

A Comparative Assessment of Recycling Practices and Infrastructure in Yenagoa and Ahoada, Nigeria

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Abstract: Urban plastic waste has become a critical environmental and public health challenge in rapidly growing Nigerian cities, yet the effectiveness of recycling policies and infrastructure in medium-sized urban centres remains under-researched. This study adopted a comparative cross-sectional survey design to assess recycling practices, infrastructure, and policy effectiveness in Yenagoa (Bayelsa State) and Ahoada (Rivers State), Nigeria. A total of 334 respondents (167 per city) were selected through stratified random sampling, and data were collected using structured questionnaires, key-informant interviews, field observations, and a review of secondary data over a six-month period. Data were analysed using descriptive statistics, a one-way analysis of variance (ANOVA), and thematic analysis. Yenagoa recorded a higher recycling rate (35%) than Ahoada (28%), supported by more developed infrastructure, including three sorting facilities and two recycling plants, compared with Ahoada's two sorting facilities and one recycling plant. Yenagoa recovered 150 tons of plastic waste monthly against Ahoada's 120 tons, and recorded a moderate environmental impact score compared with Ahoada's high impact score. Landfilling remained the dominant disposal method in both cities (50% in Yenagoa, 55% in Ahoada), while open burning persisted at 20% in each. A one-way ANOVA comparing composite performance indicators between the two cities produced a mean difference (Yenagoa: 62.33; Ahoada: 50.33) that was not statistically significant, $F(1, 4) = 0.044$, $p = .844$ - a result attributable to the small number of indicators available for testing rather than to an absence of a practical difference. The study concludes that recycling effectiveness is shaped less by the existence of policy than by infrastructural robustness, institutional coordination, and stakeholder participation, and recommends strengthened regulatory enforcement, targeted infrastructural investment, and expanded community engagement in both cities.

Keywords: recycling policy, waste management infrastructure, urban plastic waste, Niger Delta, circular economy, comparative analysis, Yenagoa; Ahoada

INTRODUCTION

The escalating volume of plastic waste in urban environments presents a formidable challenge to environmental sustainability and public health (OECD, 2022). Rapid urbanization and consumer-

driven lifestyles have driven an unprecedented rise in plastic consumption and waste generation, with an estimated 353 million tons produced globally in 2019, of which only 9% was successfully recycled (OECD, 2022). In Nigeria, widespread plastic use - driven by urban consumption patterns and weak enforcement of environmental regulations- has placed a significant burden on municipal waste management systems (Chilote & Dhakal, 2025). Cities such as Yenagoa in Bayelsa State and Ahoada in Rivers State illustrate the acute challenges of plastic waste management in medium-sized urban centres, where population growth, informal housing expansion, and infrastructural inadequacies intersect.

Located within the environmentally sensitive Niger Delta region, Yenagoa and Ahoada are undergoing notable urban transitions but remain underserved in terms of basic waste management infrastructure (Bode-Obanla & Ajisebiyawo, 2025). Both cities face recurring problems associated with improper plastic disposal, including blocked drainage systems, localized flooding, and contamination of terrestrial and aquatic ecosystems. Although recycling is widely recognized as a critical component of sustainable waste management, its operationalization in these areas remains underdeveloped, and informal waste pickers and scavengers continue to dominate the recycling chain, often working under precarious conditions and without formal recognition or institutional support (Adogu et al., 2015).

At the national level, Nigeria has sought to address plastic pollution through the National Policy on Plastic Waste Management (Federal Ministry of Environment [FME], 2020), which promotes recycling, extended producer responsibility, and stakeholder engagement. Implementation, however, remains inconsistent across sub-national contexts. Unlike Lagos State, which has comparatively developed recycling infrastructure, Bayelsa and Rivers States face significant barriers arising from limited data on plastic waste streams and weak institutional coordination (UNEP, 2018). Public awareness of, and participation in, recycling initiatives also remain minimal, with few state-supported programmes to incentivize behavioural change. This gap between policy intent and operational capacity raises important questions about the effectiveness of existing recycling policies and the adequacy of supporting infrastructure in addressing urban plastic pollution. Nigeria's National Policy on Plastic Waste Management and related state-level initiatives seek to reduce plastic leakage through recycling, public-private partnerships, and community-based waste management schemes, but implementation at the local level is frequently hampered by infrastructural deficits, weak institutional coordination, inadequate funding, low public awareness, and an absence of reliable data on plastic waste generation and recovery rates — all of which pose additional challenges for effective policy evaluation and planning.

Conceptual Framework

This study situates recycling effectiveness within the circular economy paradigm and the Integrated Solid Waste Management (ISWM) framework. The circular economy paradigm conceptualizes waste as a resource to be recovered and re-circulated rather than discarded,

emphasizing the interdependence of policy, infrastructure, and behavioural participation in closing the material loop (OECD, 2022). The ISWM framework holds that effective waste management outcomes depend on the interaction of technical (infrastructure and technology), institutional (regulation and enforcement), financial (investment and cost recovery), and social (public awareness and participation) elements, rather than on any single factor in isolation. These two frameworks jointly inform the comparative approach adopted in this study: differences in recycling outcomes between Yenagoa and Ahoada are interpreted not merely as a function of the presence or absence of policy, but as the product of the interaction between infrastructural capacity, institutional coordination, and community participation in each city.

This paper examines the effectiveness of recycling policies and infrastructure in two urban centres within the Niger Delta: Yenagoa, the capital of Bayelsa State, and Ahoada, a prominent town in Rivers State. Both locations represent distinct urban contexts characterized by varying levels of urbanization, governance capacity, economic activity, and waste management practice (Olaoti, 2024). Applying the conceptual framework outlined above, the study undertakes a comparative analysis to identify localized policy gaps, infrastructural deficits, and socio-institutional barriers to effective plastic waste recycling, and to assess the formal and informal instruments, operational systems, and socio-economic factors that shape recycling outcomes in both cities.

MATERIALS AND METHODOLOGY

Study Area

The study was conducted in two cities located in Bayelsa State and Rivers State, respectively. Yenagoa, the capital of Bayelsa State, is situated in southern Nigeria within the Niger Delta and is bordered by the Ekole River, a tributary of the River Nun, at coordinates 4°55'29" N, 6°15'51" E (Ijaola & Sakwa, 2024) (Figure 1). Yenagoa is a rapidly urbanizing area with diverse socio-economic activities ranging from commercial enterprises to small-scale industries, and its growth has outpaced its waste management infrastructure, creating significant challenges in managing plastic waste. Ahoada, located in the Orashi region of Rivers State, northwest of Port Harcourt (Figure 2), is a prominent town combining agricultural and commercial activities. Like Yenagoa, Ahoada faces growing waste management challenges linked to its expanding population and economic base.

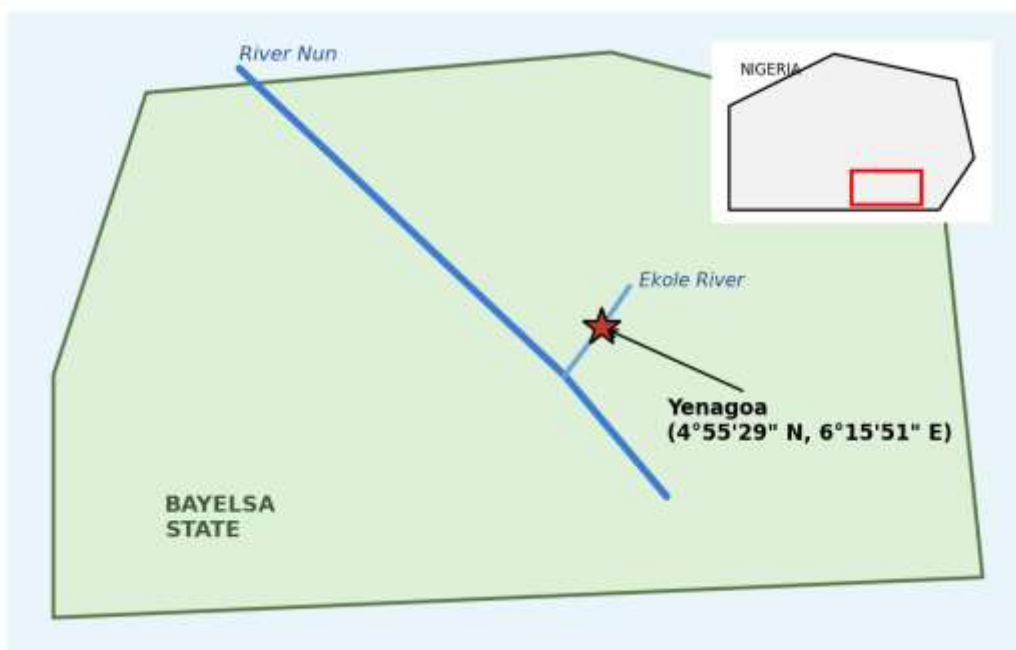


Figure 1: Schematic locator map of the Yenagoa study area, Bayelsa State, Nigeria

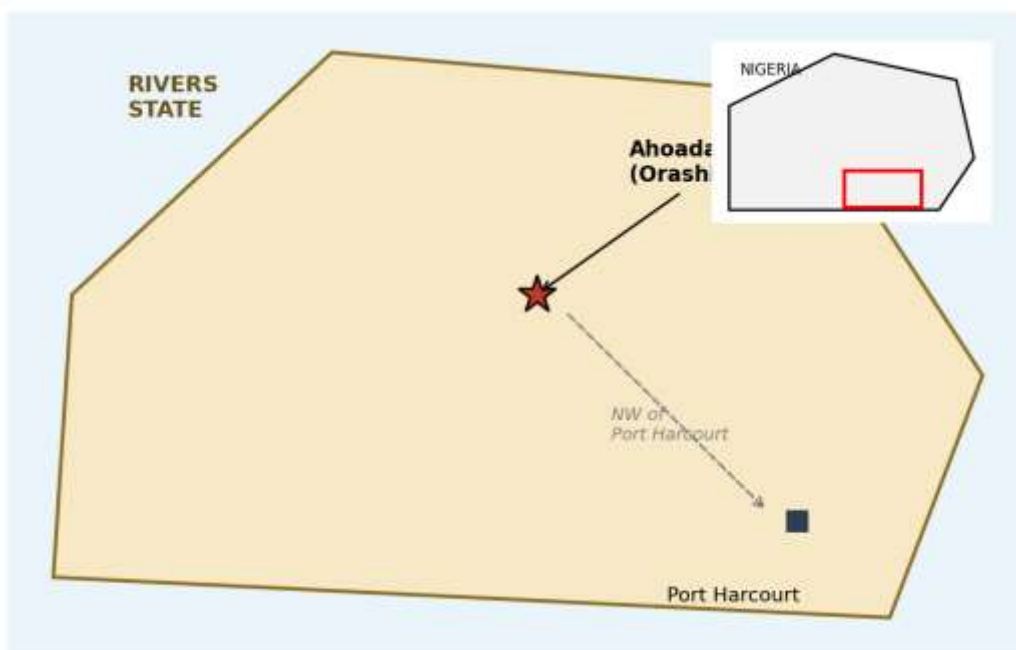


Figure 2: Schematic locator map of the Ahoada study area, Rivers State, Nigeria

Research Design

This study adopted a comparative cross-sectional survey design, integrating quantitative and qualitative approaches, to evaluate and compare the effectiveness of recycling policies and infrastructure in Yenagoa and Ahoada.

Population and Sample Size Determination

The target population comprised households, plastic recycling facility operators, and waste management officials in Yenagoa and Ahoada. In the absence of a definitive sampling frame for households engaged in plastic waste generation and disposal in either city, the sample size for each city was determined using the Cochran (1977) formula for large populations, $n = Z^2pq / e^2$, where $Z = 1.96$ (95% confidence level), $p = 0.5$ and $q = 1 - p = 0.5$ (proportion assumed in the absence of a prior estimate), and e is the margin of error. A sample of 167 respondents per city corresponds to a margin of error of approximately 7.6% under this formula, giving a combined total sample of 334 respondents across the two cities.

Sampling Technique

A stratified random sampling technique was used to ensure proportionate representation across the administrative wards of each city. Each city was first stratified into its constituent wards, after which households were selected from each ward by systematic random sampling. Plastic recycling facility operators and waste management officials were purposively selected on the basis of their direct involvement in recycling operations and policy implementation, to ensure that the qualitative component of the study captured informed, practice-based perspectives.

Data Collection Instruments and Procedure

Data were collected over a six-month period using four complementary instruments: (i) a structured questionnaire administered to household respondents, comprising closed-ended and Likert-type items on waste generation, disposal practices, and recycling participation; (ii) semi-structured interview guides administered to key stakeholders, including recycling facility operators and waste management officials; (iii) a field observation checklist used to record the physical state and operational status of collection points, sorting facilities, and recycling plants; and (iv) a review of secondary data obtained from municipal waste management records and prior studies of the two cities.

Validity and Reliability

Content validity of the questionnaire was established through expert review, focusing on the clarity, relevance, and coverage of the study objectives. A pilot test was subsequently conducted in a comparable but non-sampled community, and items identified as ambiguous were revised prior to full administration to improve the reliability of respondent data.

Data Analysis

Quantitative data were analyzed using descriptive statistics (frequencies, percentages, and means) to summarize demographic characteristics and waste management indicators, and a one-way analysis of variance (ANOVA) to test whether differences in composite performance indicators (recycling rate, resource recovery, and environmental impact score) between the two cities were statistically significant, at a significance level of $\alpha = 0.05$. Qualitative data from interviews and field observations were analysed thematically, following an inductive coding approach to identify recurring patterns relating to institutional, infrastructural, and behavioural barriers to recycling.

Ethical Considerations

Informed consent was obtained from all respondents prior to participation, and the confidentiality of individual responses was maintained throughout the study.

RESULTS AND DISCUSSION

Demographic Characteristics of Respondents

Table 1 presents the demographic profile of respondents. Both study areas show a broadly balanced gender distribution -Yenagoa (54% male, 46% female) and Ahoada (56% male, 44% female) — suggesting fair representation of opinions across sexes. The predominant age group in both locations is 31–50 years (Yenagoa: 50%; Ahoada: 45%), implying active participation of the economically productive population, who are more likely to generate and manage household waste. Education levels are relatively high, with 45% of respondents in both cities having attained tertiary education, reflecting potential awareness of recycling and environmental issues. Households and small businesses constitute the main contributors to plastic waste (over 90% combined), underscoring the importance of domestic and commercial waste management policy.

Table 1: Demographic Characteristics of Respondents

Demographic Variable	Yenagoa (N=167)	Ahoada (N=167)
Gender — Male	54%	56%
Gender — Female	46%	44%
Age 18–30	30%	35%
Age 31–50	50%	45%
Age 51 and above	20%	20%
Education — Primary	15%	20%
Education — Secondary	40%	35%
Education — Tertiary	45%	45%
Occupation — Household	60%	65%
Occupation — Business	30%	25%
Occupation — Other	10%	10%

Plastic Waste Generation and Disposal Practices

Table 2 shows a marginal difference in daily plastic waste generation between the two cities: 2.5 kg per household in Yenagoa and 2.2 kg in Ahoada. Although waste volumes are comparable, disposal patterns differ slightly. Recycling is practised by 30% of Yenagoa residents and 25% of Ahoada residents, whereas landfilling remains the dominant disposal method in both (50% and 55%, respectively). Open burning persists at 20% in both locations, reflecting unsustainable disposal habits with potential health and environmental risks (Onwuka & Ajator, 2018). Similarly, Churchill and Ijaola (2022) found that plastic and nylon bags accounted for 20.38% by mass of the total waste stream generated in Yenagoa, with the share of plastic waste rising alongside garbage volumes owing to its predominant use in product packaging. The lower recycling rate in Ahoada suggests that infrastructural and institutional gaps hinder effective waste valorisation, indicating that while awareness of recycling may exist in both cities, behavioural and systemic constraints continue to limit its adoption.

Table 2: Plastic Waste Generation and Disposal Practices

Variable	Yenagoa (N=167)	Ahoada (N=167)
Average daily plastic waste (kg/household)	2.5	2.2
Disposal method — Recycling	30%	25%
Disposal method — Landfill	50%	55%
Disposal method — Burning	20%	20%

Recycling Infrastructure and Processes

Table 3 summarizes recycling infrastructure and processes in both cities. Yenagoa has a more organized waste collection system than Ahoada's semi-organized approach, a difference that corresponds with the greater number of sorting facilities and recycling plants recorded in Yenagoa. Yenagoa's developed end-product markets facilitate circular economy processes, enhancing material recovery and profitability, whereas Ahoada's emerging markets offer weaker economic incentives for recycling.

Table 3: Recycling Infrastructure and Processes

Aspect	Yenagoa	Ahoada
Collection system	Organized	Semi-organized
Sorting facilities	3	2
Recycling plants	2	1
End-product markets	Developed	Emerging

Efficiency and Effectiveness Indicators

Table 4 presents efficiency and effectiveness indicators. Yenagoa achieves a higher recycling rate (35%) and greater resource recovery (150 tons/month) than Ahoada (28% and 120 tons/month, respectively), while its environmental impact score is Moderate compared with Ahoada's High score. The 7-percentage-point difference in recycling rate and the 25% higher resource recovery in Yenagoa point to measurable benefits from investment in organized collection, sorting, and market linkages, consistent with urban sustainability models suggesting that integrated solid waste management (ISWM) systems yield higher recovery efficiency and reduced environmental footprints (World Bank, 2022).

Table 4: Efficiency and Effectiveness Indicators

Indicator	Yenagoa	Ahoada
Recycling rate (%)	35	28
Resource recovery (tons/month)	150	120
Environmental impact score	Moderate	High

Challenges and Barriers

Table 5 indicates that both cities face significant regulatory gaps and high financial constraints, implying that policy implementation is weak or inconsistent in both locations. Ahoada experiences greater technological limitations, reflected in its more limited recycling facilities and less efficient collection system. Socio-cultural factors remain a moderate challenge in both areas, underscoring the continued need for community sensitization to improve participation in recycling programmes. Taken together, these barriers suggest that policy effectiveness is determined not solely by the existence of a policy but by the operational capacity, enforcement, and stakeholder cooperation that accompany it.

Table 5: Challenges and Barriers

Challenge/Barrier	Yenagoa	Ahoada
Technological limitations	Moderate	High
Regulatory gaps	Significant	Significant
Financial constraints	High	High
Socio-cultural factors	Moderate	Moderate

Stakeholder Insights

Table 6 highlights institutional disparities between the two cities. In Yenagoa, government support is increasing, public awareness is improving, and private-sector involvement is growing a combination that promotes recycling performance. Ahoada, by contrast, reports limited government support, low public awareness, and only emerging private-sector participation, reflecting a weaker policy-to-practice translation. This indicates that multi-stakeholder collaboration is a key determinant of recycling effectiveness, and supports the inference that institutional and behavioural reinforcement mechanisms are critical for sustainable waste management.

Table 6: Stakeholder Insights

Insight	Yenagoa	Ahoada
Government support	Increasing	Limited
Public awareness	Improving	Needs improvement
Private-sector involvement	Growing	Emerging

Comparative Statistical Analysis of Performance Indicators

A comparative analysis of mean composite performance was conducted using the three indicators presented in Table 4—recycling rate, resource recovery, and environmental impact score—standardized to a common 0–100 scale (Figure 3). The descriptive means were 62.33 for Yenagoa and 50.33 for Ahoada, a 19.3% higher mean composite score for Yenagoa. A one-way analysis of variance (ANOVA) was conducted to test whether this difference was statistically significant, yielding $F(1, 4) = 0.044$, $p = .844$. At $\alpha = 0.05$, the p -value exceeds the significance threshold, indicating no statistically significant difference between the two cities on the composite indicators tested. The corresponding effect size, eta-squared ($\eta^2 \approx 0.011$, derived from the reported F -statistic), indicates that city accounted for approximately 1.1% of the variance in composite performance — a negligible effect by conventional benchmarks.

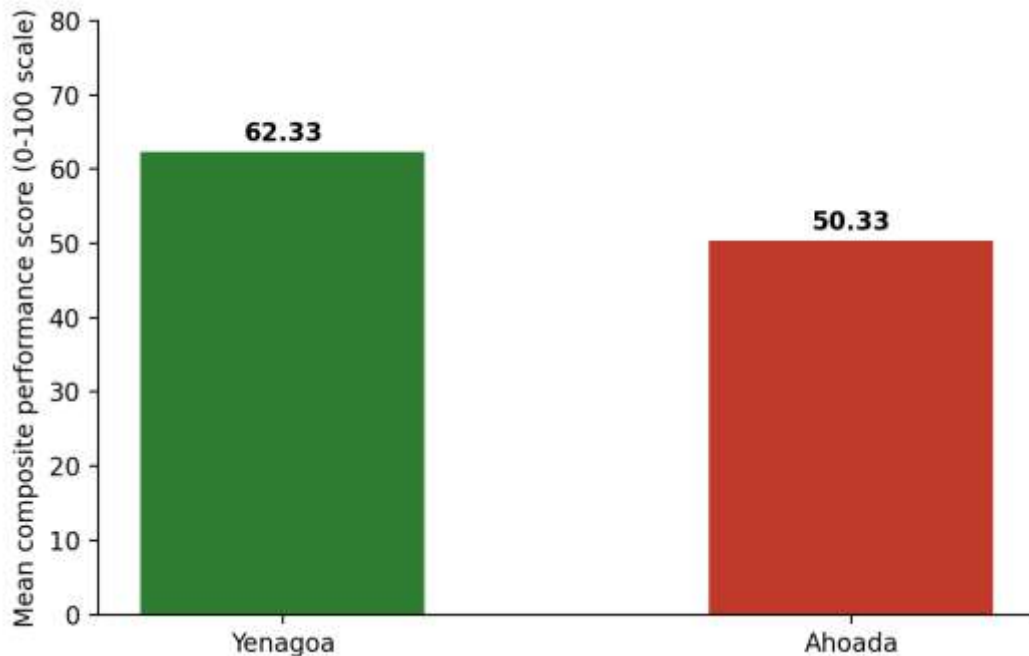


Figure 3: Mean composite performance score by city (recycling rate, resource recovery, and environmental impact score, standardized to a 0–100 scale).

This result should be interpreted with caution. The ANOVA was conducted on only three paired indicators per city—too small a sample to reliably test the normality and homogeneity-of-variance assumptions that underlie the F-test, and too small to detect all but very large effects. The non-significant result is therefore better read as a reflection of limited statistical power than as evidence that no real difference exists between the two cities; this limitation is acknowledged explicitly in the study's conclusions. Nevertheless, the practical (as opposed to statistical) significance of the observed gap remains evident: Yenagoa's more organized collection system, larger number of sorting and recycling facilities, and stronger stakeholder coordination correspond with tangible differences in recycling rate, resource recovery, and environmental impact, consistent with the view that policy implementation quality, rather than policy presence alone, determines recycling effectiveness (Stanley & Owor, 2018). This is consistent with Churchill and Ijaola (2022), who found that solid waste management in the Yenagoa metropolis was poorly organized, inefficient, and compromised by inadequate funding, weak regulatory and operational frameworks, poor public awareness and participation, and a lack of technical and technological capacity. Ogunlowo and Sopakirite (2022) similarly emphasized the importance of siting waste-recycling processing facilities close to waste-generating communities for effective solid waste management.

CONCLUSION AND RECOMMENDATIONS

This study compared the effectiveness of recycling policies and infrastructure in Yenagoa and Ahoada, two urban centres in Nigeria's Niger Delta region. The findings indicate that Yenagoa's more organized waste collection system, greater number of sorting and recycling facilities, and stronger stakeholder coordination correspond with a higher recycling rate (35% versus 28%), greater resource recovery (150 versus 120 tons/month), and a lower environmental impact score than Ahoada. Both cities, however, share broadly similar policy frameworks alongside high financial constraints and significant regulatory gaps, indicating that policy formulation alone does not account for the observed differences in outcomes.

These findings are consistent with the conceptual framework guiding this study: recycling effectiveness in both cities appears to be mediated more by infrastructural capacity, institutional coordination, and stakeholder participation than by the presence of policy instruments alone. The comparative statistical test conducted on composite performance indicators did not reach statistical significance, a result attributable to the small number of indicators available for testing rather than to an absence of a meaningful difference between the cities; this constitutes an important limitation of the present study and should be borne in mind when interpreting its conclusions.

On the basis of these findings, three recommendations are proposed. First, regulatory enforcement mechanisms should be strengthened in both cities, with particular attention to closing the gap between policy formulation and operational implementation. Second, infrastructural investment — particularly in sorting facilities, recycling plants, and end-product markets — should be

prioritized in Ahoada to narrow the infrastructural gap with Yenagoa. Third, public awareness and community engagement programmes should be expanded in both cities to improve household-level recycling participation. Future research should extend this comparative approach to a larger set of cities and a wider range of performance indicators, incorporate a longer-term time series of waste management data, and formally test the statistical assumptions underlying comparative analyses of this kind, in order to strengthen the evidence base for recycling policy in Nigeria's medium-sized urban centers.

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