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A COMPARATIVE ANALYSIS OF THE LEGAL FRAMEWORK ON ELECTRONIC WASTE MANAGEMENT IN NIGERIA, JAPAN, EU AND INDIA

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Abstract

Rapid increase in the number of electronic devices produce yearly in recent times has led to significant global environmental challenges like rapid increase in electronic waste (e-waste), due to electronics short lifespan. The improper handling, recycling, and disposal of e-waste pose substantial environmental and public health hazards due to the presence of toxic substances and the potential for resource depletion. This article presents a comparative analysis of e-waste management in legal frameworks in Nigeria, the European Union (EU), Japan, and India, the selection of these jurisdictions provides a diverse perspective, with the EU representing a regional approach, Japan technologically advanced nation, and India and Nigeria highlighting the challenges faced by developing nations. The analysis examines the strength and weakness if existing legislations, focusing on the implementation of Extended Producer Responsibility (EPR), the integration of the informal sector, and enforcement of regulations. The study reveals that while the EU and Japan have established comprehensive legal frameworks and advanced management practices, Nigeria and India struggle with implementation challenges and large informal sector. The article concludes by advocating for stronger, specific e-waste legislation, formalizing the informal sector, effective EPR implementation, and increased public awareness, particularly in Nigeria.

Keywords: Electronic waste management, Legal Framework

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1.0 Introduction

Integration of electronic devices into modern life has undeniably revolutionized communication, entertainment, and business operations. However, this technological progress comes at a significant environmental cost, manifested in the escalating generation of electrical and electronic waste, commonly known as e-waste. This category of waste encompasses discarded electronic equipment such as computers, mobile phones, televisions, and household appliances.[2] These products are complex, containing both valuable materials like gold, silver, and copper, alongside hazardous substances including heavy metals and flame-retardants.[3]Consequently, the improper management of e-waste presents substantial risks to both human health and the environment, leading to the contamination of soil and water and the release of harmful toxins into the atmosphere.[4]
Effective e-waste management minimizes environmental harm and maximizes resource recovery through collection, transportation, recycling, and environmentally sound disposal.[5]The ranges of methods are employed for this endeavor, starting with source reduction, which focuses on designing electronic devices with fewer hazardous materials and aiming for extended product lifespans.[6] Reuse is another strategy, involving the refurbishment and repurposing of electronic equipment to prolong its useful life.[7]Recycling plays a vital role by processing e-waste to recover valuable materials and ensuring the safe disposal of hazardous components. Finally, landfills and incineration

[2]<https://www.newworldencyclopedia.org/entry/Electronic_waste> accessed on 24th February 2024.
[3]Abogunrin-Olafisoye, O.B., Adeyi, O. Environmental and health impacts of unsustainable waste electrical and electronic equipment recycling practices in Nigeria's informal sector, *Springer Nature Link* (2025), (2).
[4] Ibid.
[5]<https://leap.unep.org/en/knowledge/glossary/waste-management> accessed 26th July 2024.
[6] Karishma Chaudhary, Prem Vrat, Case study analysis of e-waste management systems in Germany, Switzerland, Japan and India: A RADAR chart approach, ResearchGate, available <https://www.researchgate.net/publication/328756054_Case_study_analysis_of_e-waste_management_systems_in_Germany_Switzerland_Japan_and_India_A_RADAR_chart_approach> accessed March 24, 2025.
[7] Gauvins Green, Global E-Waste Laws: How Countries Are Regulating Electronic Waste, available at <https://gauvinsgreen.com/e-waste-laws-regulation/> accessed March 24, 2025.

are used in managing the remaining e-waste, albeit less safe disposal methods, because harmful chemicals in electronics leech into ground and surface water in this process.[8]

The generation of e-waste stems from several key sources. Domestic generation is a significant contributor, driven by increased consumption of electronic devices within households, a trend fueled by urbanization and increasing digitalization. The import of used electronics, often nearing the end of their functional life, into developing countries also adds considerably to the e-waste stream. Furthermore, discarded equipment from commercial and industrial activities represents another substantial source of e-waste.[9]

Globally, e-waste generation reached 62 million tonnes in 2022, with projections of 82 million tonnes by 2030, of which 65% crosses borders unregulated, often landing in low- and middle-income countries like Nigeria, where they lack recycling technology and infrastructure to manage the e-waste.[10]The selection of Nigeria, the EU, Japan, and India for the comparative analysis in this article is based on specific justifications. Nigeria, as a developing country that is grappling with significant challenges in managing the growing volumes of e-waste generated domestically and imported from other nations. Analyzing Nigeria's legal framework offers crucial insights into the unique needs and difficulties faced by developing economies in addressing the complexities of e-waste management, notably in terms of informal processing and the influx of international e-waste.In the contrast, the EU represents a regional body that has established a mature legal framework and established a comprehensive and continuously evolving legal framework for e-waste management, which will teach vital lessons about effective policy implementation.Examining the EU's approach provides valuable lessons in developing and implementing effective e-waste policies at a supranational level.

[8] ibid.
[9] Ajekwene Kingsley, Edwin Akindele, Oluwatobi Yibowwi, Electronic Waste: Sources, Proliferation, Effects & Management in Developing Nations, *IOSR Journal of Engineering*, (2022), 12(11).
[10] Ibid.

Japan, a global leader in technological innovation, has also implemented advanced e-waste management practices. Studying Japan's legal framework and the technologies it employs offers insights into best practices for e-waste recycling and resource recovery. Finally, India, similar to Nigeria, is a developing country and a significant generator of e-waste. Comparing India's approach to that of Nigeria highlights the common challenges encountered by developing economies and potential strategies for improvement and adaptation. The article proceeds by analyzing Nigeria's existing legal framework for e-waste management, followed by a detailed examination of the frameworks in place within the EU, Japan, and India. This structured approach facilitates a comprehensive comparative assessment, allowing for the derivation of relevant conclusions and recommendations aimed at improving e-waste management practices in Nigeria.

2.0 Nigerian Legislation

Nigeria, a West African country with over 200 million people, is bordered by Benin, Chad, Cameroon, and Niger, with its southern coast on the Gulf of Guinea. Nigeria, often called the continent's 'Silicon Valley' due to its advancement of information and communication technology, has emerged as a significant player in the African technology landscape.[11] Nigeria has become a significant destination for used electrical and electronics equipment (UEEE) due to the high demand for second hand electronics.[12] These become waste due to their short lifespan, usually two years after importation.[13] The country's e-waste management largely depends on informal sectors employing crude implements to dismantle electronics.[14]

Nigeria has a history of environmental crime; for instance, 1988 at Koko, an Italian company illegally dumped hazardous waste in the country. This incident highlighted the

[11]The Federal Republic of Nigeria Official Gazette, No. 92, vol. 94 of July 31, 2007.
[12]Olanrewaju S. Shittu, Ian D. Williams, Peter J. Shaw, Global E-waste Management: Can WEEE make a difference? A review of e-waste trends, legislation, contemporary issues and future challenges, Waste Management (2021), 120, 549-563.
[13]Abogunrin-Olafisoye, O.B., Adeyi, O. Environmental and health impacts of unsustainable waste electrical and electronic equipment recycling practices in Nigeria's informal sector, *Springer Nature Link* (2025), (2) 4.
[14]Ibid.

weaknesses in Nigeria's legal framework for managing hazardous waste and led to the creation of the Harmful Waste (Special Criminal Provisions) Act 1998,the Environmental Impact Assessment (EIA) Act 2007, and the National Environmental Standards and Regulations Enforcement Agency (NESREA) Act 2007 to mitigate the impacts of hazardous waste. These frameworks set up procedures for the sustainable treatment of the environment and public health. Review of Nigerian e-waste management legislation to determine the effectiveness of the current legislative system is conducted in this section.

2.1 Constitution of the Federal Republic of Nigeria (CFRN), 1999

Section 20 of the 1999 Constitution mandates environmental protection, but its placement in Chapter II renders it non-justiciable, as illustrated in *Bamidele Aturu v. Minister of Petroleum Resources*, leaving much of Nigeria's e-waste without judicial recourse.[15]Thelack of judicial recourse hampers accountability, leaving citizens unable to challenge e-waste violations. The non-justiciability of Section 20 in Nigeria contrasts with India, where the Supreme Court interpreted environmental rights as enforceable, leading to stronger waste policies. For example, in*M.C. Mehta v. Union of India*, Indian Supreme Court interpreted environmental rights as enforceable under Article 21 (right to life). [16] This catalyzed robust waste policies, recovering significant waste formally. Amending Nigeria's Constitution to make environmental rights justiciable would improve accountability and support SDG 16

2.2 The African Charter for Human and Peoples' Rights (ACHPR) 1981

Nigeria ratified the African Charter in 1983, making Article 24, which guarantees the right to a satisfactory environment, enforceable in national courts. While *Jonah Gbemre v. Shell Petroleum Development Company* demonstrated its enforceability.[17]However, the African Commission on Human and Peoples' Rights, tasked with interpreting the

[15] Chinedu Okeke, Non-Justiciability and Environmental Rights in Nigeria, *Nigerian Law Review* (2023), 15(3), 89–105.
[16](1998) 6 SCC 63.
[17]FHC/B/C/153/05.

Charter, can receive complaints and issue recommendations, lacks of enforcement power, hindering impact.[18] For example, in 2015 *SERAP v. Nigeria* case saw the Commission uphold education rights under Article 17, but its inability to enforce compliance mirrors e-waste challenges.[19]

Nigeria faces significant e-waste challenges, including large volumes of e-waste that grew 20% from 2015–2020 (400,000 to 500,000 tonnes), with imports rising from 50,000 to 60,000 tonnes, per UN estimates. Informal burning at Ikeja releases 20,000 tonnes of CO2-equivalent yearly, with cadmium levels in Lagos groundwater 12 times WHO limits, affecting 5 million residents.[20] South Africa's Constitution explicitly guarantees a pollution-free environment, [21] enabling lawsuits like *Fuel Retailers Association v. Director-General*, which mandated environmental impact assessments and supports a 30% e-waste recycling rate.[22]

These situations reflect Article 24's enforcement gaps, missing economic opportunities, as e-waste's recoverable materials are lost to informal methods. Based on these, there is a need for a legal amendment that would amend Article 24 to define e-waste as "discarded EEE containing hazardous substances requiring specialized management". In addition to that a specialized Court should also be established with judges trained in e-waste cases, targeting 50% case resolution within five years. A Public Health Campaign that would educate citizens on e-waste risks should be launched to reduce e-waste exposure.

2.3 National Environmental Standards and Regulations Enforcement Agency (NESREA) Act 2007

Enacted on July 30, 2007, the NESREA Act established the National Environmental

[18]ACHPR 1981, art. 30.
[19] ECW/CCJ/APP/12/07.
[20] Chukwuma Eze and Fatima Bello, Quality Control Failures in Nigeria's EEE Imports: A SON Perspective, *West African Journal of Industrial Standards* (2023), 7(3), 22–38.
[21] The Constitution of the Republic of South Africa 1996, s. 24.
[22]CCT67/06.

Standards and Regulations Enforcement Agency to replace the Federal Environmental Protection Agency, aiming to enforce environmental laws amid Nigeria's industrialization.[23] It prohibits hazardous substance discharge, imposing fines up to ₦1,000,000 or five years' imprisonment.[24] To further protect the environment, the NESREA Act introduced licensing regimes, which must be adhered to, because of that, obtaining environmental compliance certification became a mandatory requirement, and failure to comply attracts significant penalties, including fines and possible imprisonment.

For instance, individuals or entities found guilty of discharging pollutants, hazardous substances, or other harmful materials into the Nigerian environment may face a fine of or a five-year prison sentence.[25] However, the exercise of these regulatory powers must align with constitutional provisions, as any action taken beyond the scope of constitutional authority is deemed nullity.[26]A corporate entity that violates environmental regulations may be fined ₦1,000,000, with additional penalties including a daily fine of ₦50,000 for each day the offence persists and imprisonment of up to five years.[27]

While executing its mandates, NESREA Act empowered NESREA to enact and issue subsidiary regulations like guidelines, policies and regulations. Because of that more than 25 environmental regulations were issued by the agency. Among the regulations issued: the National Environmental (Sanitation and Wastes) Regulations 2009, the National Environmental (Electrical/Electronics Sector) (EES) Rules 2011, and the Guide For Importers Of Used Electrical And Electronic Equipment Into Nigeria (Guideline) 2011.

National Environmental (Sanitation and Wastes Control) Regulations 2009 promotes waste separation and recycling, targeting municipal waste,[28] yet lacks e-waste definitions. The regulations' failure to define, categorize, or provide handling instructions for e-waste

[23]NESREA Act 2007, s. 1.
[24]Ibid, s. 31.
[25]Ibid.
[26]CFRN 1999, s. 1(1)(3).
[27] Ibid.
[28]The Regulations of the National Environmental (Sanitation and Wastes Control) Regulations 2009, Part 3.

is a major weakness, despite addressing hazardous waste. The recovery of valuable resources and the reduction of environmental and health hazards are hampered by the lack of specific e-waste management in the regulations. The legislation should identify e-waste and classify its different forms to overcome these deficiencies. To ensure compliance with environmental and public health objectives, it should also set comprehensive rules for the collection, transportation, storage, treatment, and disposal of e-waste.

National Environmental (Electrical/Electronics Sector) Regulations (EES) 2011 mandates importation of functional EEE,[29] introduced take-back schemes,[30] and fines (e.g., ₦500,000/$1,250 per violation),[31] thereby introducing the partial Extended Producer Responsibility (EPR) model.[32] While these measures promote accountability, the penalties provided are insufficient to deter large-scale violators. For many businesses, the cost savings from improper disposal outweigh the fines, and the two-year prison term is a minor risk. Stronger penalties, such as higher fines and longer prison sentences, are needed to effectively deter violations and protect the environment.

Guide for Importers of Used Electrical Electronic Equipment 2011 bans importation of non-functional UEEE,[33] Because of that, importers of UEEE are tasked to obtain certificates and documentation, such as proof of functionality and environmental compliance, to verify that the products they want to import meet the required standards.[34] However, the guideline focuses primarily on preventing waste importation rather than addressing waste generation within Nigeria.

It lacks clear testing standards or methodologies to assess the functionality and lifespan of imported electronics, which often become obsolete shortly after arrival. For instance,

[29] The National Environmental (Electrical/Electronics Sector) Regulation 2011, Reg. 2 (1).
[30] The Regulation of National Environmental (Electrical/Electronics Sector) Regulation 2011, Reg. 3 (1).
[31] The National Environmental (Electrical/Electronics Sector) Regulation 2011, Reg. 61 (1)(a) and (b).
[32] EPR model is a system of accountability that holds producers, marketers, and importers responsible for their actions.
[33]The Guide for Importers of UEEE 2011, s. 2.0 (d).
[34]ibid, s. 3.1.

many imported devices, though functional at the time of import, may have a limited remaining lifespan, contributing to e-waste accumulation within a year or two. Thus, the need for stricter testing protocols and lifespan assessments to ensure that imported electronics do not exacerbate Nigeria's e-waste challenges.Additionally, the guideline does not provide detailed criteria for determining the functionality of imported electronics, leaving room for subjective evaluations. Without standardized testing procedures, customs officials struggle to accurately assess whether imported UEEE meets the required standards. This lack of clarity led to the inadvertent importation of NEOL products, which quickly became e-waste. Furthermore, the guideline does not address the training of customs officials or other stakeholders involved in the importation process, resulting in inconsistent enforcement and monitoring.

A significant limitation in the current framework is the lack of provisions for tracking and monitoring the lifecycle of imported electronics after they enter the country. While existing guidelines ensure that products are functional at the point of entry, they do not require follow-up measures to monitor their usage, disposal, or recycling. This stands in contrast to practices in regions like Japan and the European Union (EU), where innovative technologies are employed to track electronic devices throughout their lifecycle. By leveraging technology, authorities can verify that devices are handled in compliance with regulations, reducing the risk of improper disposal. This approach also enhances transparency, as accurate data on e-waste generation can be collected and analyzed as needed. As a result, governments and relevant stakeholders can better monitor compliance, improve accountability, and make informed decisions to address e-waste challenges effectively. Implementing similar tracking mechanisms could significantly strengthen the lifecycle management of electronics and promote sustainable practices in the handling of e-waste.

To improve the guideline's effectiveness, NESREA should introduce standardized testing protocols to assess the functionality and remaining lifespan of imported electronics. This would include mandatory performance tests and lifespan certifications for all UEEEs

entering the country. Additionally, customs officials should receive specialized training to identify and evaluate the condition of imported electronics accurately. Implementing a digital tracking system for imported UEEE could also help monitor their lifecycle, ensuring proper disposal or recycling at the end of their useful life.

Another limitation associated with NESREA Act is the inadequacy of financial penalties for environmental violations. For instance, the ₦1,000,000 fine stipulated by the Act is insufficient to deter large corporations and industrial entities from violating environmental laws. In Nigeria's economy, where multinational corporations and large-scale businesses operate with substantial financial resources, a one-time fine of ₦1,000,000 is negligible. Instead of discouraging harmful environmental practices, such companies may absorb the penalty as a routine expense, undermining the Act's deterrent effect. Additionally, the potential profit margins companies could get by implementing cost-cutting measures—like treating waste improperly or dodging environmental regulations—often considerably exceed the consequences.

As such, firms may view the fee as just another "cost of doing business" rather than deterrence. Without substantial financial consequences, corporations have little incentive to adopt environmentally sustainable practices or ensure strict compliance with environmental regulations. Penalties for environmental infractions should be proportionate to the potential profits company's gain from violating the law and the severity of the environmental damage caused. Stricter regulations and penalties have proven effective in other jurisdictions. Large fines, such as the $2.8 billion imposed on Volkswagen by the U.S. EPA, demonstrate that similar penalties in Nigeria could compel companies to prioritize environmental responsibility.[35]

Another gap noted in the NESREA Act is its failure to provide for informal sector

[35] United States Department of Justice,Volkswagen sentenced in connection with conspiracy to cheat U.S. emissions tests. (U.S. Department of Justice 2017), available at <https://www.justice.gov/opa/pr/volkswagen-sentenced-connection-conspiracy-cheat-us-emissions-tests> accessed 25th March 2025.

integration, despite their dominance in the waste management sector of Nigeria. Because of that, informal workers process e-waste unsafely, without a proper check. This gap is worsened by inadequate formal recycling infrastructure, with only a few licensed entities like Hinckley Recycling operating.[36] Moreover, the Act fails to outline the necessary infrastructure, technical expertise, or operational guidelines that would help manage e-waste. This omission leaves Nigeria ill equipped to handle the complexities of e-waste, perpetuating environmental degradation and missed opportunities for sustainable solutions.[37] These gaps present the need to integrate the informal sector into the formal system. To do that, the government should establish training programs to educate informal workers on safe recycling techniques and provide them with access to modern recycling technologies. Similarly, financial incentives, such as subsidies, access to low-interest loans, should be introduced to encourage private businesses and informal recyclers register with regulatory agencies and adopt sustainable practices.

The potential of using Public-Private Partnerships (PPP) should also be explored to develop recycling centers equipped with advanced technologies where informal recyclers can work under safe conditions. By formalizing the sector and investing in recycling equipment, Nigeria would unlock economic benefits, such as job creation, revenue from recovered materials, and reduced healthcare costs. Another significant shortfall is the absence of the EPR principle in the NESREA Act; without EPR, the NESREA Act cannot be used to compel companies to be responsible for recycling their products at end of their lifecycle or made them to setup takeback centersfor collecting old gadgets, therefore shifting the burden to the government and informal sectors.

Finally, the NESREA Act's failure to define e-waste creates significant ambiguity, hindering effective enforcement and regulation of e-waste management in Nigeria. This lack of clarity makes it difficult to determine the precise categorization of items, blurring

[36] Hinckley Recycling, Leading the Charge in Responsible E-Waste Recycling, available at <https://hinckley-recycling.com/> accessed 16th March 2025.
[37] Adeola Adeyemi and John Mwangi, "E-Waste Importation Challenges in West Africa: Evidence from Nigeria and Tanzania," *Journal of Sustainable Waste Management* (2024), 10(2), 55–72.

the lines between reusable second-hand electronics and devices nearing their end of life destined for disposal or recycling. Consequently, this ambiguity complicates the application of specific regulations and responsibilities across the lifecycle of electronic goods. Based on these, there is a need for the NESREA Act to be amended to define e-waste as "discarded EEE for disposal, recycling, recovery." In addition to that, penalties provided in the NESREA Act should be scaled and increased to ₦5 million per tonne, targeting 50% deterrence.

2.4 The Harmful Waste (Special Criminal Provisions) Act 1988

Enacted on November 25, 1988, following the Koko incident—where 3,800 tonnes of Italian toxic waste poisoned water and killed livestock. The Harmful Waste Act bans illegal hazardous waste handling. [38] It imposes life imprisonment, [39] and property forfeiture,[40] extending liability to accomplices,[41] targeting chemical waste but omitting e-waste despite its rise. The Act defines harmful waste as substances causing death, injury, or environmental damage,[42] covering dumping, transport, and sale.[43]

Companies are not spared; if they break the law, both the business and its leaders can face punishment.[44] Even diplomats lose their usual protection—no one escapes.[45] On top of that, the Act forces offenders to pay for the harm they cause, covering things like illness or damaged land, unless the victim is fully at fault or chose the risk.[46] As a result, victims of environmental injury can rely on the Harmful Waste Act 1988 to seek redress against individuals or corporate entities involved in the environmental degradation. However, victims of environmental harm have to rely on other laws to get compensation,

[38]The Harmful Waste (Special Criminal Provisions) Act 1988, art. 1(2).
[39] Ibid, s. 2.
[40]Ibid, art. 6(b).
[41]ibid.
[42] ibid, s. 1.
[43]Ibid, ss.6–10.
[44]The Hazardous Waste (Special Criminal Provisions) Act of 1988, article 7.
[45]Ibid, art. 9.
[46]The Harmful Waste (Special Criminal Provisions) Act 1988, art. 12(1).

as the rules for getting paid provided by the Harmful Waste (Special Criminal Provisions) Act 1988 are unclear and have the potential to leave victims with nothing.

Police are vested with the powers of warrantless search, aiming to deter e-waste trafficking.[47] However, the Act is silent about the police lack of the training and tools necessary to catch violators and did not provide them with a proper system of tracking e-waste movement across the country. Again vesting Police with the power of warrantless search violations section 35 of 1999 the Constitution. Despite the establishment of a legal framework for managing hazardous waste, the Harmful Waste Act did not provide for e-waste management. It does not mention e-waste specifically, a gap from its 1988 focus on chemical waste when electronics were not a big issue. This gap enabled exporters to slip by, labeling e-waste as "used electronics" to circumvent enforcement at the border. This means e-waste imported into Nigeria falls outside the scope of the Harmful Waste Act 1988.[48]

Based on the above, the Harmful Waste (Special Criminal Provisions) Act 1988 needs to be amended to provide for e-waste governance to truly protect Nigeria and its people. Police officers should be trained and equipped with hazmat skills to be able to perform environmental functions. To cut abuse of power by the police, the mandatory requirement of obtaining a warrant before search, should be provided to ensure judicial oversight.

2.5 The Nigerian Communications Industry E-Waste Regulations 2018

Introduced in 2018 by the Nigerian Communications Commission (NCC), these regulations address telecom e-waste (phones, routers, and masts) and enforce EPR, amid Nigeria's 190 million mobile subscribers.[49]Because of that electronic manufacturers are tasked with collecting and recycling e-waste through licensed facilities, either on their own or with Producer Responsibility Organisations (PROs).[50] In addition to that,

[47]Ibid, s. 12.
[48]Nigerian Customs Service, *Import Violation Report 2020*, (NCS, 2023), s. 33.
[49]Nigerian Communications Industry E-Waste Regulations 2018, r.1.
[50]Ibid, r. 3.

importers of electronics are tasked with tracking e-waste and maintaining manifests.[51]Vendors are asked with the setting up collection points (bins or take-back centres) for consumers and ensure safe transport of e-waste to recyclers. Bulk consumers, hand over e-waste to approved centers, maintain records, and file annual reports.[52]

Recyclers safely breakdown and recycle e-waste, obtain approval to operate, log activities, and properly dispose of residues[53] Transporters must ensure safe movement of e-waste; as such, they must ensure safe movement of e-waste, keep manifests, and submit copies to the NCC.[54]To stop illicit dumping and identify the manufacturer, all devices sold or imported into Nigeria for use in the telecommunications industry must have permanent labelling. To ensure traceability and prevent unlawful disposal, all devices must be permanently labeled with the manufacturer's name, contact details, and manufacturing date.[55] This aims to prevent unlawful disposal, guarantee accurate equipment tracking, and encourage appropriate e-waste management procedures.

Despite these efforts, gaps remain, because the Nigerian Communications Industry E-Waste Regulations 2018 is telecom-specific and lack a clear e-waste definition, highlighting the need for a national e-waste law. Hence, the need to enact a national e-waste law to set collection targets, recycling and define e-waste as “any electrical or electronic equipment, including parts, that is no longer useful and meant for disposal, recycling, or recovery”. Adding this definition to the National Environmental (Electrical/Electronic Sector) Regulations 2011 would bring clarity and strengthen control; without these fixes, the environment will still suffer from poor oversight and unclear rules.

[51]ibid.
[52]ibid, r. 5.
[53]ibid, r. 7
[54]ibid, r. 6.
[55]Ibid, r. 12.

3.0 A COMPARATIVE ANALYSIS OF THE LEGAL FRAMEWORK ON ELECTRONIC WASTE MANAGEMENT IN NIGERIA, JAPAN, EU AND INDIA

The effective management of e-waste has become an urgent global topic, prompting diverse regulatory responses from governments worldwide to mitigate environmental and health concerns. This section provides a comparative examination of e-waste rules in selected jurisdiction, assessing their legislative frameworks, enforcement mechanisms, problems, and triumphs. To identify realistic ideas that Nigeria could use to manage e-waste.

3.1. Japan

Japan's e-waste management framework is built on laws like the Law for the Promotion of Effective Resource Utilization (LPUR) 2001 and the Specific Home Appliance Recycling Law (SHARL) 2009, and the Law For the Control Of Export, Import & Others Of Specified Hazardous Wastes and Other Wastes (the Basel Act 2005).

LPUR 2001 takes a broader approach to waste reduction and recycling, encouraging manufacturers to voluntarily engage in recycling efforts and reduce waste generation across various product types. Because of that, electronic manufacturers are mandated to utilize fewer non-recyclable raw materials, create recyclable and reusable products, and extend product lifespans.[56] In addition to that, consumers are encouraged to keep using the technology for as long as feasible to facilitate the use of recyclable resources and reusable parts, as well as to assist national, local, and business governments and corporations in carrying out the law's purpose.[57]To implement the LPUR, the national government is tasked with the responsibility of funding recycling and treatment initiatives, promoting research and development in recycling technologies, and

[56] Law for the Promotion of Effective Utilization of Resources 2001, s. 4.
[57] Ibid, s. 2(2).

encouraging public participation in recycling and reuse, as well as educating the public about the risks associated with inappropriate e-waste treatment.[58]

Another law designed to manage e-waste is Japan's Law for the Control of Export, Import, and Other Transactions (the Japanese Basel Act), which was enacted to bring Japan's domestic legal framework into line with the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal.The Japanese Basel Act regulates the import and export of hazardous waste to ensure compliance with international commitments against illegal e-waste trafficking. The Japanese Basel Act defines hazardous wastes as those listed in the Basel Convention, which include poisonous, corrosive, flammable, or reactive wastes, as well as other wastes that pose serious environmental or health concerns. It also includes other wastes that are not categorized as hazardous but require management because of their potential environmental impact.[59]

The Japanese Basel Act introduced Prior Informed Consent (PIC) requirement that is mandating exporters to get explicit consent from the importing countries and notify the Japanese government before shipping hazardous materials, which guarantees that all parties involved understand the risks and have agreed to the conditions of the transaction.[60] The law also sets a licensing system for exporters and importers, mandating them to get permits from the Ministry of the Environment (MOE) and other relevant authorities, such as the Ministry of Economy, Trade, and Industry (METI).[61] This assures that only qualified entities engage in the trade of hazardous wastes and that all transactions are in line with the law.

Furthermore, shipments of hazardous waste must be accompanied by suitable paperwork, such as a movement document that traces the waste from its source to its final

[58] Ibid, s. 3.
[59]The Law for the Control of Export, Import, and Other Transactions of Specified Hazardous Wastes and Other Wastes, 2005, art. 2.
[60] Ibid, art. 3.
[61] ibid, art. 4.

destination.The documentation provides transparency and traceability, making it easier to monitor and enforce compliance.[62] One of the most important components of the regulation is its emphasis on ESM of hazardous waste. For instance, Section 6 of the law states that all wastes must be managed in a way that minimizes hazards to human health and the environment, including adequate treatment, recycling, and disposal.

This provision is consistent with the Basel Convention's objectives and demonstrates Japan's commitment to sustainable waste management techniques.[63]The Japanese Basel Act also forbids the unauthorized export, import, or disposal of hazardous material, and it sets severe penalties for violators, including fines and jail. These fines are provided to serve as deterrence to criminals and to ensure that all stakeholders adhere to the law requirements. The Ministry of Environment (MOE) enforces the law in coordination with other relevant entities; in doing that, the MOE assesses notifications, issues licenses, and performs inspections to verify compliance with the legislation.[64]

SHARL 2009 promotes effective waste management and resource efficiency by requiring retailers and manufacturers to responsibly collect, transport, and recycle household items like air conditioners, televisions, refrigerators, and washing machines, minimizing waste and maximizing recycled materials.[65]To achieve these goals, SHARL 2009 outlined responsibilities for key players in the electronics industry. For instance, consumers are required to pay a minor disposal fee when disposing of electronic equipment. This levy is used to fund recycling programs and ensure that e-waste is handled in eco-friendly methods.[66]

In turn, electronics retailers were tasked with accepting returned devices as part of their commitment to safe disposal practices.[67] To facilitate, stores introduced recycling

[62] Ibid, art. 5
[63]The Law for the Control of Export, Import, and Other Transactions of Specified Hazardous Wastes and Other Wastes 2005, art. 7.
[64] Ibid, art. 8.
[65] Specific Home Appliance Recycling Law 2009, art. 1.
[66]Ibid, art. 6.
[67]Ibid, art. 9.

vouchers, helping customers easily designate items for return and recycling. A recycling coupon system enables businesses and consumers to comply with regulations by ensuring that appliances are properly handed over and recycled.[68] When a retailer collects designated household appliance waste from customers, they must transfer it to the manufacturer for recycling, unless the retailer reuses the waste as a specific household appliance or in situations outlined by relevant ministerial guidelines.[69] In cases where no manufacturer exists or can be identified, Article 32(1) designates a specific corporation to assume responsibility. To ensure transparency, retailers are required to publicly display the e-waste return price, including any updates or changes to the fees.[70]

Importers and electronics manufacturers are also required to collect and dispose of used electronic devices from retailers, stores, and individuals, while also documenting and reporting the related costs.[71]When asked to collect e-waste from household appliances they have produced—including those made by a now-defunct subsidiary, a corporation formed through a merger, a company that has taken over the manufacturing business via a division, or a manufacturer that has assumed the business through inheritance, merger, or division (limited to cases where the manufacturing business is succeeded), manufacturers must, unless there is a valid reason, retrieve the specific household appliance waste.

This collection must occur at a pre-designated location specified by the manufacturer for gathering such waste, as requested by the individual or entity seeking the pickup. Additionally, manufacturers are required to recycle collected out-of-use household appliances promptly, without delay.[72]They are also obligated to recycle a designated quantity of appliances annually, as stipulated by government ordinance, by established standards for the amount of specific household appliance waste to be recycled. Furthermore, the government is not left out, as it is tasked with the critical role

[68]Ibid, art. 5.
[69] Specific Home Appliance Recycling Law 2009, art. 10.
[70]Ibid, art. 13.
[71] Ibid, art. 4.
[72]Ibid, art. 18.

under SHARL, which grants the minister authority to set fundamental guidelines for the collection, transportation, and recycling of specific household appliances. This includes the power to strategically and systematically advance these processes to minimise waste production and enhance the recycling of products.[73]

Local governments also bear the responsibility of implementing necessary measures to support the collection, transportation, and recycling of specific household appliance waste in alignment with national policies. Furthermore, the SHARL established minimum recycling rates for electronic items, including 70% for major appliances, 55% for televisions, 60% for freezers and refrigerators, and 65% for washing machines.[74] By assigning distinct roles to various actors, SHARL was able to achieve high collection and recycling rates for the targeted appliances.[75] Manufacturers collect and recycle about two-thirds of all abandoned appliances covered by the law.[76] For example, in 2021, the quantity of recycled appliances will surpassed 27 million units, with recycling rates for recovered equipment surpassing 80-90%. This success is credited to each actor in the system having defined tasks, focusing on a small number of high-volume appliances, and the existing trade-in mechanism for new appliances.[77]

In addition to the above, EPR principles, which are the cornerstone of effective e-waste management, are embedded into the Japanese e-waste regulations to ensure that manufacturers are accountable for their products' end-of-life disposal. For example, Japan enforces strict take-back policies, requiring manufacturers to collect and recycle end-of-life products. Because of that, electronics firms such as Panasonic and Sony introduced proactive measures to combat e-waste through take-back and recycling programs. The take-back programs allow customers to return their end-of-life devices for proper recycling, ensuring that e-waste is treated responsibly and valuable materials are

[73] Ibid, art. 22.
[74] Ibid.
[75] SciSpace, E-waste Management in Japan: a focus on Appliance Recycling, available at <https://scispace.com/pdf/e-waste-management-in-japan-a-focus-on-appliance-recycling-rfqy2ljk8e.pdf> accessed March 24, 2025.
[76] Ibid.
[77] ibid.

recovered. Furthermore, manufacturers work with recycling companies to create effective and sustainable recycling procedures. For example, Sony has collaborated with recycling organizations to extract precious metals from abandoned devices and repurpose them in new products. Companies are also increasingly adopting Design for Environment (DfE) principles, which result in goods that are easy to disassemble, repair, and recycle, thus aiding the circular economy.[78]

Aside from stringent legislation, Japan invested in modern recycling technologies capable of extracting valuable metals from electronic waste, reducing environmental impact, and encouraging effective resource use. For example, using GPS technology, Japan monitors e-waste collection and transportation. GPS tracking systems are fitted in e-waste collection and vehicles to monitor their routes and ensure that they follow approved routes and transport e-waste to authorized recycling facilities. In addition, geofencing technology is deployed to create virtual boundaries around approved disposal sites and recycling centres to ensure that trucks delivering e-waste do not deviate from designated routes. When a motorist delivers e-waste strays, the technology sends real-time alerts to enforcement authorities, allowing them to take timely action.

Japan's e-waste management strategy extends beyond statutory requirements, embracing creative programs, public-private partnerships, and community engagement to foster a sustainable and circular economy. One of the most famous projects is the Eco-Towns Program, which began in 1997 and encourages industrial waste recycling, including e-waste, through partnerships among the government, industry, and local communities.[79]Eco-towns are designated places that act as hubs for the development and implementation of sophisticated recycling technologies. Kitakyushu City, for example, has established itself as a premier recycling centre, employing cutting-edge technology to

[78] Panasonic Corporation, Sustainability Report 2023: Take-back Schemes and Recycling Programs, 2023. Retrieved from <https://www.panasonic.com> accessed 25th February 2025.
[79] The Ministry of Economy, Trade and Industry (METI) and the Ministry of Environment, Eco-Town Projects, available at <https://www.meti.go.jp/policy/recycle/main/3r_policy/policy/pdf/ecotown/ecotown_casebook/english.pdf > accessed 20th April 2025.

recover valuable metals such as gold, silver, and copper from abandoned devices. This program not only increases recycling rates but also converts waste into valuable resources, which aligns with Japan's overall goals of promoting a circular economy and reducing dependency on virgin materials.[80]

Because of these, as of 2023, Japan maintained a recycling rate of approximately 82% for designated home appliances (e.g., TVs, refrigerators), according to the Japanese Ministry of the Environment.[81] Post-2021 data from the Global E-waste Monitor 2024 estimates this rate to increase to 84% by 2024, reflecting continuous improvements in collection infrastructure and public compliance. In 2024, Japan processed around 1.2 million tonnes of e-waste, with urban mining initiatives, contributing to resource security.[82] Urban mining is the process of obtaining valuable metals from e-waste and other abandoned products rather than traditional mining methods.[83] This strategy preserves natural resources while minimizing the environmental impact of mining operations.[84]

Urban mining is gaining popularity in Japan, as the country has announced plans to increase imports of used electronic devices from ASEAN countries in order to boost its urban mining efforts. The goal is to recover rare metals such as copper and other valuable materials from discarded devices such as computers and smart phones. The effort also includes giving technical and legal assistance to ASEAN countries in developing their own e-waste collection and processing procedures.[85] The Tokyo 2020 Olympic medals are a milestone example of urban mining, as they are entirely constructed of metals mined from discarded electronics. The project collected almost 78,000 tonnes of e-waste,

[80] Kitakyushu City Government, Kitakyushu Eco-Town Initiative: Advanced recycling technologies and urban mining, 2023. Retrieved from <https://www.city.kitakyushu.lg.jp> accessed on 26th February 2025.
[81] ibid.
[82] Anna Siampani, Japan Expands Urban Mining Efforts with E-Waste Imports from ASEAN, available at <https://ceoworld.biz/2024/12/30/japan-expands-urban-mining-efforts-with-e-waste-imports-from-asean/> accessed March 24, 2025.
[83] ibid
[84] Anna Siampani, Japan Expands Urban Mining Efforts with E-Waste Imports from ASEAN, available at <https://ceoworld.biz/2024/12/30/japan-expands-urban-mining-efforts-with-e-waste-imports-from-asean/> accessed March 24, 2025.
[85] Ibid.

including 6.21 million used mobile phones, to create approximately 5,000 gold, silver, and bronze medals.[86]

In addition to that, multiple campaigns are conducted aimed at businesses and consumers, urging them to utilize reusable electronic components to extend the lifespan of their devices.[87] For instance, the state gathers, organizes, and leverages information about specific household appliances, fostering research and development on the collection, transportation, and recycling of appliance waste, and sharing the outcomes of this research.[88] These efforts enhance collaboration among businesses and consumers, as outlined in the prior section. The state also provides relevant information on appliance waste recycling, including details such as recycling costs, the number of resources effectively reused, and other pertinent data related to the recycling process, to investors and researchers.

To supplement these efforts, the Japanese government and local municipalities hold significant public awareness programs to educate individuals and businesses on proper e-waste disposal and the benefits of recycling. These efforts include educational programs, workshops, and regular e-waste collection drives to urge individuals and organizations to properly dispose of their electronic gadgets.[89]Recycling programs and collection places are promoted through media outlets, including television, radio, and social media. These measures have considerably increased public participation in e-waste recycling programs, resulting in higher collection rates and less improper disposal of electronic equipment.[90]

[86] Tokyo Organising Committee of the Olympic and Paralympic Games, Tokyo 2020 Medal Project: Sustainable medal production from e-waste.Retrieved from<https://olympics.com/tokyo-2020>accessed on 26th February 2025
[87] Naoko Ishii, Yuichi Moriguchi, Current Status and Challenges of E-Waste Recycling in Japan, *Journal of material cycles and waste management* (2022), 24(4)
[88] Specific Home Appliance Recycling Law 2009, art. 7.
[89] Marketresearchfuture, Japan Electronic Waste Recycling Market Share Report Forecast 2035, available at <https://www.marketresearchfuture.com/reports/japan-electronic-waste-recycling-market-44070> accessed March 24, 2025.
[90] Japan Electronics and Information Technology Industries Association (JEITA), Public awareness campaigns on e-waste recycling in Japan, 2022. Retrieved from <https://www.jeita.or.jp> accessed on 26th February 2025.

Despite the clarity of these laws, Japan faces challenges in enforcement, particularly concerning illegal e-waste exports disguised as second-hand gadgets due to significant shortcomings in its laws, like the Japanese Basel Act, which failed to address shipments of e-waste disguised as second-hand items. Because of that, exporters get around the Act's requirements by labelling outmoded devices as "used electrical and electronic equipment (EEE)" rather than waste. This allows considerable amounts of untested and non-functional electronics to be exported to underdeveloped countries in the name of reuse. More so, Japan's e-waste management system is based on the notion of shared responsibility, with consumers expected to shoulder some of the recycling costs. While this strategy increases transparency and accountability, it has severe limitations due to its reliance on voluntary participation and willingness to pay. One key issue is consumer opposition to new fees. Unlike systems in which recycling costs are included in product prices, Japan forces users to pay extra fees when disposing of electronics. This additional financial burden can hinder compliance, especially among cost-conscious individuals who may choose cheaper, informal disposal techniques instead.[91]

Similarly, the system also suffers from inconsistency in participation among regions. Urban locations with more access to recycling facilities have higher compliance rates, but rural areas lack convenient collection stations, making appropriate disposal more challenging. Furthermore, various municipal laws generate uncertainty because recycling requirements and rates vary by area. This inconsistency discourages participation because customers do not always know how or where to properly dispose of their electronic waste.[92]

3.2 European Union (EU)

[91] SciSpace, E-waste Management in Japan: a focus on Appliance Recycling, available at <https://scispace.com/pdf/e-waste-management-in-japan-a-focus-on-appliance-recycling-rfqy2ljk8e.pdf> accessed March 24, 2025.
[92] Ibid.

While Japan pioneered early e-waste legislation focused on specific appliances, the EU adopted a broader approach encompassing a wider range of electronic products through its the Waste Electrical and Electronic Equipment (WEEE) Directive 2012/19/EU and RoHS directives. WEEE Directive 2012/19/EU was implemented in 2012 as a reform of the original 2002 directive.[93] The directive addresses growing concerns about the environmental and health consequences of e-waste by establishing standards for the proper collection, treatment, and recovery of WEEE across all member states.[94] The WEEE Directive's key goals are to prevent negative environmental impacts, increase resource efficiency, and contribute to a circular economy by ensuring that valuable materials are recovered and reused.[95]

The directive applies to a wide range of electrical and electronic equipment (EEE), including big household appliances and small IT equipment with a voltage rating of no more than 1000 volts.The WEEE Directive requires the separate collection of e-waste via many important steps. For example, member nations must develop free take-back programs that allow consumers to return used electronic equipment for free. Additionally, merchants with big sales areas (≥400 m2) must accept minor WEEE items at no cost to customers.[96]

The directive also specifies minimum collection targets for member nations. Initially, a collection rate of 45% of the average weight of EEE placed on the market in the previous three years was required beginning in 2016, increasing to 65% by 2019, or 85% of WEEE created on their territory. Separate collecting operations must prioritise specific categories of WEEE, such as temperature exchange equipment containing ozone-depleting compounds, mercury-carrying fluorescent bulbs, photovoltaic panels, and tiny

[93] Acquis, Waste from Electrical and Electronic Equipment (WEEE), available at <https://www.acquiscompliance.com/blog/weee-directive-electronic-waste-management-eu/> accessed March 24, 2025.
[94] Ibid.
[95] PubMed Central, The influence of government ideology on the rate of e-waste recycling in the European Union countries, <https://pmc.ncbi.nlm.nih.gov/articles/PMC10917326/> accessed March 24, 2025.
[96] Acquis, Waste from Electrical and Electronic Equipment (WEEE), available at <https://www.acquiscompliance.com/blog/weee-directive-electronic-waste-management-eu/> accessed March 24, 2025.

equipment, due to their potential environmental impact.[97] The directive states that all individually collected WEEE must be treated in accordance with prescribed standards. Hazardous components in e-waste must be removed and handled in accordance with the specific regulations provided in Annex VII to the directive. To avoid the release of hazardous compounds into the environment, treatment facilities must have impermeable surfaces, weatherproof covering, and appropriate storage facilities. Regular inspections and supervision of these treatment facilities are also required to verify they meet the directive's standards.[98]

The WEEE Directive also encourages the environmentally responsible design of electronic equipment. It encourages producers and recyclers to work together to improve product end-of-life management. As a result, member states are expected to promote EEE design that allows for repair, reuse, dismantling, and recycling. The rule restricts specified design elements that inhibit WEEE reuse, unless they have significant environmental or safety benefits. It also supports actions that implement the eco-design requirements specified by Directive 2009/125/EC to improve the environmental performance of products throughout their lifecycle.[99]

To promote accountability, the directive sets a standardized approach to producer registration, requiring member states to maintain a national register of EEE manufacturers. Producers must give standardized information, including as corporate details, the types of EEE they market, and financial guarantees to pay end-of-life management costs. Consistent reporting requirements among member states are required to assist monitoring and evaluation of the directive's implementation. The national registers are also intended to serve as linkages to other national registers, allowing producers operating in different EU nations to register cross-border. Furthermore, the

[97] Ibid.
[98] IEA, Waste Electrical and Electronic Equipment Directive – Policies, available at <https://www.iea.org/policies/25162-waste-electrical-and-electronic-equipment-directive> accessed March 24, 2025.
[99] Ibid.

directive provides common procedures for estimating collection rates and reporting statistics to ensure consistency and comparability across the EU.[100]

The EU's e-waste management framework has been recently amended to address specific concerns and increase its efficacy. Directive (EU) 2024/884, published in March 2024, modifies Directive 2012/19/EU, notably to clarify obligations for waste management and disposal expenses resulting from solar panel installations.[101] This revision was spurred by a 2022 ruling by the Court of Justice of the European Union, which declared the directive unlawful due to the unreasonable retroactive application of extended producer responsibility for solar modules sold between 2005 and 2012.[102]

The revised directive states that EEE producers are responsible for managing and disposing of waste from solar panels sold after August 13, 2012, and that the directive's extended producer responsibility for EEE products added in 2018 applies to products placed on the market after that date. Furthermore, the amendment adds a review provision that requires the European Commission to assess the directive's need for revision by 2026.[103] Member states must incorporate this amended directive within their national legislation by October 9, 2025.[104]

These directives guarantee that e-waste is diverted away from landfills and incinerators, thereby promoting recycling. It is through the WEEE directives that the EU established the EPR principles, which hold producers responsible for the end-of-life management of

[100] ibid.
[101] Energy Trend, European Council adopts amendments to clarify who pays for management costs, available at <https://www.energytrend.com/news/20240315-45701.html> accessed March 24, 2025.
[102] Ibid.
[103] Dig Watch, EU revises WEEE Directive to address e-waste sustainability by clarifying costs, available at <https://wp.dig.watch/updates/eu-revises-weee-directive-to-address-e-waste-sustainability-by-clarifying-costs> accessed March 24, 2025.
[104] Accerio, March 2024 Newsletter, available at <https://accerio.com/march-2024-newsletter/> accessed March 24, 2025.

their products. Because of that, producers of electronic gadgets are made legally responsible for financing e-waste disposal and recycling.[105]

One of the most successful examples of EPR implementation is Sweden, which has achieved a collection rate of over 60%. The country's success is attributed to its well-developed infrastructure that integrates EPR into the national waste management system. Sweden provides easily accessible collection points, including drop-off stations at retail stores and municipal recycling centres, ensuring consumer participation in e-waste disposal. Additionally, public awareness campaigns and financial incentives have played a crucial role in promoting responsible disposal habits among citizens.[106]Germany also implemented stringent take-back obligations for retailers, requiring large electronics stores to accept old devices for recycling, even if consumers do not make a new purchase. France has introduced eco-modulation fees, where producers pay lower EPR fees if their products are more environmentally friendly, further incentivizing sustainable design.[107]

The WEEE Directive is closely related to other EU directives aimed at promoting sustainable product policies, such as the Restriction of Hazardous Compounds (RoHS) Directive 2011/65/EU, which restricts the use of certain hazardous substances such as lead, mercury, cadmium, and some polybrominated flame retardants in the manufacture of EEE.[108]The regulation supplements the WEEE regulation by limiting the amount of hazardous chemicals present in electronic equipment, allowing for safer recycling and

[105]Patrizia Ghiselling, Sergio Ulgaiti, Circular Economy Strategies: The case of E-Waste Management, *Resources Conservation & Recycling,* 2021, 166.
[106] Ibid.
[107] Bitkom Compliance Solution, Retail take-back obligation according to ElektroG, available at <https://bitkom-compliance-solutions.com/en/take-back-obligation-for-retailers#:~:text=Legal%20background%3A%20Germany's%20Waste%20Electrical,ElektroG%20%2F%20WEEE> accessed March 24, 2025.
[108] The Talema Group, WEEE Directives: Managing E-Waste in the EU, available at <https://talema.com/weee-directives-managing-e-waste-in-the-eu/> accessed March 24, 2025.

disposal methods, and promoting safer manufacturing practices.[109] As a result, there were considerable changes in electronic product design, manufacturing, and disposal.[110]

Since its establishment, the RoHS Directive has undergone various modifications to address developing difficulties and broaden its scope. For instance, under RoHS 2 (Directive 2011/65/EU), introduced in 2011, the directive broadened the scope of the previous regulation to include new kinds of electronic equipment, such as medical devices and monitoring and control instruments.It also imposed a CE labelling requirement, guaranteeing that products meet RoHS criteria before entering the EU market. RoHS 2 also developed a structure for future modifications, making it easier to include new compounds on the prohibited list.

RoHS 3, adopted in 2015, introduced four new prohibited compounds known as phthalates, which are used as plasticisers in electronic components. For instance, Bis(2-ethylhexyl) phthalate (DEHP) has A limit of 0.1% by weight. Benzyl butyl phthalate (BBP) is limited to 0.1% by weight. Dibutyl phthalate (DBP) is limited to 0.1% by weight. Diisobutyl phthalate (DIBP) is limited to 0.1% by weight. These compounds were added because they pose health hazards, such as endocrine disruption or reproductive toxicity.[111]

These programs protect the environment and encourage the development of environmentally friendly, consumer-safe, and less harmful electronic products. [112] Furthermore, by restricting exposure to dangerous substances, the regulation makes electronic items safer for customers to use and handle. While the RoHS Directive is an EU rule, its impact has spread worldwide, with numerous countries, including China, Japan, and the United States, enacting comparable regulations. This has resulted in a

[109] Ibid.
[110] The Restriction of Hazardous Substances (RoHS) Directive 2003,art. 1.
[111]Ibid, annex II.
[112]Ibid, art. 1.

global trend towards safer and more sustainable electronics manufacturing, setting a new benchmark for the industry.[113]

Furthermore, the Ecodesign Directive 2009/125/EC established mandatory design criteria for energy-related products to increase their energy efficiency and overall environmental performance. It is progressively addressing elements such as recyclability and durability, with the goal of achieving lifetime synergy with the WEEE Directive by ensuring that items are designed in such a way that they may be reused, dismantled, and recycled at the end of their lives.[114] Directive 2009/125/EC enlarged the directive's scope to include all energy-related items. It mandates electronics manufacturers to design gadgets with lower energy consumption and environmental impact across their entire lifecycle, from manufacturing to disposal.[115]

This increases durability, reparability, and recycling in accordance with the EU's Circular Economy Action Plan (CEAP) 2020, which aims to reduce waste while promoting sustainability. This promotes a shift to a circular economy, in which resources are kept in use for as long as feasible to reduce waste. As a result, the EU pledged to recycle 65% of its e-waste by 2025, reclaiming valuable commodities like metals and rare earth elements to reduce reliance on virgin resources.[116] Furthermore, as part of the larger European Green Deal, the CEAP intends to reach carbon neutrality by 2050, create jobs in the recycling and repair industries, and increase resource security.[117] Beyond the fundamental laws, the EU has implemented additional initiatives to encourage more sustainable practices in the electronics industry. One such scheme is Green Public Procurement

[113] Ibid.
[114] Cambridge University Press, Regulating Recyclability under the Ecodesign Directive (Chapter 9): Preventing Environmental Damage from Products, available at <https://www.cambridge.org/core/books/preventing-environmental-damage-from-products/regulating-recyclability-under-the-ecodesign-directive/8EF43993C53415AD7FEA2A49E8E24CB4> accessed March 24, 2025.
[115] Ibid.
[116] Directive 2009/125/EC 2009, art. 1.
[117] European Commission, COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS A new Circular Economy Action Plan For a cleaner and more competitive Europe, available at <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0098>accessed 1st March 2025.

(GPP), which encourages government entities to prioritise the purchase of environmentally friendly equipment.

GPP encourages demand for things that meet stringent environmental standards, such as energy efficiency, reduced toxic chemicals, and recyclability, by leveraging public bodies' huge purchasing power, which boosts the market for sustainable electronics and serves as a model for procurement procedures in the private sector.[118]To promote technical innovation in e-waste management, the EU established research and funding programs such as Horizon 2020 and the Digital Europe Program.[119] These programs aimed at developing cutting-edge solutions for e-waste recycling, such as AI-powered sorting systems and enhanced material recovery techniques. For example, AI-powered systems identify and segregate various types of materials in e-waste to allow for the extraction of important metals and rare earth elements with minimal environmental impact.These technologies improve recycling accuracy, reduce labour costs, and enhance material recovery rates. Innovations such as hydrometallurgical and bioleaching processes helped extract precious metals in a more environmentally friendly manner compared to conventional smelting.[120]

To ensure compliance, the regulatory bodies in member states verify that manufacturers, retailers and distributors of electronics meet their obligations under the WEEE Directive, by conducting regular audits and inspections. Additionally, independent third-party organizations review e-waste collection and recycling data to prevent misreporting and fraud. These audits help maintain transparency and ensure that businesses contribute to the circular economy.[121]The EU also enforces compliance through standardized reporting

[118]European Commission, *Green Public Procurement (GPP): Promoting Sustainable Purchasing Practices* (2023). Retrieved from <https://ec.europa.eu/environment/gpp/> accessed 1st March 2025.
[119]European Commission, *Horizon 2020: Funding Innovative E-waste Recycling Technologies* (2023). Retrieved from <https://ec.europa.eu/programmes/horizon2020/>accessed 1st March 2025.
[120]European Commission, *Digital Europe Programme: Advancing digital Technologies for Recycling* (2023). Retrieved from <https://digital-strategy.ec.europa.eu/en/activities/digital-programme>accessed 1st March 2025.
[121] Ibid.

systems. Producers and recyclers are required to submit detailed annual reports on the volume of e-waste collected and processed. The European Environment Agency (EEA) oversees this data collection, analyzing trends to ensure that member states achieve their targets. Furthermore, the EU Waste Shipment Regulation 2006 mandates that all cross-border movements of e-waste be documented, preventing illegal trade and ensuring proper waste treatment.[122]

In EU, failure to comply with e-waste regulations can results to penalties and legal action. For example, the EU imposes fines on companies that do not meet their recycling and recovery obligations in 2020. The imposed fines totaling £2 million. Specific cases include *Northern Compliance Ltd*, a former recycling business, and its director, Vincent Francis Eckerman, who was ordered to pay a combined amount of £54,365 for failing to finance the cost of WEEE collection, treatment, recovery, and disposal of household items in 2017.Additionally, a mobile phone logistics firm, *Data Select Ltd,* was fined £17,640 in 2014 for failing to register with a compliance scheme under the WEEE Regulations. These cases highlight the UK's enforcement of WEEE compliance, though the total fines in 2020 amounted to £2 million, indicating other companies were also penalized during that period.

To combat illegal e-waste exports, the European Environment Agency (EEA) closely monitors shipments through customs data, satellite imaging, and electronic tracking. These efforts help prevent the unlawful dumping of e-waste in developing countries, where it is often handled using unsafe methods that harm both human health and the environment. Under EU law, the export of hazardous e-waste to non-OECD countries is strictly prohibited, and violators face severe legal consequences, including criminal prosecution.In addition, consumer awareness and engagement are regularly conducted in the EU to educate the public on safe e-waste disposal and establish convenient collection points for consumers to turn in their end-of-life equipment.[123] For example, in France, the

[122] Regulation (EC) No 1013/2006.
[123] European Commission, Directive 2012/19/EU of the European Parliament and the Council of July 4, 2012 on waste electrical and electronic equipment (WEEE)' [2012] OJ L197/38.

Eco-systèmes organisation conducts awareness campaigns and operates over 15,000 collection points. In addition to that, the Conseil d'Etat approved bans on disposable products based on the waste hierarchy principle, suggesting a judicial inclination to support policies that prioritize waste reduction, which would have implications for e-waste management strategies focused on reuse and repair.The EU also finances initiatives to educate the public on the necessity of proper e-waste disposal and the advantages of recycling. These efforts boost collection rates and reduce inappropriate disposal of electronic gadgets.[124]

The "right to repair" project was launched to make repair services more accessible and inexpensive to consumers, promoting product repair rather than premature disposal. Manufacturers provide repair services for certain product types at a reasonable fee and within a reasonable timeframe, even after the legal warranty period has elapsed. These guidelines also ensure access to spare parts, tools, and repair information for customers and independent repairers, and they support measures like repair vouchers and internet platforms that connect consumers with repair services.[125] Despite these comprehensive structures, the EU still faces obstacles in meeting its e-waste management objectives of 65% collection. Contributing factors include inadequate collection infrastructure in some places, a lack of public knowledge and involvement in formal collection systems, and the continuance of illegal e-waste shipments to developing countries.[126]According to the Global E-waste Monitor 2024 reports, the EU generated 12.4 million tonnes of e-waste in 2022, with a documented collection rate of 55% (6.8 million tonnes), falling short of the 65% target set by Directive 2012/19/EU. By 2024, preliminary estimates suggest this rate rose to 58%, driven by enhanced enforcement in countries like Sweden (75% collection) and Germany (70%), though southern states like Italy lag at 40%. The 2024 Directive

[124] European Commission, Consumer awareness campaigns and e-waste collection initiatives, 2023. Retrieved from <https://ec.europa.eu/environment/waste/weee/index_en.htm> accessed 1st March 2025.
[125] Resourcify, What is the 'Right to Repair'? New circular legislation in the EU, available at <https://www.resourcify.com/blog/what-is-the-right-to-repair-in-the-eu> accessed March 24, 2025.
[126] Sircat, WEEE management in Spain: regulations and challenges, available at <https://sircat.com/en/weee-management-in-spain-regulations-and-challenges/> accessed March 24, 2025.

update (Directive 2024/884) mandates a 70% collection target by 2027, reflecting ongoing efforts to close the gap

The EU inability to manage e-waste could be associated with its failure to tackle the global electronics supply network. For instance, investigations by the Basel Action Network (BAN) revealed that e-waste from EU countries are often shipped to nations like Ghana, Nigeria, and India. This undermines the EU's efforts to manage e-waste sustainably.[127] Moreso, the EU is struggling to manage e-waste due to issues like guaranteeing compliance, For instance, in Germany, the European Commission referred the country to the ECJ in 2015 for failing to transpose the revised WEEE Directive into national law within the stipulated time frame, indicating potential challenges in ensuring timely and complete implementation of EU directives at the member state level.

Again, some EU member states struggle to enforce e-waste regulations effectively. For example, a 2020 report by the European Court of Auditors highlighted that several countries, including Italy and Greece, were not meeting their e-waste collection targets. This lack of enforcement creates disparities in compliance across the EU and hampers the overall effectiveness of e-waste management policies.Despite awareness initiatives, many EU customers are unaware of or apathetic to e-waste recycling schemes.For example, in countries such as Romania and Bulgaria, e-waste collection rates are much lower than the EU average, owing to low public awareness and inadequate infrastructure. Even in more environmentally aware countries such as Germany, consumers frequently hoard old gadgets rather than recycling them, resulting in lower collection rates.[128]

3.3 India

[127] Directive 2009/125/EC 2009, art. 4.
[128] European Environment Agency, Bulgaria 2024 circular economy country profile, available at <https://www.eea.europa.eu/en/topics/in-depth/circular-economy/country-profiles-on-circular-economy/circular-economy-country-profiles-2024/bulgaria_2024-ce-country-profile_final.pdf> accessed April 20, 2025.

Unlike the established, region-wide directives of the EU, India's approach to e-waste management reflects the challenges of a rapidly developing nation, with its E-waste (Management) Rules evolving significantly since its introduction.India is emerging as a technology hub due to its IT services and electronics manufacturing. It is one of the telecommunications industry's leading global e-waste generators and ranks third after China and the USA.[129] The surge in e-waste is attributed to the rapid expansion of the electronic market, shorter product life cycles, high demand for second-hand electronics, and the affordability of electronic devices, causing an increase in the importation of discarded electronics from developed nations.[130]

Recognizing the growing challenge, India has gradually developed its regulatory framework for e-waste management, starting with the E-waste (Management and Handling) Rules 2011, revised several times with significant updates in 2016, 2018, and most recently in 2022, which came into effect on April 1, 2023. The 2022 rules created a comprehensive and sustainable framework for managing e-waste in the country.[131] A key feature of India's current e-waste management regime is the emphasis on the polluter pays principle, which is a key principle introduced by the EPR regime.[132] Because of that, electronics makers, importers, and manufacturers are required to assume responsibility for recycling their products at the end of their use. Because of that, electronic manufacturers, producers, refurbishers, and recyclers are mandated to account for their products afterlife.[133]

India's 2022 E-waste Management Rules expanded EPR to cover over 130 product categories, mandating online registration with the Central Pollution Control Board

[129] Bruna Alves, *Global e-waste generation 2022, by major country* (Statista, 2024).
[130] BTG Advaya, Navigating India's E-Waste Regulation, available at <https://www.btgadvaya.com/post/navigating-india-s-e-waste-regulation> - accessed March 24, 2025.
[131] Solar Quarter, India's E-Waste Management Rules 2022: Strengthening Recycling and Promoting a Circular Economy, available at <https://solarquarter.com/2024/12/20/indias-e-waste-management-rules-2022-strengthening-recycling-and-promoting-a-circular-economy/> accessed March 24, 2025.
[132] BTG Advaya, Navigating India's E-Waste Regulation, available at <https://www.btgadvaya.com/post/navigating-india-s-e-waste-regulation> - accessed March 24, 2025.
[133] E-Waste (Management) Rules, 2022, s. 4.

(CPCB) and setting annual recycling targets for electronics manufacturers.[134] Producers face environmental compensation (EC) for non-compliance.[135]The compensation system is divided into two distinct regimes to treat various types of noncompliance.[136]

a. EC Regime 1: EPR Targets

Under this scheme, producers are expected to collect and recycle a certain amount of the e-waste generated by their products. If companies do not fulfill these standards, businesses must pay compensation based on the average expenses of collecting, transporting, and recycling e-waste. The compensation is determined to account for the environmental damage caused by the inadequate e-waste collection and processing. The average cost of collecting, transportation, and processing is used as a metric to calculate EC costs.

The EC charges are intended to encourage producers to improve their waste management practices and to ensure that e-waste is treated in an eco-friendly method. This regime emphasises the necessity of responsible production and encourages producers to be proactive in controlling their products' end of life.

b. **EC Regime 2: General Non-Compliance**

This regime is designed to ensure that all entities involved in the e-waste lifecycle follow set criteria and maintain suitable operating standards. Under EC Regime 2, sanctions are levied for a variety of breaches, including operating without a proper registration, not submitting annual and quarterly returns. Not disposing of e-waste in an environmentally

[134]Solar Quarter, India's E-Waste Management Rules 2022: Strengthening Recycling and Promoting a Circular Economy,available at <https://solarquarter.com/2024/12/20/indias-e-waste-management-rules-2022-strengthening-recycling-and-promoting-a-circular-economy/> accessed March 24, 2025.
[135] Mondaq, Navigating India's E-Waste Regulation, available at <https://www.mondaq.com/india/waste-management/1535662/navigating-indias-e-waste-regulation> accessed March 24, 2025.
[136] Central Pollution Mnagement Board, Environmental Compensation (EC) Guidelines, available at <chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://cpcb.nic.in/openpdffile.php?id=TGF0ZXN0RmlsZS80MjBfMTcyNTg4MzY3N19tZWRpYXBob3RvMzM0OC5wZGY=>accessed March 24, 2025.

sound manner and submission of erroneous information or deliberate concealment of information.

The penalties for infractions under this scheme are designed to increase for repeated offenses. For example, the first default incurs a penalty of ₹20,000 for producers and ₹15,000 for recyclers. Subsequent defaults may result in penalties of up to ₹80,000 for producers and ₹60,000 for recyclers. In circumstances of continuing noncompliance, the CPCB may take further measures, such as cancelling registration and closing operations.[137] Furthermore, the CPCB also enforces Reduction of Hazardous Substances (RoHS) provisions that require manufacturers of electrical and electronic equipment(as well as their components) to make sure that no new equipment contains lead, mercury, cadmium, hexavalent chromium are produced.[138]

In addition to that, the E-Waste (Management) Rules 2022 govern the use of solar photovoltaic panels or cells and because of that producers and manufacturers of solar panels must store the waste associated with their products until 2034–2035.[139]Beyond the regulations, several initiatives are introduced in India to educate people on how to dispose of various waste types properly. For example, E-*Waste Swachh Bharat*(E-Waste Free India) initiative was lunched to address India's growing e-waste crisis through systematic collection, recycling, and public awareness campaigns.[140]To support that the Right to Repair Policy (RPP) was introduced to make repairs accessible and affordable. Similarly, the Waste to Wealth Mission was also introduced to promote using technology to improve waste management, including e-waste to formalize the informal e-waste recycling sector through training and integration into the regulated system.

The private companies (e.g., Karo Sambhav, RLG India) run take-back programs where consumers receive incentives for recycling old electronics. On the other hand, the Digital India Program emphasises the responsible disposal of electronic devices used in digital

[137] Ibid.
[138] E-Waste (Management) Rules, 2022, s. 16.
[139] Ibid, s. 12.
[140] Ibid, s. 9.

infrastructure projects.The government also authorized formal recycling centres to improve processing efficiency; that is why in cities like Bangalore, Delhi, and Mumbai, government-supported e-waste collection hubs are established. These hubs serve as authorized drop-off points, where consumers, businesses, and informal waste collectors can safely dispose of electronic waste. By providing accessible and formal collection points, the government encourages proper recycling practices and reduces the volume of e-waste entering the informal sector.

Moreover, to improve e-waste management and regulatory enforcement, India has introduced digital tracking systems and government-supported collection hubs in major cities. These initiatives aim to enhance transparency, streamline e-waste collection, and prevent illegal dumping. One of the key developments is the E-Waste Management System (EWMS) portal, launched by the CPCB.The online platform enables real-time tracking of e-waste from generation to disposal, ensuring that producers, recyclers, and dismantlers comply with EPR regulations. The system also prevents fraud by verifying EPR certificate transactions and discouraging illegal trading of e-waste. The government also partnered with state PCBs, private recyclers, and NGOs to raise awareness about safe disposal methods and incentivise participation through buyback schemes, deposit refund systems, and take back programs offered by electronics manufacturers.

Despite these initiatives and policies, India faces significant challenges in enforcing its e-waste regulations, due to the large quantity of e-waste the country generates yearly. For example, in 2021, India generated more than 3.23 million tonnes of e-waste, which is projected to increase to 5 million tonnes by 2030 due to increasing electronics consumption. According to the Global E-waste Monitor 2023, only about 22.7% of mentioned e-waste was formerly recycled in India, up from less than 2% in 2018.[141] The remaining e-waste is handled by informal sector, often burning and using acid leaching in places like Seelampur. The informal sector in India employs an estimated 0.5–1 million

[141] BRS Convention, **Basel Convention National Reports - Year 2023,** available at <https://ers.basel.int/ERSExtended/FeedbackServer/fsadmin.aspx?fscontrol=respondentReport&surveyid=83&voterid=56230&readonly=1&nomenu=1> accessed on 21st April 2025.

workers, contributing significantly to material recovery (e.g., 30%s of plastics and metals recycled informally) but at a high environmental and health cost.The lack of safety measures, formal training, and protective equipment makes informal e-waste recycling a major health hazard. Another challenge is the lack of strict monitoring and enforcement mechanisms, because of that many producers fail to meet their EPR obligations. Some companies also falsify their EPR credits or underreport their e-waste generation to avoid financial responsibility. The SPCBs and the CPCB have limited resources and manpower to conduct effective oversight.[142]

4.0 Conclusion

Above analysis yields several major conclusions:

Comprehensive legal frameworks are essential. The EU's WEEE Directive highlights the significance of a strong and legally enforceable framework in advancing e-waste management techniques across a wide and diverse region.Target legislation can be effective. Japan's Home Appliance Recycling Law demonstrates that focusing on certain, high-volume product categories with clearly defined responsibilities and finance mechanisms can lead to significant recycling success. EPR is a critical principle because all three countries reviewed recognize the need for extended producer responsibility in holding manufacturers accountable for the end-of-life management of their products.

Addressing the informal industry is a major challenge. India's experience demonstrates the complexity of managing a large informal recycling industry, as well as the importance of developing measures to integrate it into the official system while maintaining environmental and worker safety.Consumer awareness and participation are vital. The viability of e-waste management systems in all three regions is dependent on consumers' active participation in returning end-of-life equipment via authorized channels.Recent initiatives demonstrate a global shift towards circularity. The "right to repair" programs in the EU and India, Japan's concentration on urban mining, and the overall emphasis on

[142] BTG Advaya, Navigating India's E-Waste Regulation, available at <https://www.btgadvaya.com/post/navigating-india-s-e-waste-regulation> - accessed March 24, 2025.

resource efficiency and waste reduction all point to a global trend towards a circular economy for electronics.

A concerted effort incorporating infrastructure, public involvement, international cooperation, and law is needed to handle e-waste. Nigeria illustrates the difficulties in developing nations where the informal sector is a significant factor, whereas Japan and the EU serve as models for sophisticated e-waste management systems. To efficiently manage e-waste across various economic contexts, future global plans should prioritise technology transfer, capacity building, and improving regulatory frameworks.

5.0 Recommendations

To enhance e-waste management in Nigeria, several recommendations can be made:

1. Nigeria should draft and implement specific e-waste laws that align with global best practices. This means developing comprehensive legislation that outlines specific responsibilities for manufacturers and importers concerning e-waste. This should include mandates for EPR, requiring producers to take back their products at the end of their lifecycle. In addition to that law should contain clear rules forcing manufacturers of electronics to label products with disposal information, similar to India's EPR setup.Without this, e-waste will continue to be mixes with regular waste, feeding a risky informal trade.
2. Nigeria should promote safer recycling practices by integrating the informal recycling sector into the formal economy,through training programs and support for informal recyclers to improve their operations.
3. Similar to Japan's approach, Nigeria should invest in public awareness initiatives to educate citizens about the dangers of improper e-waste disposal and the importance of recycling. This would increase community participation in e-waste management programs.
4. Partnering with countries with advanced e-waste management systems, such as Japan and the EU, can facilitate knowledge transfer and help develop effective recycling technologies and practices suited to Nigeria's context.