A Framework for the Adoption of Waste Banking in Bauchi Metropolis, Nigeria

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ABSTRACT

Waste banking is a waste management system that incentivises the exchange of sorted recyclable waste for rewards in cash or kind, offering a promising circular-economy solution. However, its adoption remains largely undocumented in northern Nigeria. This study assesses the factors that influence the adoption of waste banking in Bauchi metropolis and proposes an evidence-based framework to support its implementation. A total of 400 households were surveyed using a structured questionnaire, and the data were analysed using descriptive statistics and binary logistic regression. Results show low awareness of waste banking (41%), despite strong positive perceptions of its environmental benefits (72%) and high willingness to participate in the system (71%). Regression analysis identifies eight significant predictors of adoption: awareness, educational level, environmental concern, income level, perceived monetary benefit, distance to collection centres, institutional trust, and prior knowledge of the informal scavenging system. Perceived monetary benefit emerged as the strongest predictor (OR = 4.67), followed by awareness (OR = 3.37) and environmental concern (OR = 2.59), indicating that both economic incentives and behavioural attitudes are central to household participation. On the contrary, distance to collection points negatively affected adoption, underscoring the need for decentralised, accessible facilities. Drawing on these findings, the study proposes a five-pillar adoption framework emphasising awareness creation, economic incentives, decentralised infrastructure, trust-building, and behavioural reinforcement. The study concludes that waste banking has significant potential to strengthen resource recovery and promote sustainable waste management in the Bauchi metropolis. Effective implementation of the proposed framework can accelerate the city's transition toward a circular and environmentally resilient urban economy.

Keywords: Waste Banking, Adoption, Framework, Waste, Management, Bauchi metropolis

Introduction

Municipal solid waste management (MSWM) has become one of the most pressing environmental challenges facing rapidly urbanising cities in developing countries. Nigeria's urban centres generate increasing amounts of household and commercial waste each year, while disposal systems have not expanded at a pace sufficient to keep pace with rising demand (Musa *et al.*, 2024). The result is the proliferation of open dumps, blocked drainage channels, and widespread environmental pollution, with significant implications for public health and urban sustainability (Muyiwa, 2023; Zhechen *et al.*, 2024). In northern Nigerian cities, the situation is further complicated by infrastructural deficits, limited funding for waste services, and weak enforcement of environmental regulations (Al-Wabel, 2022). These persistent challenges necessitate exploring innovative, community-oriented strategies for waste recovery and recycling.

One such strategy gaining attention globally is waste banking, an incentive-driven approach that encourages households to sort and deposit recyclable materials at designated collection points in exchange for monetary or non-monetary rewards. Waste banking aligns with circular economy principles by transforming waste into a resource and reducing the volume of material destined for landfills (Ferdoush *et al.*, 2024; World Bank, 2020). Countries such as Indonesia and Thailand have demonstrated that well-structured waste bank programmes can mobilise citizen participation, strengthen recycling industries, and contribute to local environmental improvement (Arumdani *et al.*, 2021). These international experiences highlight the potential of waste banking, yet its adaptation to the socio-cultural, institutional and economic realities of Nigerian cities remains limited.

In Nigeria, the adoption of formal recycling incentives at the household level is still in its infancy. Although scattered pilot initiatives exist, particularly within private-sector recycling firms and youth-led environmental organisations, research shows that awareness, accessibility, and institutional support remain critical barriers to adoption (Abila, 2018). Social factors, including household perceptions of waste, trust in collection systems, and willingness to participate in incentive-based programmes, also influence adoption outcomes (Charles, 2025; Nnaji, 2020). These contextual variations underline the need for location-specific frameworks that identify the determinants of participation and outline actionable steps for local implementation.

Bauchi metropolis, a fast-growing urban centre in north-eastern Nigeria, provides a compelling context for such inquiry. The city faces mounting waste management pressures driven by population growth, densification, and inadequate formal waste collection infrastructure (Usman, 2017). Preliminary assessments indicate a high volume of recyclable materials within household waste streams, but recovery rates remain very low due to limited sorting practices and the absence of structured recycling incentives (Duru *et al.*, 2019; Ciprian, 2015). Understanding the behavioural, socio-economic, and institutional drivers of waste banking adoption is indeed crucial for designing effective interventions that can support sustainable waste governance in the city.

In response to these needs, this study therefore develops an evidence-based framework for the adoption of waste banking in Bauchi metropolis. Using household survey data and logistic regression analysis, the study examines the factors influencing residents' willingness to participate in waste banking initiatives. The resulting framework integrates behavioural drivers, incentive mechanisms, institutional arrangements, and operational components suitable for the local context. Beyond contributing empirical insights to the growing scholarship on circular economy practices in Africa, the framework aims to guide policymakers, waste management agencies, community organisations, and private-sector actors in implementing scalable and community-responsive waste banking systems.

Literature Review

As rapid urbanization and changing consumption patterns push waste generation beyond the capacity of conventional collection and disposal systems, urban solid waste management has become an urgent policy and planning challenge in many developing countries (Kaza *et al.*, 2018; UN-Habitat, 2020). Studies consistently report that municipal services in such contexts are constrained by limited budgets, inadequate infrastructure, weak institutional coordination, and low public participation, which together lead to open dumping, burning, blocked drains, and health risks (Guerrero *et al.*, 2013; Ezeah & Roberts, 2012). The World Bank's "What a Waste 2.0 synthesis" underscores that these challenges are not only technical but also institutional and behavioural, requiring integrated solutions that recover value from wastes while engaging communities and markets (Kaza *et al.*, 2018). It is in this broader global and regional context that community-oriented and incentive-based approaches like waste banking have attracted attention in recent years.

Waste banking is a community-level model that treats sorted recyclables as a tradable "deposit" that households can exchange for cash, goods or credits. The idea has been widely implemented in Indonesia and

several other countries where community waste banks (Bank Sampah) combine local mobilisation, simple bookkeeping, and guaranteed offtake by recyclers to generate recycling streams and household income (Sembiring & Nitivattananon, 2010). Evaluations of these programs show they can raise source-separation rates, increase local recycling volumes, and stimulate small-scale entrepreneurship when well-integrated with local markets and supported by sustained awareness campaigns (Kirchherr *et al.,* 2017). However, existing literature has shown that the success of the system depends on multiple enablers: clear incentive mechanisms, accessible collection points, reliable market linkages for materials, and institutional arrangements that formalize roles and finance operations (Marshall & Farahbakhsh, 2013; United Nations Environment Programme [UNEP], 2018). Where these enablers are weak, waste banks may remain ineffective, informal, or unsustainable.

In sub-Saharan Africa, experiments related to buy-back centres, material recovery parks, and community recycling cooperatives provide mixed lessons for waste banking. Reviews of African experience emphasize the importance of integrating informal waste scavengers, securing stable offtake arrangements, and tailoring incentives to local socio-economic realities (Kabiga, 2025; Oguntoyinbo, 2012; Adewale, 2023). Studies of household recycling behaviour in some West African countries reveal consistent barriers, low awareness of recycling value, distance to collection points, and distrust of programme managers. Consequently, this limits participation even when incentives are offered (Nwosu, 2020; Olukanni & Akinyinka, 2018). These regional insights suggest that the transferability of the waste banking model cannot be assumed; successful adoption requires adaptation to specific institutional capacities, market structures, and cultural norms.

Focusing on Nigeria, empirical research documents a long-standing mismatch between waste generation and municipal management capacity. Ogwueleka (2009) and other related studies have shown that collection coverage is often low, landfilling standards are poor, and recycling remains dominated by informal pickers (waste scavengers), operating without legal recognition or social protection. Household studies indicate modest environmental awareness but inconsistent sorting practices, constrained by a lack of infrastructure and weak incentives (Adeniran *et al.,* 2017; Mu'azu *et al.,* 2023). While Nigeria hosts a dynamic informal recycling sector, there is little evidence of coordinated waste banking initiatives at the city scale. Instead, recycling tends to be fragmented, with limited integration into municipal planning or formal markets. This gap signifies

both a challenge and an opportunity. Waste banking could mobilize recyclables and livelihoods, but only if policymakers, the market, and social levers are aligned with local realities.

The adoption and diffusion of waste banking as an innovation is best understood through complementary theoretical lenses. A Theory of Planned Behaviour by Ajzen (1991) posits that behavioural intentions are shaped by attitudes, subjective norms, and perceived behavioural control. When applied to waste segregation, the theory highlights the role of individual beliefs about benefits and the social pressures, as well as the logistical capacity that enables actions. Empirical studies using the planned behaviour theory find that incentives and social norms strongly influence household recycling intentions (Nguyen *et al.,* 2016), suggesting that a waste banking framework must address both motivational and capability factors. More so, Diffusion of Innovations (DOI) theory further contributes by emphasizing how attributes of an innovation, relative advantage, compatibility, complexity, trialability, and observability, affect adoption rates across a community (Jürgen *et al.,* 2025). Waste banking offers a relative advantage when economic returns or convenience exceed existing practices, but only if the model is perceived as simple and observable at local scales.

Institutional perspectives are also crucial. Institutional theory underscores how regulations, professional standards, social expectations, and shared beliefs shape organizational behaviour (Scott, 2014). In many Nigerian cities, weak regulatory clarity, overlapping mandates, and limited budget predictability inhibit institutional strengthening, and formalization of roles for municipal agencies, NGOs, and private recyclers is therefore a prerequisite for scaling waste banks. Finally, Stakeholder theory draws attention to the network of actors, like households, informal collectors, private recyclers, NGOs, and municipal bodies, whose divergent interests must be aligned through governance mechanisms, benefit-sharing arrangements, and transparent management (Ritika *et al,* 2023; Ostrom, 1990; Freeman, 1984). Studies of multi-stakeholder initiatives in waste emphasize that inclusion and fair incentive distribution increase local legitimacy and operational stability.

Empirical literature identifies common barriers and enablers that inform a practical framework. Barriers include a lack of awareness, weak enforcement, insufficient collection infrastructure, the absence of stable markets for recyclables, and social distrust. The factors are repeatedly documented across African and Asian contexts (Guerrero *et al.,* 2013; Nwosu, 2020). The enablers include clear incentive mechanisms in cash and kind, decentralized and accessible collection nodes,

participatory governance structures, integration of informal actors, and market development strategies that secure buyer commitments (Marshall & Farahbakhsh, 2013; Kaza *et al.*, 2018). Technology and simple digital tools like SMS-based credit notifications or mobile wallets have been shown to improve transparency and participation in some settings; however, they need to be customized for local literacy and connectivity constraints (Sakai *et al.*, 2020).

Despite the insights mentioned above, knowledge gaps remain in the literature. For instance, there is limited empirical evidence on how the combined influence of behavioural intentions, institutional capacities, and market mechanisms operates in northern Nigerian cities specifically; regional social norms, governance structures, and market dynamics may differ from better-studied contexts. Secondly, most evaluations of waste bank programs focus on operational outcomes (volumes collected or income generated), but less frequently examine the policy and governance pathways necessary for city-level scaling and integration with municipal services. Thirdly, few studies have produced an actionable multi-stakeholder adoption framework that explicitly maps incentive designs, institutional roles, and phased implementation pathways calibrated to the constraints of Nigerian cities. Addressing these gaps, the research develops a framework for the Bauchi metropolis that articulates the behavioural, institutional, infrastructural, and market levers required for feasible and scalable adoption of waste banking.

Aim and Objectives of the Study

The study is aimed at assessing the prospects of adopting waste banking in Bauchi metropolis, Nigeria, with a view to developing a framework for its effective implementation. The aim was achieved through the following objectives;

a) To assess the level of waste banking awareness of households in Bauchi metropolis;

b) To examine the factors that may influence household adoption of waste banking in Bauchi metropolis;

c) To analyse the willingness of households in Bauchi metropolis to adopt wasting banking;

d) To develop a framework that outlines strategies for the adoption of waste banking in Bauchi metropolis.

Methodology

Study Area

Bauchi metropolis is the headquarters of Bauchi Local Government Area (LGA) and Bauchi State, Nigeria. The metropolis is located between longitude 9.716263^0E & 9.927408^0E and latitude 10.284918^0N & 10.297406^0N (as shown on Figure 1). The landmass of the metropolis is about $156.938 km^2$ (Ministry of Land and Survey Bauchi, 2025). The area is made up of a traditional city in the core, as well as the surrounding neighbourhoods, satellite communities, and farmlands. The metropolis stretches between Giwo Science Academy in the North, Bauchi main urban graveyard in the East, and Gudum settlement to the West (Yahaya *et al.*, 2023)

According to the 2006 Population and Housing Census (PHC), the population of the metropolis was 345,667 as of 2006. When projected to 2025, the population stands at 739,132 at a 4.0% growth rate (National Population Commission [NPC], 2025). Although a chunk of the inhabitants are civil servants and business individuals, the majority engage in farming activities. The metropolis experiences rapid population growth, rising solid waste generation, and limited waste recovery infrastructure. Waste management is primarily coordinated by the Bauchi State Environmental Protection Agency (BASEPA), with informal waste pickers playing a significant supplementary role in collecting recyclable wastes. The city's socio-economic diversity makes it suitable for investigating the potential adoption of waste banking.

Research Design

The study employed a mixed-methods design, integrating quantitative and qualitative approaches to develop a robust framework for the adoption of waste banking in Bauchi metropolis. The quantitative aspects involved the measurement of awareness, attitudes, behavioural intentions, and the enabling factors influencing adoption, while the qualitative component offered in-depth insights into institutional dynamics, community perceptions, and operational barriers. This complementary approach supports triangulation and improves the internal validity of the findings (Qassimi, 2023). The design aligns with existing sustainability and behavioural adoption studies that combine surveys with interviews to capture both individual-level and contextual determinants (Research Studies Press, 2025).

Target Population and Sampling Size

The target population comprised Household residents of Bauchi metropolis for the quantitative survey. For the qualitative interviews, key institutional stakeholders, who are made up of government officials (BASEPA), private waste collectors, environmental NGOs, and community leaders, constituted the population. However, to carry out a proper Focus Group Discussion (FGD) in the study, representatives of resident groups from all the neighbourhood groups were considered in

the study area. Applying the Yamane (1967) formula for estimating the sample size (as shown in Equation 1), a sample size of 400 was obtained.

$$n = \frac{N}{1 + Ne^2} \qquad (1)$$

Where:

n = Sample size

N = 739,132 (the 2025 projected population of the study area)

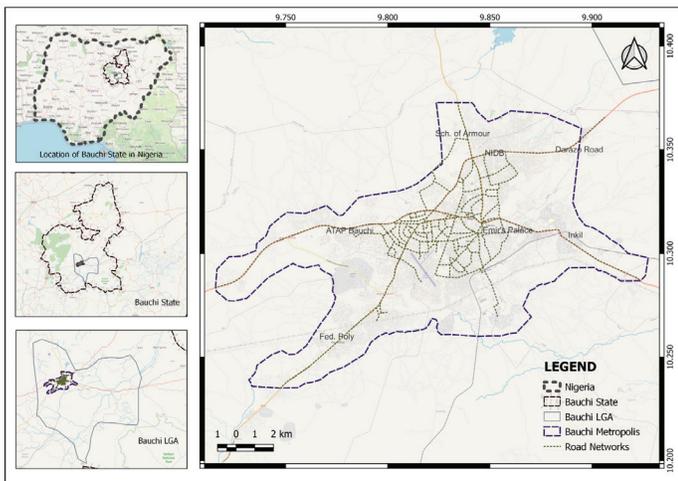e = (5% acceptable margin of error)

Figure 1: The Study Area

Source: Ministry of Land and Survey Bauchi (2025)

Sampling Technique

A proportionate stratified sampling technique was employed, which involves using the clearly defined administrative wards within the metropolis and randomly selecting households in each ward based on the percentage of its population (see Table 1 and Figure 2). Purposive sampling of stakeholders was carried out for interviews and FGDs based on their relevance to waste management systems.

Table 1: Sample Size

S/N	Wards	Pop. /Ward	Percentage	Sample size
1	Majidadi A	81,305	11%	44
2	Majidadi B	105,652	14%	56
3	Dan-Iya	116,122	16%	64
4	Dankade	66,522	9%	36
5	Dawaki	118,152	16%	64
6	Tirwun	59,131	8%	32
7	Miri	98,196	13%	52
8	Makama	94,052	13%	52
	TOTAL	**739,132**	100.00%	**400**

Source: Author (2025)

Methods of Data Collection

Questionnaire Survey

A structured, close-ended questionnaire was administered to households within Bauchi metropolis (according to the proportion per ward shown on Table 1) to collect data on socio-economic characteristics, awareness and knowledge of waste banking, perceived benefits and barriers, enabling factors (like policy, incentives, accessibility), as well as willingness to participate in the waste banking system. The questionnaire employed is made up of 5-point Likert scales and nominal categories. 400 copies of the questionnaire were distributed, and only 384 were retrieved and used for the analysis.
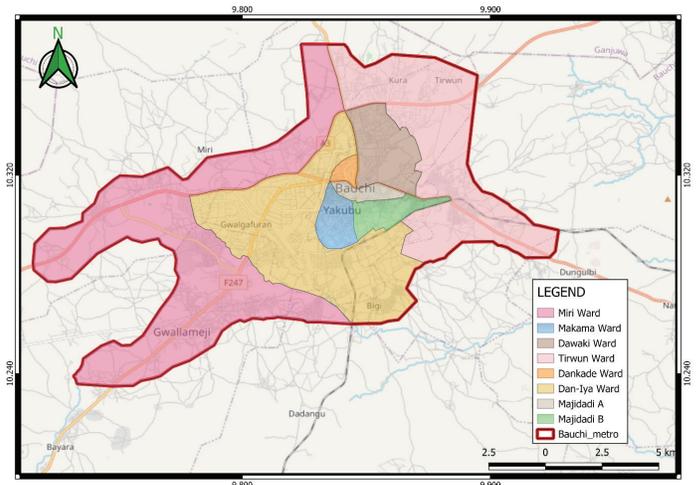

Figure 2: Administrative Wards in Bauchi Metropolis

Interviews and Focus Group Discussion

Semi-structured interviews were conducted with BASEPA officials, private waste contractors, environmental NGOs, the community, and religious leaders. The key informant interviews explored institutional readiness, regulatory frameworks, potential incentives, cultural influences, and logistical challenges. The Focus Group Discussion (FGD) was conducted with a few residents mobilized by community leaders to examine communal attitudes, behavioural norms, and social influences affecting the probability of waste banking adoption in the study area. The FGD consisted of 8 participants.

Research Instruments and Validation

Three instruments were used, namely: the Household questionnaire, the Interview guide, and the FGD guide.

All the instruments were validated through expert review and pilot testing with 20 residents. Content and construct validity were carried out to ensure the optimum quality of the data collected. Experts in urban environmental planning and waste management assessed the instruments for relevance, clarity, and measurement of theoretical constructs using theories of planned behaviour and innovation diffusion. Internal consistency was assessed using Cronbach's Alpha, resulting in a coefficient of 0.78 across the key scales, which is an acceptable reliability (Nunnally, 1978).

Methods of Data Analysis

To achieve the set objectives, qualitative and quantitative methods of data analysis were applied. Descriptive statistics, correlation analysis, and binary logistic regression techniques were used for the quantitative analyses in SPSS. The dependent variable was the adoption of waste banking by the Bauchi community (1 =

willing to adopt, 0 = unwilling). Whereas, the independent variables include: awareness level, perceived benefits, behavioural attitudes, socio-economic characteristics, and proximity to facilities. As shown in equation 1, the logistic regression was used to model the relationship between the dependent variable and the independent variables. The estimate was obtained using a Maximum Likelihood Estimation (MLE). Table 2 presents the variables used in the Logistic Regression model.

$$\left(\frac{P(Y=1)}{1-P(Y=1)}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k + \in \qquad (1)$$

Where:

P(Y = 1) = probability of adopting waste banking

$X_1 \ldots X_k$ = predictors

β_0 = intercept

β_k = coefficients

Table 2: Logistic Regression Variables

Variable	Denotations	Description	Data Type
Adoption	Y_1	Willingness to adopt WB	Nominal
Awareness	X_1	Knowledge of WB	Nominal
institutional trust	X_2	Trust in the System (Government/NGO)	Nominal
Incentive	X_3	Expectation of Reward	Nominal
Distance	X_4	Accessibility to WB Points	Nominal
Education	X_5	Educational Level	Ordinal
Income	X_6	Monthly Income	Ordinal
Environmental concern	X_7	Environmental concern	Nominal
Prior exposure to recycling	X_8	Prior knowledge of the informal scavenging system	Nominal

Source: Author (2025)

A thematic content analysis was used to synthesize the data obtained through the interviews and FGD transcripts. The data was coded into thematic clusters: institutional capacity, socio-cultural influences, operational barriers, incentives and motivational factors, as well as community expectations. NVivo-assisted coding was used to enhance trustworthiness and ensure systematic organization of themes.

The study followed ethical principles of voluntary participation, informed consent, confidentiality, and anonymity. Respondents were informed that data would be used solely for academic purposes, and participation could be withdrawn at any stage.

Results and Discussion

The survey of existing points of sale (PoS) for recyclable solid wastes in Bauchi metropolis revealed 47 locations across the area (as shown in Figure 3). Most of the PoS are concentrated in the center of the metropolis, even though about 15 are scattered along the fringes.

Analysis of the data collected involves descriptive statistics and binary logistic regression to examine the socioeconomic, behavioural, and infrastructural determinants shaping households' readiness to participate in waste banking initiatives within Bauchi metropolis. The results are subsequently discussed in the context of contemporary literature on sustainable solid waste management and behavioural adoption models.

The socio-economic profile of the 384 respondents indicates a youthful and relatively educated population, with 38.5% aged 18–30 years, 44.8% aged 31–45 years, and 16.7% above 45 years. Slightly more males (54.2%) participated compared to females (45.8%). A significant proportion (61.4%) possessed tertiary education, reflecting a population capable of understanding and engaging with innovative waste management practices. However, awareness of waste banking remained low at 41%, even though 63% of respondents believed that waste possesses monetary value and 72% agreed that waste banking could improve environmental quality. Notably, 71% expressed willingness to register with a waste bank if the system becomes operational. These descriptive findings suggest that while awareness is limited, the attitudinal background is favourable for adoption, implying that targeted sensitisation and structured incentives could quickly enhance participation.
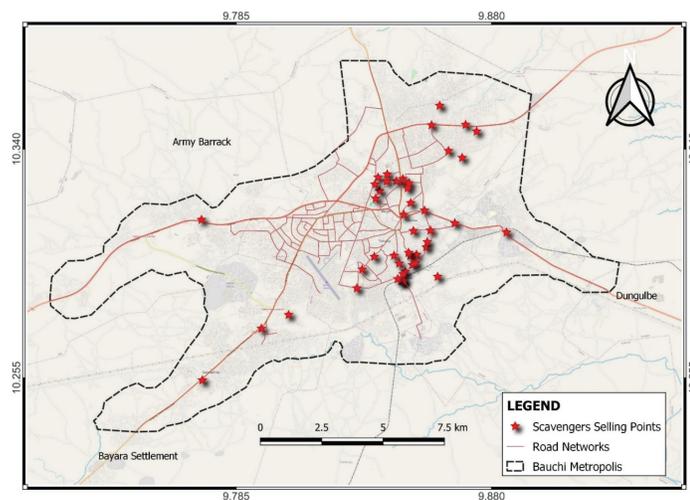

Figure 3: Scavengers Selling Points in the Study Area

Source: BASEPA (2025)

To statistically determine factors influencing the likelihood of adopting waste banking in Bauchi metropolis, a binary logistic regression model was employed. The dependent variable was the intention to adopt waste banking, coded as 1 for "adopt" and 0 for "not adopt." Independent variables included awareness of waste banking, educational level, income level, environmental concern, perceived monetary benefit, distance to collection centres, trust in institutions, and prior exposure to recycling activities. The model demonstrated a good overall fit, with a Chi-square value of 78.42 ($p < 0.001$), a Nagelkerke R^2 of 0.41, and a classification accuracy of 78.6%. These indicators confirm that the selected variables significantly explain variations in adoption behaviour within the study area.

The regression results reveal the statistically significant predictors of waste banking adoption among the explanatory variables in the study area. Awareness of waste banking was a strong positive determinant ($p < 0.001$), with individuals who had prior knowledge being 3.37 times more likely to adopt the system than those unaware of it. This mirrors findings from Indonesia, Thailand, and parts of East Africa, where awareness campaigns significantly improved participation in community-based recycling systems. Education also positively influenced adoption, indicating that individuals with higher educational attainment appreciate the environmental and economic relevance of innovative waste initiatives better. In the same vain, income level also increased the likelihood of adoption, although having a moderate effect size. Higher-income households were found to be more capable of organising their waste, investing in storage, or participating in structured recycling systems.

Table 2: Results for the Factors Influencing Adoption of Waste Banking in Bauchi metropolis

S/N	Predictor Variable	B	SE	Wald	Sig. (p-value)	Odds Ratio (Exp(B))
1	Awareness of waste banking	1.214	0.312	15.12	0.000	3.37
2	Educational level	0.682	0.245	7.76	0.005	1.98
3	Income level	0.419	0.181	5.36	0.021	1.52
4	Environmental concern	0.953	0.301	10.02	0.002	2.59
5	Perceived monetary benefit	1.541	0.354	18.97	0.000	4.67
6	Distance to the collection centre	-0.736	0.227	10.58	0.001	0.48
7	Trust in the system (government/ NGO)	0.527	0.214	6.09	0.014	1.69
8	Prior exposure to recycling	0.418	0.192	4.73	0.030	1.52
	Constant	-2.317	0.534	18.78	0.000	—

Source: Author (2025)

Environmental concern emerged as a strong predictor (OR = 2.59), implying that individuals who care about environmental quality are more receptive to waste banking as a strategy for reducing pollution and improving neighbourhood cleanliness. The most influential predictor was found to be the perceived monetary benefit, having an odds ratio of 4.67. Respondents who believed that waste has financial value were almost five times more likely to adopt waste banking. This result underscores the dominance of livelihood motivations in urban informal recycling dynamics, especially in the common Nigerian cities like Bauchi. It aligns with behavioural theories, such as the Theory of Planned Behaviour, which emphasise perceived benefits as central to behavioural intentions.

Distance to collection centres had a significant negative effect, suggesting that increased walking distance reduces the likelihood of adoption. This emphasizes the need for decentralised waste bank nodes within short walking distances of residential neighbourhoods. Trust in institutions also played an important role, indicating that past failures of municipal waste services or lack of transparency may discourage residents from participating in new initiatives without credible assurances. Finally, prior exposure to recycling activities positively influenced adoption, supporting the notion that experience shapes environmental behaviour. Individuals who had previously engaged in any recycling-related activity were 1.52 times more likely to adopt waste banking.

Overall, these findings indicate that the adoption of waste banking in Bauchi metropolis is shaped by a combination of awareness, perceived benefits, socio-economic status, environmental concerns, infrastructural convenience, and institutional credibility. The results strongly support the need for a comprehensive adoption of a framework that integrates sensitisation campaigns, economic incentives, decentralised collection points, trust-building mechanisms, and sustained behavioural reinforcement. Such a framework would not only drive participation but also ensure long-term sustainability of waste banking as a component of circular economy strategies in Nigerian urban centres.

Conclusion and Recommendations

In conclusion, the study assessed the determinants of waste banking adoption in Bauchi metropolis and proposed a framework to guide its effective implementation. Results from descriptive analysis revealed that, while awareness of waste banking was relatively low, residents hold strong positive perceptions regarding the environmental and economic value of waste recovery. Despite limited knowledge of the waste bank, the high willingness among households to participate suggests a favourable foundation for introducing waste banking as part of the broader strategy for managing solid waste in Nigerian cities.

The logistic regression model identified several statistically significant predictors of adoption, namely awareness of waste banking, educational level, income status, environmental concern, perceived monetary benefit, proximity to collection centres, institutional trust, and previous exposure to recycling activities. Among these variables, perceived monetary benefit emerged as the strongest driver, underscoring the critical role of economic incentives in motivating behavioural change in Nigerian urban contexts. Awareness and environmental concerns were also influential, underscoring the importance of disseminating information and reinforcing pro-environmental attitudes.

Conversely, long distances to waste collection points and low institutional trust were key barriers, suggesting structural and governance constraints that must be addressed to sustain participation. Overall, the findings demonstrate that the adoption of waste banking in Bauchi metropolis is shaped by a combination of behavioural, socio-economic, institutional, and infrastructural factors. The proposed adoption framework, anchored on awareness creation, economic incentives, decentralised accessibility, trust-building, and behavioural reinforcement, is therefore well aligned with the realities of the study area. Implementing this framework has the potential to enhance resource recovery, reduce environmental degradation, and contribute to a functional circular economy within the city.

With strong public support, the presence of recycling markets, and growing environmental concerns, Bauchi metropolis is well-positioned to adopt waste banking as an innovative circular-economy solution. As presented in Figure 4, the successful implementation of the recommended framework will not only reduce waste disposal challenges but also generate economic opportunities, promote environmental sustainability, and strengthen urban resilience

Figure 4: Framework for the Adoption of Waste Banking in Bauchi Metropolis

The Arrows from each pillar point toward the household adoption to indicate that all five pillars collectively influence household adoption. Whereas, the small arrows from the household adoption back to the pillars indicate learning and positive reinforcement over time. Based on the findings and the conceptualized framework, the following recommendations are proposed to support effective adoption of waste banking in Bauchi metropolis:

Intensify Awareness and Environmental Education Campaigns: Low awareness emerged as a major barrier. Thus, targeted sensitisation programmes should be implemented through community meetings, radio jingles, social media, schools, and religious institutions. Demonstration projects and educational materials should clearly illustrate how waste banking works, its benefits and how households can participate.

Provide Strong Economic Incentives to Encourage Participation: Given the strong influence of perceived monetary benefit, waste banks should offer clear and competitive financial rewards. Incentives may include cash payments, digital credit systems, utility bill discounts, or redeemable points. Partnerships with recycling industries can help guarantee consistent pricing and sustainable operations.

Establish Decentralised Waste Bank Collection Points: Distance significantly reduces the likelihood of adoption. Therefore, multiple neighbourhood-level waste bank kiosks should be established across Bauchi metropolis. These should be located within walkable distances and strategically positioned in high-density residential districts. Mobile waste-bank vehicles can complement the fixed centres and serve peripheral areas.

Strengthen Institutional Trust and Governance: Transparent management practices are essential to build confidence. Waste bank operators in Bauchi should adopt clear guidelines for weighing, pricing, recordkeeping, payout schedules, and customer communication.

Government agencies must also create enabling policies, support private operators, and ensure oversight to maintain accountability.

Integrate Waste Banking into Existing Waste Management Systems: Waste banking should not operate in isolation. It should be linked to the city's current waste collection routes, sanitation units, and recycling industries (within and outside the metropolis). Collaboration among the relevant government agencies, local entrepreneurs, NGOs, community-based organisations and the union of scavengers can improve efficiency and scale-up potential.

Promote Behavioural Reinforcement and Community Engagement: Long-term participation requires continuous behavioural reinforcement. This can be achieved through community competitions, reward programmes, capacity-building workshops, and school-based recycling clubs. Engaging women's groups, youth associations, and traditional leaders will further strengthen community ownership.

Implement Pilot Projects Before Large-Scale Rollout: Pilot waste banks should be established in selected neighbourhoods across the metropolis by BASEPA or any agency that might be saddled with the responsibility for implementation to test the operational model, refine incentive structures, and assess community response. Lessons from the pilot phase can then be used to design an efficient city-wide model.

Support Research, Monitoring, and Evaluation: Continuous data collection and periodic evaluation are crucial for understanding participation patterns and improving service delivery. Further studies should explore the environmental and economic impacts of waste banking, its scalability, integration with GIS-based site suitability analysis, and the role of digital tools in improving user engagement.

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