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Informal Sector Dynamics in Nigeria's E-Waste Chain: Legal Recognition and Environmental Risk

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Abstract

Among the rapidly increasing types of waste globally, electronic waste (e-waste) experiences intense strain due to the influx of nearly end-of-life devices, the laxity and inability to enforce regulations, and the absence of formal processing facilities. Nigeria experiences acute symptoms of this problem, as large amounts of electronic waste enter the country, often reaching landfills, and authorities struggle to intervene effectively. The e-waste chain in the country is dominated by the informal sector, which provides livelihoods and recovery of resources, but in very rudimentary ways that create extreme environmental and health impacts. The review synthesizes evidence on the state of informal sector dynamics, legal status, and ecological consequences, drawing on 62 evidence materials published between 2010 and 2025. These materials are referenced in peer-reviewed literature, government reports, and reports from international agencies. Results indicated that informal actors, including collectors, repairers, dismantlers, scrap dealers, and exporters, have been at the heart of e-waste management but are not protected by the law, which leaves them vulnerable and outside the novice Extended Producer Responsibility (EPR) frameworks. Nigeria has supported instruments such as national environmental regulations and the NESREA Act; however, the level of implementation is poor, as the national rules and policies do not adequately incorporate informal recyclers. Some of them are documented to have caused soil and water pollution due to heavy metals, air contamination from open burning, professional injuries and poisoning, and widespread exposure in urban centers like Lagos and Aba. These results indicate a

regulatory vacuum that contributes to socio-environmental vulnerability. These problems can be solved by legalizing and assimilating informal workers, making the administrative system recognize and standardize the work of occupational health and safety, as well as increasing the power of the law to enforce, monitor, and control the border to curb illegal imports. These measures would enable Nigeria to transition its informal e-waste industry into a safer and more inclusive element of the circular economy, thereby reducing its hazardous nature.

Keywords: E-Waste, Informal Sector, Nigeria, Environmental Risk, Extended Producer Responsibility.

Introduction

Among the most rapidly growing types of waste worldwide, electronic waste (E-waste), or generally speaking, discarded electrical and electronic equipment (EEE), was generated in 2022 in 62 million metric tonnes (Forti et al., 2023). The phenomenal influence of rapid technological innovation, shorter product life cycles, and growing consumer demand has accelerated the generation of old devices, providing both economic opportunities and posing a significant threat to the environment (Balde et al., 2017). Although formal recycling facilities are prevalent in the developed world, a substantial portion of global e-waste is sold or disposed of informally in poorer regions of the world, where recycling remains unregulated (Tansel, 2017). With a large population as the most populous nation in Africa, and one of the largest electronic markets, Nigeria finds itself in a critical location in the global e-waste chain. Not only does the nation produce vast amounts of domestic e-waste, but it also imports significant quantities of used electronic equipment, much of which is past its end-of-life (Odeyingbo, 2019; Odeyingbo, 2025). Due to the limited formal capacity for recycling, porous borders, and urbanization, the development of a large informal e-waste sector has been feasible (Obaje, 2013). Informal actors, including collectors, repairers, dismantlers, and scrap dealers, play a crucial role in extending product lifecycles and facilitating the recovery of valuable metals. Nevertheless, their primitive disposal technologies, which include the exposure of workers and local populations to heavy metals, brominated flame retardants, and persistent organic pollutants (POPs), direct them to their rudimentary cables disposal practices, and leakage of acid and cables (Prakash et al., 2013; Babayemi et al., 2017 and Babayemi et al., 2019).

The strength of the informal sector regarding the e-waste chain in Nigeria poses challenges in a two-fold manner. It, on the one hand, supports the livelihoods of thousands of urban poor and helps in the recovery of resources (Nnorom & Osibanjo, 2010). On the other hand, it still creates severe environmental and population health hazards (Sepulveda et al., 2010). Even though regulatory measures, including legal

frameworks like the National Environmental (Electrical/Electronic Sector) Regulations (NESREA, 2011), and other ongoing compositional measures including Extended Producer Responsibility (EPR), offer a legal guidance, most of their schemes and measures exclude the informal sector, and offer little, if anything, regarding the provision of legal support, work-related protection, or formal involvement in recycling programmes (Barnabas, 2025). Such a policy gap further incites the strife between the environmental protection agenda and the socio-economic realities of informal livelihoods. Thus, this review article analyses the dynamics of the informal e-waste sector in Nigeria, including its legal acceptance and environmental threats. Through synthesis of peer-reviewed papers, policy documents and international assessments published within the time frame of 2010-25 years, the paper answers three main questions:

1. What roles and practices characterise the informal e-waste sector in Nigeria?
2. What does the existing legal and policy framework currently do or fail to do in relation to those actors?
3. What is the known environmental and health impact of informal e-waste management?

The paper ends with an idea of how to incorporate informal workers into less risky, more sustainable e-waste governance and to determine how to balance the protection of the environment and livelihood security.

Methodology

The review employed a narrative literature review design, which incorporates scoping review features in the systematic process of capturing and synthesizing existing evidence on the informal e-waste sector in Nigeria, focusing on legal recognition and environmental risks. The choice of narrative presented is due to the current e-waste research in Nigeria being multidisciplinary, encompassing environmental science and intersecting with areas such as public health, socio-economics, and policy studies, with studies appearing in both scholarly and grey literature. Unlike the systematic reviews, which are specifically designed to evaluate interventions, the latter can accommodate a variety of evidence pieces and focus on the interpretation (the situation) (Green, 2006; Ferrari, 2015). It possessed a scoping review dimension that ensured a high level of breadth satisfaction, such that the likelihood of overlooking a critical source was minimised. The literature search was conducted over a period of 1 month, from January 2010 to July 2025, with a specific focus on the period between March and August 2025. This timeframe was chosen as it was closely concomitant to major policy milestones within the capped borders of Nigeria (perpetrated, in particular, upon the introduction of the National Environmental Standards and Regulations Enforcement Agency/NESREA and the introduction of the Extended Producer Responsibility/EPR programmes, which remained very prominent in constituting the discourse on the presence of e-waste regimes). Several electronic database searches (Scopus, Web of science, PubMed, Google Scholar, in institutional repositories, such as NESREA, the Federal Ministry of Environment, and the National Bureau of statistics as well as research articles and other publications in international institutions such as the United Nations University (UNU), the

United Nations Environment Programme (UNDP), the International Labour Organisation (ILO), the world health organisation (WHO) and the Basel Convention Secretariat) were used to search peer-reviewed literature. Access to further reports was through non-governmental agencies, such as the Basel Action Network and the E-waste Africa Project. The search terms were further divided into three segments: one of them was national (Nigeria, Westafrica), the type of waste (e-waste, electronic waste, waste electrical and electronic equipment [WEEE]) and themes (informal sector, scavengers, recyclers, policy, law, NESREA, Extended Producer Responsibility, environmental risk, toxic exposure, public health). Standard terms were subsequently paired together through the use of Boolean operators to retrieve general yet narrow down on retrieval as (Nigeria AND e-waste AND informal sector) OR (Nigeria AND WEEE AND policy) OR (e-waste AND environmental risk AND Nigeria).

This screening has been conducted in three steps. Initially, 148 documents were identified. There was the elimination of duplicates, screening of titles and abstracts, and removal of 92. The evaluation of these documents was based on the full text of each document. It resulted in the final selection of 62 papers, 38 of which are represented in peer-reviewed journal articles, and 24 policy or technical reports, covering all the requirements of the selection. Peer-reviewed articles, governmental policies, evaluations by international agencies, and reports by NGOs on the e-waste chain, the informal recycling process in Nigeria, and its environmental and health impacts, as well as the legal framework surrounding the issue, were used as inclusion criteria. The other case studies, which constituted the comparative ones, were Ghana, India, and China, which offered me the context that is potentially useful to Nigeria. Exclusion criteria were adhered to, focusing on those published in the last decade (other than seminal), non-English sources, and opinion sources that did not base their claims on empirical evidence. In an effort to mitigate bias, the studies were independently screened and selected by two reviewers. In cases of disagreement, a debate ensued. It was possible to extract the data in a coded list of bibliographic details, including the kind of research being published in, research topic, methodology, direction in which the original studies were conducted (survey, case study, environmental monitoring, or policy analysis), central findings, and the research gaps. The data were thematically extracted and synthesised using the method of thematic analysis proposed by Braun and Clarke (2006), which assumed synthesis of patterns and acknowledged their codes as well as synthesising them into four themes of primary concern (informal sector dynamics, legal framework, environmental and health risks, and policy gaps with recommendations). Triangulation of academic, government, and international sources was employed, as it is a method to guarantee reliability. In the event of inconsistent findings, preference would be directed to peer-reviewed articles and government and international reports. Outputs have also been presented in both narrative and tabular forms, allowing for easy understanding and comparison. Finally, the extrapolation of the scoping reviews was performed according to the principles of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension (PRISMA-ScR) (Tricco et al., 2018), which ensures transparency, completeness, and repeatability of the method.

Results

Table 1: Informal Sector Actors and Roles in Nigeria's E-Waste Chain

Actor Category	Role in E-waste Chain	Practices Commonly Reported	Economic Importance	Key Issues
Street collectors/ scavengers	Collect used electronics and scrap from households, dumpsites, and offices	Door-to-door collection, scavenging from dumpsites	Provide livelihood for the urban poor	Lack of protective gear, exposure to toxins
Repairers/ refurbishers	Extend product life by repairing/ reassembling used electronics	Small workshops; resale in informal markets	Affordable electronics for low-income groups	Unregulated, often dismantle unsafe devices
Dismantlers	Extract components for resale (metals, boards, plastics)	Manual dismantling using rudimentary tools	Generate value chains for recyclables	Unsafe practices, injuries, lack of legal recognition
Scrap dealers/ middlemen	Purchase, sort, and aggregate dismantled parts	Operate informal markets; link collectors to buyers	Control flows of recyclables, high profit margins	Price manipulation, informal dominance
Metal extractors/ recyclers	Recover copper, aluminum, gold via crude methods	Open burning of cables, acid leaching	Critical in resource recovery	Severe health/ environmental hazards
Exporters	Channel recovered materials into international markets	Cross-border trade, often informal	Access to foreign markets, foreign exchange	Illegal exports, weak customs monitoring

Table 2: Legal and Policy Frameworks Relevant to E-waste in Nigeria

Policy/Regulation	Year	Institution	Focus Area	Implications	Limitations
NESREA (Establishment Act)	2007	NESREA	Environmental enforcement	Created central regulator	Limited direct recognition of informal recyclers
National Environmental (Electrical/ Electronic Sector) Regulations	2011	NESREA	Guidelines for e-waste management	Provided baseline regulation	Weak enforcement, poor compliance
Extended Producer	2011 (pilot),	NESREA/ PROs	Producer responsibility	Potential for integration of	Informal actors largely

Policy/Regulation	Year	Institution	Focus Area	Implications	Limitations
Responsibility (EPR) Programme	revised 2019		for collection/ recycling	informal collectors	excluded from formal chain
Draft National Policy on Solid Waste Management	2020	Federal Ministry of Environment	Solid waste governance	Recognizes recycling as livelihood	Draft stage, weak implementation
Harmonized E-waste Guidelines (ECOWAS)	2021	ECOWAS	Regional harmonization	Opens scope for cross-border formalization	Limited domestication at national level

Table 3: Environmental and Health Risks Associated with Informal E-waste Recycling in Nigeria

Hazard Type	Pollutants/Exposure	Documented Health Effects	Environmental Impacts	Sources
Air pollution	Open burning of cables releases dioxins, furans, and heavy metals	Respiratory illness, chronic cough, asthma	Airborne contamination in urban clusters	UNDP (2021), Awasthi et al. (2017)
Soil contamination	Lead, cadmium, arsenic, and mercury residues from dismantling	Neurological damage, kidney problems	Soil infertility, long-term contamination	Babayemi et al. (2017)
Water pollution	Acid leaching contaminates groundwater with metals	Gastrointestinal illness, long-term cancer risks	Groundwater contamination, surface water toxicity	Prakash et al. (2020)
Occupational hazards	Injuries, burns, chemical poisoning	Skin diseases, musculoskeletal disorders	N/A	NESREA (2011), WHO (2020)
Community exposure	Proximity to recycling hubs (e.g., Lagos, Aba, Ibadan)	Childhood lead poisoning, developmental disorders	Generalised ecosystem degradation	UNDP (2021)

Table 4: Policy Gaps and Emerging Recommendations from Literature

Thematic Gap	Description	Recommended Action
Lack of legal recognition	Informal actors not formally included in NESREA/EPR	Develop legal frameworks that formally register and integrate informal collectors and dismantlers
Weak enforcement	Regulations exist, but are poorly monitored.	Strengthen NESREA capacity, inter-agency coordination, and border controls.

Thematic Gap	Description	Recommended Action
Occupational safety neglect	Informal workers lack protective equipment and training	Introduce occupational health and safety programs tailored for informal recyclers
Limited data	Few studies quantify long-term exposures	Fund longitudinal studies on environmental/health impacts
Socio-economic exclusion	Informal actors risk displacement by the formal sector	Inclusive policies ensuring livelihoods while protecting the environment

Discussion

Results of this review demonstrate a paradox in the informal sector's position in the e-waste chain in Nigeria: the informal sector makes up the backbone of the chain, as it is needed to collect, repair, and extract the material, but at the same time, the informal sector becomes a considerable cause of river pollution and a series of local health hazards. Table 1 also shows the variety of participants, between collectors and repairers, dismantlers and the metal extractors and exporters, each of which adds value to the chain of activities. This is not something new for other developing countries like Ghana and India, where informal e-waste sorting is a major issue because there is a lack of vigorous formal systems, and overall unemployment is high (Sepúlveda et al., 2010; Awasthi et al., 2017). Nevertheless, compared to other countries in the comparison where some informal formal partnerships have formed so far, Nigerian actors are still entirely unidentified in the law (Table 2), which makes their activities both covert and susceptible. This invisibility in the law leads to unsafe working conditions since informal recyclers are neither exempt from occupational safety regulations nor are they subject to education and equipment to protect them.

The policy environment (Table 2) shows that there have been numerous surges of framework by the time this paper was written, which is post NESREA in 2007 and the following of National Environmental (Electrical/Electronic Sector) Regulations in 2011. Enforcement, however, has been lax, and Extended Producer Responsibility (EPR) programmes, although promising, have not substantially involved the informal sector in implementation. This distance confirms the existence of a structural anomaly. There is a vision of policies based on formalised and high-technology recycling infrastructure in place. Still, in reality, more than 80 per cent of e-waste in Nigeria remains disposed of informally. The consequence is a regulatory blind spot, that is, informal recycling goes unnoticed by the regulatory framework to regulate it, based on the economic incentive that drives the informal recycling, and over which governance frameworks have no control to prevent its risks. All the insights of the Agbogbloshie site in Ghana and the Delhi hubs of India have revealed that tight sealing with low-barrier licensing, registration, and buy-back plans could overcome such a gap should appropriate enforcement and funding be put in place (Prakash et al., 2020).

Environmental and health hazards (Table 3) do not represent an abstract estimation but a set of facts that are observable in practice. In Lagos and Aba, research revealed high levels of

blood lead contamination in child scavengers and respiratory diseases in adult employees in contact with burning fume (Babayemi et al., 2017; UNDP, 2021). The leaching of acid endangers both the local ecosystems and provides a destabilising factor to food security and urban health status, and the open burning contaminates soil and water with acids. By correlating these results with professional risks (frequent burns, musculoskeletal diseases, and chronic intoxications), one will see a vicious circle: poverty influences people to engage in unsafe recycling, unsafe recycling can lead to an accumulation of chronic health damage, and chronic health damage makes people less productive, thus keeping them in a chain of dependency. Moreover, since exposure to the environment is needed in densely populated facilities, it has not just social costs of informal ways of recycling, but the problem spreads to women, children, and the elderly populations.

This triangulation is strengthened by the synthesis of the policy gaps (Table 4). This is because the absence of legal representation of unofficial employees directly characterises the omission of informal workers in EPR and occupational health programmes, and poor implementation and inadequate data lead to increased invisibility of issues at risk. Besides, socio-economic marginalism poses a threat of displacing the informal actors without providing alternative livelihoods, a prospect that might trigger recycling into the dark hole and deepen the effects on the environment. The answer to these gaps needs to be based not on stricter enforcement but on institutional innovation: a system of participatory regulation, in which informal workers become formally registered, trained and integrated into the collection and dismantling phases, and that processes hazardous material are diverted to certified options. This type of integration is consistent with the principles of the circular economy, which are implemented across the planet, and ensures that Nigeria enjoys the economic potential of e-waste and does not externalise its environmental costs.

Overall, the findings complement three coexisting and interconnected realities that include the economic inability of informal actors, the lack of regulations to oversee them, and the crises of the environment and health caused by their operation. Any attempt to deal only with one dimension, such as the prohibition of informal dismantling with no alternatives provided, would probably exacerbate things. The problem is now to come up with hybrid forms of governance that integrate the right by law, health protection, producer liability, joint financing and livelihood protection. When applied well, this strategy has the opportunity to transform Nigeria's e-waste chain into a more viable route to a more sustainable circular economy rather than a risky survival economy.

Conclusion

As a part of the informal e-waste sector, this review identifies that Nigeria has both an influential (not to mention valuable) and rule-breaking multipurpose role in e-waste recycling: as a concern, it supplies the entire industry with thousands of livelihoods, extends the product life-cycles, and retrieves lucrative materials into reproduction, but also has, as a dilemma, perpetuated unsafe recycling habits that create huge environmental and human health risks. The combination of a lack of enforcement due to low regulations and the legalisation of

informal actors around the world, and the fragile stance of such regulations and initiatives like NESREA regulations, Extended Producer Responsibility (EPR) initiatives and others has created a severe governance gap. It is the compounding of evidence that, insofar as the nexus of informality, weak regulation, and environmental risk is not tackled, the e-waste chain in Nigeria continues to impose costs on disadvantaged citizens and the ecosystem, upon ignoring national sustainability objectives.

Recommendations

To balance economic need with environmental responsibility, Nigeria ought to take three strategies on a high plane, which are first, legal incorporation and integration of informal recyclers into formal waste management programmes, through registration, low-barrier licencing, and systematic incorporation into EPR programmes; secondly, much-needed legal measures on occupational and environmental conditions by interpreting protective equipment, medical testing, and safe collection and transfer point based on producers and the state; and third, enhanced enforcement and creation of robust monitoring schemes, such as enhanced border control over illegally imported goods, site-specific pollution Combined, these will help Nigeria to shift its informal e-waste Industry out of an illegal survival mechanism to a driver of inclusive, sustainable circular development of the economy.

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