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A Rationale for a Polycentric National Digital Registry for Informal Waste Recovery Pickers in a Circular Economy

Abstract

Informal waste pickers are indispensable to material recovery and circular economy (CE) outcomes in Nigerian cities, yet they remain structurally invisible in official data systems, social protection schemes, and climate-governance frameworks. Drawing on doctoral research conducted in six high-intensity waste zones in Lagos and Abuja (n = 500 waste pickers, complemented by FGDs and KIIs), this article develops a policy-oriented rationale for a polycentric national digital registry for informal waste recovery pickers in Nigeria. The empirical evidence confirms that waste pickers contribute significantly to waste diversion, recycling and climate mitigation, while experiencing extreme socio-economic precarity, occupational health risks and systematic exclusion from municipal databases and digital platforms (e.g., EPR traceability systems, mobile payments). Existing digital initiatives in the Nigerian waste sector tend to prioritize aggregators and formal contractors, thereby deepening the "data injustice"—the erasure or instrumentalization of marginalized groups within digital economies. Against this backdrop, the article argues that a centralized, top-down registry would be ill-suited to the fragmented, multi-actor nature of Nigeria's waste and climate governance landscape. Instead, it proposes a polycentric digital registry architecture anchored in Elinor Ostrom's theory of polycentric governance and collective action, where multiple centers of authority—national agencies, state waste authorities, municipalities, cooperatives, producer responsibility organizations and civil-society partners—co-produce, steward and use registry data under shared rules. It concludes that a polycentric national digital registry is not merely a technical tool, but a governance reform capable of transforming informal waste pickers from "uncounted labour" into recognized partners in Nigeria's circular economy, NDC implementation and just-transition agenda.

Introduction

Nigeria's rapidly urbanizing cities face escalating challenges of municipal solid waste management, with Lagos and Abuja representing two distinct but interconnected waste frontiers. Lagos, a megacity with dense commercial corridors and complex value chains, generates thousands of tonnes of waste per day, while Abuja's planned core and expanding peri-urban fringe are characterized by fragmented collection systems and proliferating informal dumpsites. In both contexts, informal waste pickers play a critical yet unrecognized role in diverting recyclables from open dumps and drains, thereby reducing environmental burdens and sustaining livelihoods at the urban margins.

Research from around the world, including studies focused on African countries, has shown that informal recyclers underpin de facto circular economy outcomes—through recovery, sorting, and supply of secondary materials while remaining excluded from formal planning, infrastructure investments, and social protection. (Medina, 2007; Scheinberg et al., 2010; Schenck et al., 2019). In Nigeria, this paradox is particularly acute:

informal waste pickers contribute significantly to SDGs 8, 11 and 12, yet are frequently harassed, displaced, or ignored in policy frameworks and urban planning processes.

At the same time, Nigeria is advancing multiple policy agendas that explicitly rely on robust data and monitoring systems: the National Policy on Solid Waste Management, EPR Guidelines, the National Circular Economy Roadmap, the Climate Change Act and the implementation of Nigeria's NDC and LT-LEDS. These frameworks emphasize data-driven decision-making and MRV of waste, emissions, and circular-economy indicators, but they are largely blind to the informal labour systems that make these goals feasible in practice.

The doctoral study underpinning this article found that most informal waste pickers in Abuja and Lagos are absent from any municipal or national registry, receive cash-based payments from intermediaries, and are excluded from digital innovations such as mobile payments, QR-based tracking and EPR traceability tools. This "digital invisibility" produces a vicious cycle: because waste pickers are not counted in digital systems, they are overlooked in policy and resource allocation; their contributions to circular economy and climate mitigation are neither measured nor rewarded.

A growing literature on data justice warns that digitalization can deepen, rather than resolve, inequalities when marginalized groups lack agency over how their data are collected, used and monetized (Taylor, 2022). In the Nigerian waste sector, digital pilots have tended to focus on tracking materials and revenues for companies and producer responsibility organizations, leaving waste pickers as "data shadows" whose labour is rendered visible only at the point where materials enter formal depots.

At first glance, a national digital registry for waste pickers appears to offer a solution—making pickers visible, enabling social protection and informing circular-economy metrics. However, Nigeria's multi-layered governance structure, with overlapping mandates across federal, state and local institutions, renders a purely centralised registry both politically and operationally fragile. The thesis evidence shows that Lagos and Abuja already exhibit divergent trajectories: Lagos demonstrates partial recognition of waste pickers through LAWMA's cooperative pilots, while Abuja pursues more restrictive zoning and aesthetics-driven enforcement that repeatedly displaces informal actors.

This article therefore asks: What kind of national digital registry can recognize and protect informal waste pickers, while fitting Nigeria's complex governance landscape and supporting circular-economy and climate-governance objectives?

Building on the thesis findings and drawing from Ostrom's (1990) work on polycentric governance, we argue for a polycentric national digital registry—one that is nationally framed but co-governed by multiple centers of authority (national agencies, state waste authorities, municipalities, cooperatives, EPR schemes, NGOs), and explicitly grounded in principles of environmental justice and data justice.

The specific objectives of the article are to:

1. Synthesise empirical evidence from Abuja and Lagos that demonstrates the need for a digital registry of informal waste pickers;

2. Explain why a polycentric rather than strictly centralized registry architecture is more appropriate for Nigeria's circular-economy and climate-governance context; and

3. Propose design features, governance arrangements and safeguards for a polycentric national digital registry that advances visibility, rights, and fair benefit-sharing for waste pickers.

Materials and Methods

Research Design

This article draws on a participatory rapid appraisal (PRA) research design anchored in the author's doctoral study on socio-economic and environmental impacts of informal waste pickers in Abuja and Lagos Metropolis. The primary study adopted a cross-sectional, participatory rapid appraisal (PRA) design, combining quantitative surveys (n = 500 waste pickers) with qualitative methods (FGDs, KIIs and stakeholder mapping).

For the purposes of this article, the original dataset was re-analysed with a focus on:

- socio-economic indicators relevant to registry design (gender, age, migration status, education, digital access, cooperative membership);

- interaction profiles with authorities (AEPB, LAWMA, local governments, police, market associations);

- existing formal and informal identification practices (ID cards, uniforms, tags, cooperative lists); and

- experiences and perceptions of digital platforms, mobile phones, and data sharing.

This empirical base is complemented by a policy and institutional review of national and state-level documents, including the National Policy on Solid Waste Management, NESREA EPR Guidelines, the National Circular Economy Roadmap, NCCC climate documents, and key international guidance on data justice and gender-responsive digital inclusion.

Study Area

The original research covered six high-intensity waste zones in two Nigerian cities:

- **Abuja:** Idu Industrial Area, Mpape, Gosa Market

- **Lagos:** Ojota, Agege, Mushin

These locations were purposively selected based on reconnaissance visits, expert consultations and evidence of concentrated informal recycling activity, allowing comparative analysis across different urban forms and governance arrangements. Abuja's planned districts and strong state presence produce a relatively centralized regulatory environment, while Lagos's dense, commercially driven waste system exhibits deeper entanglement between formal and informal actors and a more diversified governance field.

Population, Sample Size and Sampling Procedure

The study population comprised informal waste pickers involved in collection, sorting and sale of recyclables (plastics, metals, paper, glass, and organics). Most work without contracts or social protection and operate in hazardous environments (open dumpsites, busy roadsides, drains).

A multi-stage sampling approach was used:

1. Purposive selection of the two cities and six zones;

2. Mapping of waste "hotspots" within each zone (dumpsites, roadside collection points, recycling markets);

3. Stratified random sampling of pickers at each hotspot, with strata based on gender and work typology (mobile vs. stationary; individual vs. cooperative-based); and

4. Snowball sampling to reach hard-to-access groups (women working from home, night-shift pickers, elderly workers).

In total, 500 respondents were surveyed, and multiple FGDs and KIIs were conducted with municipal officials, waste authorities, NGOs, cooperative leaders and EPR actors.

Data Collection Instruments

The structured questionnaire captured:

- demographic characteristics and migration status;

- work history, earnings, and material recovery patterns;

- health conditions and occupational risks;

- forms of organization and interaction with authorities; and

- access to phones, banking, digital platforms and identification documents.

FGDs explored collective strategies, gendered vulnerabilities, experiences with enforcement, and perceptions of digital and cooperative initiatives. KIIs gathered insights into existing data systems, registration practices, and institutional views on formalizing or registering waste pickers.

Analytical Approach for the Registry Rationale

The article re-interprets the empirical and policy data through three analytical lenses:

1. Environmental justice – to understand how digital invisibility intersects with distributive, recognitional and procedural injustice.

2. Data justice – to evaluate who is counted, who controls data, and who benefits from emerging digital systems in the waste and climate sectors.

3. Polycentric governance – to identify institutional configurations in which multiple centers of authority can share responsibility for governing a national digital registry.

The synthesis then informs a set of design principles and institutional options for a polycentric national digital registry for informal waste recovery pickers.

Results and Discussion

Empirical Basis for a National Digital Registry

The thesis results show that informal waste pickers in Abuja and Lagos are central to waste diversion and recycling, yet virtually absent from official data systems.

Municipal authorities such as AEPB and LAWMA maintain records of licensed contractors and, in some cases, primary aggregators, but they do not systematically register the hundreds of pickers operating at dumpsites and markets like Mpape, Gosa, Ojota and Agege. As summarised in Figure 1, multiple dimensions of socio-economic vulnerability and institutional invisibility converge to keep these workers outside formal registries.

Key patterns relevant to registry design include:

i.   High socio-economic vulnerability: Most pickers live below or near the national minimum wage, with volatile income streams dependent on fluctuating prices and buyer power.

ii.   Limited formal identification: A significant share lacked up-to-date national IDs, voter cards or other official documents, relying instead on informal recognition through depot owners, security agents or local leaders.

iii.   Digital exclusion: Many pickers use basic phones, with low access to smartphones, mobile data or app-based platforms; digital payments are rare, and most transactions are cash-based.

iv.   Fragmented interactions: Engagement with authorities is inconsistent and often mediated by middle-men or cooperative heads, limiting direct voice and accountability.

These findings confirm a structural visibility gap: waste pickers are "known" locally as workers, but they are not legibly counted in any national or city-level system that could support social protection, occupational health programmes, circular-economy planning or climate MRV.
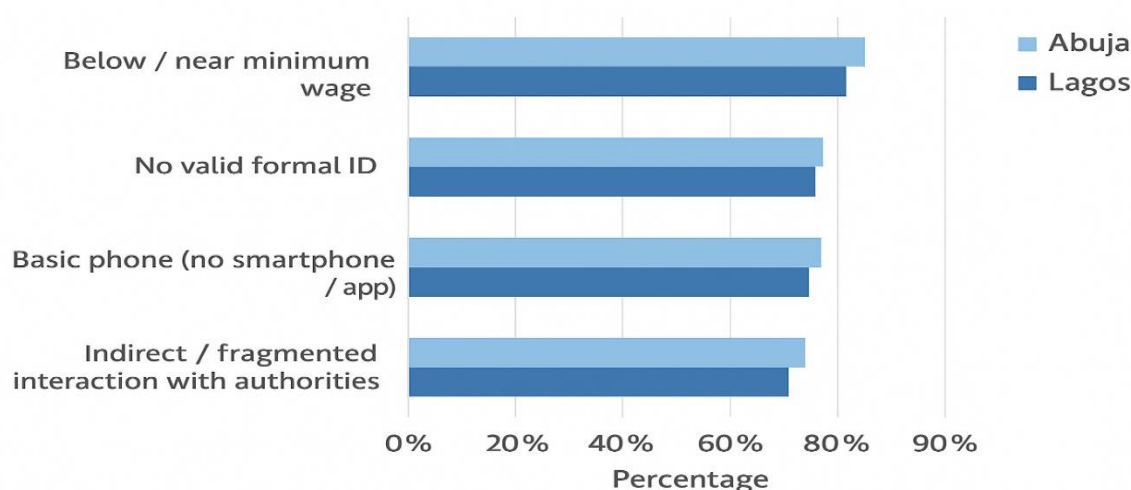

Figure 1. Key vulnerability and invisibility indicators among informal waste pickers in Abuja and Lagos

A national digital registry therefore responds to several interlocking needs:

i.   Recognition and rights: establishing pickers as legitimate workers in urban governance and policy;

ii.   Evidence for CE and climate policy: quantifying their contributions to recycling, waste diversion and emissions reduction;

iii.   Targeting of support: enabling health, livelihood and climate-finance programmes to reach waste pickers directly; and

iv.   Inclusion in EPR and carbon-credit systems: providing the data backbone for benefit-sharing and service contracts.

Digital Exclusion and Data Justice Concerns

The thesis's dedicated section on Digital Integration and Data Justice documents how existing digital initiatives in Nigeria's waste sector largely bypass waste pickers. Platforms such as pilot EPR traceability systems tend to interact with aggregators and recyclers, not with the pickers who do the most hazardous work.

Field evidence from Abuja and Lagos indicates that most waste pickers:

i.   do not appear in municipal or company databases;

ii.   lack access to smartphone-based apps and digital wallets; and

iii.   have limited trust in how data might be used, often fearing eviction or policing rather than support.

This aligns with Taylor's (2022) argument that marginalized groups often experience "data injustice": they are either absent from data systems, or included in ways that expose them to harm without corresponding benefits. In Lagos, for instance, digital enforcement tools and aesthetic regulations have sometimes been used to displace or criminalize informal activities; in Abuja, enforcement campaigns have cleared central areas while leaving pickers unrecognized at peripheral dumpsites.

A national registry designed purely as a control or surveillance instrument could reinforce these injustices. The challenge, therefore, is to design a registry that:

i.   counts waste pickers for the purposes of recognition, protection and reward;

ii.   does not criminalize or displace them; and

iii.   ensures that any value generated from data (e.g., plastic credits, carbon assets, EPR payments) is shared with those who produce it.

Why a Polycentric Registry Architecture?

Nigeria's waste and climate-governance landscape is inherently polycentric: multiple institutions operate at different scales with overlapping mandates—NCCC, FMEnv, NESREA, state waste management agencies (e.g., LAWMA), local governments, producer responsibility organizations, and a dense web of cooperatives, NGOs and community-based organisations.

Ostrom (1990) argues that polycentric systems, where multiple centers of authority make rules and manage resources within a common framework, can be more adaptive, equitable and resilient than strictly centralized arrangements—provided there are clear rules, communication channels and conflict-resolution mechanisms.

Applying this to a national digital registry suggests that:

i.   A single, centrally managed registry risks becoming technocratic, distant from local realities, and vulnerable to political or technical failures.

ii.   A polycentric registry, by contrast, can be nationally standardized but locally operated by different actors (municipalities, cooperatives, EPR schemes), with shared data standards and interoperable systems.

In practical terms, a polycentric national digital registry for waste pickers would:

1.   Establish national standards for data fields (e.g., basic demographics, work typology, location, cooperative membership, materials handled) and privacy safeguards;

2.   Authorize multiple registry "nodes" (e.g., LAWMA, AEPB, other state agencies, accredited NGOs, cooperatives) to enroll pickers and update records;

3.   Use interoperable digital tools (mobile apps, USSD codes, offline-first devices) capable of functioning in low-connectivity environments; and

4.   Permit contextual customization, so that Lagos, Abuja and other cities can add relevant fields without breaking national comparability.

Such an arrangement mirrors successful cooperative-based integration models documented in South Africa, Latin America and elsewhere, where local organizations maintain membership lists and ID cards under broad policy frameworks, rather than relying solely on distant bureaucracies. (Schenck et al., 2019; Scheinberg et al., 2011).

Design Features of a Polycentric National Digital Registry

Building on the empirical and theoretical insights, key design features include:

a. *Low-Barrier, Inclusive Enrolment*

i.   Multiple entry points: waste pickers can register through cooperatives, NGOs, municipal officers, or EPR field teams.

ii.   Minimal documentation requirements, with options for step-wise verification (e.g., starting with basic biographical data and later linking national ID where available).

iii.   Use of offline-capable tools (e.g., tablets, USSD-based forms) to accommodate low smartphone and data penetration.

b. *Data Standards and Interoperability*

i. Core fields agreed nationally (e.g., gender, age, city, primary work zone, material specialization, cooperative membership), with unique identifiers (ID numbers or QR codes) for each worker.

ii. Interoperable formats that allow integration with municipal waste data, climate MRV systems, and social-protection platforms.

c. *Governance and Accountability Mechanisms*

- A national steering committee (NCCC, FMEnv, NESREA, NBS and representatives of waste picker organizations, women's groups and CSOs) to oversee standards and data-justice safeguards.

- Local oversight structures (e.g., city-level multi-stakeholder forums) to monitor enrollment practices, resolve disputes and ensure that registration leads to tangible benefits.

d. *Data-Justice Safeguards*

i. Explicit consent protocols, with clear communication (in local languages) about why data are collected and how they will be used.

ii. Legal and policy assurances that registry data cannot be used for evictions, punitive enforcement, or discrimination, with independent complaint mechanisms.

iii. Mechanisms for equitable benefit-sharing where data underpin financing (e.g., plastic credits, carbon credits, EPR fees).

e. *Gender-Responsive Design*

i. Ensuring that registry processes are accessible to women pickers (e.g., flexible registration locations and times, childcare considerations, privacy for survivors of GBV).

ii. Capturing gender-disaggregated indicators (earnings, exposure to hazards, decision-making roles) to inform gender-responsive policy, consistent with UN Women guidance.

5. *Implications for Circular Economy and Climate Governance*

A polycentric digital registry would generate several system-level benefits:

i. Circular-economy metrics: Municipalities and national agencies could quantify the volumes of recyclables mobilized by registered pickers and link these to CE targets in the National Circular Economy Roadmap.

ii. Climate MRV: Registry data could feed into MRV systems for Nigeria's NDC and LT-LEDS, especially for waste-sector emissions and informal recovery-driven mitigation, as highlighted in the thesis's carbon-asset analysis.

iii. EPR and private-sector partnerships: Producer responsibility organizations could contract registered pickers or cooperatives as service providers, with traceable payments and safeguards against exploitation.

iv. Social protection and just transition: Registry data could be cross-linked with health insurance schemes, safety-equipment programmes and climate-adaptation funds, aligning with global calls for just transitions in informal economies.

In short, the registry becomes a backbone infrastructure for polycentric, data-driven governance of circular economy and climate action, with informal waste pickers recognized as central actors rather than residual beneficiaries.

Conclusion and Recommendations

This article has reframed the challenge of informal waste picker invisibility as a governance and data-justice problem that demands a systemic solution. Using empirical evidence from Abuja and Lagos, it has demonstrated that informal waste pickers are indispensable to Nigeria's circular economy and climate-mitigation efforts, yet remain uncounted in official data systems and excluded from digital innovations. We argue that a polycentric national digital registry offers a more context-appropriate and justice-oriented pathway than a purely centralized registry. Grounded in Ostrom's theory of polycentric governance and informed by environmental justice and data-justice perspectives, the proposed registry would be nationally standardized but co-governed by multiple actors, with strong safeguards to ensure that data are used for recognition, protection and fair reward—not for surveillance or displacement. By positioning waste pickers as visible, rights-bearing workers within Nigeria's circular-economy and climate-governance architecture, a polycentric digital registry can help bridge the gap between policy rhetoric and on-the-ground realities, advancing both sustainability and

social justice. The following recommendations were provided;

i. Mandate NCCC, FMEnv, NESREA and NBS to co-develop a legal and technical framework for a national digital registry of informal waste pickers, explicitly incorporating data-justice and environmental-justice principles.

ii. Establish pilot registry nodes through LAWMA and AEPB in collaboration with cooperatives, NGOs and EPR schemes, testing interoperable tools and shared governance arrangements before national scaling.

iii. Create national and city-level steering platforms that include waste picker representatives, women's groups and civil society organizations in decision-making on registry design, data use and benefit-sharing.

iv. Embed gender-responsive guidelines in registry operations, including safe spaces for women's registration, support for childcare, and collection of gender-disaggregated indicators.

v. Link registry data to municipal waste audits, national CE metrics and NDC MRV frameworks, enabling Nigeria to account for informal recovery contributions to emissions reduction and resource efficiency.

vi. Design registry participation as a gateway to PPE, health screening, training, microfinance, climate-finance programmes, and EPR service contracts, thereby building trust and incentives for sustained engagement.

vii. Enact clear rules prohibiting the use of registry data for punitive enforcement or evictions, ensure informed consent, and create accessible mechanisms for grievances and redress.

Limitations and Directions for Future Research

This article is derived from a broader doctoral study focused on Abuja and Lagos and therefore has several limitations. First, the empirical base is geographically bounded to six high-intensity waste zones and does not represent the full diversity of informal waste work across Nigeria's states and secondary cities. The registry design principles are thus indicative rather than prescriptive; future work should test and adapt them in other urban and peri-urban contexts.

Second, while the study captures important aspects of digital exclusion and institutional interactions, it does not provide a full technical blueprint for registry software, cybersecurity or interoperability with all existing government databases. Detailed systems design,

cost analysis and capacity assessments will be required before nationwide implementation.

Third, the analysis is largely qualitative in its treatment of governance and data justice. Quantitative modelling of potential impacts—such as changes in social-protection coverage, EPR payments or climate-finance flows under different registry scenarios—would strengthen the policy case and inform resource allocation.

Future research could therefore:

i. Undertake multi-city pilots that test different registry governance models (municipality-led, cooperative-led, EPR-anchored) and compare outcomes for inclusion, trust and benefit-sharing;

ii. Explore digital-literacy and co-design processes with waste pickers themselves, ensuring that user interfaces, consent mechanisms and feedback loops reflect their priorities;

iii. Examine gendered impacts of digital registries, particularly how women pickers navigate visibility, privacy, and access to benefits; and

iv. Integrate registry development with carbon-asset methodologies, assessing how registry data can support credit-grade MRV for waste-sector mitigation under Article 6 and voluntary carbon markets.

By advancing these research frontiers, scholars and practitioners can help ensure that a national digital registry for waste pickers becomes a cornerstone of just, polycentric circular-economy governance in Nigeria and a model for other countries in the Global South.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Credit Authorship Contribution Statement

Ukemezia, D. O.: Conceptualization, Methodology, Formal analysis, Investigation, Resources, Data curation, Visualization, Project administration, Writing - original draft. **Woke, G. N. and Edwin-Wosu, N. L.:** Supervision, Methodology, Validation, Formal analysis, Data curation, Visualization, Review & Editing.

References

Adesina, O., & Olajide, O. (2020). Digital innovations in Nigeria's waste management sector: Opportunities and risks for informal workers. *Journal of Urban Management*, 9(3), 45–59.

Akinwale, A., & Adeboje, A. (2020). Governance, informality and waste management in Lagos. *African Urban Studies Review*, 12(1), 33–52.

Bullard, R. D. (1990). *Dumping in Dixie: Race, class, and environmental quality*. Westview Press.

Chambers, R., & Conway, G. (1992). *Sustainable rural livelihoods: Practical concepts for the 21st century*. IDS Discussion Paper 296.

Folke, C., Carpenter, S., Walker, B., Scheffer, M., Chapin, T., & Rockström, J. (2010). Resilience thinking: Integrating resilience, adaptability and transformability. *Ecology and Society*, 15(4), 20.

GAIA. (2021). *Inclusive waste management: A rights-based approach*. Global Alliance for Incinerator Alternatives.

Gutberlet, J. (2012). *Empowering collective recycling initiatives: Video documentation and action research with waste pickers in Brazil*. Resources, Conservation and Recycling, 60, 16–22.

Hoornweg, D., & Bhada-Tata, P. (2012). *What a waste: A global review of solid waste management*. World Bank.

Ilesanmi, A., & Adewuyi, O. (2021). Zoning, informality and environmental governance in Abuja. *Nigerian Journal of Urban and Regional Planning*, 15(2), 77–96.

Medina, M. (2007). *The world's scavengers: Salvaging for sustainable consumption and production*. AltaMira Press.

Medina, M. (2014). Globalization, development, and municipal solid waste management in Third World cities. El Colegio de la Frontera Norte.

National Bureau of Statistics (NBS). (2022). *2022 demographic statistics bulletin*. NBS.

National Circular Economy Roadmap. (2023). *Nigeria circular economy roadmap*. Federal Government of Nigeria / UNEP / NCCC.

National Council on Climate Change (NCCC). (2023). *Nigeria's national climate change policy and NDC implementation plan*. NCCC.

National Environmental Standards and Regulations Enforcement Agency (NESREA). (2020a). *National policy on solid waste management*. NESREA.

National Environmental Standards and Regulations Enforcement Agency (NESREA). (2020b). *Guidelines for extended producer responsibility in Nigeria*. NESREA.

Nigeria National Plastic Action Partnership (NPAP). (2023). *Nigeria national plastic action roadmap*. Global Plastic Action Partnership.

Ogunniyi, A., & Babalola, A. (2023). Digitalising informal recycling in Nigeria: Potentials and pitfalls. *Waste & Society*, 5(1), 1–19.

Omole, F., & Akunleye, O. (2019). The politics of informality: Waste picking and urban space in Lagos. *Urban Studies*, 56(12), 2448–2464.

Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. Cambridge University Press.

Oyelola, O. T., & Babatunde, A. I. (2017). Health implications of informal waste scavenging in Lagos, Nigeria. *Waste Management & Research*, 35(1), 69–77.

Parnell, S., & Pieterse, E. (2010). Urban governance and policy. In *The African Cities Reader* (pp. 109–126). Chimurenga / African Centre for Cities.

Robbins, P. (2012). *Political ecology: A critical introduction* (2nd ed.). Wiley-Blackwell.

Roy, A. (2005). Urban informality: Toward an epistemology of planning. *Journal of the American Planning Association*, 71(2), 147–158.

Samson, M. (2020). Extended producer responsibility and the politics of informal integration in Africa. *Waste Management & Research*, 38(5), 455–462.

Schenck, R., Blaauw, P., & Viljoen, J. M. M. (2019). Waste pickers and the informal economy in South Africa. *International Labour Review*, 158(2), 147–170.

Scheinberg, A., Simpson, M. H., Gupt, Y., & Anschütz, J. (2010). *Economic aspects of the informal sector in solid waste management*. GIZ / WASTE / GTZ.

Scheinberg, A., Wilson, D. C., & Rodic, L. (2011). *Solid waste management in the world's cities: Water and*

sanitation in the world's cities 2010. UN-Habitat / Earthscan.

Schlosberg, D. (2007). *Defining environmental justice: Theories, movements, and nature*. Oxford University Press.

Schlosberg, D. (2020). *Defining environmental justice: Theories, movements, and nature* (2nd ed.). Oxford University Press.

Taylor, L. (2022). *Data justice: A new frontier for environmental equity*. Cambridge University Press.

UN Women. (2020). *Gender equality in waste management: A global perspective*. UN Women.

UN Women. (2021). *Gender-responsive waste management toolkit*. UN Women.

UN Women. (2023). *Digital inclusion framework for waste sector programming*. UN Women.

UNDP. (2022). *Smart waste solutions: Digitalizing informal waste systems in West Africa*. UNDP.

UNDP. (2023). *Participatory MRV for climate action: Lessons from Kenya and Nepal*. UNDP.

UN-Habitat. (2021). *Urban waste and health in informal settlements: A review of global evidence*. UN-Habitat.

Wilson, D. C., Rodic, L., Scheinberg, A., Velis, C., & Alabaster, G. (2012). Comparative analysis of solid waste management in 20 cities. *Waste Management & Research*, 30(3), 237–254.

World Bank. (2022). *The Global Findex database 2021: Financial inclusion, digital payments, and resilience in the age of COVID-19*. World Bank.