URBAN WASTE MANAGEMENT AND ITS IMPACT IN PORT HARCOURT METROPOLITAN CITY: A CRITICAL EVALUATION

Chinnah Promise Chinwe, PhD
Department of Public Administration and Governance,
World Innovators University, USA
promise.chinnah@wiuglobal.com

Chinnah Charity, PhD
Department of Fine and Applied Arts,
Ignatius Ajuru University of Education
charity.chinnah@iaue.edu.ng

Atanya Bernard Owedano
Department of Political Science,
Yokubu Gowon University.
owedsben@gmail.com

Abstract

Rapid urbanization, industrialization, commercialization, and population growth have significantly increased municipal solid waste generation in Port Harcourt Metropolitan City, Nigeria. Despite the establishment of the Rivers State Waste Management Agency (RIWAMA) in 2015 and the adoption of Public–Private Partnership (PPP) arrangements, waste management challenges remain pervasive due to inadequate infrastructure, weak institutional coordination, insufficient funding, ineffective enforcement of environmental regulations, and limited public environmental awareness. This study critically evaluates urban waste management in Port Harcourt using a qualitative policy review design based on secondary data. A systematic documentary review was conducted of peer-reviewed journal articles, government publications, RIWAMA reports, NESREA policy documents, World Bank reports, UNEP reports, WHO publications, and other credible institutional sources published between 2015 and 2025. Data were analyzed using thematic content analysis to identify major patterns relating to waste generation, institutional capacity, environmental impacts, and policy effectiveness. Findings indicate that Port Harcourt generates approximately 2,000–3,000 tonnes of municipal solid waste daily [Rivers State Waste Management Agency, 2023; exceeding the capacity of existing waste management infrastructure. Major constraints include inadequate funding, poor institutional coordination, weak enforcement of sanitation laws, inadequate waste collection infrastructure, and limited recycling capacity. These challenges have contributed to flooding, environmental pollution, public health risks, ecosystem degradation, and declining urban aesthetics. The study concludes that achieving sustainable waste management in Port Harcourt requires integrated institutional reforms, increased investment in waste infrastructure, adoption of modern waste-processing technologies, strengthened public-private partnerships, improved environmental education, and effective enforcement of environmental regulations.

Keywords: Urban waste, waste management, RIWAMA, environmental pollution, Port Harcourt, sustainability.

Introduction

Urban waste management has become one of the most pressing environmental governance challenges confronting rapidly urbanizing cities in developing countries. Accelerated population growth, industrialization, commercial expansion, and changing consumption patterns have substantially increased the volume and complexity of municipal solid waste, often exceeding the

capacity of municipal authorities to provide efficient collection, transportation, treatment, recycling, and recovery services [UNEP, 2023; World Bank, 2019]. Port Harcourt, the capital of Rivers State, is one of Nigeria's foremost industrial and commercial centers. The city hosts numerous oil and gas industries, manufacturing firms, commercial establishments, educational institutions, and residential settlements that collectively generate substantial quantities of municipal solid waste daily. Once celebrated as the "Garden City" because of its environmental beauty and greenery, Port Harcourt has experienced progressive environmental deterioration due to rapid urbanization, inadequate urban planning, poor waste management practices, and weak enforcement of environmental regulations [Stanley & Owhor, 2018]. Current estimates indicate that the metropolis generates between 2,000 and 3,000 tonnes of municipal solid waste daily [Rivers State Waste Management Agency, 2023], considerably exceeding the operational capacity of existing waste management systems. Consequently, indiscriminate disposal of refuse along roadsides, drainage channels, markets, and open spaces has become widespread, contributing to flooding, environmental pollution, public health challenges, and declining urban aesthetics [Ogene & Elechi, 2021].

In response, the Rivers State Government established RIWAMA in 2015 through the RIWAMA Law to coordinate waste collection, transportation, disposal, environmental sanitation enforcement, and public awareness campaigns [Rivers State Government, 2016]. The agency also collaborates with licensed private waste operators through PPP arrangements to improve service delivery. Nevertheless, persistent operational challenges continue to undermine effectiveness [RIWAMA].[2023]. While existing studies have examined technical disposal or pollution in Nigerian cities [Ayomoh, 2018; Ogbonna et al., 2017; Omokaro et al., 2025], fewer have integrated institutional capacity, governance performance, environmental sustainability, and public health outcomes within the post-2015 RIWAMA policy context. Comparative studies of Lagos [Omole & Alakinde, 2022] and Abuja focus on technical operations rather than governance outcomes. This study addresses that gap by providing a critical, governance-focused evaluation of urban waste management in Port Harcourt between 2015 and 2025, situated within Environmental Health

Theory and the SDG framework.

Research Objectives

The study seeks to:

1. Assess existing waste management practices in Port Harcourt Metropolitan City.
2. Examine institutional and operational challenges affecting RIWAMA.
3. Evaluate the environmental and public health implications of poor waste management.
4. Recommend sustainable policy strategies for improving urban waste management in Port Harcourt.

Significance of the Study

This study contributes to literature by integrating environmental governance, institutional performance, and public health perspectives into the analysis of urban waste management in a post-reform context. It provides evidence-based recommendations useful to policymakers, environmental regulators, urban planners, development practitioners, and researchers on sustainable urban development. The comparative and conceptual dimensions also make it relevant to other Gulf of Guinea cities facing similar governance deficits.

Methodology

This study adopted a qualitative policy review design based exclusively on secondary data. A systematic documentary review was employed to synthesize evidence on urban waste management in Port Harcourt Metropolitan City between 2015 and 2025.

Data Sources and Search Strategy: Materials were identified from Scopus, Web of Science, Google Scholar, government portals, and institutional repositories using Boolean search terms: "Port Harcourt AND waste management", "RIWAMA AND governance", "municipal solid waste Nigeria", "PPP AND waste Africa", and "urban environmental health". Included sources comprised peer-reviewed journal articles, books, RIWAMA annual reports, NESREA policy documents, World Bank publications, UNEP reports, WHO reports, and other credible institutional documents. Excluded sources were non-peer-reviewed blogs, undated reports, and materials outside the 2015–2025 period.

Analytical Approach: The collected data were analyzed using thematic content analysis [Braun & Clarke, 2006]. Initial codes were developed around four a priori themes: waste generation trends, institutional/operational capacity, environmental and health impacts, and policy effectiveness. Themes were refined through iterative review to ensure internal coherence. Credibility was enhanced by triangulating estimates and claims across at least two independent institutional sources. To reduce bias, coding was cross-checked by both authors.

Limitations of Design: The reliance on secondary data limits direct validation through field observation or stakeholder perspectives. This is acknowledged in Section 8.0. However, for a post-policy evaluation, documentary analysis provides a valid basis for assessing institutional performance and policy gaps.

Conceptualization and Literature Review

Concept of Urban Waste

Urban waste refers to unwanted materials generated from human activities within urban environments, including household, commercial, institutional, industrial, and construction sources [Ezeudu & Ezeudu, 2022]. In Port Harcourt, the waste stream is heterogeneous due to industrial activity, market trade, and household consumption patterns.

Concept of Waste Management: Waste management refers to the systematic process of preventing, collecting, transporting, sorting, treating, recycling, recovering, and safely disposing of waste in ways that protect public health and the environment [NESREA]. Modern waste management follows the waste hierarchy: Prevention → Reduction → Reuse → Recycling → Recovery → Disposal [UNEP]. The hierarchy prioritizes upstream interventions over end-of-pipe disposal. [2023]

Global Public-Private Partnership Models in Urban Waste Management.

Public-Private Partnerships have become a dominant institutional response to municipal waste crises in rapidly urbanizing economies. The underlying logic is risk-sharing: government retains regulatory and planning authority while private actors provide capital, technology, and operational efficiency [World Bank, 2022]. In Brazil, São Paulo's "Clean City" program demonstrates a concession model where private firms are paid per tons collected and penalized for missed routes. This increased collection efficiency from 78% in 2010 to 92% in 2020, but required strong

municipal monitoring units [World Bank, 2022]. Performance-based contracts were central. India's Swachh Bharat Mission 2.0 emphasizes PPPs for waste-to-energy and composting plants in cities like Pune and Indore. Indore's achievement of "zero waste to landfill" status in 2021 is attributed to decentralized segregation at source, strict enforcement, and community-based micro-enterprises contracted through PPPs [Ezeudu et al., 2024; Kaza et al., 2018]. Community participation and behavioral change were institutionalized.

In Sub-Saharan Africa, South Africa's eThekwini Municipality uses long-term PPP contracts for landfill management and recycling. A key success factor has been ring-fenced budgets and independent regulatory oversight. Ghana's Accra Metropolitan Assembly has piloted PPPs for transfer stations, but faces challenges of contract enforcement and informal sector integration [Oteng-Ababio, 2018].[Ogwueleka][2022] For Port Harcourt, the lesson is clear: PPPs alone do not resolve capacity gaps. Effectiveness depends on 1) transparent contracting, 2) performance-based payment, 3) independent monitoring, and 4) citizen participation. RIWAMA's model aligns with the concession approach, but lacks the monitoring and community segregation components observed in Indore and eThekwini. This comparative gap justifies the current study's focus on institutional and behavioral dimensions beyond technical collection.

Waste Governance in Other Nigerian Metropolitan Cities.

Within Nigeria, Lagos and Abuja provide important comparators. The Lagos State Waste Management Authority (LAWMA) was restructured in 2017 to introduce private sector operators under franchise agreements. Studies show improved road clearance but persistent challenges in low-income areas where collection fees are unaffordable [Omole & Alakinde, 2022; Popoola et al., 2020]. Abuja's Environmental Protection Board has attempted integrated solid waste management, but faces inter-agency duplication with the Federal Capital Development Authority. Kano faces similar issues of funding, enforcement, and informal dumping [Omokaro et al., 2025].[Agunwamba][2017] Port Harcourt differs in two ways. First, RIWAMA was created after the 2015 flood events, giving it a specific disaster-risk mandate [Rivers State Government, 2016]. Second, the city's oil and gas industrial base creates hazardous and commercial waste streams not dominant in Kano. However, like Lagos and Abuja, PHC exhibits weak data harmonization, limited recycling infrastructure, and low public compliance.

Existing literature on Lagos [Omole & Alakinde, 2022] and Kano [Omokaro et al., 2025] emphasizes technical or economic factors. Few studies integrate RIWAMA's post-2015 governance reforms with public health and SDG outcomes. This study fills that gap by evaluating PHC as a governance case, not only a technical one.

Conceptual Framework: Linking Governance, Environment, and Health

To guide analysis, this study develops an integrated framework [Figure 1]. Environmental Health Theory provides the foundation: environmental degradation creates pathways for disease, flooding, and ecosystem loss [WHO]. Institutional capacity mediates this relationship.[2023]



Figure 1. Integrated Waste Governance Framework for Port Harcourt
Note. The framework shows how institutional inputs produce environmental and health outcomes aligned to SDGs. Source: Authors' conceptualization, 2025.

The framework posits that when RIWAMA's funding, coordination, enforcement, and infrastructure are weak, waste accumulation increases. This leads to the five impact domains identified in Section 6.0: environmental degradation, health risks, flooding, water/air pollution, and economic/social loss. These outcomes directly undermine SDG 3, 6, 11, 12, and 13.
Conversely, strengthening PPPs, environmental education, and monitoring creates feedback loops that reduce waste generation and improve livability. This model situates PHC within global SDG discourse while keeping RIWAMA at the center of analysis.

Waste Management In Port Harcourt Metropolitan City
4.1 Waste Generation Trends and Capacity Gap, 2015–2025
Table 1 synthesizes estimates from RIWAMA, World Bank, and peer-reviewed studies.

Table 1. Selected secondary – sources of estimates Municipal Solid Waste Generation vs Collection Capacity, Port Harcourt, 2015-2025*

Year	Est. Generation [tonnes/day	Estimated Collection [tonnes/day]	Capacity Gap [%]	Source
2015	1,800	1,200	33.3	Rivers State Government, 2016
2018	2,100	1,350	35.7	Stanley & Owhor, 2018
2021	2,500	1,500	40.0	Ogene & Elechi, 2021
2023	2,800	1,650	41.1	RIWAMA, 2023
2025	3,000	1,700	43.3	World Bank, 2022

The available secondary evidence is consistent with World Banks observations that waste generation in rapid urbanizing cities can outpace infrastructure investment, World Bank, 2019, 2022.

The estimates presented in table 1 indicates a great increase in waste generation pressure alongside a continuous lacuna between estimated waste generation and stated collection capacity. This analysis is based entirely on secondary sources. Therefore, the figures in Table 1 reflect estimates reported

elsewhere, not primary data gathered by the researchers. The estimates span different sources, reporting years, and approaches, which means they are not fully comparable over time. The table is included to demonstrate the broad trend of rising waste-generation pressure and the reported gap in collection capacity, rather than to assert exact annual measurements. In cases of conflicting data, priority is given to RIWAMA and other recognized institutional or peer-reviewed sources, with an acknowledgment of possible methodological variation. For PHC the direct implication is that without capital investment in trucks, transfer stations, recycling facilities and other waste management facilities the existing capacity gap may continue to be on the increase.

Data for the study were gathered through secondary sources, the figures presented in table 1 should be interpreted as reported estimates rather than direct measurement by researchers. Besides these estimations are gotten from different sources, reporting periods, and with different methodological approaches. The data on the table are not longitudinal dataset. The table is used to show the astronomical increase of waste generation pressure and collection capacity.

Institutional Mapping of RIWAMA and PPP Actors

RIWAMA's mandate includes collection, transportation, disposal, enforcement, and public education [Rivers State Government, 2016]. Operationally, it contracts licensed private waste operators under PPPs. However, institutional challenges persist: budget allocations have not matched waste growth, inter-agency coordination with the Ministry of Environment is weak, and monitoring of contractor performance is limited [RIWAMA].[2023]. Funding flows are often ad hoc, with limited ring-fencing for capital expenditure. This contrasts with eThekwini's model of dedicated waste levies. Furthermore, the informal waste sector, which handles significant recycling in other cities, is not formally integrated into RIWAMA's structure [Oteng-Ababio, 2018]. Strengthening these institutional linkages is critical for sustainability .[Ogwueleka][2022]

The Informal Waste Sector and Resource Recovery

The informal waste sector and resource recovery is a very essential sector in waste management in urban cities because of their role in management of waste. The informal sector refers to person, group of persons or network of people that are significantly important in the waste management sector although not officially authorized or fully integrated by government as part of the waste management team. There functions and roles cannot be overemphasized in Port Harcourt city when it comes to management of waste. They are people or small businesses that sorts, collect, buy, sale and recycle waste aside the official recognized certified bodies by the government. Waste pickers, scrab dealers and other scavengers for waste materials. They are also involved in recycling of waste. Resource Recovery. This simply means extracting useful materials, energy, nutrients or produce from waste instead of sending everything to the landfill or open dumping. Under this process so many waste are converted useful things such as plastics, condemn iron, papers or energy are recovered from waste disposed items or things. It's is imperative for the informal sector to be integrated, registered, guided and given operational guidance and monitored by government for effective waste management.

Existing Policy Measures

Policy responses include the RIWAMA Law 2015, NESREA's National Environmental (Sanitation and Wastes Control) Regulations 2009 as revised, and public awareness campaigns [NESREA]. Enforcement remains weak due to limited personnel and logistical constraints. Recycling is minimal, with most waste disposed at open dumpsites rather than engineered landfills.[2023]

Theoretical Framework

The study is anchored on Environmental Health Theory, which explains the relationship between environmental quality and human health [WHO]. It posits that poor environmental management contributes directly to disease transmission, pollution, flooding, and environmental degradation. [2023]. The Environmental Health Theory is used as an instrument for evaluating how poor urban waste management affect the environmental and human health condition and its sustainability. The theory regulates the analysis in establishing connection between poor waste management and other adverse affect to the environment and humanity in general. The theory goes further to highlight the relationship between institutional / operational weakness in management of waste. It provides a sound logical ground for interpreting how waste management practices creates environmental conditions and health challenges. The theory helps us to explain and understand why improvement in waste management, environmental education, recycling, enforcement and institutional capacity are essential for curbing health challenges.
The framework aligns with:

SDG 3: Good Health and Well-being; SDG 6: Clean Water and Sanitation; SDG 11: Sustainable Cities and Communities; SDG 12: Responsible Consumption and Production; SDG 13: Climate Action. This alignment allows the study to assess waste management not only as an environmental issue but as a development issue.

Impacts of Poor Waste Management in Port Harcourt Metropolitan City
Poor waste management in Port Harcourt has profound environmental, public health, economic, and social consequences. These impacts are interrelated and demonstrate the need for an integrated approach to urban environmental governance.

Environmental Degradation
Indiscriminate dumping has degraded the physical environment. Refuse accumulation on roadsides, markets, waterways, and open spaces has diminished environmental quality and undermined the city's historical reputation as Nigeria's "Garden City." Uncontrolled disposal also contributes to soil contamination, loss of biodiversity, and deterioration of urban landscapes. [Ayomoh] [2018]

Public Health Implications
Improper disposal creates breeding grounds for mosquitoes, flies, rodents, and other disease vectors. Communities become more vulnerable to communicable diseases such as cholera, typhoid fever, diarrhoea, and malaria. Open burning of refuse releases particulate matter and toxic gases, increasing respiratory illnesses, particularly among children and older adults [WHO, 2022; WHO, 2023].

Flooding and Drainage Obstruction
Disposal of waste into drainage channels obstructs water flow during heavy rainfall. This contributes to recurrent flooding across Port Harcourt, resulting in infrastructure damage, displacement, disruption of economic activities, and financial losses [Ogene & Elechi, 2021]. Flooding has become an annual occurrence in several wards.

Water Pollution
Leachate from unmanaged dumps contaminates surface water and groundwater. This threatens drinking water quality and increases waterborne disease risk. Pollution of rivers, streams, and wetlands also affects aquatic ecosystems and local livelihoods dependent on fishing. [Ayomoh] [2018]

Air Pollution and Climate Change
Open burning emits methane, carbon monoxide, sulphur compounds, and fine particulate matter, contributing to air pollution and climate change [UNEP]. These emissions worsen existing air quality challenges associated with industrial activity in Port Harcourt [WHO].[2023][2022]

Economic Consequences
Poor waste management discourages investment, reduces tourism potential, lowers property values, and increases public expenditure on sanitation and healthcare. Resources that could support development are often redirected to emergency waste management and flood response [World Bank, 2022].

Social and Psychological Effects
Living in polluted environments reduces residents' quality of life, weakens community pride, and affects mental well-being [Popoola et al., 2020]. Persistent environmental neglect may also normalize indiscriminate disposal, making behavioral change more difficult.

Discussion of Findings: A Comparative and Policy Lens
The study demonstrates that municipal solid waste generation in Port Harcourt has exceeded the operational capacity of existing systems. This aligns with World Bank and UNEP observations that rapid urbanization has overwhelmed waste management in many developing countries [World Bank, 2022; UNEP, 2023]. Institutional weaknesses—including inadequate funding, insufficient infrastructure, weak regulatory enforcement, and poor inter-agency coordination—remain major barriers. Although RIWAMA has introduced PPP initiatives, impact has been constrained by implementation gaps and resource limitations [RIWAMA]. This mirrors findings from Lagos, where franchise models improved main roads but not peripheral settlements [Omole & Alakinde, 2022].[2023]

Comparatively, Indore's success shows the importance of segregation at source and micro-enterprise integration [Ezeudu et al., 2024]. Accra's experience highlights the need to formalize informal recyclers [Oteng-Ababio, 2018]. Port Harcourt lacks both components. The absence of a circular economy approach means recyclable materials continue to enter landfills, increasing environmental load.

The findings reinforce Environmental Health Theory by showing a direct relationship between environmental quality and public health outcomes. Poor waste management contributes to flooding, water pollution, disease outbreaks, and declining urban livability, underscoring the importance of preventive environmental management [WHO].[2023]. From an SDG perspective, PHC's current trajectory undermines progress on SDG 11.6 “reduce the adverse per capita environmental impact of cities” and SDG 12.5 “substantially reduce waste generation through prevention, reduction, recycling and reuse”. Without reform, SDG targets for 2030 are unlikely to be met. Overall, evidence suggests that improvement requires more than increased collection. It demands integrated reforms involving institutional strengthening, investment in modern technologies, behavioral change through environmental education, and stronger collaboration among government agencies, private operators, informal actors, and communities.

Limitations of The Study
This study relied exclusively on secondary sources. It did not include primary data from interviews, surveys, or field observations. Variations in reporting methods among institutions may also account

for differences in waste generation estimates. Despite these limitations, the study synthesized recent, credible literature from 2015–2025 to provide a comprehensive, policy-relevant assessment. Future studies should adopt mixed-methods approaches, combining documentary analysis with household surveys, interviews with RIWAMA officials and contractors, and field observations to generate richer empirical evidence. Geospatial analysis of dumpsites would also strengthen the evidence base.

Conclusion

This study critically evaluated urban waste management and its impacts in Port Harcourt Metropolitan City. Rapid urbanization, population growth, and industrial expansion have increased municipal solid waste generation beyond the capacity of existing infrastructure. Although RIWAMA and PPP arrangements have improved coordination, persistent challenges including inadequate funding, weak infrastructure, ineffective enforcement, low public environmental awareness, and limited recycling capacity, continue to undermine sustainability. The consequences are evident in environmental degradation, recurrent flooding, water and air pollution, increased public health risks, and declining urban livability. Comparative analysis shows that cities that have improved outcomes combined PPPs with monitoring, community participation, and circular economy practices. Addressing these challenges requires coordinated policy reforms, sustained investment, stronger institutions, technological innovation, and active public participation. The Integrated Waste Governance Framework proposed here provides a basis for such reforms.

Recommendations

The study recommends that:

1. Government should substantially increase and ring-fence funding for RIWAMA to improve operational capacity and infrastructure.
2. Modern waste management technologies, including recycling facilities, composting plants, and waste-to-energy systems, should be developed.
3. PPPs should be strengthened through transparent, performance-based contractual arrangements and effective independent monitoring.
4. Environmental education and public awareness campaigns should be intensified to encourage segregation at source and responsible disposal.
5. Environmental sanitation laws should be strictly enforced, with appropriate sanctions for offenders.
6. Recycling and resource recovery programmes should be expanded to promote a circular economy and reduce dependence on landfills.
7. Urban planning authorities should integrate waste management infrastructure into future city expansion plans.
8. Government should establish continuous monitoring and evaluation systems to assess RIWAMA's operational performance and policy outcomes.
9. Community-based organizations, civil society groups, traditional institutions, and informal waste actors should be actively involved in promoting environmental sanitation.
10 informal waste collectors and recyclers should be integrated and monitored by government for effective waste management.

References

Agunwamba, J. C. (2017). _Solid waste management in Nigeria: Problems and issues_. University Press.

Ayomoh, M. K. (2018). Solid waste characterization and management practices in Port Harcourt

metropolis. _Journal of Environmental Studies_, 9(2), 45–58.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. _Qualitative Research in Psychology_, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Ezeudu, T. S., & Ezeudu, O. B. (2022). Sustainable municipal solid waste management in Nigeria: Challenges and prospects. _Journal of Environmental Management and Safety_, 13(2), 45–58.

Ezeudu, T. S., Agunwamba, J. C., & Ezeudu, O. B. (2024). Environmental regulation and sustainable household waste management in Nigeria. _Environmental Development_, 45, 100746. https://doi.org/10.1016/j.envdev.2024.100746

Ibeh, J. I., & Kanu, I. A. (2022). "The church and ecological concerns: A dogmatic systematic approach." *AKU: An African Journal of Contemporary Research,* 3(2), 176-193.

Ibeh, J. I., & Kanu, I. A. (2022). "Human dimension of the ecological crisis in Nigeria: The imperatives of *Caritas in Veritate. Journal of African Studies and Sustainable Development,* 3(2), 254-270.

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_. World Bank. https://doi.org/10.1596/978-1-4648-1329-0

National Environmental Standards and Regulations Enforcement Agency. (2023). _National solid waste management policy implementation report_. NESREA.

Ogene, M., & Elechi, G. (2021). Flooding and commercial disruption in Port Harcourt metropolis. _Journal of Urban Development Studies_, 9(1), 33–48.

Ogbonna, D. N., Amangabara, G. T., & Ekere, T. O. (2017). Institutional weaknesses and urban waste management in Nigeria. _International Journal of Waste Management_, 5(2), 21–35.

Ogwueleka, T. C. (2022). Waste management and urban sustainability in developing countries. _African Journal of Environmental Management_, 15(1), 50–68.

Omokaro, G. O., Michael, I., & Efeni, O. S. (2025). Waste management in Nigeria: Systemic failures, circular economy pathways and sustainable solutions. _Environmental Development_, 48, 101363. https://doi.org/10.1016/j.envdev.2025.101363

Omole, F. K., & Alakinde, M. K. (2022). Managing solid waste in Nigerian urban centres: Issues and prospects. _Journal of Geography and Regional Planning_, 15(3), 89–99.

Oteng-Ababio, M. (2018). Private sector involvement in solid waste management in the Greater Accra Metropolitan Area, Ghana. _Habitat International_, 79, 21–30. https://doi.org/10.1016/j.habitatint.2018.06.005

Popoola, A., Yusuf, R. O., & Aremu, A. S. (2020). Public health implications of poor municipal solid waste management in Nigerian cities. _Environmental Health Insights_, 14,

1178630220948912. https://doi.org/10.1177/1178630220948912

Rivers State Government. (2016). _Rivers State Waste Management Agency (RIWAMA) Law, 2015_. Government Printer.

Rivers State Waste Management Agency. (2023). _Annual operational report_. RIWAMA.

Stanley, H., & Owhor, S. (2018). Municipal solid waste generation and management in Port Harcourt metropolis. _Journal of Environmental Science and Policy_, 4(2), 55–70.

United Nations Environment Programme. (2023). _Global waste management outlook 2024_. UNEP.

World Bank. (2019). _What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050_. World Bank. https://doi.org/10.1596/978-1-4648-1329-0

World Bank. (2022). _Municipal solid waste management for sustainable urban development_. World Bank.

World Health Organization. (2022). _Global analysis of health care waste in the context of COVID-19_. WHO.

World Health Organization. (2023). _Compendium of WHO and other UN guidance on health and environment_. WHO.