

The 9rs Framework for Sustainable Solid Waste Management in Nigeria: Policy, Practice, And Pathways to a Circular Economy

Osu, Musa Udeh¹

¹ Department of Environmental Health Science, College of Medicine and Allied Health Sciences, Nasarawa State University, Keffi, Nasarawa State, Nigeria
Email: osumudeh@nsuk.edu.ng

ARTICLE INFO

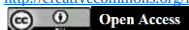
Keywords:

9Rs framework, circular economy, solid waste management, waste-to-energy, sustainable development

Vol.01, No.04, 2026

Copyright © 2026 by author(s) and Scientific Research Publishing Inc. This work is licensed under the Creative Commons Attribution International License (CCBY4.0).

<http://creativecommons.org/licenses/by/4.0/>



ABSTRACT

Nigeria, Africa's most populous nation, generates an estimated 32 million tonnes of solid waste annually, yet only approximately 20% is formally collected and managed. This article determines the 9Rs framework — Refuse, Reduce, Reuse, Repurpose, Recycle, Recover, Redesign, Remanufacture, and Refurbish — as a hierarchical circular economy strategy for transforming Nigeria's solid waste crisis into an engine of sustainable development. Drawing on Nigeria's 2020 National Policy on Solid Waste Management, the World Bank's 2024 Lagos State roadmap, peer-reviewed academic literature, and regulatory frameworks from the National Environmental Standards and Regulations Enforcement Agency (NESREA), this article analyses the policy landscape, implementation challenges, economic opportunities, and emerging success stories. The article argues that a systematic, multi-stakeholder application of the 9Rs, underpinned by robust governance, adequate financing, and formalization of the informal sector, can enable Nigeria to achieve over 60% formal waste collection by 2035 and transition toward a fully circular economy by 2040.

Introduction

Nigeria stands at a critical environmental crossroads. As Africa's most populous country and largest economy, it generates an estimated 32 million tonnes of solid waste annually — a figure projected to rise to 107 million tonnes by 2050 as urbanization and population growth accelerate (Kaza et al., 2018; Lagos Business School Sustainability Centre, 2023). Yet the country's formal waste management infrastructure remains severely underdeveloped: only approximately 20% of generated waste is collected through formal systems, leaving the vast majority to accumulate in open dumps, waterways, and urban streets (FMEnv, 2020; World Bank, 2024).

32M - Tonnes of solid waste generated annually in Nigeria,
20% - Formally collected through official systems,
0.51kg - Waste generated per capita per day,
107M - Projected tonnes by 2050 (World Bank, 2024).

The scale of the crisis is particularly acute in Lagos, a coastal megacity of over 24 million residents that generates an estimated 13,000 metric tons per day (TPD) of municipal solid waste (MSW), of which only approximately 4,200 TPD — a 33% collection rate — is formally managed (World Bank, 2024). The remainder clogs drains, pollutes the Lagos Lagoon, and contributes to recurrent flooding, public health emergencies, and greenhouse gas emissions from open burning and uncontrolled decomposition (Ezeudu et al., 2021; World Bank, 2024).

At the national level, the consequences are equally severe. A 2022 report by the non-profit Clean-Up Nigeria found that over 172.7 million Nigerians — approximately 86.35% of the population — live in environments considered unclean by global standards (Lagos Business School Sustainability Centre,

2023). The United Nations Industrial Development Organisation (UNIDO) estimates that of Nigeria's 32 million tonnes of annual waste, plastics alone account for 2.5 million tonnes, placing Nigeria among the 20 nations responsible for 83% of global riverine plastic emissions into the ocean (Meijer et al., 2022; Lagos Business School Sustainability Centre, 2023).

Globally, the waste management challenge is intensifying. The World Bank's landmark *What a Waste 2.0* report projects that global waste generation will rise from 2.01 billion tonnes in 2018 to 3.40 billion tonnes by 2050, with Sub-Saharan Africa — where Nigeria is the dominant economy — expected to see waste volumes nearly triple over the same period (Kaza et al., 2018). In this context, the transition from a linear "take-make-dispose" economy to a circular model is not merely desirable but existentially necessary.

The 9Rs framework — a hierarchical circular economy strategy encompassing Refuse, Reduce, Reuse, Repurpose, Recycle, Recover, Redesign, Remanufacture, and Refurbish — offers a structured, evidence-based pathway for this transition (Kirchherr et al., 2017; APEC, 2020). Nigeria has formally embedded this framework in its 2020 National Policy on Solid Waste Management, signaling a policy commitment to circular economy principles (FMEnv, 2020). However, the gap between policy aspiration and implementation reality remains vast.

This article provides a comprehensive, academically rigorous analysis of the 9Rs framework in the Nigerian context. It examines the policy architecture, implementation challenges, economic opportunities, and emerging success stories, before offering evidence-based recommendations for accelerating Nigeria's transition to a sustainable, circular waste management system.

2.0 THE 9RS FRAMEWORK EXPLAINED: PRINCIPLES AND NIGERIAN APPLICATIONS

The 9Rs framework is a hierarchical model of circular economy strategies, ordered from the most to least preferred in terms of resource conservation and environmental benefit (Kirchherr et al., 2017; APEC, 2020). Originally conceptualized by Potting et al. (2017) and subsequently elaborated by the Ellen MacArthur Foundation (Ellen MacArthur Foundation, 2023), the framework moves from strategies that prevent waste generation entirely (Refuse, Reduce) through those that extend product life (Reuse, Repurpose, Refurbish, Remanufacture, Redesign) to those that recover value from end-of-life materials (Recycle, Recover). Nigeria's 2020 National Policy on Solid Waste Management explicitly adopts this hierarchy as its guiding framework (FMEnv, 2020).

"The circular economy is a systems solution framework that tackles global challenges like climate change, biodiversity loss, waste, and pollution. It is based on three principles, driven by design: eliminate waste and pollution, circulate products and materials at their highest value, and regenerate nature." — Ellen MacArthur Foundation (2023)

R1 – Highest Priority

Refuse

Avoiding the use of raw materials or products altogether by abandoning unnecessary functions. In Nigeria, this translates to public awareness campaigns discouraging single-use plastics, the 2020 National Policy on Plastic Waste Management's ban on single-use plastic bags, and community-level "zero-waste" initiatives (FMEnv, 2020).

R2

Reduce

Minimizing resource consumption and improving production efficiency. Nigerian applications include bulk-buying cooperatives in urban markets, energy-efficient manufacturing incentives, and the National Policy's mandate for producers to minimize packaging waste (Ezeudu & Ezeudu, 2019; FMEnv, 2020).

R3

Reuse

Using discarded products in their original form without significant modification. Nigeria's vibrant second-hand goods markets — from Oshodi in Lagos to Onitsha in Anambra — represent one of the world's most extensive informal reuse economies, diverting millions of tonnes of goods from landfills annually (Ezeudu et al., 2021; UN-Habitat, 2023).

R4

Repurpose

Giving a product or component a new function or application. Community-based organisations across Nigeria repurpose plastic bottles as building materials, tyres as playground equipment, and organic waste as compost for urban agriculture — practices supported by the National Policy's community collection point framework (Ezeudu & Ezeudu, 2019; FMEnv, 2020).

R5

Recycle

Breaking down materials to their basic level for remanufacture into new products. Nigeria's recycling sector, though largely informal, handles significant volumes of PET plastics, metals, and paper. Formal recyclers such as Recycle Points and We cyclers have established collection networks in Lagos, while the National Policy targets a 65% recycling rate for MSW by 2030 (FMEnv, 2020; World Bank, 2024).

R6

Recover

Extracting energy or value from waste that cannot otherwise be kept in the loop, including waste-to-energy (WtE) technologies. Lagos State's planned transformation of the Olusosun landfill into a waste-to-energy station, in partnership with Zoom Lion Ghana, exemplifies this R in practice (PM News Nigeria, 2024; World Bank, 2024).

R7

Redesign

Redesigning products and systems for circularity from the outset. Nigeria's Extended Producer Responsibility (EPR) framework, enforced by NESREA, incentivises manufacturers to redesign packaging for recyclability or biodegradability, with a national target that all plastic packaging be recyclable or compostable by 2025 (NESREA, 2009; FMEnv, 2020).

R8

Remanufacture

Rebuilding products to original specifications using reclaimed parts. Lafarge Nigeria's "Geocycle" programme — the country's first full-fledged professional waste co-processing service — remanufactures industrial waste into cement kiln fuel, diverting hazardous materials from landfills while reducing fossil fuel consumption (Ezeudu & Ezeudu, 2019; Trinomics, 2020).

R9 – Lowest Priority

Refurbish

Renewing used items to a like-new condition. Nigeria's thriving electronics repair sector — particularly in Alaba International Market, Lagos — refurbishes millions of electronic devices annually, extending product lifespans and reducing e-waste generation, though largely without formal regulatory support (UNEP, 2018; Ezeudu et al., 2021).

The hierarchical nature of the 9Rs is critical: strategies higher in the hierarchy (Refuse, Reduce) preserve more value and generate greater environmental benefit than those lower down (Recycle, Recover) (Kirchherr et al., 2017). As Ezeudu and Ezeudu (2019) demonstrate in their case studies of

Nigerian industrial waste management, the most impactful interventions are those that prevent waste generation at source, rather than managing it after the fact. This principle should guide Nigeria's policy prioritization.

3.0 POLICY FRAMEWORK: NATIONAL POLICY, LAGOS STATE ROADMAP, AND FEDERAL-STATE COLLABORATION

3.1 The 2020 National Policy on Solid Waste Management

The cornerstone of Nigeria's waste governance architecture is the 2020 National Policy on Solid Waste Management (NPSWM), developed by the Federal Ministry of Environment (FMEnv) to establish an integrated, safe, and economically sustainable solid waste management system (FMEnv, 2020). The policy explicitly adopts the 9Rs hierarchy as its guiding framework and sets ambitious targets: increasing formal collection coverage from approximately 20% to over 60% by 2035, achieving a 65% recycling rate for MSW by 2030, and reducing waste to landfill to a maximum of 10% of MSW by 2030 (FMEnv, 2020; NESREA, 2025).

The NPSWM identifies several priority areas: waste avoidance and minimisation through public awareness campaigns and producer incentives; reuse and repurposing via community collection points and informal sector networks; recycling and recovery through expanded formal collection services and investment in material-separation facilities; and waste-to-energy as a complementary strategy for non-recyclable residuals (FMEnv, 2020). The policy also mandates a federal-state collaboration framework, requiring coordinated legal, financial, and technical mechanisms across all tiers of government (FMEnv, 2020; NESREA, 2025).

Complementing the NPSWM is the 2020 National Policy on Plastic Waste Management (NPPWM), which bans single-use plastic bags and expanded polystyrene above 30 microns, mandates that all plastic packaging be recyclable or biodegradable by 2025, and targets a 50% reduction in plastic bag use per person by 2030 (FMEnv, 2020). Both policies were approved by the Federal Executive Council and are legally binding on all states and local government areas.

3.2 NESREA's Regulatory Framework

The National Environmental Standards and Regulations Enforcement Agency (NESREA), established under the NESREA Act No. 25 of 2007, is the primary regulatory body responsible for enforcing Nigeria's environmental laws, including those governing solid waste management (NESREA, 2009; Atsegbua et al., 2012). NESREA enforces a suite of regulations directly relevant to the 9Rs framework (see Table 1).

Table 1: NESREA Suite of Regulations to the 9Rs Framework

Regulation	Year	Key Provisions	Relevant Rs
National Environmental (Sanitation and Wastes Control) Regulations	2009	Waste segregation, collection, transportation standards; duties of all government tiers; penalties for non-compliance	R2, R3, R5
National Environmental (Solid Waste Management) Regulations	2009	Standards for waste segregation, collection, transportation, treatment, and disposal	R2–R6
Extended Producer Responsibility (EPR) Regulations	2014	Manufacturers, producers, and importers must take responsibility for post-consumer waste from their products	R1, R7, R8
National Environmental (Plastic Waste Control) Regulations	2026	Comprehensive lifecycle management of plastic waste; bans, levies, and recycling targets	R1, R2, R5, R7



National (Battery Control) Regulations	Environmental Regulations	2024	Safe collection, recycling, and disposal of batteries; EPR for battery manufacturers	R5, R8, R9
---	------------------------------	------	---	------------

Despite this regulatory architecture, enforcement remains a significant challenge. NESREA (2025) acknowledges that weak institutional capacity, inadequate funding, and coordination failures between federal and state agencies have limited the practical impact of these regulations. The NESREA Act's replacement of the Federal Environmental Protection Agency (FEPA) in 2007 was intended to strengthen enforcement, but resource constraints continue to hamper effective monitoring (Atsegbua et al., 2012).

3.3 The Lagos State Roadmap (2025–2040)

Lagos State, as Nigeria's economic capital and most populous city, has developed the most advanced sub-national waste management framework in the country. The World Bank's 2024 report, *Improving Solid Waste and Plastics Management in Lagos State: A Way Forward*, provides a comprehensive roadmap covering the period 2025 to 2040, aligned with the Lagos State Development Plan 2052 (World Bank, 2024).

The roadmap is structured around four time horizons — quick wins (2025), short-term (2027), medium-term (2030), and long-term (2040) — and encompasses thematic areas including waste collection infrastructure, source separation, material recovery facilities (MRFs), plastic recycling, refuse-derived fuel (RDF), and engineered landfills (World Bank, 2024). Key targets include: deploying two-bin (wet and dry) segregated waste systems at households and commercial premises; establishing at least one engineered sanitary landfill by 2027; incentivising private investment in MRFs and composting plants; and transforming Lagos into a national and regional plastic recycling hub by 2040 (World Bank, 2024).

The Lagos Waste Management Authority (LAWMA), established in 1977 and restructured under Edict No. 55 of 1991, is the statutory agency responsible for implementing this roadmap. LAWMA has evolved from direct waste collection to a public-private partnership (PPP) model, with over 340 registered private sector participants providing door-to-door collection services across the state (NESREA, 2025; C40 Cities, 2015). The C40 Cities network has recognised Lagos's PPP model as a global good practice for private sector participation in municipal waste management (C40 Cities, 2015).

3.4 Federal-State Collaboration Framework

The NPSWM mandates a federal-state collaboration framework that requires coordinated legal, financial, and technical mechanisms to embed the 9Rs across all urban centres (FMEnv, 2020). This framework assigns overarching policy responsibility to the Federal Ministry of Environment, regulatory enforcement to NESREA, and operational implementation to state and local government agencies (NESREA, 2025). The African Development Bank's Nigeria Circular Economy Working Group (NCEWG), established in 2023, provides an additional platform for multi-stakeholder coordination on circular economy implementation (World Bank, 2024).

4.0 CHALLENGES AND BARRIERS TO 9RS IMPLEMENTATION

Despite the existence of a comprehensive policy framework, Nigeria faces formidable structural, institutional, financial, and behavioural barriers to implementing the 9Rs framework at scale. These challenges are well-documented in the academic literature and government assessments (Ezeudu et al., 2021; World Bank, 2024; NESREA, 2025).

4.1 Weak Institutional and Legal Framework

The NPSWM itself acknowledges the "absence of adequate laws and enabling legislations; lack of political will; weak enforcement of available laws, regulations, and applicable sanctions" as primary obstacles to effective waste management (FMEnv, 2020). Coordination failures between federal, state,

and local government agencies create regulatory gaps that waste generators exploit (NESREA, 2025). The multiplicity of agencies with overlapping mandates — FMEnv, NESREA, state environmental agencies, and local government councils — generates confusion and accountability deficits (World Bank, 2024).

4.2 Inadequate Financing/Funding

Solid waste management is chronically underfunded in Nigeria. The water supply, sewerage, and waste management sector contributed only 0.17% of total real GDP in Q4 2022, despite growing at 4.92% in that quarter (National Bureau of Statistics [NBS], 2022). In Lagos State, the budget allocated to the SWM sector remains insufficient relative to the scale of the challenge, with the social cost of mismanaged waste estimated at approximately \$218 million per year (World Bank, 2024). Financing mechanisms — including government budget allocations, donor funding, sector user charges, and private investment — are fragmented and inadequate (World Bank, 2024).

4.3 Infrastructure Deficits

Nigeria's waste management infrastructure is severely underdeveloped. Most municipalities rely on uncontrolled disposal sites, and formal recycling systems are not commonplace (UNEP, 2018; ODI, 2020). In Lagos, only 4,200 TPD of the estimated 13,000 TPD generated is formally collected, leaving 8,800 TPD — over two-thirds of the city's waste — unmanaged (World Bank, 2024). Material recovery facilities (MRFs), composting plants, and waste-to-energy installations are largely absent outside of pilot projects (Ezeudu & Ezeudu, 2019; World Bank, 2024).

4.4 Marginalization of the Informal Sector

Nigeria's informal waste sector — comprising an estimated hundreds of thousands of waste pickers, cart pushers, and small-scale recyclers — performs a critical function, filling gaps that formal systems cannot address (UN-Habitat, 2023; INCLUDE Platform, 2024). UN-Habitat reports that informal waste pickers collect 50–100% of waste in cities in low-income countries at no cost to municipalities (UN-Habitat, 2010). Yet these workers face criminalization, societal stigma, exclusion from social services, and hazardous working conditions (INCLUDE Platform, 2024). The Cleaner Lagos Initiative's proposed ban on cart pushers and wheelbarrow operators exemplifies the tension between formalization goals and the livelihoods of informal workers (World Bank, 2024).

4.5 Behavioural and Cultural Barriers

Household waste management behaviour in Nigeria is shaped by a complex interplay of income levels, access to services, social norms, and information availability (World Bank, 2024). A household survey conducted as part of the World Bank's Lagos study found that a significant proportion of households resort to open dumping due to inadequate collection infrastructure, not lack of awareness (World Bank, 2024). Ezeudu et al. (2021) identify "co-production" — the active involvement of communities in waste management — as a critical but underutilized strategy for overcoming behavioural barriers in the Nigerian context.

4.6 Data Deficits

Comprehensive and reliable data on waste generation, composition, collection rates, and treatment are largely absent in Nigeria, a challenge recognized by UNEP (UNEP, 2018) and the World Bank (World Bank, 2024). The absence of reliable data hampers evidence-based policy planning, performance monitoring, and investment decisions. The NPSWM identifies data collection as a priority, but implementation has been slow (Results for America, 2018; FMEnv, 2020).

5.0 OPPORTUNITIES AND ECONOMIC POTENTIAL

Nigeria's waste crisis, while severe, also represents a significant economic opportunity. The failure to formalise the waste recycling sector deprives the country of value from an estimated 32 million tonnes of waste generated yearly (Lagos Business School Sustainability Centre, 2023). UNEP estimates that

70–80% of MSW generated in African cities is recyclable, with an estimated economic value of US\$8 billion per year across the continent (CCAC, 2023). Nigeria, as Africa's largest economy, stands to capture a disproportionate share of this value.

5.1 Job Creation and Livelihoods

A well-functioning circular waste economy has significant potential for job creation. The World Bank's Lagos roadmap identifies waste management as a driver of inclusive economic growth, with opportunities across the entire value chain — from collection and sorting to processing, manufacturing, and energy generation (World Bank, 2024). The formalisation of Nigeria's informal waste sector alone could create hundreds of thousands of decent, regulated jobs, while providing workers with access to social protection, health services, and financial inclusion (UN-Habitat, 2023; INCLUDE Platform, 2024).

5.2 Plastic Recycling as an Economic Driver

Nigeria's plastic waste stream represents a particularly significant economic opportunity. With 2.5 million tonnes of plastic waste generated annually, and growing demand from domestic and international recyclers for PET, HDPE, and other recyclable plastics, the sector has attracted significant private investment (Lagos Business School Sustainability Centre, 2023; World Bank, 2024). The World Bank's Lagos study identifies plastic recycling as a potential engine for transforming Lagos into a national and regional recycling hub, with multiplier effects across manufacturing, logistics, and services (World Bank, 2024).

5.3 Waste-to-Energy Potential

Nigeria's large organic waste fraction — food, wood, and green waste constitute a significant proportion of MSW composition in Lagos (World Bank, 2024) — creates substantial potential for biogas generation, composting, and refuse-derived fuel (RDF) production. The World Bank roadmap recommends incentivising RDF adoption by factories as a strategy for boosting offtake of non-recyclable and hard-to-recycle materials (World Bank, 2024). Renewable energy generated from waste could supply small and medium-sized businesses, reducing dependence on diesel generators and contributing to Nigeria's energy transition goals (FMEnv, 2020).

5.4 Extended Producer Responsibility as a Financing Mechanism

Nigeria's EPR framework, enforced by NESREA, creates a mechanism for shifting the financial burden of waste management from governments and taxpayers to producers and importers (NESREA, 2009; World Bank, 2024). The Food and Beverage Recycling Alliance (FBRA) — a voluntary EPR initiative involving major consumer goods companies including Intercontinental Distillers, International Breweries, and Tulip Cocoa — demonstrates the potential of industry-led EPR to fund collection infrastructure and public awareness campaigns (World Bank, 2024). Strengthening and mandating EPR across all relevant sectors could generate significant financing for the 9Rs transition.

5.5 Digital Technology and Waste-Fintech

The emergence of digital platforms for waste management represents a transformative opportunity for Nigeria. Pakam Technology Limited — Africa's first waste-fintech platform — digitises the entire waste value chain, turning recyclables into bankable assets and providing real-time traceability, ESG-ready data, and instant payments to waste collectors (Pakam, 2026). Such platforms can bridge the gap between informal waste workers and formal recycling markets, while generating the data needed for evidence-based policy and investment decisions.

6.0 SUCCESS STORIES AND PILOT PROJECTS

Despite the scale of Nigeria's waste management challenges, a number of innovative initiatives demonstrate the feasibility of the 9Rs framework in the Nigerian context. These success stories provide proof-of-concept for scaling circular economy approaches nationally.

6.1 Wecyclers: Community-Based Recycling in Lagos

Wecyclers is a Lagos-based for-profit social enterprise that provides convenient door-to-door recycling services in densely populated, low-income urban neighbourhoods. By rewarding households with points exchangeable for everyday goods, Wecyclers has mobilised thousands of households to separate and surrender recyclable materials, creating a reliable supply of post-consumer plastics for the formal recycling industry (Trinomics, 2020; RVO, 2021). The enterprise has partnered with major consumer brands including Nestlé Nigeria and Unilever, and received the King Baudouin Foundation African Development Prize in 2018–19 (Wecyclers, 2019). Wecyclers exemplifies the Reuse and Recycle Rs in practice, while also demonstrating the viability of community co-production as a waste management strategy (Ezeudu et al., 2021).

6.2 Olusosun Landfill Transformation: From Dumpsite to Energy Station

The Olusosun landfill in Lagos — a 40-hectare site receiving up to 10,000 tonnes of waste per day and the largest dumpsite in Africa — is being transformed into a showcase of waste-to-energy and circular economy innovation (PM News Nigeria, 2024). LAWMA has partnered with ZoomLion Ghana to install geotextile covers, solar panels, and material recovery facilities that will separate metals, plastics, and organics for recycling, while excavated waste is processed at newly built waste-to-energy plants in Ikorodu and Badagry (PM News Nigeria, 2024). Simultaneously, the University of Lagos and the AFRETEC Seed-Grant Project are applying AI techniques to extract carbon from landfill gas for renewable power generation (University of Lagos, 2025). The "Adopt-a-Bin" programme accompanying this initiative aims to raise Lagos's recycling rate from approximately 8% to over 20% within three years (PM News Nigeria, 2024).

6.3 Lafarge Geocycle: Industrial Waste Co-Processing

Lafarge Nigeria's Geocycle programme — launched in 2018 as the country's first full-fledged professional waste co-processing service — collects waste from municipalities and industries, pre-processes it, and co-processes it as alternative fuel and raw material in cement kilns (Trinomics, 2020). This initiative exemplifies the Remanufacture and Recover Rs, diverting hazardous and non-recyclable materials from landfills while reducing the cement industry's dependence on fossil fuels. Geocycle's model aligns with the circular economy principle of keeping materials at their highest value for as long as possible (Ellen MacArthur Foundation, 2023).

6.4 LAWMA's Public-Private Partnership Model

Lagos Waste Management Authority's evolution from a direct service provider to a PPP coordinator represents a significant institutional innovation. With over 340 registered private sector participants providing door-to-door collection services, LAWMA's model has expanded waste collection coverage, improved service quality, and introduced modern equipment including compacting trucks and street sweepers (C40 Cities, 2015; NESREA, 2025). The C40 Cities network has documented this model as a global good practice, noting that LAWMA's PSP Handbook — which sets specific criteria, operating guidelines, and performance evaluation metrics for private sector participants — has been instrumental in ensuring accountability and service quality (C40 Cities, 2015).

6.5 Pakam Technology: Waste-Fintech for Circular Economy

Pakam Technology Limited has pioneered the integration of financial technology with waste management, creating a platform that turns recyclable materials into bankable assets. Through its Circular Collector Program, Pakam equips waste entrepreneurs with instant payment systems, real-time traceability, ESG-ready data reporting, access to loans of up to 60,000 Naira, and hire-purchase options for electric tricycles (Pakam, 2026). This model addresses multiple barriers simultaneously: it formalises informal waste workers, provides financial inclusion, generates data for policy, and creates economic

incentives for recycling — embodying the Recycle and Reduce Rs while advancing the broader circular economy agenda.

7.0 CONCLUSION

Nigeria's solid waste crisis is one of the most pressing environmental and public health challenges facing the country. With 32 million tonnes of waste generated annually, a formal collection rate of only approximately 20%, and a population projected to exceed 400 million by 2050, the status quo is unsustainable (Kaza et al., 2018; FMEnv, 2020). The 9Rs framework — Refuse, Reduce, Reuse, Repurpose, Recycle, Recover, Redesign, Remanufacture, and Refurbish — offers a hierarchical, evidence-based pathway for transforming this crisis into an opportunity for sustainable development, economic growth, and social inclusion.

Nigeria has made significant progress in establishing the policy architecture for a circular waste economy. The 2020 National Policy on Solid Waste Management, the NESREA regulatory framework, the Lagos State 2025–2040 roadmap, and the emerging EPR system collectively provide a strong foundation (NESREA, 2009; FMEnv, 2020; World Bank, 2024). Success stories from Wecyclers, Pakam, Lafarge Geocycle, and the Olusosun transformation demonstrate that circular economy solutions are not only feasible but economically viable in the Nigerian context.

However, the gap between policy aspiration and implementation reality remains vast. Weak enforcement, inadequate financing, infrastructure deficits, marginalisation of the informal sector, and data deficits continue to undermine progress (Ezeudu et al., 2021; World Bank, 2024; NESREA, 2025). Closing this gap will require sustained political will, multi-stakeholder collaboration, innovative financing, and a genuine commitment to integrating the informal sector as a valued partner rather than a problem to be eliminated.

The ambition embedded in Nigeria's policy framework — achieving over 60% formal waste collection by 2035 and a fully circular economy by 2040 — is achievable, but only if the recommendations outlined in this article are implemented with urgency and consistency (FMEnv, 2020; World Bank, 2024). The 9Rs are not merely an environmental framework; they are pathways to economic growth, social inclusion, environmental protection, and Nigeria's emergence as a leader in Africa's circular economy transition.

"The 9Rs framework reminds us that waste is not a problem to be managed — it is a resource to be valued. Nigeria's transition to a circular economy is not a cost; it is an investment in the health, prosperity, and resilience of 220 million people and the generations that will follow them".

8.0 RECOMMENDATIONS

Based on the analysis of Nigeria's policy framework, implementation challenges, economic opportunities, and success stories, the following evidence-based recommendations are proposed for accelerating the 9Rs transition in Nigeria. These recommendations draw on the World Bank's 2024 Lagos roadmap (World Bank, 2024), the NPSWM (FMEnv, 2020), and the academic literature (Ezeudu & Ezeudu, 2019; Kirchherr et al., 2017; Ezeudu et al., 2021).

8.1 Strengthen Policy and Legal Frameworks

Enact comprehensive national solid waste management legislation that gives legal force to the NPSWM, establishes clear mandates for all tiers of government, and provides enforceable penalties for non-compliance. Harmonise federal and state regulations to eliminate overlaps and gaps (FMEnv, 2020; NESREA, 2025).

8.2 Increase and Diversify Financing

Establish a dedicated National Solid Waste Management Fund, drawing on government budget allocations, EPR levies, carbon credits from waste-to-energy projects, and international climate finance.

Develop bankable project pipelines to attract private investment in MRFs, composting plants, and WtE facilities (Kaza et al., 2018; World Bank, 2024).

8.3 Formalize and Integrate the Informal Sector

Develop a national framework for integrating informal waste pickers into formal waste management systems, providing access to social protection, health services, financial inclusion, and capacity building. Recognise informal workers as key stakeholders in EPR schemes and MRF operations (UN-Habitat, 2023; UNEP, 2018; INCLUDE Platform, 2024).

8.4 Scale Public Awareness and Behaviour Change

Implement sustained, evidence-based public awareness campaigns that go beyond information provision to address the structural barriers to sustainable waste behaviour — including inadequate infrastructure, economic incentives, and social norms. Leverage behavioural insights, as recommended by the World Bank's Lagos study, to design effective interventions (World Bank, 2024).

8.5 Invest in Waste Management Infrastructure

Prioritize investment in source-separation infrastructure (two-bin systems), material recovery facilities, composting plants, and engineered landfills in all states. Incentivize private sector investment through tax breaks, land allocation, and guaranteed offtake agreements for recycled materials and energy (FMEnv, 2020; World Bank, 2024).

8.6 Establish Robust Performance Metrics and Data Systems

Develop a national waste data management system that tracks waste generation, composition, collection rates, recycling rates, and treatment outcomes at state and local government levels. Use this data to set evidence-based KPIs, monitor progress, and hold agencies accountable (Results for America, 2018; FMEnv, 2020).

8.7 Support Innovation and Technology Adoption

Create an enabling environment for waste-tech and waste-fintech innovation through regulatory sandboxes, innovation grants, and public procurement preferences for circular economy solutions. Scale successful models such as Wecyclers, Pakam, and Geocycle through government partnerships and blended finance (Trinomics, 2020; Pakam, 2026).

8.8 Build Institutional Capacity

Invest in the technical and managerial capacity of NESREA, state environmental agencies, and local government waste management units. Establish a national centre of excellence for circular economy and waste management, drawing on international partnerships with UNEP, UN-Habitat, and the World Bank (UNEP, 2018; NESREA, 2025).

REFERENCES

1. APEC (Asia-Pacific Economic Cooperation). (2020). *Circular economy: Don't let waste go to waste*. APEC Policy Support Unit. https://www.apec.org/docs/default-source/publications/2020/1/circular-economy/220_psu_circular-economy---dont-let-waste-go-to-waste.pdf
2. Atsegbua, L., Akintayo, D., & Dimowo, F. (2012). Nigeria: Review of NESREA. *Law, Environment and Development Journal*, 8(1), 116–130. <https://lead-journal.org/content/12116.pdf>
3. C40 Cities. (2015). *C40 good practice guides: Lagos — Private sector participation*. C40 Cities Climate Leadership Group. <https://www.c40.org/case-studies/c40-good-practice-guides-lagos-private-sector-participation>
4. Climate and Clean Air Coalition (CCAC). (2023). *Roadmap for transformative action on open burning in Africa*. CCAC Secretariat.



https://www.ccacoalition.org/sites/default/files/resources/files/OpenBurning_AfricaRoadmap_2_WHY_0.pdf

5. Ellen MacArthur Foundation. (2023). *The circular economy: Introduction and overview*. Ellen MacArthur Foundation. <https://www.ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview>
6. Ezeudu, O. B., & Ezeudu, T. S. (2019). Implementation of circular economy principles in industrial solid waste management: Case studies from a developing economy (Nigeria). *Recycling*, 4(4), 42. <https://doi.org/10.3390/recycling4040042>
7. Ezeudu, O. B., Agunwamba, J. C., Ugochukwu, U. C., & Ezeudu, T. S. (2021). Temporal assessment of municipal solid waste management in Nigeria: Prospects for circular economy adoption. *Reviews on Environmental Health*, 36(3), 327–344. <https://doi.org/10.1515/reveh-2020-0084>
8. Ezeudu, O. B., Oraefosi, T. C., Agunwamba, J. C., & Ugochukwu, U. C. (2021). Co-production in solid waste management: Analyses of emerging cases and implications for circular economy in Nigeria. *Environmental Science and Pollution Research*, 28(37), 52392–52404. <https://doi.org/10.1007/s11356-021-14471-8>
9. Federal Ministry of Environment (FMEnv), Federal Republic of Nigeria. (2020). *National Policy on Solid Waste Management (NPSWM)*. Federal Ministry of Environment. Retrieved from <https://nesrea.gov.ng>
10. Federal Ministry of Environment (FMEnv), Federal Republic of Nigeria. (2020). *National Policy on Plastic Waste Management (NPPWM)*. Federal Ministry of Environment. <https://faolex.fao.org/docs/pdf/nig214338.pdf>
11. INCLUDE Platform. (2024). *Formalizing the informal waste picker economy for sustainable development in Nigeria*. INCLUDE Knowledge Platform. <https://includeplatform.net/wp-content/uploads/2025/02/FINAL-INCLUDE-REPORT-2024-1.pdf>
12. Kaza, S., Yao, L., Bhada-Tata, P., & Van Woerden, F. (2018). *What a waste 2.0: A global snapshot of solid waste management to 2050*. Urban Development Series. World Bank. <https://doi.org/10.1596/978-1-4648-1329-0>
13. Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling*, 127, 221–232. <https://doi.org/10.1016/j.resconrec.2017.09.005>
14. Lagos Business School Sustainability Centre. (2023, June 16). *Sustainable waste management: Economic spin-offs of at-source waste separation*. Lagos Business School. <https://sustainabilitycentre.lbs.edu.ng>
15. Meijer, L. J. J., van Emmerik, T., van der Ent, R., Schmidt, C., & Lebreton, L. (2021). More than 1000 rivers account for 80% of global riverine plastic emissions into the ocean. *Science Advances*, 7(18), eaaz5803. <https://doi.org/10.1126/sciadv.aaz5803>
16. National Bureau of Statistics (NBS), Nigeria. (2022). *Nigerian GDP report Q4 2022*. National Bureau of Statistics. <https://www.nigerianstat.gov.ng>
17. National Environmental Standards and Regulations Enforcement Agency (NESREA). (2009). *National Environmental (Sanitation and Wastes Control) Regulations, S.I. No. 28*. Federal Republic of Nigeria Official Gazette. <https://nesrea.gov.ng/laws-regulations>
18. National Environmental Standards and Regulations Enforcement Agency (NESREA). (2025). *Assessment report of gaps and needs of solid waste management in Nigeria*. NESREA. <https://nesrea.gov.ng>

19. ODI (Overseas Development Institute). (2020). *Waste management in Africa: A review of cities' experiences*. ODI Working Paper. <https://media.odi.org/documents/Waste management in African cities FINAL VERSION.pdf>
20. Pakam Technology Limited. (2026). *Pakam: Africa's first waste-fintech platform*. Pakam.ng. <https://pakam.ng>
21. PM News Nigeria. (2024, October 18). Lagos to shut down Olusosun, Solous dumpsites for waste-to-energy project. *PM News Nigeria*. <https://pmnewsnigeria.com>
22. Potting, J., Hekkert, M., Worrell, E., & Hanemaaijer, A. (2017). *Circular economy: Measuring innovation in the product chain* (PBL Report No. 2544). PBL Netherlands Environmental Assessment Agency.
23. Results for America. (2018). *Team Nigeria policy brief: National Policy on Solid Waste Management*. Results for America. <https://results4america.org/wp-content/uploads/2018/07/Nigeria-Team-Policy-Brief.pdf>
24. RVO (Netherlands Enterprise Agency). (2021). *Business opportunities in Nigeria's waste and circular economy sector*. RVO. <https://www.rvo.nl>
25. Trinomics. (2020). *Circular economy in Africa-EU cooperation: Country report Nigeria*. Trinomics. <https://trinomics.eu>
26. UNEP (United Nations Environment Programme). (2018). *Africa waste management outlook*. UNEP. <https://www.unep.org>
27. UN-Habitat. (2010). *Solid waste management in the world's cities*. UN-Habitat. <https://unhabitat.org>
28. UN-Habitat. (2023). *Leaving no one behind: The informal waste and recovery sector*. UN-Habitat. https://unhabitat.org/sites/default/files/2023/04/en_2503_leaving_no_one_behind.pdf
29. University of Lagos (UNILAG). (2025, March). *2025 World Recycling Day: UNILAG, partners engage stakeholders on application of AI techniques for carbon extraction at Olusosun landfill*. University of Lagos. <https://unilag.edu.ng>
30. Wecyclers. (2019). *Nestlé Nigeria and Wecyclers to tackle plastic waste pollution in Lagos*. Wecyclers Blog. <http://blog.wecyclers.com>
31. World Bank. (2024). *Improving solid waste and plastics management in Lagos State: A way forward*. World Bank. <https://documents1.worldbank.org/curated/en/099101824172020522/pdf/P1761781eb744507f184b01f525451f4014.pdf>