



# Assessing Municipal Waste Management Readiness for Circular Economy Transition

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<p><b>Received:</b> 27/02/2026 <b>Accepted:</b> 18/04/2026 <b>Published:</b> 05/06/2026</p>	<p><i>This study assesses the readiness of municipal solid waste management (MSWM) systems in the Abuja metropolis and its environs for transition to a circular economy (CE) model, addressing escalating waste challenges within Nigeria's urban landscape. Guided by the objective to evaluate multidimensional readiness and develop a localized understanding of system dynamics, the study employs a convergent parallel mixed-methods design, integrating quantitative surveys (n=421) with qualitative Key Informant Interviews (n=25). Theoretical frameworks—Urban Metabolism Theory, Ecological Modernization Theory, and Institutional Theory—frame the analysis across institutional, infrastructural, socio-behavioural, and policy dimensions. Descriptive statistics reveal a moderate overall CE readiness (composite mean = 2.76/5), where relatively strong socio-behavioural willingness (mean = 3.12) is severely constrained by deep infrastructural deficits (mean = 2.41). Exploratory Factor Analysis (EFA) validates a four-factor readiness structure explaining 67.4% of the total variance, while Multiple Linear Regression (MLR) and Structural Equation Modelling (SEM) identify institutional readiness as the strongest predictor of transition capability (<math>\beta=0.285, p&lt;0.001</math>). Qualitative themes highlight severe inter-agency coordination silos, the proliferation of illegal dumpsites, significant untapped market potential for recyclables, and an urgent need for institutionalized behavioral incentives. The study concludes that while a CE transition in Abuja is highly feasible, it requires targeted governance reforms, infrastructural investments in Material Recovery Facilities (MRFs), and the formal integration of the informal waste sector.</i></p>	

**Keywords:** Circular Economy, Municipal Solid Waste Management, Readiness Assessment and Transition.

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## Introduction

Rapid urbanization, population growth, and shifting consumption patterns have exacerbated the challenges of municipal solid waste management (MSWM) in developing countries, particularly within sub-Saharan Africa. Nigeria, with an annual urban growth rate exceeding 4%, exemplifies this trend by generating an estimated 32 million tonnes of municipal solid waste (MSW) annually. Per capita waste generation has risen significantly from 0.5 kg/day in the 1990s to over 0.7 kg/day in recent years. In major administrative hubs like the Abuja Federal Capital Territory (FCT), this surge in waste volume has completely outstripped the capacity of existing infrastructure, leading to fragmented and unsustainable collection, treatment, and disposal mechanisms.

Traditional waste management approaches in Nigerian cities adhere strictly to a linear "take–make–use–dispose" model. This architecture relies heavily on open dumping, irregular collection schedules, and weak regulatory enforcement, which collectively accelerate resource depletion, environmental degradation, and severe public health risks. Landfills in Abuja, such as those located in Gosa and Mpape, are heavily overused and directly linked to soil and groundwater pollution affecting peri-urban communities. Globally, the linear model is heavily critiqued; estimates show that up to 95% of material economic value is permanently lost within linear configurations, prompting a global paradigm shift toward circular economy (CE) principles.

The circular economy model is conceptualized as a restorative and regenerative system that emphasizes waste reduction, reuse, recycling, resource recovery, and closed-loop processes to decouple economic growth from environmental degradation. In the waste sector, CE promotes structural practices like segregation-at-source, organic composting, waste-to-energy conversion, and extended producer responsibility (EPR). For Nigeria, transitioning to a CE model directly aligns with national targets under the National Waste Management Policy (2020) and global commitments under Sustainable Development Goal (SDG) 12 (Responsible Consumption and Production) and SDG 13 (Climate Action).

Abuja presents a compelling, strategic case for a CE transition. As a planned capital city hosting over 3 million residents and generating approximately 1,200 tonnes of waste daily, its institutional landscape is split between the Abuja Environmental Protection Board (AEPB), localized Area Councils, and private franchise operators. Despite modern layouts, the city grapples with low recycling rates (estimated at 10–15%), a total absence of formal material recovery facilities, and a lack of formal recognition for the city's 5,000+ informal waste pickers who drive the baseline recovery landscape. This backdrop raises a pivotal operational question: To what extent is Abuja's municipal waste management system structurally, institutionally, and behaviorally ready for a circular economy transition?

### 1.2 Statement of the Problem

Despite Abuja's status as one of Nigeria's most systematically planned cities, its MSWM framework exhibits structural deficiencies that directly impede sustainable development. Waste collection coverage is highly inconsistent, frequently falling below 70% in peri-urban areas and sparking widespread illegal dumping. Furthermore, final disposal is

dominated by unmanaged dumpsites showing critical overuse, open burning, and hazardous leachate seepage into local ecosystems.

The prevailing system entirely lacks core CE structural components, such as source-segregation pathways or functional composting plants to manage the city's massive organic waste load. While informal waste pickers recover significant shares of recyclables, they face high health risks, social marginalization, and complete exclusion from formal municipal waste frameworks.

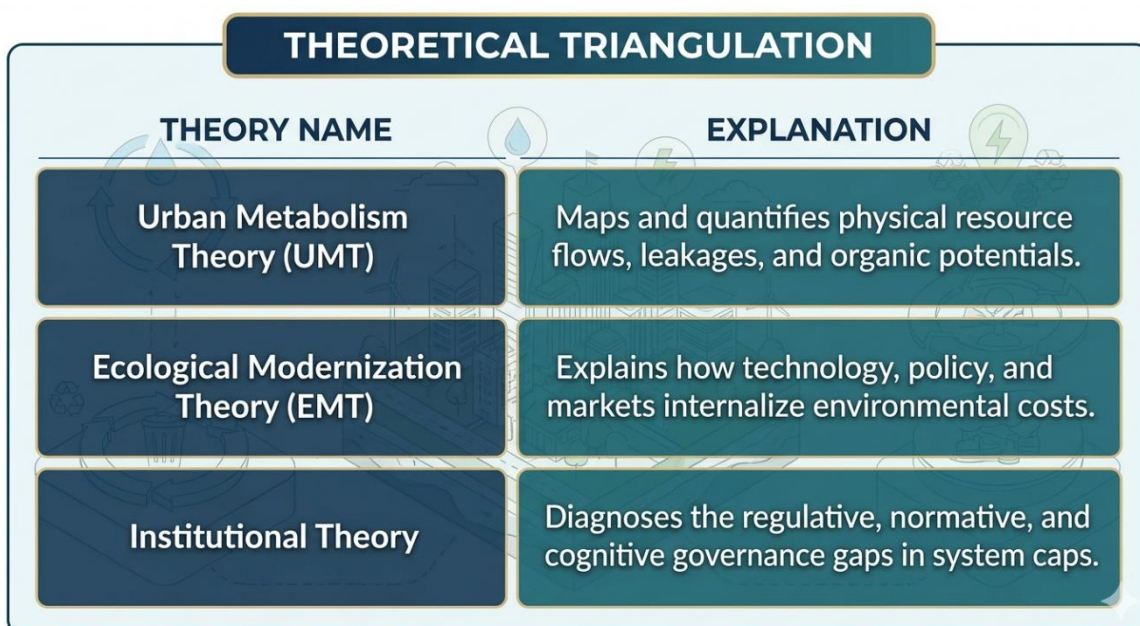
This problem is compounded by fragmented governance. Responsibilities are unclearly divided among the AEPB and local Area Councils (such as AMAC and Bwari), leading to coordination failures, data deficits, and regulatory enforcement gaps. Nationally, policies like EPR exist on paper but suffer from a total lack of monitoring and funding. At the civic level, residents exhibit low levels of waste-separation compliance due to entrenched habits and a lack of enabling municipal infrastructure.

To date, no comprehensive, multidimensional empirical readiness assessment has been conducted for the Abuja metropolis and its environs. Without a rigorous baseline evaluation across institutional, infrastructural, socio-economic, and behavioral dimensions, any attempted transition risks being superficial, leading to ineffective public investments and missed opportunities for sustainable urban resilience.

### Theoretical Framework & Literature Review

#### Theoretical Triangulation

To capture the complex systemic, technological, and institutional factors influencing waste transitions in a developing urban landscape, this study synthesizes three complementary theoretical lenses:



- **Urban Metabolism Theory (UMT):** Conceptualizes the city as a living organism consuming material inputs and excreting waste outputs. UMT highlights the linear inefficiencies ("metabolic overload") occurring at Abuja's dumpsites and provides the analytical basis for transforming these linear paths into circular loops via resource quantification.
- **Ecological Modernization Theory (EMT):** Posits that environmental protection and economic growth can be mutually reinforcing through technological innovation, policy reforms, and market-based instruments. EMT frames CE interventions (like automated sorting and EPR) as vehicles for modernizing Abuja's waste sector into a generator of green jobs.
- **Institutional Theory:** Examines the regulative (laws/enforcement), normative (societal values/expectations), and cognitive (shared cultural beliefs) pillars that dictate organizational behavior. It provides the analytical diagnostic tool to understand why Abuja's fragmented governance architecture and weak enforcement mechanisms continuously restrict systemic innovation.

### Empirical Context and Gaps

Prior empirical literature across sub-Saharan Africa consistently highlights that structural fragmentation, weak financing, and low source-separation habits trap municipal waste systems within linear loops. In Nigeria, empirical studies from global hubs like Lagos and Ibadan confirm that while informal recyclers form the practical backbone of material recovery, they face systemic institutional neglect.

Abuja-specific empirical literature remains highly sparse and narrow. Existing studies focus almost exclusively on descriptive metrics, such as private contractor collection efficiencies or basic waste characterization within single local government areas. A profound synthesis gap exists: prior research has failed to evaluate how institutional governance, infrastructure capacity, public behavioral profiles, and market incentives interact as an interdependent system. This study fills this gap by deploying an integrated mixed-methods readiness assessment tailored directly to Abuja's multi-tiered governance and socio-ecological realities.

## Research Methodology

### Mixed-Methods Research Design

The study deployed a convergent parallel mixed-methods design. Quantitative and qualitative data strands were collected concurrently, analyzed independently, and subsequently integrated during the final interpretive stage to ensure comprehensive triangulation.

### Sampling and Spatial Stratification

The geographic scope targeted the Abuja metropolis and its interconnected peri-urban environs, cutting across four strategically selected Area Councils within the FCT:

1. **Abuja Municipal Area Council (AMAC):** The high-density administrative and commercial urban core.
2. **Bwari Area Council:** A rapidly expanding peri-urban zone characterized by massive informal settlements.
3. **Gwagwalada & Kuje Councils:** Crucial transitional zones capturing urban-rural spillover effects and informal waste flows.

For households, the minimum statistically representative sample size (n=384) was calculated using Cochran's formula for infinite populations:

$$n = \frac{Z^2 \cdot p \cdot (1 - p)}{E^2}$$

Adjusting for cluster design effects and a 10% non-response margin, a final target of 450 households was established. A multistage sampling technique combined geographic stratification with systematic random household selection. Concurrently, purposive and snowball sampling were utilized to select 30 formal institutions and 25 key informants across the formal and informal waste sectors.

### Model Specification

To statistically test the structural drivers of circular economy transition readiness, a Multiple Linear Regression model was specified:

$$CER_i = \beta_0 + \beta_1 INST_i + \beta_2 INFRA_i + \beta_3 SOCIO_i + \beta_4 POLICY_i + \epsilon_i$$

Where:

- CER<sub>i</sub>: Composite Circular Economy Readiness Index score for respondent i (normalized on a 0–1 or 1–5 scale).
- INST<sub>i</sub>: Institutional Readiness Index (governance, coordination, competence).
- INFRA<sub>i</sub>: Infrastructural Readiness Index (facilities, MRFs, logistics).
- SOCIO<sub>i</sub>: Socio-Economic and Behavioral Readiness Score (awareness, sorting habits).
- POLICY<sub>i</sub>: Policy and Regulatory Readiness Index (EPR, enforcement baseline).
- ε<sub>i</sub>: Stochastic error term.

## Results, Analysis, and Discussion

### Quantitative Response Overview

Out of 450 distributed household questionnaires, 421 fully completed instruments were recovered, yielding an exceptionally robust response rate of 93.6%. Instrument reliability was empirically validated, returning a Cronbach's



threshold) confirmed that Institutional/Policy Governance explained the largest share of variance, followed sequentially by Infrastructural Capacity, Socio-Behavioural Dynamics, and Financial/Market Incentives.

### Econometric Drivers of CE Readiness

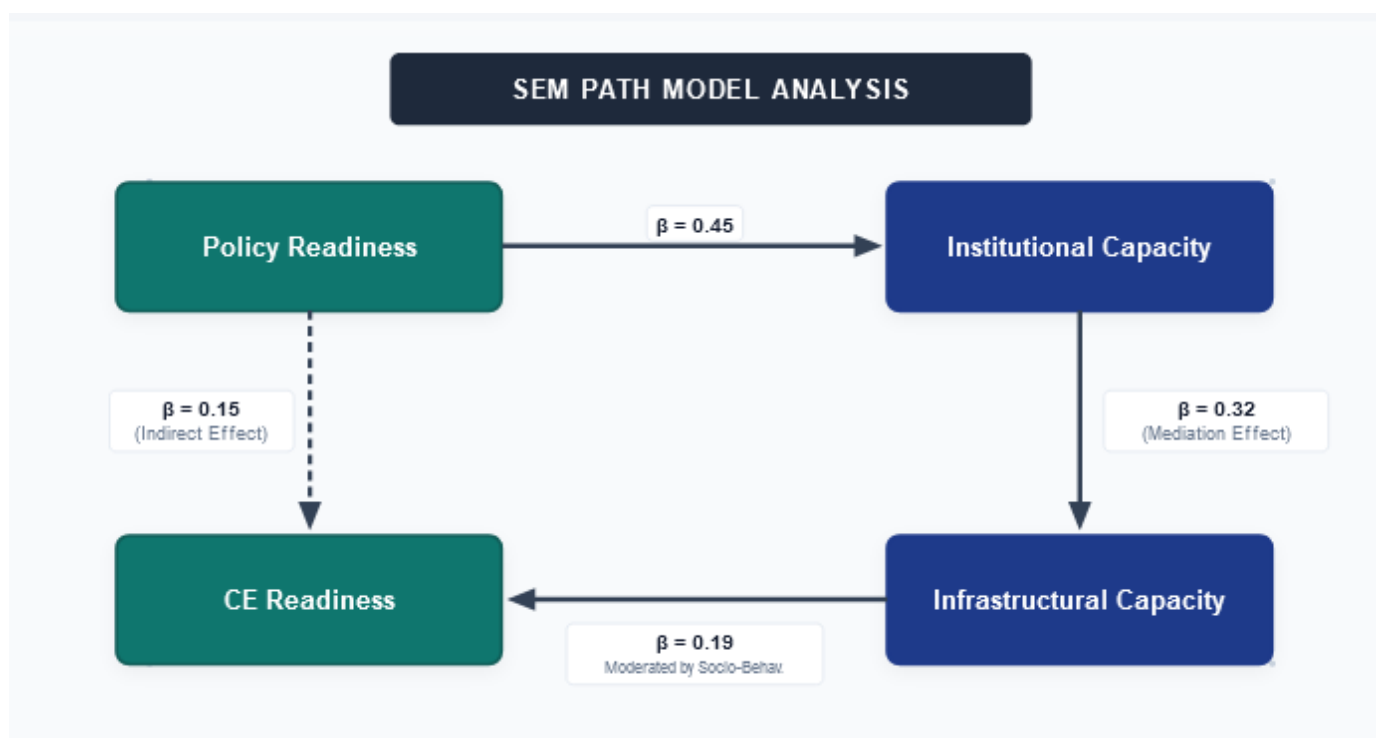
Ordinary Least Squares (OLS) estimation of the specified regression model revealed that all four hypothesized dimensions exert a statistically significant, positive influence on Abuja's overall transition readiness ( $R^2=0.62$ ,  $F=172.4$ ,  $p<0.001$ ):

$$CER=0.452+0.285INST+0.242INFRA+0.174SOCIO+0.136POLICY$$

Institutional Readiness emerged as the most powerful determinant ( $\beta=0.285$ ,  $t=7.06$ ,  $p<0.001$ ), followed closely by Infrastructural Readiness ( $\beta=0.242$ ,  $t=7.13$ ,  $p<0.001$ ). Socio-Behavioural ( $\beta=0.174$ ) and Policy factors ( $\beta=0.136$ ) were also significant drivers. Crucially, diagnostic testing confirmed the model's high stability: all Variance Inflation Factors (VIF) fell well below 2.5, proving the complete absence of multicollinearity.

### Structural Equation Modelling (SEM) Pathways

To trace the indirect and systemic dependencies among these dimensions, a comprehensive path analysis was executed via SEM (Model Fit: CFI=0.92, TLI=0.90, RMSEA=0.048, SRMR=0.059).



The SEM path diagram mapped several vital systemic flows:

- 1. Policy-to-Institutional Path ( $\beta=0.45$ ,  $p<0.01$ ):** Confirms that clear, actionable regulatory mandates are prerequisite to building municipal enforcement capabilities.
- 2. Institutional-to-Infrastructural Mediation ( $\beta=0.32$ ,  $p<0.01$ ):** Demonstrates that institutional capacity directly dictates physical infrastructure investments; weak governance actively creates infrastructural gaps.
- 3. Socio-Behavioural Moderation ( $\beta=0.19$ ,  $p<0.05$ ):** An interaction pathway showing that high civic awareness significantly amplifies the operational return on infrastructure investments.

### Qualitative Synthesis and Triangulation

Thematic analysis of the qualitative data strand ( $n=25$ ) revealed four highly descriptive thematic nodes that perfectly contextualize the econometric results:

- 1. Weak Institutional Coordination:** Informants from both the public and private sectors detailed severe jurisdictional overlaps and a total lack of communication between the AEPB and local Area Councils. This qualitative bottleneck explains why Institutional Readiness acts as the primary drag on the regression model's predictive power.
- 2. Proliferation of Illegal Dumpsites:** Key informants explicitly mapped over 150 illegal, active dumpsites across Abuja's peri-urban boundaries. This phenomenon directly corroborates the low quantitative infrastructural mean (2.41) and highlights severe urban metabolic leakages.
- 3. Vibrant Recyclable Market Potential:** Private recycling innovators reported a massive, unmet local and international demand for recovered PET plastics and organic compost. The market is economically viable, yet completely unassisted by state mechanisms.

4. **Absence of Structured Incentives:** Informants unanimously called for formal fiscal frameworks, such as tax waivers for green startups and community-level "cash-for-trash" initiatives, to convert passive civic willingness into structural compliance.

## Conclusion and Strategic Policy Recommendations

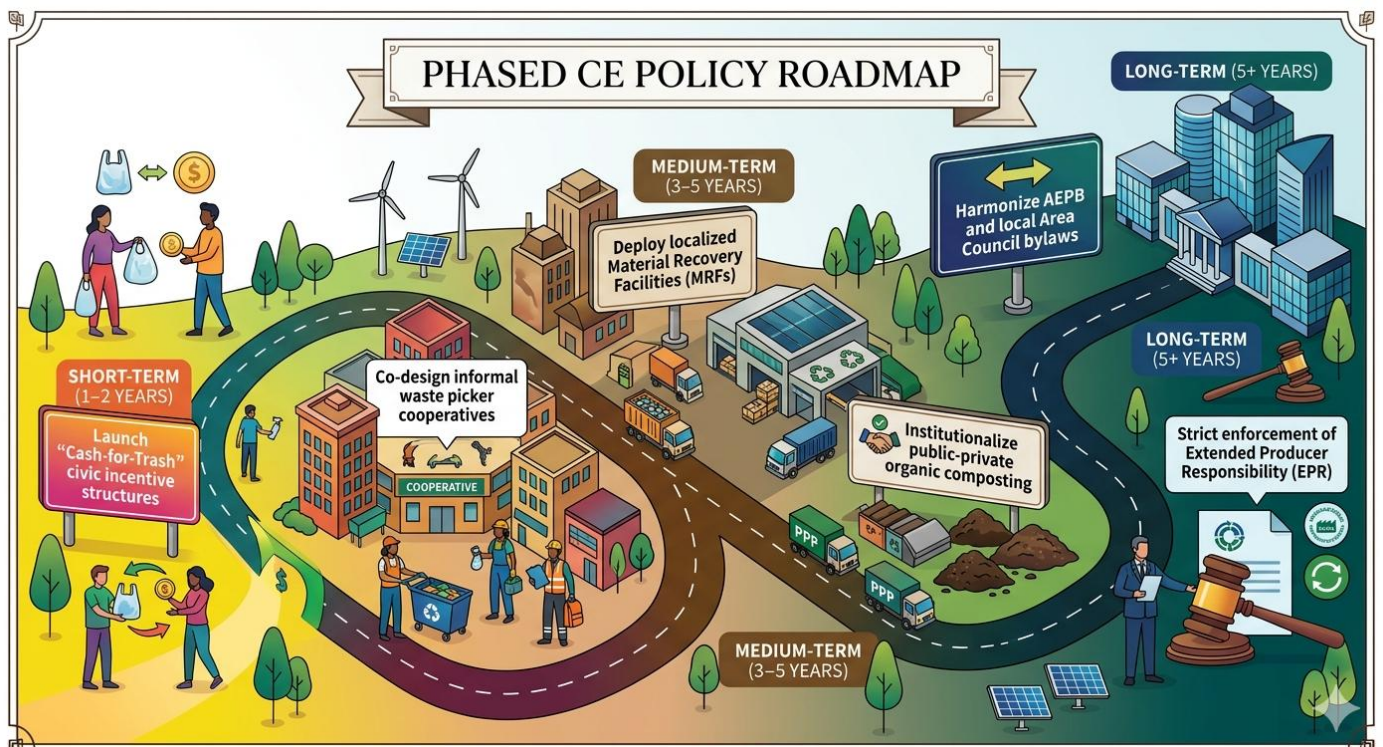
### Conclusion

This study provides clear empirical proof that the Abuja metropolis and its environs possess a moderate but highly uneven foundation for a circular economy waste transition. The primary bottleneck is not public resistance or awareness, but rather severe institutional coordination silos and physical infrastructural deficits.

Currently, Abuja's urban metabolism remains profoundly linear, resulting in substantial financial loss and environmental degradation as high-value resources are dumped into unmanaged landfills. However, by utilizing its highly literate population, massive organic waste load, and active informal sector, Abuja can execute a successful CE transition if it shifts from fragmented, disposal-oriented practices to integrated, resource-recovery governance.

### Policy Matrix and Actionable Pathways

To operationalize these findings, the following phased, multi-dimensional policy recommendations are proposed for the Federal Capital Territory Administration (FCTA) and the AEPB:



### Institutional & Governance Frameworks

- **Establish a Unified CE Coordination Unit:** Create a dedicated, centralized administrative unit within the AEPB to bridge the communication gaps between federal environmental mandates and local Area Council execution frameworks.
- **Formalize and Integrate the Informal Sector:** Shift away from marginalization by actively registering informal waste pickers into recognized neighborhood cooperatives. Provide them with formal collection routes, safety gear, and micro-credit access to optimize plastic and metal recovery loops.

### Infrastructural & Technological Interventions

- **Invest in Material Recovery Facilities (MRFs):** Prioritize public-private partnerships (PPPs) to construct decentralized sorting hubs and MRFs across

the AMAC and Bwari axes to halt recyclable contamination.

- **Scale Up Organic Waste Composting:** Capitalizing on the city's 52% organic waste share, establish municipal-scale composting operations to supply organic fertilizer to agricultural zones in neighboring corridors, effectively closing the biological nutrient cycle.

### Economic, Fiscal, and Behavioral Incentives

- **Deploy Localized Financial Incentives:** Roll out municipal tax credits for green recycling startups and institute drop-off recycling centers that offer micro-rewards to residents for separated waste streams.
- **Enforce Extended Producer Responsibility (EPR):** Activate strict localized monitoring of national EPR guidelines, legally compelling beverage and

electronics manufacturers to fund urban buy-back and reverse-logistics collection networks.

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