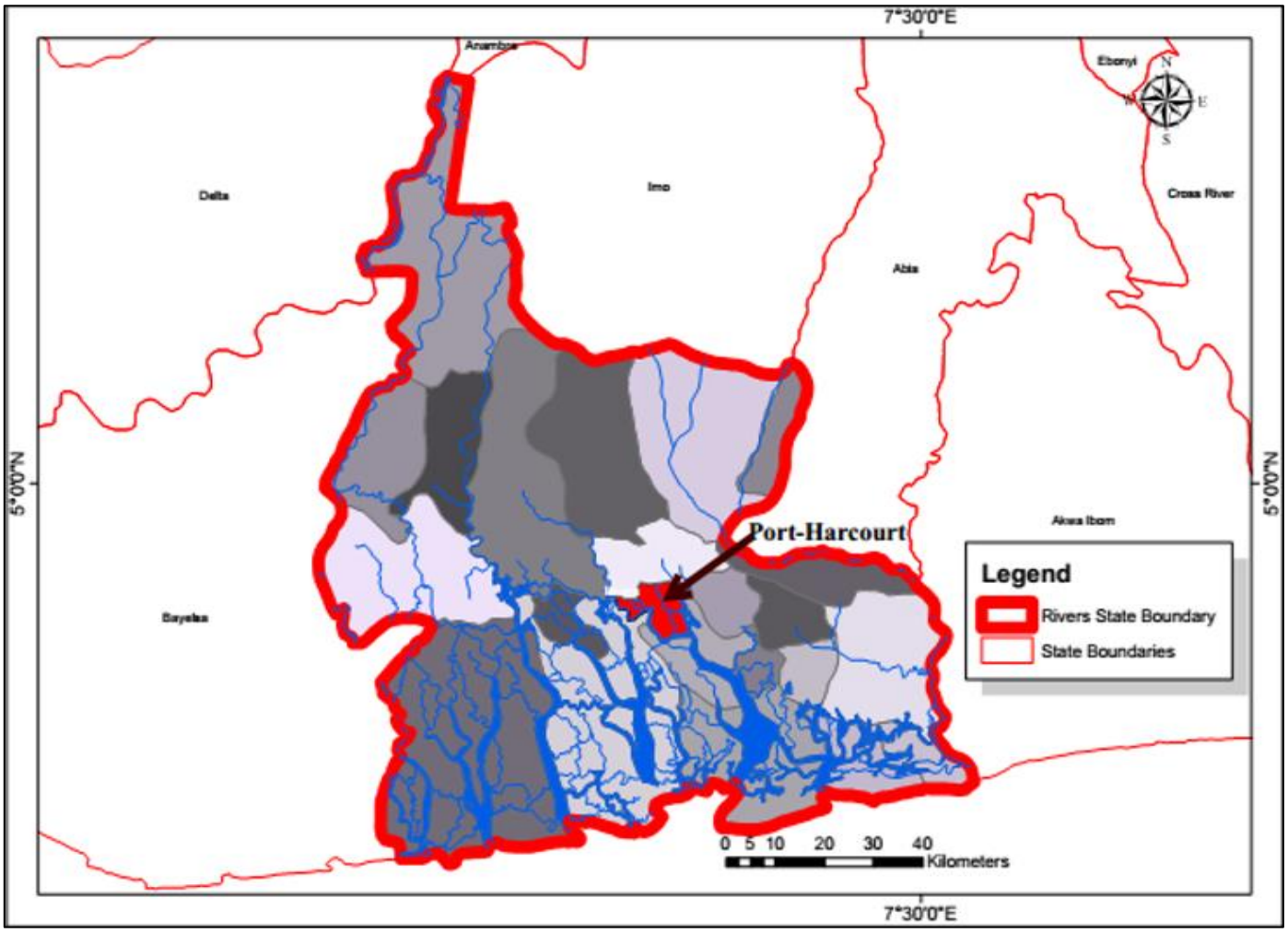

Fig 4 Rivers State Showing its Local Government Areas
Source: Adapted from Nigerian Administrative Map Shapefile

- *Population*

The city has witnessed enormous growth in its population, since its inception. Over the years the city has grown in leaps and bounds from a lean population of about 7,000 people in 1914 (Ogbonna, *et al*., 2007) to population of 440,399 according to the 1991 census (National Population Commission, 1992). Its current population is estimated to be 3,636,547 in 2024 (World Population Review). Port Harcourt is not only a key administrative center but also an important commercial and educational center as well as railway terminus with a viable sea and airport. It is now the center of Nigeria oil and gas industry. The city therefore is a veritable magnet that attracts immigrants not only from rural areas but also from other parts of the country.

- *Land Use*

The colonial government founded Port Harcourt to serve as a seaport and railway terminus and it attracted firms, government institutions and business outfits from other parts of Nigeria. Later the oil companies emerged to exploit the crude oil found in the state. Thus, the once labeled Garden City is now known as the Treasure Base of the Nation (Emenike, 1999 cited in Weli *et al*., 2009). The land use within the city is broadly divided into three categories: Residential, Commercial and Industrial Areas. Residential land use occupies the largest area. It is comprised of locations designated and reserved for high, middle and low income dwellers. The high-income areas include government residential areas (GRA) phases 1 and 2, Presidential Housing Estate, Rumubekwe, Silver Valley, and Shell Housing Estate, which are inhabited mostly by senior civil servants, business elites and professionals. The middle-income dwellers occupy places within Port Harcourt Old Township (Borikiri, Churchill, Aggrey Road, Creek Road, Bernard Car, and many more), D/Line, Odilily Road, Woji, Abuloma, Elelenwo, Rumumasi, Rumuola and Eagle Island. The low-income dwellers occupy places within Diobu (mile 1, 2 and 3), Eneka, Rainbow Town, and many more.

Commercial land use includes places like Aggrey Road, Forces Avenue, Azikiwe Road, Olu Obasanjo Road, Rumuola Road, lkwerre Road. Other areas include Mile 1, 2 and 3 Diobu, Town Market, Creek Road, Aggrey Road, Odili Road, Rumuomasi Market, Aba Road and Industry Road. The industrial land use can be divided into heavy and light industrial areas. The light industries are mainly situated at the Trans-Amadi Industrial Layout, while the heavy industries, such as petrochemicals, refineries and seaports are situated at Eleme and Onne.

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- *Economic Importance of Port Harcourt*

Following the discovery of crude oil in commercial quantities at Oloibiri in current Bayelsa State in 1956, the economy of Port Harcourt was transformed when the first shipment of Nigerian crude oil was exported through the city in 1958. The economy of Port Harcourt was further boosted around crude oil exploratory activities with the discovery of more oil wells in Rivers State and consequently, the city became the oil hub of Nigeria.

Port Harcourt is a major industrial centre in Nigeria. It has a large number of multinational firms and other industrial concerns mainly located at the Trans-Amadi Industrial Area. The area covers a landmass of a thousand-hectare (2,500-acre) and is considered a major industrial zone in Port Harcourt. Some of the companies located in the area include Total Nigeria Limited, International Breweries, Aluminum Works, Nigerian Engineering Works (NEW), Berger Paint and Dulux Paint. The availability of an airport at Omagwa in Ikwerre Local Government Area, seaports at Abonema wharf and Onne, respectively, as well as two major refineries at Eleme Local Government Area, has boosted commerce and commercial activities in Port Harcourt. The petroleum industry has had a direct and significant impact on the growth of the city. Major commercial activities of the city include trading, transportation, banking, estates development, hotels and catering and educational institutions (private and public schools).

- *Urban Growth*

Urban growth is characterized by expansion of built-up settlements through urban expansion. Port Harcourt occupied a landmass of 15.54 sq. kilometers belonging to the indigenous people of Ikwerre and Okirika, when it was established as a seaport and a railway terminus in 1912. The territory later grew to become a metropolis covering an area of 360 sq. kilometers in the 1980s (Owei *et al*., 2010). The buoyant economy of the city expectedly attracted an influx of people into the state, most of whom resided in Port Harcourt. The city could be described as containing planned and unplanned areas because of its rapid urbanization rate. Besides the major oil companies, such as Shell, Mobil, Total and Agip that had their headquarters in Port Harcourt, several multinational trading corporations, such as the United Africa Company (UAC), Patterson Zochonis (PZ), Lever Brothers and Coca-Cola also featured prominently in the city.

Urban growth can be attributed to several factors. Some of which include increased birthrate, migration from rural areas and from other urban areas in search of better living conditions. People may move from one location to another because of push or pull factors. Examples of push factors include insecurity, harsh economic conditions, and ethnic intolerance, while examples of pull factors include available economic opportunities, peace and tranquility and other conditions regarded as the opposite of push factors (Imaitor *et al.*, 2020). In view of this assertion, the rapid Port Harcourt urban growth could be attributed to migration primarily due to pull factors of economic opportunities, because of the presence of oil companies and other multinational trading conglomerates. The result of the influx of people into the city is congestion, due to the unplanned nature of some parts of the city. This thus led to overstretching of the available social amenities and created several urban informal settlements for low-income earners.

The influx of low-income earners in Port Harcourt, due to the pull factors of economic opportunities, have encouraged patronage of used electrical and electronic equipment in the city, because of their relatively low prices. Consequently, markets have been created for used electrical and electronic equipment at certain locations in the city, amongst which are the GSM market at Garrison and markets for television, refrigerator, musical instruments, washing machines, and other household appliances, at Iloabuchi and Ojoto Streets, Mile 2 Diobu. The obvious implication for the wide patronage of used electrical and electronic equipment, as observed in the city, is the indiscriminate disposal of e-wastes, because of their relatively short lifespan.

- *Prevalence of Used Electrical and Electronic Equipment in Port Harcourt*

The seaports at Abonema wharf and Onne, situated in Port Harcourt and Eleme respectively have created entry points for the shipments of used electrical and electronic equipment from foreign countries to Port Harcourt. There is therefore, a prevalence of used electrical and electronic equipment in Port Harcourt. Hotspots for the sale of used electrical and electronic equipment in Port Harcourt are located at Garrison (known for the sale of GSM and other telephone accessories), Ojoto and Iluabuchi streets (known for the sale of television sets, washing machines, refrigerators, musical equipment, public address systems, air conditioners and other household equipment) and Artillery (known for the sale of telephones, telecommunication equipment, computers, laptops and their accessories). This has been attributed as some of the reasons why an effective e-waste management system has become a necessity in Port Harcourt.

➢ *Research Design*

This study adopted a descriptive research design because it was aimed at observing, describing, and documenting the variables identified through a field survey. The study reported events as they were observed in the field without any form of manipulation. The study also employed a cross-sectional research design, which involved collecting data from a representative sample of the selected population at a single point in time. This approach enabled the researcher to gather comprehensive information and draw inferences that could be generalized to the broader target population.

➢ *Sources of Data*

- *Primary Data Source*

The primary data for this study were obtained through a field survey involving the administration of questionnaires to various stakeholders, including consumers, electrical and electronic equipment dealers, operators of Producer Responsibility Organizations (PROs), operators of recycling firms, the Rivers State Waste Management Authority (RIWAMA), key staff of the National Environmental

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Standards and Regulations Enforcement Agency (NESREA), and key staff of the Rivers State Ministry of Environment. In addition, direct observations of events related to the variables under investigation were conducted, while interviews were held with key actors within the Extended Producer Responsibility (EPR) policy management value chain. The engagement of these major stakeholders enabled the study to gain a comprehensive understanding of the quantity and types of electronic waste generated within the metropolis. This approach provided crucial insights into the existing challenges and effectiveness of current e-waste management practices, thereby supporting a robust assessment of the impact of the Extended Producer Responsibility (EPR) policy.

- *Secondary Data Source*

Secondary data for this study were obtained from a variety of credible sources, including peer-reviewed journal articles, published books, official documents, and relevant materials accessed both in print and through online databases. Additional information was sourced from institutional records and published statistics relating to the study area, particularly from the National Environmental Standards and Regulations Enforcement Agency (NESREA), the Rivers State Waste Management Authority (RIWAMA), and the Rivers State Ministry of Environment.

- *Types of Data Required in the Study*

✓ *Quantitative Data (Obtained from Questionnaire Survey)*

Quantitative data were collected through the administration of questionnaires. These data provided measurable insights into public and stakeholder perceptions, levels of awareness, compliance, participation, and involvement in the implementation of the Extended Producer Responsibility (EPR) policy.

✓ *Secondary Data (Documentary Review and Official Records)*

Secondary data consisted of existing information obtained from authoritative sources that provided historical, regulatory, and statistical context for the study. These included:

- Published literature on Extended Producer Responsibility (EPR) and electronic waste management.
- Government reports, policy documents, and environmental regulations.
- Records and reports from NESREA, RIWAMA, and the Rivers State Ministry of Environment.
- Statistical data on electronic waste generation, collection, recycling, and disposal practices.
- Relevant national and international reports on electronic waste management and environmental sustainability.

Table 1 Chemical Components of E-Waste

Contaminant	**E-waste Component**
Polybrominated diphenyl ethers (PBDEs) polybrominatedbiphenyls (PBBs) tetrabromobisphenol-A (TBBPA)	Flame retardants
Polychlorinated biphenyls (PCB)	Condensers, transformers
Chlorofluorocarbon (CFC)	Cooling units, insulation foam
Polycyclic aromatic hydrocarbons (PAHs)	Product of combustion
Polyhalogenated aromatic hydrocarbons (PHAHs)	Product of low-temperature combustion
Polychlronated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs)	Product of low-temperature combustion of PVCs and other plastic
Americium (Am)	Smoke detectors
Antimony (Sb)	Flame retardants, plastics
Arsenic (As)	Doping material
Barium (Ba)	Getters in cathode ray tubes (CRTs)
Beryllium (Be)	Silicon-controlled rectifiers
Cadmium (Cd)	Batteries, toners, plastics
Chromium (Cr)	Data tapes and floppy disks
Copper (Cu)	Wiring
Gallium (Ga)	Semiconductors
Indium (In)	LCD displays
Lead (Pb)	Solder, CRTs, batteries
Lithium (Li)	Batteries
Mercury (Hg)	Fluorescent lamps, batteries, switches
Nickel (Ni)	Batteries
Selenium (Se)	Rectifiers
Silver (Ag)	Wiring, switches
Tin (Sn)	Solder, LCD screens
Zinc (Zn) and rare earth elements	CRT screens

E-waste: An assessment of global production and environmental impacts
Source: Robinson (2009) *http://www.kiwiscience.com/JournalArticles/STOTEN2009.pdf*

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Table 2 Substances Contained in Mobile Phones

Name of Substance	Location	Percentage (%) Content
Plastics	Case, circuit board	40%
Glass, ceramics	LCD screen, chips	20%
Copper, compounds	Circuit board, wires, connectors, batteries	10%
Nickel, compounds	NiCd or NMH batteries	2-10%
Potassium hydroxide	battery, NiCd, NiMH	5%
Cobalt	Lithium-ion Battery	1-5%
Carbon	Batteries	5%
Aluminum	Case, frame, batteries	3%
Steel, ferrous metal	Case, frame, charger, batteries	10%
Bromine	Circuit board	
Cadmium	NiCd battery	
Chromium	Case, frame	
Lead	Circuit board	
Antimony	Case; circuit board	
Arsenic	Gallium arsenide LED	
Silver	Circuit board, keypad	
Gold	Connectors, circuit board	
Zinc	Circuit board	
Barium	Circuit board	

Source: Basel Convention (2010). Mobile Phone Partnership Initiative

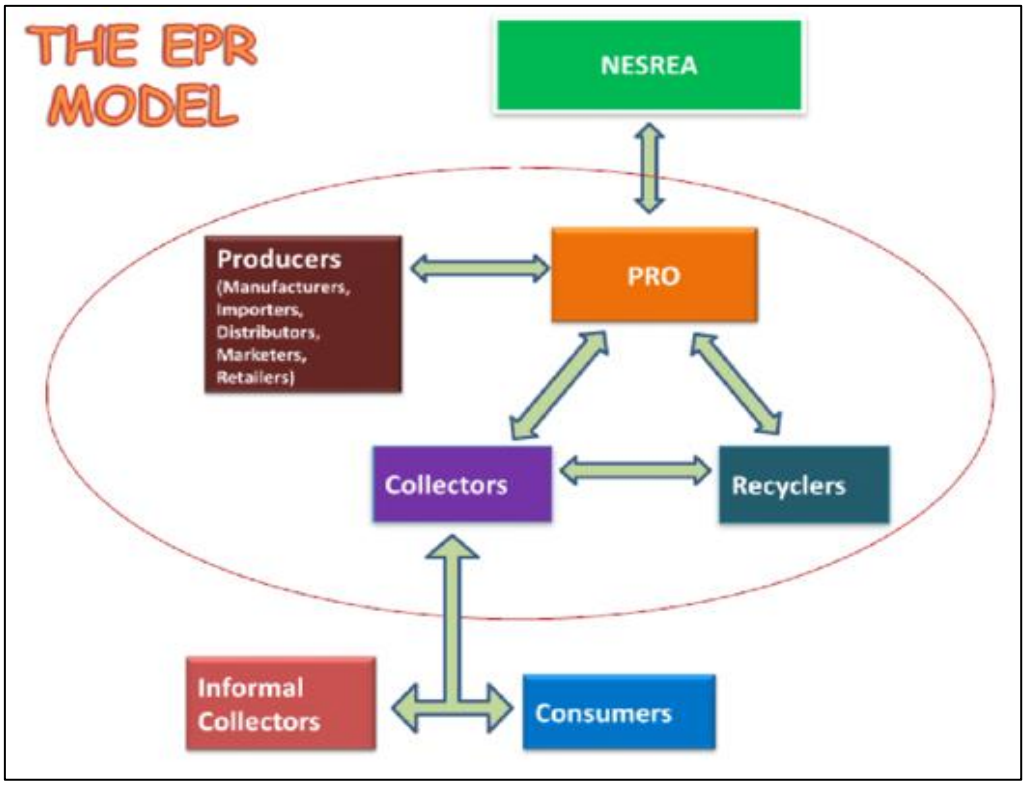

Fig 5 The Extended Producer Responsibility Model in Nigeria
Source: Idowu Kunlere

➢ *Population, Sample and Sampling Technque*

- *Population*

The population of the study included all households (consumers) in Port Harcourt Metropolis, shop owners engage in the sale of electrical and electronic equipment, repairers of used electrical and electronic equipment, recycling companies, manufacturers of electrical and electronic equipment or their agents and producer responsibility organizations (PROs).

The population figures for Port Harcourt metropolis from the 2006 census stood at 462,350 for Port Harcourt Local Government Area (LGA) and 530,702 for Obio-Apkor LGA, with an annual growth rate of 3.02%. Combined, this totaled 993,052 (National Population Commission of Nigeria,

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2006). Utilizing this growth rate, a projection was made to estimate the current population for 2024 using the population growth model proposed by Liu *et al.*, (2021). This will also include staffs of NESREA and RIWAMA.

The population was projected using

$$P_t = P_0 e^{r\Delta t} \quad (1)$$

Where

- ✓ P_t = Projected population at time *t* (in years)
- ✓ P_0 = Initial population = 993,052
- ✓ e = Exponential growth constant
- ✓ r = Annual population growth rate in percentage (3.02%)
- ✓ Δt = Absolute change in time (in years) = 19

So we obtained the 2025 projected population of Port Harcourt metropolis as

$$P_{2025} = 993{,}052\left(e^{(0.0302)(19)}\right)$$

$$P_{2025} = 1{,}762{,}667$$

Thus using the formula we obtained the 2024 projected population of the study area to be approximately 1,762,667.

- *Sample Size Determination*

According to Yamane (1967) and Israel (1992), the sampling size of any population that is more than 100,000 persons is 400 using the equation below at ±5% level of precision. However, our population is small and thus our sample size will also be smaller.

The sampling method is given thus:

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

Where

- ✓ n = sample size
- ✓ N = population size
- ✓ e = level of significant (usually ±5%)

So we have

$$n = \frac{1{,}762{,}667}{1 + 1{,}762{,}667\ (0.05^2)} \simeq 400$$

Hence a sample size of 400 will be used in this study in this study.

➢ *Sampling Techniques*

In conducting a socio-economic study within Port Harcourt Metropolis, the adoption of a robust and well-considered sampling strategy is critical to ensuring the collection of accurate and representative data. This study will employ a stratified random sampling technique to guarantee adequate representation of all relevant population segments. Port Harcourt Metropolis comprises Port Harcourt City Local Government Area (PHALGA) and parts of Obio-Akpor Local Government Area. The selection of a stratified sampling approach is informed by the heterogeneous nature of the population, which is composed of multiple, non-overlapping subgroups (strata).

By stratifying the population based on geographic location—specifically by LGA—this method facilitates a systematic and comprehensive representation of the study area. Each LGA will be treated as a distinct stratum, acknowledging the potential socio-economic variations and unique characteristics that may exist across different parts of the metropolis. This approach enhances the reliability and generalizability of the study findings across the broader population. Field surveys, questionnaires, was deployed to achieve the objectives of this research.

➢ *Method of Data Collection*

Data for this study will be collected using both quantitative and qualitative approaches to ensure a comprehensive understanding of the impacts of the Extended Producer Responsibility (EPR) policy on e-waste management and its role in promoting a circular economy within Port Harcourt Metropolis.

The survey shall be distributed to both residents and key stakeholders involved in the implementation of the EPR policy. These stakeholders shall include producers, consumers, recyclers, retailers, government agencies, and producer responsibility organization.

The survey questionnaire will consist of various sections aimed at assessing the level of awareness, implementation challenges, and the performance of stakeholders in adhering to their responsibilities under the EPR policy. The instrument will use a 5-point Likert scale to capture responses ranging from Strongly Disagree (SD) to Strongly Agree (SA), enabling the quantification of opinions and perceptions on key aspects of the policy's effectiveness and implementation. The survey shall be administered through both physical distribution and online platforms to ensure that a broad sample of participants from different demographics and sectors are reached, thereby providing a comprehensive view of the situation in Port Harcourt Metropolis.

In addition to the quantitative data, qualitative data will be obtained through in-depth interviews with selected stakeholders. These interviews aim to explore deeper insights into the practical realities, challenges, and contextual issues affecting the implementation of the EPR policy. The interviews will be semi-structured to allow flexibility while maintaining consistency across sessions. This qualitative component is intended to complement the survey findings by capturing nuanced perspectives that may not be fully expressed through structured questionnaires.

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III. RESULTS

➢ *Demographic Characteristics*

Table 3 Demographic Characteristics of Respondents

Variable	Category	Frequency	Percentage (%)
LGA of Residence/Business	PHALGA	158	40.8
	OBALGA	229	59.2
	Total	**387**	**100**
PHALGA Location (n = 158)	Azuabie Town	8	5.1
	Abuloma	9	5.7
	Agip	10	6.3
	Amadi Ama	8	5.1
	Borokiri	10	6.3
	Bundu Ama	8	5.1
	D-Line	15	9.5
	Diobu	25	15.8
	Old GRA	9	5.7
	New GRA	10	6.3
	Ogbunabali	12	7.6
	Elekahia	9	5.7
	Nkpolu Oroworukwo	8	5.1
	Nkpogu	7	4.4
	Rumukalagbor	6	3.8
	Eagle Island	6	3.8
	Other	8	5.1
	Total	**158**	**100**
OBALGA Location (n = 229)	Alakahia	29	12.7
	Atali	17	7.4
	Woji	43	18.8
	Rumuokwuta	37	16.2
	Choba	35	15.3
	Rumuomasi	31	13.5
	Elelenwo	21	9.2
	Eligbam	10	4.4
	Other	6	2.6
	Total	**229**	**100**
Gender	Male	219	56.6
	Female	168	43.4
	Total	**387**	**100**
Type of Premises	Household	214	55.3
	Business Premises	119	30.7
	Both	54	14
	Total	**387**	**100**
Age (Years)	18–25	61	15.8
	26–33	101	26.1
	34–41	99	25.6
	42–49	65	16.8
	50–57	39	10.1
	58 and Above	22	5.7
	Total	**387**	**100**
Educational Attainment	Primary School	22	5.7
	Secondary School	76	19.6
	ND/HND/B.Sc.	191	49.4
	M.Sc.	53	13.7
	Ph.D.	17	4.4
	Others	28	7.2
	Total	**387**	**100**
Employment Status	Government Employee	68	17.6

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	Private Employee	101	26.1
	Self-Employed	133	34.4
	Unemployed	38	9.8
	Student	47	12.1
	Total	**387**	**100**
Monthly Income	Less than ₦20,000	32	8.3
	₦20,000–₦50,000	70	18.1
	₦51,000–₦80,000	79	20.4
	₦81,000–₦100,000	57	14.7
	₦101,000–₦130,000	48	12.4
	₦131,000–₦150,000	34	8.8
	₦151,000–₦500,000	49	12.7
	₦501,000–₦1,000,000	12	3.1
	₦1,100,000 and Above	6	1.6
	Total	**387**	**100**
Role in E-Waste Management	Producer/Manufacturer	24	6.2
	Consumer	281	72.6
	Recycler	36	9.3
	Policymaker/Government Official	16	4.1
	Other	30	7.8
	Total	**387**	**100**
Years of Experience	Less than 1 year	49	12.7
	1–3 years	123	31.8
	4–6 years	97	25.1
	7–10 years	69	17.8
	More than 10 years	49	12.7
	Total	**387**	**100**

Source: Researcher's Field Study, 2026.

➢ *Impacts of the Extended Producer Responsibility (EPR) Policy on E-Waste Management in Port Harcourt Metropolis*

Table 4 Respondents' Perception of the Impacts of the Extended Producer Responsibility (EPR) Policy on E-Waste Management in Port Harcourt Metropolis

Variable	Category	Frequency	Percentage (%)
The EPR policy has increased awareness of proper e-waste disposal methods among residents in Port Harcourt.	Strongly Disagree	38	9.8
	Disagree	83	21.4
	Undecided	59	15.2
	Agree	132	34.1
	Strongly Agree	75	19.4
	Total	**387**	**100**
Producers in Port Harcourt are effectively implementing the EPR policy by creating systems for collecting used electronics.	Strongly Disagree	52	13.4
	Disagree	94	24.3
	Undecided	67	17.3
	Agree	111	28.7
	Strongly Agree	63	16.3
	Total	**387**	**100**
The EPR policy has led to an increase in formal recycling activities in Port Harcourt.	Strongly Disagree	44	11.4
	Disagree	81	20.9
	Undecided	62	16
	Agree	126	32.6
	Strongly Agree	74	19.1
	Total	**387**	**100**
Consumers are more likely to participate in e-waste recycling programs because of the EPR policy.	Strongly Disagree	36	9.3
	Disagree	78	20.2
	Undecided	65	16.8

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	Agree	132	34.1
	Strongly Agree	76	19.6
	Total	**387**	**100**
E-waste disposal points and recycling centres are now more accessible in Port Harcourt due to the EPR policy.	Strongly Disagree	63	16.3
	Disagree	97	25.1
	Undecided	60	15.5
	Agree	104	26.9
	Strongly Agree	63	16.3
	Total	**387**	**100**
Enforcement of the EPR policy by the government has been effective in reducing informal e-waste dumping.	Strongly Disagree	71	18.3
	Disagree	101	26.1
	Undecided	58	15
	Agree	96	24.8
	Strongly Agree	61	15.8
	Total	**387**	**100**
The EPR policy has contributed to a reduction in environmental pollution caused by e-waste in Port Harcourt.	Strongly Disagree	42	10.9
	Disagree	79	20.4
	Undecided	61	15.8
	Agree	127	32.8
	Strongly Agree	78	20.2
	Total	**387**	**100**
The EPR policy encourages producers to design products that are easier to recycle.	Strongly Disagree	47	12.1
	Disagree	82	21.2
	Undecided	63	16.3
	Agree	121	31.3
	Strongly Agree	74	19.1
	Total	**387**	**100**
Collaboration between producers, consumers, and recyclers has improved due to the EPR policy.	Strongly Disagree	49	12.7
	Disagree	86	22.2
	Undecided	64	16.5
	Agree	118	30.5
	Strongly Agree	70	18.1
	Total	**387**	**100**
The EPR policy is a significant step toward achieving a circular economy in Port Harcourt.	Strongly Disagree	33	8.5
	Disagree	69	17.8
	Undecided	63	16.3
	Agree	140	36.2
	Strongly Agree	82	21.2
	Total	**387**	**100**

Source: Researcher's Field Study, 2026.

Table 5 Independent Samples t-Test Comparing Respondents' Perception of the Impacts of the EPR Policy Based on Agreement Level

Group	Category	Frequency (n)	Mean Score	Std. Deviation	t-value	df	Sig. (2-tailed)	Decision
Disagreeing Group	Strongly Disagree + Disagree + Undecided	148	2.21	0.71	-24.87	385	0.003	Significant
Agreeing Group	Agree + Strongly Agree	239	4.24	0.63				
Total		**387**						

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➢ *Implementation of the Extended Producer Responsibility (EPR) Policy by NESREA in Port Harcourt Metropolis*

Table 6 Respondents' Perception of the Implementation of the Extended Producer Responsibility (EPR) Policy by NESREA in Port Harcourt Metropolis

Variable	Category	Frequency	Percentage (%)
The EPR policy has increased awareness of proper e-waste disposal methods among residents in Port Harcourt.	Strongly Disagree	38	9.8
	Disagree	83	21.4
	Undecided	59	15.2
	Agree	132	34.1
	Strongly Agree	75	19.4
	Total	**387**	**100**
Producers in Port Harcourt are effectively implementing the EPR policy by creating systems for collecting used electronics.	Strongly Disagree	52	13.4
	Disagree	94	24.3
	Undecided	67	17.3
	Agree	111	28.7
	Strongly Agree	63	16.3
	Total	**387**	**100**
The EPR policy has led to an increase in formal recycling activities in Port Harcourt.	Strongly Disagree	44	11.4
	Disagree	81	20.9
	Undecided	62	16
	Agree	126	32.6
	Strongly Agree	74	19.1
	Total	**387**	**100**
Consumers are more likely to participate in e-waste recycling programs because of the EPR policy.	Strongly Disagree	36	9.3
	Disagree	78	20.2
	Undecided	65	16.8
	Agree	132	34.1
	Strongly Agree	76	19.6
	Total	**387**	**100**
E-waste disposal points and recycling centres are now more accessible in Port Harcourt due to the EPR policy.	Strongly Disagree	63	16.3
	Disagree	97	25.1
	Undecided	60	15.5
	Agree	104	26.9
	Strongly Agree	63	16.3
	Total	**387**	**100**
Enforcement of the EPR policy by the government has been effective in reducing informal e-waste dumping.	Strongly Disagree	71	18.3
	Disagree	101	26.1
	Undecided	58	15
	Agree	96	24.8
	Strongly Agree	61	15.8
	Total	**387**	**100**
The EPR policy has contributed to a reduction in environmental pollution caused by e-waste in Port Harcourt.	Strongly Disagree	42	10.9
	Disagree	79	20.4
	Undecided	61	15.8
	Agree	127	32.8
	Strongly Agree	78	20.2
	Total	**387**	**100**
The EPR policy encourages producers to design products that are easier to recycle.	Strongly Disagree	47	12.1
	Disagree	82	21.2
	Undecided	63	16.3
	Agree	121	31.3

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	Strongly Agree	74	19.1
	Total	**387**	**100**
Collaboration between producers, consumers, and recyclers has improved due to the EPR policy.	Strongly Disagree	49	12.7
	Disagree	86	22.2
	Undecided	64	16.5
	Agree	118	30.5
	Strongly Agree	70	18.1
	Total	**387**	**100**
The EPR policy is a significant step toward achieving a circular economy in Port Harcourt.	Strongly Disagree	33	8.5
	Disagree	69	17.8
	Undecided	63	16.3
	Agree	140	36.2
	Strongly Agree	82	21.2
	Total	**387**	**100**

Source: Researcher's Field Study, 2026.

Table 7 Independent Samples t-Test Comparing Respondents' Perception of the Implementation of the Extended Producer Responsibility (EPR) Policy by NESREA Based on Agreement Level

Group	Category	Frequency (n)	Mean Score	Std. Deviation	t-value	df	Sig. (2-tailed)	Decision
Disagreeing Group	Strongly Disagree + Disagree + Undecided	158	2.26	0.72	**-25.61**	**385**	**0**	**Significant**
Agreeing Group	Agree + Strongly Agree	229	4.18	0.65				
Total		**387**						

- *Challenges Encountered by Various Stakeholders of the EPR Policy While Performing Their Respective Duties*

Table 8 Respondents' Perception of the Challenges Encountered by Various Stakeholders of the EPR Policy While Performing Their Respective Duties

Variable	Category	Frequency	Percentage (%)
Producers face financial constraints in implementing take-back and recycling programmes.	Strongly Disagree	18	4.7
	Disagree	35	9
	Neutral	47	12.1
	Agree	171	44.2
	Strongly Agree	116	30
	Total	**387**	**100**
Consumers lack awareness and incentives to participate in e-waste collection and recycling initiatives.	Strongly Disagree	16	4.1
	Disagree	28	7.2
	Neutral	41	10.6
	Agree	178	46
	Strongly Agree	124	32
	Total	**387**	**100**
Recyclers encounter difficulties accessing modern facilities for processing e-waste.	Strongly Disagree	17	4.4
	Disagree	30	7.8
	Neutral	45	11.6
	Agree	169	43.7
	Strongly Agree	126	32.6
	Total	**387**	**100**
Retailers are reluctant to engage in take-back schemes due to logistical challenges.	Strongly Disagree	20	5.2
	Disagree	36	9.3

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	Neutral	58	15
	Agree	164	42.4
	Strongly Agree	109	28.2
	Total	**387**	**100**
Government agencies face limited resources to enforce compliance with the EPR policy.	Strongly Disagree	15	3.9
	Disagree	26	6.7
	Neutral	39	10.1
	Agree	175	45.2
	Strongly Agree	132	34.1
	Total	**387**	**100**
The absence of a robust monitoring system hinders effective implementation of the EPR policy.	Strongly Disagree	17	4.4
	Disagree	29	7.5
	Neutral	40	10.3
	Agree	171	44.2
	Strongly Agree	130	33.6
	Total	**387**	**100**
Stakeholders experience a lack of collaboration and coordination in implementing the EPR policy.	Strongly Disagree	19	4.9
	Disagree	33	8.5
	Neutral	48	12.4
	Agree	166	42.9
	Strongly Agree	121	31.3
	Total	**387**	**100**
The informal sector's involvement in e-waste management disrupts formal recycling processes.	Strongly Disagree	18	4.7
	Disagree	27	7
	Neutral	44	11.4
	Agree	168	43.4
	Strongly Agree	130	33.6
	Total	**387**	**100**
Stakeholders face challenges with policy clarity and interpretation of their specific roles.	Strongly Disagree	21	5.4
	Disagree	39	10.1
	Neutral	53	13.7
	Agree	159	41.1
	Strongly Agree	115	29.7
	Total	**387**	**100**
Limited funding and infrastructure impede the achievement of EPR policy goals in Port Harcourt.	Strongly Disagree	13	3.4
	Disagree	24	6.2
	Neutral	37	9.6
	Agree	174	45
	Strongly Agree	139	35.9
	Total	**387**	**100**

Source: Researcher's Field Study, 2026.

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Table 9 Independent Samples t-Test Comparing Respondents' Perception of Challenges Encountered by Stakeholders in EPR Policy Implementation

Group	Category	Frequency (n)	Mean Score	Std. Deviation	t-value	df	Sig. (2-tailed)	Decision
Disagreeing Group	Strongly Disagree + Disagree + Neutral	117	2.18	0.68	**-29.64**	**385**	**0.002**	**Significant**
Agreeing Group	Agree + Strongly Agree	270	4.31	0.59				
Total		**387**						

IV. DISCUSSIONS

Table 5 shows that, in general, the respondents perceived that the Extended Producer Responsibility (EPR) policy had a positive impact on the management of electronic waste in Port Harcourt Metropolis. The majority of respondents agreed that the policy has: raised awareness about correct e-waste disposal methods (53.5%); encouraged consumers to join e-waste recycling programmes (53.7%); promoted formal recycling activities (51.7%); and is a significant step towards a circular economy (57.4%). Nevertheless, respondents expressed comparatively low levels of agreement on the availability of e-waste collection centres (43.2%) and the efficacy of government enforcement in curbing informal e-waste dumping (40.6%). These results indicate that while respondents recognise potential benefits of the EPR policy, there are apprehensions about its practical implementation, particularly in terms of enforcement and infrastructure.

The independent samples t-test results in Table 5 also indicated a statistically significant difference between the agreeing and disagreeing groups on perceived impacts of the EPR policy (t = -24.87, df = 385, p = .003). Higher scores on the positive perceptions of the policy impacts were obtained from respondents in the agreeing group (M = 4.24, SD = 0.63) than those in the disagreeing group (M = 2.21, SD = 0.71). The great finding show that there is a general acknowledgement by respondents on EPR policy as an important way of improving electronic waste management despite existing implementation challenges.

These findings are in line with Forti et al (2020) who stated that countries that implement EPR policies have better e-waste collection systems, higher public awareness and more efficient recycling. Similarly, Faibil et al. (2023) showed that producer responsibility schemes improve environmental sustainability through proper collection, recovery and recycling of end-of-life electronic products. The relatively low agreement on government enforcement and collection infrastructure is consistent with Wirtu et al. (2025) who observed that many developing countries continue to struggle with insufficient enforcement mechanisms, limited recycling infrastructure, and weak institutional capacity, which undermines the effectiveness of EPR programs.

Table 6 indicates that respondents had mixed perceptions on the implementation of the Extended Producer Responsibility policy by the National Environmental Standards and Regulations Enforcement Agency (NESREA). While the respondents largely agreed that the agency had been instrumental in raising awareness and promoting stakeholder participation, a comparatively smaller number of respondents felt that NESREA had effectively enforced compliance, provided adequate collection facilities or improved monitoring activities. The responses indicate that the regulatory framework is in place but its implementation has not yet reached the level of effectiveness expected by most stakeholders.

The independent samples t-test results in Table 7 showed a statistically significant difference between the respondents in the agreeing and disagreeing groups (t = -25.61, df = 385, p <.001). The agreeing group scored higher on the mean (M = 4.18, SD = 0.65) than the disagreeing group (M = 2.26, SD = 0.72). This suggests that a significant difference existed between the respondents who viewed the implementation of NESREA positively and those who viewed the implementation as inadequate. This finding suggests that the agency has made progress but nevertheless the gaps in implementation are large.

The findings concur with Atieno et al. (2026) who stressed that effective regulatory enforcement, stakeholder collaboration, adequate financing, and continuous monitoring are critical for the success of EPR implementation. Similarly, Arum et al. (2024) reported that the weak institutional capacity, logistics and technical resources are still hampering the effective electronic waste governance in many African countries. The results are also in line with Odeyingbo et al. (2025) who found that the effectiveness of EPR legislation, adopted in many developing countries, is hampered by weak enforcement and poor recycling infrastructure.

The results in Table 8 show that majority of the respondents were in agreement that many obstacles still hinder the implementation of the Extended Producer Responsibility policy in Port Harcourt Metropolis. More than two-thirds of the respondents agreed that producers are financially constrained in implementing take-back programmes (74.2%), consumers do not have adequate awareness and incentives to participate in recycling initiatives (78.0%), recyclers face difficulties in accessing modern recycling facilities (76.3%) and government agencies are working with limited financial and institutional resources (79.3%). Respondents also cited lack of adequate monitoring systems, poor stakeholder collaboration, policy ambiguity, dominance of the informal recycling sector and inadequate funding and infrastructure as major barriers to effective EPR implementation.

Table 8 shows the independent samples t-test result, which revealed a statistically significant difference between respondents in the agreeing group and respondents in the

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disagreeing group (t = -29.64, df = 385, p = .002). The agreeing group of respondents scored significantly higher (M = 4.31, SD = 0.59) than the disagreeing group (M = 2.18, SD = 0.68), which suggests broad agreement that these challenges significantly impede the successful implementation of the EPR policy. Another confirmation of the fact that the respondents strongly regarded the stakeholder-related constraints as significant impediments to sustainable e-waste management is the significant t-test result.

The results are consistent with the findings of Debrah et al. (2022) who identified inadequate financing, weak governance systems, poor institutional coordination and limited technical capacity as major impediments to sustainable waste management in developing countries. Similarly, Atieno et al. (2026) found that informal recycling activities, poor collection infrastructure, lack of monitoring systems and poor enforcement of policies are some of the major challenges facing e-waste management in Africa. Likewise, Gupta and Dash, (2023). identified strengthening institutional capacity, improving stakeholder collaboration, expanding recycling infrastructure and increasing public awareness as fundamental requirements for successful implementation of Extended Producer Responsibility policies.

V. CONCLUSION

The study investigated the effect of Extended Producer Responsibility (EPR) policy on electronic waste management in Port Harcourt Metropolis, Rivers State, Nigeria. The results indicated that the respondents generally viewed the EPR policy as having a positive impact on e-waste management through higher awareness in the public, higher participation in recycling and a higher awareness of the importance of a circular economy. The study however found that the implementation of the policy by the regulatory authorities especially NESREA is still constrained by weak enforcement, inadequate monitoring, insufficient collection infrastructure and limited collaboration among stakeholders. Moreover, producers, recyclers, consumers and government agencies still face huge financial, technical and institutional challenges in the effective implementation of the EPR policy. Independent samples t-tests showed statistically significant differences between those who agreed and those who disagreed on the impacts of the policy, the effectiveness of its implementation and the challenges encountered (Table 5), indicating that these issues are widely recognised by stakeholders.

These findings suggest that NESREA and other relevant government agencies should intensify the enforcement of the EPR policy through regular monitoring, inspections and strict compliance on producers and importers of electrical and electronic equipment. “Also, the government should make e-waste collection centres more accessible in Port Harcourt Metropolis and provide financial and technical support to licensed recyclers for better recycling capacity. Continuous public awareness campaigns should be intensified to educate households, businesses and consumers on proper e-waste disposal practices and the benefits of participating in take back programmes. Moreover, increased collaboration between government agencies, producers, recyclers, retailers and the informal sector should be promoted to create an integrated and sustainable e-waste management system that can facilitate the effective implementation of the EPR policy and catalyse Nigeria’s move to a circular economy.

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REFERENCES

[1]. Ajani, O. I., & Kunlere, M. O. (2019). *Extended producer responsibility (EPR) programme for electrical and electronic waste management in Nigeria*. National Environmental Standards and Regulations Enforcement Agency (NESREA).

[2]. Arum, E. C., Nwosu, E. O., Nwatu, S. I., & Chime, I. P. (2024). Strategies for E-Waste Management in West Africa: A Comparative Study of Nigeria and Ghana. *International Journal of Development and Sustainability*, *13*(5), 367-383.

[3]. Athanasios, V. (2018). Circular economy: Concept, challenges, and opportunities. *Environmental Economics and Policy Studies, 20*(1), 1–15.

[4]. Atieno, E., Ikapel, F., Birundu, J., Tampushi, L., Ayuma, C., Tanui, E., & Esau, K. (2026). Extended Producer Responsibility (EPR) Regulations: A Comprehensive Literature Review for Regulatory Impact Assessment (RIA) in Kenya. *Journal of Geoscience and Environment Protection*, *14*(2), 117-156.

[5]. Baldé, C. P., Forti, V., Gray, V., Kuehr, R., & Stegmann, P. (2017). *The Global E-waste Monitor 2017: Quantities, flows and resources*. United Nations University, International Telecommunication Union, and International Solid Waste Association.

[6]. Calliafas, F. (2012). Waste electrical and electronic equipment (WEEE) legislation in the United Kingdom: An overview. *Journal of Environmental Law and Policy, 14*(2), 85–98.

[7]. Campbell-Johnston, K., Vermeulen, W. J. V., de Olde, E. M., & Reike, D. (2022). Extended producer responsibility in the European Union: Lessons for the circular economy. *Journal of Cleaner Production, 337*, 130489.

[8]. Debrah, J. K., Teye, G. K., & Dinis, M. A. P. (2022). Barriers and challenges to waste management hindering the circular economy in Sub-Saharan Africa. *Urban Science, 6*(3), 57.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug574

[9]. Faibil, D., Asante, R., Agyemang, M., Addaney, M., & Baah, C. (2023). Extended producer responsibility in developing economies: Assessment of promoting factors through retail electronic firms for sustainable e-waste management. *Waste Management & Research, 41*(1), 117-142.
[10]. Forti, V., Baldé, C. P., Kuehr, R., & Bel, G. (2020). The global e-waste monitor 2020. *United Nations University (UNU), International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/Geneva/Rotterdam, 120*, 14.
[11]. Grönkvist, S. (2022). Extended producer responsibility for waste electrical and electronic equipment in the European Union. *Resources, Conservation and Recycling Advances, 15*, 200089.
[12]. Gupt, Y., & Sahay, S. (2015). Review of extended producer responsibility: A case study approach. *Waste Management & Research, 33*(7), 595–611.
[13]. Gupta, D., & Dash, S. (2023). Challenges of implementing extended producer responsibility for plastic-waste management: lessons from India. *Social Responsibility Journal*, *19*(9), 1595-1612.
[14]. Hsu, C. H., Lin, Y. H., & Chen, M. C. (2022). Electronic waste management and sustainable resource recovery: A global review. *Sustainability*, *14*(19), 12476.
[15]. Huang, F., Chen, Q., Ma, W., & Evans, R. (2022). Promoting public engagement with household waste separation through government social media: A case study of Shanghai. *Journal of Environmental Management*, *320*, 115825.
[16]. Konya, R. S., Nwankwoala, H. O., & Nwankwoala, M. O. (2015). Electronic waste generation and disposal practices in Port Harcourt metropolis, Nigeria. *International Journal of Waste Resources, 5*(4), 1–7.
[17]. Leclerc, S. H., & Badami, M. G. (2019). Extended producer responsibility for electronic waste management: Policy drivers and implementation challenges. *Journal of Environmental Management*, *251*, 109618.
[18]. Mallick, P., Das, S., Sharma, A., & Kumar, S. (2024). Extended producer responsibility for electronic waste management: Progress, challenges and future directions. *Journal of Cleaner Production, 452*, 142201.
[19]. National Environmental Standards and Regulations Enforcement Agency. (2011). *National Environmental (Electrical/Electronic Sector) Regulations, 2011*. Federal Government of Nigeria.
[20]. Odeyingbo, O. A., Deubzer, O. K., & Ogunmokun, O. A. (2025). Assessment of the impact of the revised National E-Waste Framework on the informal E-Waste sector of Nigeria. *Recycling, 10*(3), 117.
[21]. Okwu, E. O., Nwankwoala, H. O., & Weli, V. E. (2022). Assessment of informal waste electrical and electronic equipment recycling at MTN Phone Village, Rumukurushi, Port Harcourt, Nigeria. *Journal of Environmental Science and Pollution Research, 8*(2), 55–67.
[22]. Osibanjo, O., & Nnorom, I. C. (2007). The challenge of electronic waste (e-waste) management in developing countries. *Waste Management & Research, 25*(6), 489–501.
[23]. Serpe, F. P., Baldé, C. P., Kuehr, R., & Stegmann, P. (2025). Global electronic waste generation and recycling trends: Progress towards sustainable management. *Waste Management, 196*, 45–58.
[24]. Shanmugasundaram, S., & Tamilarasu, A. (2023). Digital transformation and sustainable development: The role of emerging digital technologies. *Sustainability*, *15*(9), 7395.
[25]. Solving the E-waste Problem (StEP) Initiative. (2014). *One global definition of e-waste*. United Nations University.
[26]. Sthiannopkao, S., & Wong, M. H. (2013). Handling e-waste in developed and developing countries: Initiatives, practices, and consequences. *Science of the Total Environment, 463–464*, 1147–1153.
[27]. Villorejo (2019). Waste Management in Vienna, Austria. Garbage bins for recycling on the street.*https://www.alamy.com/vienna-austria-august-14-2019-garbage-bins-for-recycling-on-the-street-image271958858.html*
[28]. Watkins, E., & Gionfra, S. (2019). *EPR in the EU plastics strategy and the circular economy: A focus on plastic packaging*. Institute for European Environmental Policy.
[29]. Wirtu, Y. D., Godana, U. A., & Tucho, G. T. (2025). A review of public perception and awareness of e-waste management in developing countries: challenges and opportunities for sustainable solutions. *Environmental Reviews*, *33*, 1-12.
[30]. World Health Organization. (2024). *Electronic waste (e-waste)*. World Health Organization.
[31]. Zhong, L., & Zhao, L. (2012). Extended producer responsibility and waste electrical and electronic equipment management in China. *Waste Management & Research, 30*(11), 1118–1126.

Pate 1 E-Wastes Found at Iloabuchi Street, Mile 2 Diobu, Port Harcourt

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Plate 2 Informal E-Waste Collector Along a Street in Old GRA, Port Harcourt


Plate 3 E-Wastes to be Discarded at Garrison, Ogbum-nu-Abali, Port Harcourt


Plate 4 E-wastes Stored to be Discarded at Garrison, Ogbum-nu-Abali, Port Harcourt