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Construction Waste Management Practices and Contributing Factors in the Building Industry in North-West Nigeria

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ABSTRACT

This study assessed construction waste management practices and identified the key factors contributing to construction waste generation in the building industry in North-West Nigeria. A mixed-method explanatory sequential design was adopted, integrating quantitative survey data with qualitative interview findings. A structured questionnaire validated and pilot-tested (Cronbach's alpha = 0.85) was administered to 232 respondents comprising 165 registered builders, 39 waste management experts, and 28 regulatory officials across the seven states of the zone, selected through stratified random sampling. A semi-structured interview protocol was administered to 67 purposively selected participants in the qualitative phase. Quantitative data were analysed using mean, standard deviation, and one-way ANOVA, while qualitative data were analysed thematically using NVivo 15, with triangulation employed to validate and deepen the quantitative findings. Results showed that construction waste management practices across all eight dimensions of the waste management cycle were inadequate, with an overall grand mean of 2.78 (SD = 0.84). Qualitative themes confirmed informal disposal, absent recycling activity, and weak regulatory enforcement as the dominant practice characteristics. All ten leading waste generation factors were strongly agreed upon, with demolition rework (mean = 4.55), inaccurate material estimation (mean = 4.53), and poor material handling (mean = 4.52) as the most critical. Qualitative data further confirmed poor site management and procurement inaccuracies as the most persistently cited generation drivers. Significant inter-group differences were established on both waste management practices (F = 8.204, p = .000) and waste generation factors (F = 6.813, p = .001). The study recommends mandatory site waste management planning and targeted professional capacity building as immediate priorities.

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INTRODUCTION

The construction industry is among the largest contributors to solid waste generation globally, with construction and demolition waste accounting for between 25% and 40% of total waste streams in most countries (Dawood *et al*., 2021). In Nigeria, the building industry generates an estimated three million tonnes of construction waste annually, of which the North-West geopolitical zone comprising Kano, Kaduna, Katsina, Jigawa, Sokoto, Zamfara, and Kebbi States contributes approximately 22.75%, equivalent to over 682,500 tonnes per year (Chukwumaobi, 2025). Despite this substantial volume, the management of construction waste in the region remains largely informal, poorly regulated, and structurally deficient (Yohanna *et al*., 2023; Ogunmakinde *et al*., 2022).

Research on construction waste management practices and their determinants has

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grown considerably within the Nigerian literature, with documented studies from Lagos (Ogunmakinde *et al*., 2022; Bayewun *et al*., 2023), Kaduna (Yohanna *et al*., 2023), and Rivers State (Otali & Adewuyi, 2025). However, the North-West geopolitical zone remains severely underrepresented in the empirical literature. No previous study has simultaneously and comprehensively assessed current waste management practices across the full waste management cycle and identified the key factors driving waste generation across all seven states of the region. This gap in the evidence base constrains the development of targeted policy, regulatory, and professional interventions in a zone where the consequences of unchecked waste mismanagement are particularly acute.

The absence of structured waste management systems in the region is further compounded by weak inter-agency regulatory coordination, limited investment in waste collection and recycling infrastructure, and inadequate professional training in waste management obligations among construction practitioners. Open burning and illegal dumping remain the dominant waste disposal methods, posing direct risks to soil quality, groundwater safety, air quality, and public health across urban and peri-urban communities in the zone. Addressing these conditions requires, as a prerequisite, a comprehensive empirical assessment of the current state of waste management practice and the factors that drive waste generation in the region.

STATEMENT OF THE PROBLEM

Construction waste management in North-West Nigeria is characterised by a persistent pattern of institutional failure, operational informality, and environmental harm. Field assessments across the zone consistently document the predominance of open burning and illegal dumping as primary disposal methods, the near-total absence of recycling and reuse practices, chronic non-enforcement of the regulatory provisions contained in the National Environmental Standards and Regulations Enforcement Agency (NESREA) Act and State Environmental Protection legislation, and a severe deficit of recycling infrastructure, designated waste storage facilities, and licensed collection systems (Yohanna *et al*., 2023; Bayewun *et al*., 2023; Ogunmakinde *et al*., 2022). These conditions generate direct environmental consequences including soil and groundwater contamination, air pollution, and public health hazards alongside substantial economic costs from lost material value and excessive project expenditure attributable to material waste.

The factors driving waste generation in the region are multi-dimensional, spanning design accuracy, procurement planning, site management competence, material handling practices, and regulatory enforcement effectiveness. However, no comprehensive, empirically validated account of the specific factors most critical to waste generation in the North-West building industry context has previously been produced. Equally, no systematic assessment of current waste management practices across the full eight-stage waste management cycle has been conducted across the region. This dual empirical gap, covering both the characterisation of current practice and the identification of generation factors, constitutes the specific problem that this study addresses.

Aim and Objectives of the Study

The aim of the study is to assess construction waste management practices and identify the key factors contributing to construction waste generation in the building industry in North-West Nigeria. Specifically, the study seeks to:

1. Assess construction waste management practices in the building industry in North-West Nigeria.
2. Identify the key factors contributing to construction waste generation in the building industry in North-West Nigeria.

Research Questions

The following research questions guided the study:

1. What are the construction waste management practices in the building industry in North-West Nigeria?

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2. What are the key factors contributing to construction waste generation in the building industry in North-West Nigeria?

Hypotheses

The following null hypotheses were tested at the 0.05 level of significance:

H01: There is no significant difference in the mean responses of registered builders, waste management experts, and waste regulatory officials on construction waste management practices in the building industry in North-West Nigeria.

H02: There is no significant difference in the mean responses of registered builders, waste management experts, and waste regulatory officials on the key factors contributing to construction waste generation in the building industry in North-West Nigeria.

METHODOLOGY

A mixed-method explanatory sequential design was adopted (Creswell & Creswell, 2018), in which quantitative data were collected and analysed first, with qualitative data subsequently gathered to deepen and explain the quantitative findings. The study was conducted across all seven states of the North-West geopolitical zone of Nigeria. The target population comprised 354 respondents: 287 registered builders from the Nigerian Institute of Building (NIOB), 39 waste management experts from the Federal Ministry of Environment, and 28 regulatory officials from the National Environmental Standards and Regulations Enforcement Agency (NESREA).

A sample of 232 respondents was selected using stratified random sampling based on Krejcie and Morgan's (1970) sample size table, 165 registered builders drawn proportionally across the seven states, with all 39 experts and all 28 regulatory officials included in full given their small population size and specialised relevance. For the qualitative phase, 67 participants were purposively selected across the three groups to ensure diversity of institutional affiliation and professional experience. Data were collected using two instruments: the Development of Waste Management Framework Questionnaire (DWMFQ), a 56-item structured questionnaire rated on a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree), and a Semi-Structured Interview Protocol (SSIP) comprising seven open-ended items designed to elicit contextual explanations of waste management conditions and generation factors from participants' professional experience.

Face validity of both instruments was confirmed by five subject matter experts. Pilot testing of the DWMFQ in Bauchi State (n = 20) yielded a Cronbach's alpha of 0.85, indicating adequate reliability. The hand delivery method was employed for questionnaire administration with the assistance of seven trained state-level research assistants, achieving a 100% response rate. Quantitative data were analysed using mean, standard deviation, and one-way ANOVA in SPSS Version 27, with a decision rule of 3.41 to 5.00 = Agreed, 2.61 to 3.40 = Undecided, and 1.00 to 2.60 = Disagreed. Qualitative data from the SSIP were transcribed, coded, and analysed thematically using NVivo 15, with themes reported alongside the quantitative findings as triangulating evidence to ensure convergent validity and enrich interpretation.

RESULTS

Research Question One

What are the construction waste management practices in the building industry in North-West Nigeria? Results for answering research question one are presented in Table 1.

Table 1: Mean Ratings of Construction Waste Management Practices in the Building Industry in North-West Nigeria

S/N	Waste Management Dimension	Grand Mean	SD	Decision
1	Waste Generation	2.56	0.85	Disagreed
2	Waste Collection	2.87	0.83	Undecided
3	Waste Segregation	2.78	0.82	Undecided

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S/N	Waste Management Dimension	Grand Mean	SD	Decision
4	Waste Storage	2.67	0.84	Undecided
5	Waste Transportation	2.74	0.83	Undecided
6	Waste Recycling	2.15	0.92	Disagreed
7	Waste Reuse	2.24	0.91	Disagreed
8	Waste Disposal	2.69	0.83	Undecided
	Overall Grand Mean	**2.78**	**0.84**	**Undecided**

Source: Field Survey (2024). n = 232. Decision rule: 3.41 to 5.00 = Agreed; 2.61 to 3.40 = Undecided; 1.00 to 2.60 = Disagreed.

Table 1 shows that the overall grand mean of 2.78 (SD = 0.84) falls within the undecided range, indicating that construction waste management practices across the full waste management cycle are generally inadequate in the building industry in North-West Nigeria. Waste recycling (GM = 2.15) and waste reuse (GM = 2.24) recorded the lowest means, both falling in the disagreed range and confirming the near-total absence of resource recovery practices on construction sites in the region. Waste generation (GM = 2.56) was also in the disagreed range, while waste collection (GM = 2.87), waste segregation (GM = 2.78), waste storage (GM = 2.67), waste transportation (GM = 2.74), and waste disposal (GM = 2.69) all fell in the undecided range, indicating that respondents could neither affirm nor deny the existence of structured practices across these dimensions.

Qualitative Findings for Research Question One

Thematic analysis of interview responses from the 67 participants produced five themes that triangulated and deepened the quantitative findings, as presented in Table 2.

Table 2: Thematic Summary of Construction Waste Management Practices in North-West Nigeria (n = 67)

Theme	Frequency	Percentage	Implication
Predominantly informal and unregulated waste disposal	65	97.0%	Absence of formalised disposal systems across all sites
Minimal recycling and reuse activity	62	92.5%	Near-total absence of resource recovery infrastructure
Inadequate regulatory enforcement	60	89.6%	Regulatory non-enforcement is a systemic characteristic
Limited worker training on waste management	57	85.1%	Human capital gaps are widespread
High reliance on open burning and illegal dumping	54	80.6%	Informal disposal methods are entrenched

Source: Field Interview (2024). n = 67.

Table 2 shows that 97.0% of participants confirmed that disposal arrangements on construction sites in the region are predominantly informal and unregulated, while 92.5% affirmed the near-total absence of recycling and reuse activity. One regulatory official stated that most construction sites dump waste wherever is convenient without any system or designated site. A waste management expert noted that burning is the most common disposal method as it is fast, cheap, and unchallenged by any authority. These qualitative responses corroborate the quantitative finding that recycling and reuse recorded the lowest practice means and confirm that the undecided and disagreed ratings in Table 1 reflect a genuine absence of structured waste management arrangements rather than lack of respondent knowledge.

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Research Question Two

What are the key factors contributing to construction waste generation in the building industry in North-West Nigeria?

Results for answering research question two are presented in Table 3.

Table 3: Mean Ratings of Key Factors Contributing to Construction Waste Generation in the Building Industry in North-West Nigeria

S/N	Factor	Mean	SD	Decision
1	Demolition and rework due to construction errors	4.55	0.53	Strongly Agreed
2	Inaccurate material estimation	4.53	0.54	Strongly Agreed
3	Poor handling and storage of materials on site	4.52	0.54	Strongly Agreed
4	Lack of enforcement of waste regulations	4.51	0.55	Strongly Agreed
5	Use of low-quality materials leading to rejection	4.49	0.56	Strongly Agreed
6	Poor site management and supervision	4.49	0.56	Strongly Agreed
7	Lack of awareness of waste management practices	4.48	0.56	Strongly Agreed
8	Time pressure and tight project schedules	4.47	0.57	Strongly Agreed
9	Design changes during construction	4.46	0.57	Strongly Agreed
10	Absence of recycling or reuse practices on site	4.46	0.57	Strongly Agreed
	Overall Grand Mean	4.44	0.58	Strongly Agreed

Source: Field Survey (2024). n = 232.

Table 3 shows that all ten identified factors were strongly agreed upon as significant contributors to construction waste generation, with an overall grand mean of 4.44 (SD = 0.58). Demolition and rework due to construction errors ranked first (mean = 4.55), followed by inaccurate material estimation (mean = 4.53) and poor handling and storage of materials on site (mean = 4.52). Lack of enforcement of waste regulations ranked fourth (mean = 4.51), indicating that respondents perceive regulatory failure as a direct driver of waste generation. The remaining six factors, comprising use of low-quality materials (mean = 4.49), poor site management and supervision (mean = 4.49), lack of awareness (mean = 4.48), time pressure and tight project schedules (mean = 4.47), design changes during construction (mean = 4.46), and absence of recycling or reuse practices (mean = 4.46), were all equally strongly agreed upon across the three respondent groups.

Qualitative Findings for Research Question Two

Thematic analysis of interview responses on waste generation factors produced five themes presented in Table 4.

Table 4: Thematic Summary of Key Factors Contributing to Construction Waste Generation in North-West Nigeria (n = 67)

Theme	Frequency	Percentage	Implication
Poor site management and supervision	60	89.6%	Weak on-site oversight directly enables avoidable waste
Inaccurate estimation and procurement errors	58	86.6%	Surplus materials from poor estimation translate directly into waste
Design changes and rework	55	82.1%	Late design alterations generate significant avoidable waste volumes
Inadequate skills and lack of training	52	77.6%	Workforce skill deficits contribute to material damage and wastage

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Theme	Frequency	Percentage	Implication
Weak enforcement of waste regulations	47	70.1%	Regulatory gaps allow wasteful practices to persist unchecked

Source: Field Interview (2024). n = 67.

Table 4 shows that poor site management and supervision was the most frequently cited theme (89.6%), followed by inaccurate estimation and procurement errors (86.6%). One registered builder stated that materials are often over-ordered because estimates are not properly done and the excess ends up as waste. A regulatory official observed that when the design changes midway, whatever has already been ordered or built for the old design becomes waste. These qualitative responses directly corroborate the quantitative ranking in Table 3 and confirm that the three most critical waste generation factors reflect genuine and persistent operational realities on construction sites across the region.

Hypothesis One

There is no significant difference in the mean responses of registered builders, waste management experts, and waste regulatory officials on construction waste management practices in the building industry in North-West Nigeria. Results for testing hypothesis one is presented in Table 5.

Table 5: One-Way ANOVA of Inter-Group Differences on Construction Waste Management Practices

Source of Variation	Sum of Squares	df	Mean Square	F	p-value
Between Groups	13.524	2	6.762	8.204	.000
Within Groups	188.641	229	0.824		
Total	202.165	231			

Note: Significant at p < 0.05. Post-hoc: Tukey HSD.

Table 5 reveals that there is a significant difference in the mean responses of registered builders, waste management experts, and waste regulatory officials on construction waste management practices in the building industry in North-West Nigeria ($F(2, 229) = 8.204$, $p = .000$). Since the p-value (.000) is less than the .05 level of significance, the null hypothesis H01 is rejected. Tukey HSD post-hoc analysis revealed that registered builders rated current practices significantly less negatively than both waste management experts ($p = .007$) and regulatory officials ($p = .016$), while no significant difference was found between the waste management expert and regulatory official groups. This indicates that expert and regulatory stakeholders perceive the state of construction waste management practices in the building industry in North-West Nigeria as more critically deficient than registered builders do.

Hypothesis Two

There is no significant difference in the mean responses of registered builders, waste management experts, and waste regulatory officials on the key factors contributing to construction waste generation in the building industry in North-West Nigeria.

Results for testing hypothesis two are presented in Table 6.

Table 6: One-Way ANOVA of Inter-Group Differences on Key Factors Contributing to Construction Waste Generation

Source of Variation	Sum of Squares	df	Mean Square	F	p-value
Between Groups	10.932	2	5.466	6.813	.001
Within Groups	183.714	229	0.802		
Total	194.646	231			

Note: Significant at p < 0.05. Post-hoc: Tukey HSD.

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Table 6 reveals that there is a significant difference in the mean responses of registered builders, waste management experts, and waste regulatory officials on the key factors contributing to construction waste generation in the building industry in North-West Nigeria ($F(2, 229) = 6.813$, $p = .001$). Since the p-value (.001) is less than the .05 level of significance, the null hypothesis H02 is rejected. Tukey HSD post-hoc analysis revealed that the significant difference was primarily between registered builders and waste management experts ($p = .027$), with experts rating the severity of waste generation factors significantly higher than builders. No significant difference was found between waste management experts and regulatory officials. This indicates that waste management experts perceive the identified factors as more critically severe contributors to construction waste generation than registered builders do.

Findings

1. Construction waste management practices across all eight dimensions of the waste management cycle were generally inadequate in the building industry in North-West Nigeria, with waste recycling and waste reuse recording the lowest practice ratings. Qualitative themes confirmed that informal and unregulated disposal, the absence of recycling and reuse activity, and inadequate regulatory enforcement are the dominant characteristics of current practice in the region.
2. Demolition and rework due to construction errors, inaccurate material estimation, and poor handling and storage of materials on site were the three most critical factors contributing to construction waste generation in the building industry in North-West Nigeria. Qualitative evidence confirmed poor site management, procurement inaccuracies, and design changes as the most persistently cited operational drivers of waste generation.
3. There was a significant difference in the mean responses of registered builders, waste management experts, and waste regulatory officials on construction waste management practices in the building industry in North-West Nigeria ($F(2, 229) = 8.204$, $p = .000$), with expert and regulatory groups rating current practices as significantly more deficient than registered builders.
4. There was a significant difference in the mean responses of registered builders, waste management experts, and waste regulatory officials on the key factors contributing to construction waste generation in the building industry in North-West Nigeria ($F(2, 229) = 6.813$, $p = .001$), with waste management experts rating the severity of identified factors significantly higher than registered builders.

DISCUSSION OF FINDINGS

The finding that construction waste management practices are inadequate across all eight dimensions of the waste management cycle, corroborated by qualitative themes confirming informal disposal and the absence of recycling activity, is consistent with the broader Nigerian construction waste literature. Yohanna *et al*. (2023) documented identical conditions in Kaduna Metropolis, establishing that waste management on construction sites is predominantly informal and characterised by indiscriminate dumping.

Bayewun *et al*. (2023) similarly found that waste management practices on Lagos State construction sites were generally inadequate, while Ogunmakinde *et al*. (2022) confirmed that reduce, reuse, and recycle principles are rarely applied in practice by Nigerian construction firms. The historical persistence of these conditions, first documented by Ajayi *et al*. (2008) nearly two decades ago, confirms that the problem is structurally embedded and requires mandatory framework-driven intervention rather than voluntary compliance initiatives.

The finding that demolition rework, inaccurate material estimation, and poor material

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handling are the three most critical waste generation factors, further substantiated by qualitative confirmation of poor site management and procurement inaccuracies as the most persistently cited operational drivers, aligns with Dania *et al*. (2021) and Aule *et al*. (2025), who identified analogous factors as primary waste generation determinants among Nigerian construction professionals. The high ranking of regulatory enforcement failure as a direct generation factor confirms that respondents perceive its absence as an active enabler of wasteful practice rather than a passive background condition.

The significant inter-group differences on both waste management practices and generation factors, with expert and regulatory groups rating conditions more critically than builders, reflect the broader systemic visibility that professional oversight roles confer across multiple sites and projects. This pattern is consistent with Yohanna *et al*. (2023) and Bayewun *et al*. (2023) and implies that intervention strategies must be anchored on mandatory regulatory requirements rather than voluntary professional uptake, as the urgency perception gap between builders and expert stakeholders would otherwise impede adoption. The convergence of quantitative and qualitative findings across both research dimensions confirms the internal coherence of the mixed-method design and strengthens the empirical basis of the study's conclusions.

CONCLUSION

This study provides the first comprehensive, mixed-method, multi-stakeholder assessment of construction waste management practices and contributing factors across all seven states of North-West Nigeria. Quantitative findings, corroborated by qualitative evidence, establish that waste management practices are systematically inadequate across the entire waste management cycle, with recycling and reuse virtually absent and open burning and illegal dumping as the dominant disposal methods. Ten key factors were confirmed as significant contributors to construction waste generation, with operational, managerial, and regulatory dimensions all prominently represented. Statistically significant inter-group differences on both dimensions confirm that expert and regulatory stakeholders perceive the problem more critically than builders, reinforcing the case for mandatory regulatory intervention. The study contributes an integrated quantitative and qualitative evidence base that policymakers, regulatory agencies, professional bodies, and construction firms can act upon to initiate the structural transformation of waste management practice in the building industry in North-West Nigeria.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made:

1. National Environmental Standards and Regulations Enforcement Agency and State Environmental Protection Agencies should make Site Waste Management Plans a mandatory requirement for building permit approval on all construction projects in North-West Nigeria, directly addressing the inadequate waste collection, segregation, storage, and disposal practices established in Finding One.
2. The Nigerian Institute of Building (NIOB) and the Council of Registered Builders of Nigeria (CORBON) should incorporate waste-conscious material estimation, site supervision, and material handling into mandatory Continuing Professional Development programmes for registered builders, directly targeting the three most critical waste generation factors established in Finding Two.

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