Published by

British Journal of Contemporary Research

BEXFORD PUBLISHING

Development of an Integrated Solid Waste Management System (ISWMS) for FCT Abuja, Nigeria

Original Research Article | Volume 1 | Issue 4 | 2026 | Article Number: 006

Accepted: 15 August 2026 | Published: 10 September 2026 | ISSN: 2979-8582 (Online)

Crossref : **https://doi.org/10.67693/BJCR-NV346UTN**

Aminu Bello-Dange[1], Prof Ikenna Osu Okonkwo[1], Dr Richmond Ideozu[1]

[1]Institute of Natural Resources, Environmental Management and Sustainable Development, University of Port Harcourt, Rivers State, Nigeria,

Correspondence: Aminu Bello-Dange, aminudange@gmail.com

Abstract

With the increasing rate of urbanisation, the growing population and the increasing rate of consumption, the management of solid waste in the Federal Capital Territory (FCT) of Abuja is becoming an uphill task. Although there are policies and some private sector involvement in waste collection, the system is fragmented, disposal focused and lacks spatial balance. This study develops a context-specific Integrated Solid Waste Management System (ISWMS) for Abuja using a concurrent triangulation mixed-methods design. Quantitative data were obtained from 689 valid survey responses, including 494 households and 195 business, institutional, civil society and waste-sector respondents. Qualitative data were drawn from 23 key stakeholder interviews and focus group discussions with 24 informal waste sector actors comprising waste pickers, scrap dealers and recyclers. Descriptive statistics, regression analysis, chi-square tests, thematic coding and triangulation matrices were used to diagnose system performance and translate the evidence into a phased ISWMS model. Findings show that only 42.3% of households reported door-to-door collection, 28.1% experienced irregular collection, 14.4% used open dumping and 5.1% burned waste on site. Source segregation was low at 26.3%, while 66.4% of households were unaware of municipal waste regulations. Institutional fragmentation among AEPB, FMENV, NESREA, Area Councils and private contractors was confirmed by 69.6% of key informant's interviews. At present, Abuja generates approximately 1.33 million tonnes of solid waste annually. This value is expected to rise to 1.84 million tonnes by 2035. The proposed Integrated Solid Waste Management System (ISWMS) is designed to capture waste management governance reform, phased investments in infrastructure, integration of the informal waste sector as cooperatives, sustainable financing of the system, and the introduction of performance monitoring. This article argues that the waste management challenges in Abuja are best understood as a systems governance challenge, and as such, a comprehensive and integrated reform approach is necessary to address the challenge, rather than piecemeal technical solutions.

Keywords: Integrated Solid Waste Management, Iswms, Abuja, Municipal Solid Waste, Circular Economy, Informal Waste Sector, Waste Governance, Nigeria

1.0 INTRODUCTION

1.1 Background to the Study

African cities currently experiencing fast-paced urbanisation face changes in the nature and structure of solid waste due to the expansion of the urban populace, growth in consumerism, and the proliferation of packaged goods. These challenges are most significant for cities that were planned, like Abuja (Nigeria), and are now sprawling unplanned metropolitan regions. Waste management in rapidly evolving urban centers is faced with many contradictions on how differing aspects of waste management are planned versus how they are operationalised.

The waste management framework in the Federal Capital Territory (FCT) of Nigeria, on paper, has a defined waste management authority and regulatory policies for the waste management sector. This includes the commitment to implement waste management provisions such as source separation and recycling. The realities of waste management services in the FCT, however, show that waste collection services are inconsistent, waste source separation is virtually non-existent, and the dominant activity of removing waste is carried out by informal recyclers. The challenges in the waste management system in Abuja demonstrate a complex contradiction that defines most waste management systems. The lack of integration between the formal and informal sectors is a dominant feature of the waste management system in Abuja.

The situation is dire because the rate of waste generation is exceeding the rate of growth of the institutions and infrastructure necessary for waste management. The research upon which this manuscript is based estimates that the Federal Capital Territory (FCT) currently produces approximately 1.33 million tonnes of municipal solid waste per year and is forecasted to reach 1.84 million tonnes by the year 2035 under a scenario of moderate growth. If there is no change in the design and function of the waste management system, the city of Abuja will continue to rely on the threats to human health and the environment of open waste dumping, uncontrolled and incinerating waste disposal, and the informal waste management sector.

The concept of Integrated Solid Waste Management (ISWM) will help analyse and design policy because it recognises that waste management is more than collection and disposal of waste. It recognises the interconnections and relationships between physical flows of waste, the role of various stakeholders, the finance and governance systems, the degree of public participation, the role of the informal sector, collection and treatment infrastructure and the performance of the system. The ISWM recognises the importance of context in the design of a collection and treatment infrastructure system that manages waste. This is particularly important for Abuja, Nigeria.

1.2 Problem Statement and Research Gap

In the Federal Capital Territory (FCT) of Abuja, fragmented models of municipal solid waste management dominate the urban landscape, despite the city's growing population. Although FCT agencies, the private sector, and aspects of national policies related to the climate and circular economy exist, they do not operate as an integrated system. Formal waste management services are largely confined to well-planned urban dwellings. Peri-urban and rural settlements face irregular waste collection, long distances to disposal sites, and are subjected to open waste dumping and burning, and poor enforcement and control of waste management with limited recovery and waste management infrastructure. Urbanisation, accompanied by increases in domestic and commercial activities, will result in increasing municipal solid waste generation.

This is compounded by limited extension of waste collection, differentiated disposal services, and poor performance of waste contractors (Federal Ministry of Environment, 2020; Imam et al., 2008; Ogwueleka, 2013).

The main problem is the absence of the Integrated Solid Waste Management System (ISWMS) that is locally relevant and integrated with all the links of the waste chain within one governance system.

Although private sector waste collection is prevalent, waste collection performance is not linked to standards of service. Nor are national policies on waste separation, extended producer responsibility, recognition of informal workers, and circular economy integrated in practice.

There is a dearth in the body of literature addressing municipal solid waste management in Nigeria's capital, Abuja. Most of the studies focused on Abuja and other Nigerian urban municipal solid waste management systems reveal waste collection deficits, infrastructural deficits, low recycling rates, low public awareness, poor enforcement, and low public participation. Many of these studies, however, offer little more than a description of the state of solid waste management and/or use a single method (most often a survey) to collect data. There is little or no evidence focused on identifying the main drivers on how to improve solid waste management in Abuja and transform it from a largely unaccountable waste disposal management system to a more inclusive, preventive, and circular system that accounts for the informal sector (Kaza et al., 2018; van de Klundert & Anschütz, 2001; Wilson et al., 2015).

The research gap, therefore, is the absence of an empirically grounded, phased, institutionally assigned, financially realistic, and performance-monitorable ISWMS for FCT Abuja. This article addresses that gap by developing a context-specific framework capable of improving governance, service delivery, waste diversion, circular economy outcomes, informal-sector integration, contractor accountability, climate-sensitive planning, and environmental sustainability across Abuja’s planned-core and peri-urban growth dynamics.

1.3 Conceptual Framework

This article establishes five complementary conceptual foundations. First, the waste hierarchy places prevention, reuse, recycling, recovery, and disposal in that order. Second, the circular economy concept promotes the retention of productive use of materials through recycling, composting, remanufacturing, and recovery markets. Third, the integrated sustainable system framework framework links physical waste flows, stakeholder participation and governance sustainability. Fourth, socio-technical transition theory explains how entrenched “collect-and-dump” regimes can be disrupted through niche innovations such as source segregation pilots, cooperative recovery systems, composting and digital route optimisation. Fifth, stakeholder theory highlights the need to recognise informal waste pickers, scrap dealers and recyclers as system actors rather than peripheral or illegal participants.

Together, these frameworks support systems interpretation of Abuja’s waste management challenge. Low segregation is not merely a household attitude problem; it reflects weak infrastructure, limited buyer networks and mixed-waste collection design. Informal recycling is not a marginal activity; it constitutes a functional but unrecognised circular economy. Poor service coverage is not only a fleet issue; it is linked to contractor incentives, institutional fragmentation and under-resourced Area Councils. The proposed ISWMS therefore treats governance reform as the enabling foundation for physical infrastructure, behavioural change and circular economy transition.

2.0 LITERATURE REVIEW

Literature about Integrated Solid Waste Management (ISWM) expresses that viable solutions for waste management should not be understood solely as isolated systems of service collection. Instead, they should

consider the greater system as the Integrated Sustainable Waste Management framework. The framework involves three interrelated dimensions; the flows of waste in a physical sense, the participation of interested parties/stakeholders, and the structures of governance (Van De Klundert and Anschütz, 2001; Wilson, et al 2013). The application of the framework to Abuja is valid as the challenge of the city does not concern solely the lack of services. There is also poor coordination of agencies, inadequate financing, low household participation, the exclusion of informal waste recycling, poor monitoring of waste management contractors, and lack of good quality waste management data.

Inadequate waste management services in Low and middle-income countries (LMICs) is a characteristic response to high levels of urban waste generation. Construction of new waste management services is no longer an option in LMICs due to the overwhelming need. The World Bank's global assessment calls for the implementation of sound waste-management data, adequate financing, the governance of the private sector, and the inclusion of the informal sector in management planning (Kaza et al., 2018). For Abuja, all these things are relevant and critical. The city has no established functional waste-flow database, a financing system that reflects costs, a system for the monitoring of contractors, and formal management services for the recovery of waste.

Imam et al. (2008) and Ogwueleka (2009, 2013) examined various weaknesses in the operational and institutional frameworks of the waste management systems of Abuja and other Nigerian cities, including overlapping mandates, poor enforcement, weak cost recovery, infrastructure gaps, low collection efficiency, mixed waste streams and a reliance on disposal. While these studies demonstrate the magnitude of the waste management challenges in Abuja, they do not formulate a comprehensive design of an Integrated Solid Waste Management System (ISWMS) that delineates institutional assignments, prioritises infrastructural interventions, incorporates informal sector participants, and establishes a connection between waste diversion, financing, and performance evaluation.

Several authors examined the waste hierarchy and the circular economy and their implications on systems approaches in waste management. The Nigerian National Policy on Solid Waste Management (Federal Ministry of Environment, 2020) outlines strategies for waste minimisation, source separation, recycling, collaboration, extended producer responsibility, and public participation, and while these strategies are poorly implemented at the local government level, they create a foundation for a circular economy. Likewise, the circular economy advocates for a waste management system that incorporates resource recovery, reuse of materials, treatment of organic waste, and closure of the loop (Geissdoerfer et al., 2017; Kirchherr et al., 2018) and demonstrates the need for Integrated Sustainable Waste Management (ISWM) in Abuja.

Literature also offers another important contribution concerning the monitoring of performance. The WasteAware indicators suggest a methodology for the assessment of collection coverage and the managed treatment and disposal of waste, recovery of resources, economic viability, social and institutional equity, and public engagement (Wilson et al., 2015). These indicators are applicable to Abuja since they can express the general principles of sustainability in quantifiable measures and thus assist in the staged execution of sustainable goals, allow comparison of performance between various districts, express the funding and investment required the most, and evaluate the sustainability and development of waste management systems over a certain duration.

The literature generally indicates that what is needed to address the municipal solid waste management situation in Abuja is a comprehensive, integrated system, as opposed to a piecemeal approach. Nevertheless, a definite gap is found in that there is no comprehensive, Abuja-specific Integrated Solid Waste Management System (ISWMS) that combines the elements of governance restructuring,

implementation of the waste management hierarchy, circular economy, data systems, financial accountability, contractor control, informal sector inclusion, household engagement, and performance assessment. This article seeks to fill this gap by proposing an ISWMS specifically for the FCT Abuja, Nigeria, to facilitate the best practice combined approaches of environmentally sustainable resource recovery and planning.

3.0 MATERIALS AND METHODS

3.1 Study Area

The research was done in Abuja within the Federal Capital Territory (FCT) of Nigeria. The FCT is made up of six Area Councils: the Abuja Municipal Area Council (AMAC), Bwari, Gwagwalada, Kuje, Kwali and Abaji. These Area Councils showcase a variety of settlement conditions and include both formally planned urban areas and settlements, as well as peri-urban and rural areas. Because of this variety, Abuja is ideal for assessing a differentiated ISWMS, as it may not assume service conditions to be the same across the entire territory.

3.2 Research Design

A concurrent triangulation mixed-methods design was employed. Quantitative and qualitative data were collected, analysed, and integrated during the interpretation phase. This design was appropriate since municipal waste management is a socio-technical system that requires measurable service indicators and qualitative understanding of governance and institutional and stakeholder perceptions as well as the informal sector.

3.3 Data Sources and Sample

The quantitative data set included 689 valid survey responses comprising 494 household surveys and 195 surveys from non-household respondents which included businesses and market respondents, along with employees from government and non-government organisations, environmental agencies, civil society groups, waste associations, and waste evacuation companies. The qualitative data component included 23 key informant interviews and focus group discussions with the personnel from the Abuja Environmental Protection Board (AEPB), the National Environment and Sustainable Resources Agency (NESREA), the Federal Ministry of Environment and Nigeria (FMENV), private sector community contractors, and 24 workers from the informal waste sector (waste picking, scrap dealing, and recycling).

Data source	Sample / participants	Purpose
Household and institutional survey	689 valid responses, including 494 households	Measured waste practices, awareness, collection access, willingness to pay and satisfaction
Key stakeholder interviews	23 participants	Explored governance, financing, enforcement, policy implementation and contractor performance
Focus group discussions	24 informal actors	Documented informal recovery practices, health and safety, formalisation willingness and circular economy constraints

Source: Field Survey (2026)

3.4 Analytical Methods

Descriptive statistics were used to summaries waste practices, collection coverage, segregation behaviour, awareness and satisfaction. Chi-square tests examined associations between settlement type, collection frequency, disposal method, segregation and willingness to pay. Evaluating predictors of waste generation, service satisfaction, waste segregation, and unsound waste disposal was based on results of the Ordinary Least Squares regression and Linear Probability Models. Thematic analysis was applied to qualitative interviews and focus group discussions and results were integrated using triangulation matrices.

4. RESULTS

4.1 Existing Waste Management Practices

The results show that Abuja's waste management system remains predominantly linear and disposal oriented. Of the households surveyed, 42.3% reported door-to-door waste collection services. 24.9% utilised community waste collection service. 14.4% disposed of waste via open dumping, while 5.1% burned their waste in situ. Waste transfer stations were utilised by 4.0% of households. 4.5% of households reported the use of other disposal routes, such as waterways, and 3.4% reported using a combination of disposal methods. 28.1% of households reported irregular waste collection services, while 2.4% stated that their household never had waste collection services.

Indicator	Finding	System implication
Door-to-door collection	42.3% of households	Formal collection is not yet universal and is spatially uneven
Open dumping	14.4% of households	Uncollected waste is diverted to environmentally unsound disposal routes
On-site burning	5.1% of households	Air pollution and respiratory health risks remain linked to service failure
Irregular collection	28.1% of households	Collection frequency is a critical performance constraint
Households with no collector	11.5%	Last-mile service gaps persist, especially outside core urban districts

Source: Field Survey (2026)

Food and organic waste comprised the bulk of waste composition, followed by waste from plastics and paper. The leading combination of waste from households was food, paired with plastic and paper, accounting for 26.9% of the total. This combination suggests a great opportunity to recover compostable and recyclable materials, assuming that the systems for waste collection and separation at the source are improved. Yet, the low 26.3% of households that separate their waste for recycling shows that the current waste collection system does not provide sufficient motivation for the segregation of waste.

4.2 Waste Generation and Population Growth

Waste production in FCT is predicted to rise sharply. Estimates show generation of municipal solid waste would increase on the order of 361,000 tonnes in 2006 to 1.33 million tonnes in 2026, a 268.4% increase,

while time series techniques would suggest an increase to 1.545 million tonnes by 2030 and 1.836 million tonnes by 2035, assuming no change in the population or the per capita level of solid waste generation as of now.

Year	Population estimate (million)	Rate (kg/cap/day)	Estimated annual waste (kt/yr)
2006	1.41	0.70	361
2020	3.28	0.85	1,018
2026	4.05	0.90	1,330
2030*	4.60	0.92	1,545
2035*	5.30	0.95	1,836

Source: Field Survey (2026)

Regression analysis identified household size as the strongest predictor of weekly household waste generation, with each additional household member associated with approximately 0.61 kg/week of additional waste. Monthly income was also positively associated with waste generation, reflecting the relationship between consumption, packaging and waste output. Settlement type was not independently significant after controlling for income and household size, indicating that socio-economic structure is more important than location alone for generation-volume prediction.

4.3 Constraints to Sustainable Waste Management

Five interrelated constraint domains were identified: technical, financial, institutional, behavioural and environmental. Technical constraints include inadequate fleet capacity, ageing compactor trucks, absence of route optimisation, lack of functional transfer stations, overreliance on the Gosa/Dutse disposal site and absence of large-scale composting or material recovery infrastructure. Financial constraints include weak cost recovery, inconsistent user-fee collection, insufficient AEPB budget allocations and the absence of a ring-fenced waste fund.

Institutional constraints were the most persistent. Most key informants confirmed mandate overlaps or coordination gaps among AEPB, Area Councils, NESREA, FMENV and private contractors. Contractor agreements were described as weakly standardised and insufficiently performance based. The behavior constraints on segregation and recycling were related to the awareness of policies and the presence of nearby buyers and informal pickers. The challenges to environmental and public health were from blocked drains and burns to refuse and the emission of foul odors, pests, soil and water pollution, and the contamination of soil and water and the risk of disease and death.

Constraint domain	Key evidence	Implication for ISWMS
Technical	No functional transfer stations; no composting or MRF infrastructure at scale	Infrastructure must be sequenced from collection stabilisation to recovery

Financial	Weak cost recovery and unfenced revenue	A dedicated Waste Services Fund is required
Institutional	69.6% of stakeholders confirmed overlaps or gaps	Statutory coordination and independent audit are necessary
Behavioural	Only 26.3% segregate; 66.4% unaware of regulations	Public education must be paired with enabling infrastructure
Environmental	Open dumping, burning, flooding and vector risks remain visible	Waste reform contributes to public health and climate resilience

Source: Field Survey (2026)

4.4 Policy Framework Evaluation

The 2020 National Policy on Solid Waste Management contains relevant principles, including source segregation, integrated waste management, recycling and resource recovery. However, the field evidence shows weak implementation at household and municipal levels. The proportion of the population aware of municipal waste regulations stood at 25.9%, whereas 66.4% had no knowledge of these regulations. Such discrepancy in awareness levels suggests that the policy has failed to reach its target population.

Accountability discrepancy was detected during stakeholder assessment interviews. Implementing agencies tended to rate policy performance more positively, while independent observers, private operators and community-level actors rated implementation as partial, weak or inconsistent. This divergence indicates the absence of credible independent performance auditing. A policy-practice gap matrix identified severe gaps in collection coverage, source separation and rural/peri-urban equity, with high gaps in disposal standards, recycling and recovery, informal sector integration and public awareness.

4.5 Informal Sector and Circular Economy Potential

The informal waste sector is central to Abuja's existing material recovery system. Waste pickers collect plastics, aluminum tins and cartons from dumpsites, streets and households. Scrap dealers purchase, sort and resell metals and plastics, while recyclers convert recovered plastic into pellets. Although these actors perform useful circular economy functions, they operate without formal contracts, PPE, training or social protection. All 24 focus group participants expressed willingness to be formally registered or integrated into the waste management system.

The dominant household barrier to recycling was the absence of nearby buyers or buy-back points, cited by 31.3% of respondents. This indicates that recycling behaviour is constrained less by lack of interest than by weak market access and infrastructure. Recyclers reported major scaling opportunities but also cited police harassment, lack of credit, insufficient government support and poor electricity supply. These findings show that Abuja's circular economy potential is not absent; it is institutionally suppressed and under-supported.

4.6 Discussion

The results show that the waste management problems in Abuja are deeply systemic in nature. Failures in collection lead to the dumping and burning of waste in the open; low service frequency leads to low

satisfaction; collection in mixed forms leads to the abandonment of source segregation; an absence of buy-back points leads to the abandonment of recycling; and informal recyclers recover waste but are excluded from the system; and agencies have overlapping mandates and are not held accountable or restructured for better performance. These failures reinforce one another, making isolated technical solutions insufficient.

The strongest policy implication is that governance reform must precede and enable infrastructure investment. New trucks, bins, composting plants or waste-to-energy facilities will not deliver sustained change if institutional mandates remain fragmented, contractor performance remains unverified, financing remains unfenced and communities remain disconnected from service feedback mechanisms. Conversely, governance reform without service improvements will not build public trust or willingness to pay. The ISWMS must therefore be phased but integrated: governance, financing, collection, segregation, recovery and informal sector integration must move as linked components.

The finding that higher income reduces segregation probability is particularly important. It suggests that segregation is not primarily a function of education or environmental values but of collection design. If door-to-door mixed waste collection is used, there is little incentive to separate waste, and thus, the effectiveness of such collection systems and behavior-change campaigns is low, unless supported by color-coded bins, differentiated collection systems, buy-back points, and visible waste recovery pathways.

The informal sector findings also challenge conventional waste governance assumptions. Informal waste actors are not resisting formalisation; they are waiting for an institutional pathway into the formal system. Cooperative registration, health and safety support, contract participation and buy-back point operation would convert an existing informal circular economy into a recognise, safer and more productive component of ISWMS.

4.7 Proposed Integrated Solid Waste Management System for Abuja

The proposed ISWMS is organised around four pillars: governance and institutional architecture reform; phased physical infrastructure investment; inclusive stakeholder integration; and sustainable financing and performance monitoring. Each pillar responds directly to the empirical failures documented in the study.

4.7.1 Pillar One: Governance and Institutional Architecture

The first pillar is the establishment of an Integrated Waste Management Coordination Authority (IWMCA) for the FCT. The IWMCA should not replace AEPB's operational role but should function as a statutory coordination, licensing, tariff-setting, performance-monitoring and inter-agency dispute-resolution body. Its governing structure should include AEPB, NESREA, FMENV, the six Area Councils, private operators, civil society and formally registered informal sector cooperatives. This arrangement would address the accountability vacuum created by fragmented mandates.

All private waste collection contracts should be converted into performance-based Service-Level Agreements (SLAs). The service level agreements must incorporate criteria for targets, frequency of collections, complaints handling, GPS-based route checking, quarterly performance reporting and financial penalties for underperformance. A public performance record of the contractors must be kept.

An Independent Waste Governance Audit Unit should be established within the FCT audit architecture to conduct annual reviews of public waste institutions and bi-annual contractor audits. Audit reports should be published and linked to corrective action plans. This would address the agency-assessor divergence observed in the policy evaluation results.

4.7.2 Pillar Two: Phased Infrastructure Investment

The physical infrastructure programme should be sequenced in three phases. Phase One should stabilise foundational systems through fleet renewal, GPS tracking, four decentralised transfer stations, household registration, colour-coded bin distribution and engineering upgrades to the Gosa/Dutse disposal facility. Priority transfer station corridors should include Gwagwalada, Bwari/Kuje, Kwali/Abaji and Nyanya/Karu.

Phase Two should expand diversion and recovery infrastructure. Two composting facilities should be developed: one serving AMAC/Bwari and another serving Gwagwalada/Kuje/Kwali. Material Recovery Facilities should be co-located with transfer stations and operated partly through registered waste cooperatives. Buyback points should be established across all Area Councils to address the dominant household recycling barrier.

Phase Three should introduce advanced circular economy infrastructure, including a modest residual waste-to-energy facility only after source separation, composting, MRF recovery and reliable waste supply chains have matured. This sequencing is important because high-capital technologies are more likely to fail when deployed before foundational governance, collection reliability and waste characterisation systems are in place.

4.7.3 Pillar Three: Informal Sector Integration

ISWMS should formalise informal actors through a three-tier cooperative model. Tier One cooperatives would comprise primary waste pickers organised by service zones. Tier Two cooperatives would comprise scrap dealers and recyclers organised around material streams. Tier Three would be a cooperative federation with representation on the IWMCA board. Cooperative registration should include business identity, occupational safety training, PPE, group insurance, transparent material pricing and access to municipal waste management sub-contracts.

Private contractors should be required to allocate a defined share of collection routes, especially in peri-urban and last-mile areas, to certified cooperatives. This would improve service reach while recognising informal workers as legitimate environmental service providers. Cooperative operation of buy-back points and MRF sorting lines would further connect household segregation to actual recovery markets.

4.7.4 Pillar Four: Financing and Performance Monitoring

The financing mechanism should be a dedicated Waste Services Fund administered by the IWMCA. Revenue should include user fees, contractor remittances, enforcement penalties, FCT Administration allocations, climate finance, development grants and EPR-related recovery funds. Expenditure should be restricted to waste operations, infrastructure, enforcement, monitoring, cooperative integration, public education and applied research.

A progressive cost-reflective user fee schedule should be introduced only after visible service improvements begin, because willingness to pay is shaped by trust and service credibility. Commercial and institutional waste generators should pay volumetric or service-level tariffs. Digital payment mechanisms should reduce cash leakage and permit transparent auditing.

Waste Aware indicators should be adopted as the annual performance dashboard. Core indicators should include collection coverage, controlled treatment/disposal, diversion rate, revenue adequacy, inclusivity, governance quality and user satisfaction. A Waste Management Data System should integrate GPS route data, household registers, contractor reports, disposal-site environmental monitoring and periodic waste composition audits.

ISWMS pillar	Main intervention	Expected outcome
Governance	IWMCA, SLAs, independent audit	Clear accountability and performance-based management
Infrastructure	Transfer stations, GPS, composting, MRFs, landfill	Expanded coverage, reduced dumping and higher diversion
Stakeholder integration	Three-tier waste cooperative model	Safer livelihoods and stronger circular economy recovery
Financing and monitoring	Waste Services Fund, digital tariffs, WasteAware dashboard	Sustainable revenue and transparent progress tracking

4.8 Implementation Roadmap

Phase	Time frame	Priority actions	Lead institutions
Phase 1: Stabilisation	Years 1–3	Establish IWMCA; redesign contracts; install GPS; distribute segregation bins; build transfer stations; start cooperative registration; upgrade Gosa/Dutse controls	FCTA, AEPB, Area Councils, NESREA, IWMCA
Phase 2: Diversion and recovery	Years 3–7	Commission composting facilities; establish MRFs and buy-back points; enforce EPR; introduce progressive tariffs; conduct WasteAware audits	IWMCA, AEPB, NESREA, cooperatives, private operators
Phase 3: Advanced circularity	Years 7–15	Develop residual WtE facility; construct engineered landfill; scale data-driven planning; run independent impact evaluation	FCTA, IWMCA, private investors, NESREA

4.9. Policy Implications

For the FCT Administration, the central implication is that waste management should be treated as an integrated environmental infrastructure and governance priority rather than an urban sanitation afterthought. Statutory coordination, ring-fenced financing and independent auditing are necessary to make technical investments sustainable.

For AEPB, the findings require a shift from contractor licensing to contractor performance management. Coverage, frequency, route verification, response time and customer satisfaction ought to be made quantifiable in contracts.

The article underscores the need for NESREA and FMENV to make national policies on solid waste management, plastic and EPR into implementable local policy systems. Producer responsibility will remain weak unless linked to actual recovery channels, registered recyclers and verified material flows.

For communities and civil society, the ISWMS creates a role in service feedback, source separation, buy-back participation and monitoring. Community participation must be linked to infrastructure and economic incentives, not awareness-only campaigns.

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This article has developed a context-specific Integrated Solid Waste Management System for Abuja based on primary mixed-methods evidence. The analysis shows that Abuja's waste management challenge is not primarily the absence of policy or isolated infrastructure; it is a systems-governance failure in which fragmented mandates, weak contractor accountability, unreliable financing, low household segregation, inadequate infrastructure and informal sector exclusion reinforce one another.

A credible ISWMS for Abuja must therefore integrate governance reform, phased infrastructure investment, informal sector cooperative integration, source separation, circular economy infrastructure, sustainable financing and performance monitoring. The proposed model offers an actionable pathway for moving Abuja from a disposal-dominated waste regime toward a more equitable, accountable and resource-efficient system. When adopted using statutory powers, phased financing, and independent monitoring, the Abuja ISWMS can serve as a replicable model for other quickly urbanising cities in Nigeria and Africa.

5.2 Recommendations

1. Establish an Integrated Waste Management Coordination Authority for the FCT with statutory responsibility for coordination, licensing, tariff-setting and performance monitoring.
2. Convert private waste contractor agreements into performance-based SLAs with GPS verification, coverage targets, response-time obligations and public performance reporting.
3. Create an Independent Waste Governance Audit Unit to assess public agencies and private contractors using triangulated operational, household and geospatial evidence.
4. Develop at least four decentralised transfer stations serving Gwagwalada, Bwari/Kuje, Kwali/Abaji and Nyanya/Karu corridors.
5. Introduce colour-coded household source separation infrastructure before enforcing segregation mandates.
6. Commission composting facilities and material recovery facilities before considering high-capital residual waste-to-energy infrastructure.
7. Formalise informal waste pickers, scrap dealers and recyclers through a three-tier cooperative model with PPE, training, insurance and municipal sub-contract access.
8. Establish community buy-back points across all Area Councils to connect household recycling behaviour to real recovery markets.
9. Create a ring-fenced Waste Services Fund supported by user fees, public allocation, EPR contributions, penalties and climate/development finance.
10. Adopt WasteAware indicators and a Waste Management Data System to track collection, treatment,

diversion, inclusivity, finance, governance and user satisfaction.

References

Abila, B., & Kantola, J. (2019). From waste to resources: A study of the transitions of plastic recycling in developing world cities. American Journal of Applied Sciences, 16(4), 116–132.

Abuja Environmental Protection Board. (2022). Annual environmental sanitation report. AEPB.

Adedara, M. L., Taiwo, R., & Bork, H.-R. (2023). Municipal solid waste management in sub-Saharan Africa: A systematic review and meta-analysis. Resources, Conservation and Recycling, 191, 106887.

Adewumi, I. K., Mafimisebi, O. P., & Oluwole, F. A. (2018). Municipal solid waste characterization and management in Abuja, Nigeria. Journal of Applied Science and Environmental Management, 22(1), 91–97.

Ajzen, I. (1991). The theory of planned behavior. Organizational Behavior and Human Decision Processes, 50(2), 179–211.

Bello Dange, A. (2026). *Evaluation of municipal solid waste management practices in the Federal*

Capital Territory (FCT), Abuja and its environs (Doctoral thesis, University of Port Harcourt).

Buwah, P., Jibrin, A., & Dada, A. (2024). Solid waste management challenges in the Federal Capital Territory, Abuja: A governance and infrastructure assessment. Urban Climate, 44, 101207.

Creswell, J. W., & Plano Clark, V. L. (2018). Designing and conducting mixed methods research (3rd ed.). SAGE Publications.

Ezeah, C., & Roberts, C. L. (2014). Analysis of barriers and success factors affecting the adoption of sustainable management of municipal solid waste in Nigeria. Journal of Environmental Management, 103, 9–14.

Ezeudu, O. B., & Ezeudu, T. S. (2024). Extended producer responsibility and plastic waste governance in Nigeria: Progress, gaps, and reform pathways. Resources, Conservation and Recycling, 202, 107370.

Federal Ministry of Environment. (2020). National Policy on Solid Waste Management. Federal Republic of Nigeria.

Freeman, R. E. (2010). Strategic management: A stakeholder approach. Cambridge University Press.

Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case-study. Research Policy, 31(8–9), 1257–1274.

Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2017). The circular economy: A new sustainability paradigm? *Journal of Cleaner Production*, *143*, 757–768. https://doi.org/10.1016/j.jclepro.2016.12.048

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

Imam, A., Mohammed, B., Wilson, D. C., & Cheeseman, C. R. (2008). Solid waste management in Abuja, Nigeria. Waste Management, 28(2), 468–472.

Kaza, S., Yao, L., Bhada-Tata, P., & Van Woerden, F. (2023). What a waste 2.0: A global snapshot of solid

waste management to 2050. World Bank.

Kirchherr, J., Reike, D., & Hekkert, M. (2018). Conceptualizing the circular economy: An analysis of 114 definitions. Resources, Conservation and Recycling, 127, 221–232.

Ogwueleka, T. C. (2013). Survey of household waste composition and quantities in Abuja, Nigeria. Resources, Conservation and Recycling, 77, 52–60.

Ogwueleka, T. C. (2009). Municipal solid waste characteristics and management in Nigeria. *Iranian Journal of Environmental Health Science & Engineering*, *6*(3), 173–180.

Osman, A. I., Farghali, M., Liu, E., Hassan, D., Ihara, I., & Lu, K. (2024). Municipal solid waste management in Asia and Africa: Challenges, opportunities and solutions. Science of the Total Environment, 913, 169745.

Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. Science, 325(5939), 419–422.

Pholoto, L., & Chitaka, T. (2022). Guidelines for waste picker integration into formal waste management systems in South Africa. South African Journal of Science, 118(9/10), 1–9.

Scheinberg, A., Wilson, D. C., & Rodić, L. (2010). Solid waste management in the world's cities. UN-Habitat.

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

Van de Klundert, A., & Anschütz, J. (2001). Integrated sustainable waste management: The concept. WASTE.

Wilson, D. C., Velis, C. A., & Rodić, L. (2013). Integrated sustainable waste management in developing countries. Proceedings of the Institution of Civil Engineers—Waste and Resource Management, 166(2), 52–68.

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

Wilson, D. C., Rodić, L., Modak, P., Soos, R., Carpintero, A., Velis, K., et al. (2015). Global waste management outlook. UNEP.

Wilson, D. C., Velis, C., & Cheeseman, C. (2006). Role of informal sector recycling in waste management in developing countries. Habitat International, 30(4), 797–808.