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Proneness of Building Materials to Waste in Oyo State, Nigeria

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ABSTRACT

Construction material waste poses a significant challenge to project cost, environmental sustainability, and efficient resource utilisation in the construction industry, particularly in rapidly developing regions such as Ibadan, Oyo State, Nigeria. This study assessed the proneness of building materials to waste and examined the factors influencing waste in building materials in the study area. This was with a view to enhancing construction project delivery. Primary data were collected from 15out of 16 Quantity Surveying firms, representing a 93.75% response rate and 55 out of 75 Construction firms, representing a 73.33% response rate via structured questionnaires. This made a total of 70 responses and a response rate of 76.92%, which were properly filled and used for analysis. Findings from the analysis showed that all seven building materials investigated were moderately prone to waste. Blocks with mean score (MS) and standard deviation (SD) of 3.24 and 1.377, respectively was the material most prone to waste, followed by timber (MS=3.09; SD=1.401), and cement (MS=3.01; SD=1.34) constituting the top three materials that are prone to waste mostly due to factors such as handling during transportation (MS=3.86), design variation due to poor on-site management (MS=3.84) and site accessibility (MS=3.70), competence of skill operatives (MS=3.70), site supervision (MS=3.61, and defective material (MS=3.51). The study concluded that the seven building materials investigated are moderately prone to waste and therefore recommends paying more critical attention to causative factors in order to further minimize waste.

INTRODUCTION

Building materials are substances or products used in construction that are selected based on their structural, environmental, and performance characteristics. These materials can include naturally occurring substances like wood and sand, or manufactured substances like steel, cement, block, plastic, and glass. They are major determinants of the structural integrity and functionality of construction products. These materials are often wasted due to several factors, thereby increasing construction costs and, in the worst scenario, leading to the use of lower-quality material. Building material wastage is the difference between the value of materials delivered and accepted on site and those properly used as specified and accurately measured in the work, after deducting the cost savings of substituted materials transferred elsewhere, in which unnecessary cost and time may be incurred (Eze *et al.,* 2017).

The proneness of these building materials to waste is a significant concern in the construction industry, impacting project cost, sustainability, and resource maximisation. Several studies have been conducted on the subject matter of material waste around the world. These included Formoso *et al.* (2002), Khaled *et al.* (2015), Kabirifa *et al.* (2020), Can *et al.* (2023) and Jafar *et al.* (2023). At the local level, studies like Eze *et al*. (2017), Mbabuike and Nnadi

(2019), Adewuyi and Odesola (2020), Ibe (2023) and Ifeoma *et al*. (2024) have also investigated material waste.

LITERATURE REVIEW

Formoso *et al*. (2002) investigated the measurement of material waste in Brazil's building sector and found that waste generation was high on construction sites. The study concluded that waste could be reduced by improving the managerial capability at the design, procurement, and construction stages. Similarly, Can *et al*. (2023) investigated material waste management in Turkey using brick waste. They found that efficient material waste management is an antidote to cost overruns, reduces landfill demand, enhances resource management profits, and maximises quality.

Khaled *et al*. (2015) developed a construction material waste management system in Iraq with a view to managing trash on the job site. Despite being certified by numerous specialists, its efficacy was hampered by managerial incompetence and a lack of proper understanding of building material waste management. Only at the project level was the system suggested. Ja'far *et al*. (2023) investigated the causes and effects of material waste in construction projects in Amman, Jordan. The study found that vandalism, rework due to design changes and material suppliers'delays were the major causes of material waste. The study recommended the development of potential solutions for controlling construction waste in addition to carrying out further research on the subject matter. Kabirifar *et al*. (2020) investigated the factors that contribute to trash generation in the Australian construction industry. The study found that stakeholder behaviour and legislation, among others, influence waste generation in the study area. In the Nigerian construction industry, Eze *et al*. (2017) conducted a study on material waste in Minna, Nigeria and established that the most wasteful materials are timber formwork, mortar, block/bricks and concrete. Furthermore, Mbabuike and Nnadi (2019) studied construction material waste and control strategies in Nigeria, and found that design modifications, low worker and building professional experience are the major causes of material waste. Usman (2023) evaluated waste management practices in public and private projects in Abuja, Nigeria and concluded that transportation, rework, negligence, inappropriate handling, and storage are the causes of material waste. Adewuyi and Odesola (2020) studied the potential of material waste control methods on construction sites in South-South Nigeria and concluded that the methods have a significant potential to reduce material waste on site.

Ifeoma *et al*. (2024) investigated material waste on building sites and found that design modifications, inadequate attention to dimensional coordination, and damage during transit contributed to material waste on site. Similarly, Ibe (2023) analysed the causes and contribution level of building material waste in Abuja, Nigeria, and found that alteration and design modifications are the major causes of material waste on project sites.

From the above studies, it is evident that knowledge gaps exist in the areas of proneness of building materials to waste and the factors influencing the proneness of these building materials, which this study wishes to fill. In addition, there is a need to determine which materials are prone to wastage in a local setting like Ibadan, Oyo State, due to its rapid growth in urbanization and industrialization. As urban areas expand, there is increasing demand for housing infrastructure and public services, which leads to a surge in construction activities, with a significant amount of construction waste generation. This will reduce materials wastage in Oyo State, reduce construction costs, and invariably improve project completion rate. Besides, studies that investigated as many as seven building materials waste are scanty in the literature; hence, this research. Therefore, the objectives of this study are to assess the proneness of building materials to waste in Oyo State, Nigeria, and examine the factors influencing waste in building materials in the study area. It is expected that this study will determine the material most prone to waste among the seven often used construction materials, examine causative factors and proffer how it can be reduced.

METHODOLOGY

A cross-sectional quantitative survey research design was used for this study. This design is appropriate for gathering measurable data on building material waste and the influencing factors. To compare the data collected, two groups of respondents were used for the study. The study was carried out in Ibadan, the capital city of Oyo State. According to Akintayo *et al.* (2025), it is one of the largest cities in West Africa, comprising a diverse mixture of urban and suburban settlements. The choice of Ibadan is based on a pilot survey which suggested massive building construction to support the teeming population of the city.

The study population for this research comprises Quantity Surveying and Construction firms operating within Oyo State, Nigeria. These entities were chosen due to their direct involvement in the estimation and control of construction waste. Quantity Surveying firms play a crucial role in the cost estimation of construction waste, while Construction firms are responsible for the actual implementation of projects and the procurement, handling and control of building materials on construction sites. Therefore, both groups possess valuable insights on the proneness of building materials to waste and the factors influencing waste generation in the construction industry. The sampling frame of Quantity Surveying firms in Oyo State is 16 (NIQS Oyo State Chapter, 2025). Total enumeration was taken of Quantity Surveying firms, while purposive sampling of 75 Construction firms registered with the Bureau of Public Procurement, Oyo State, was done because of availability, convenience, interest and knowledge of the selected firms. This sample size of 75 construction firms is deemed statistically significant for quantitative research.

Primary data were collected for this study using a structured questionnaire designed to elicit data on the objectives of the study. The questionnaires were constructed using a 5-point Likert scale. For the first objective, respondents were asked to score the proneness of the seven building materials investigated to waste on a scale of 1 to 5, 5 for extremely prone, 4 for very prone, 3 for moderately prone, 2 for slightly prone and 1 for not prone. Similarly, for the second objective, respondents were required to score the factors influencing building materials waste on a scale of 1 to 5, 5 for extremely influential, 4 for very influential, 3 for moderately influential, 2 for slightly influential, and 1 for not influential. The questionnaire included closed-ended questions to facilitate quantitative analysis. The survey was administered to the respondents personally and collected at later dates by appointment. Data collected in this study were analysed using Mean Score, Standard Deviation, T-test and Factor Analysis. Regarding validity and reliability, expert review and pilot testing of the questionnaire were done. The questions were aligned with the objectives of the research to ensure content validity. Reliability is measured using Cronbach's Alpha, with a target value of 0.5 or higher representing acceptable internal consistency.

RESULTS AND DISCUSSION

Out of a total of 91 questionnaires administered to the respondents, 77 were retrieved, but 70 were properly filled and used for analysis. This represents a response rate of 76.9%. Regarding the profile of the respondents, 62.9% have at least a

B.Sc. academic qualification while 78.6% are professionally qualified. The average years of experience of the respondents is 14 and none of them have executed fewer than 18 projects. These indicate that the responses they provided can be relied upon in concluding the results of this research. Regarding the validity and reliability of the data collected for this study, the measurement scale was assessed using Cronbach's Alpha Coefficient. Seven items were used to measure the proneness of building materials to waste, with a coefficient of 0.63 indicating a moderate level of internal consistency. Similarly, the 13 items of the variables influencing material waste produced a coefficient of 0.73, indicating high reliability.

Proneness of Building Materials to Waste

Table 1 presents the results of the analysis of data on proneness of building materials to waste. From the table, masonry blocks are shown to be the leading material that is prone to waste with a mean score (MS) of 3.24 on a 5-point Likert scale. It is closely followed by Timber (MS = 3.09), Cement (MS = 3.03), and Granite (MS = 3.01).

Table 1: Proneness of Building Materials to Waste

	Overall			QS Firms			Construction Firm			T-Test	
Materials	**MS**	**SD**	**R**	**MS**	**SD**	**R**	**MS**	**SD**	**R**	**F**	**P**
Blocks	3.24	1.377	1	3.07	1.280	1	3.29	1.410	1	0.254	0.616
Timber	3.09	1.401	2	3.6	1.549	2	2.95	1.339	7	1.606	0.209
Cement	3.03	1.340	3	3.00	1.000	3	3.04	1.427	2	3.891	0.053
Granite	3.01	1.222	4	2.93	1.100	4	3.04	1.261	3	0.304	0.583
Rebars	2.94	1.339	5	2.80	1.265	5	2.98	1.367	4	0.123	0.727
Tiles	2.87	1.284	6	2.80	1.014	6	2.89	1.356	5	1.553	0.217
Paints	2.81	1.266	7	2.53	1.125	7	2.89	1.301	6	0.492	0.485

MS= Mean Score; SD= Standard Deviation; R= Rank; F= Statistic Value; P= Probability Value

The Table shows that out of the seven materials investigated, Paint is the least prone to waste (MS = 2.81). Overall, all seven materials are moderately prone to waste (MS between 2.81 and 3.24, approximately 3.0). Comparatively, t-tests indicate that there is no statistically significant difference (at the 95% confidence level) in the scoring of the two groups (Quantity Surveying and Construction firms) on the proneness of materials to waste in the study area. In other words, the two groups are unanimous in their scoring of the proneness of the seven materials to waste. However, it is instructive to note that Timber is highly prone (MS = 3.6, approximately 4.0) to waste in the opinion of QSFs, whereas it is moderately prone (MS = 2.95, approximately 3.0) to waste in the opinion of CFs. This means that QSFs view waste in Timber to be more critical than CFs in the study area. Findings on the proneness of building materials to waste partly align with Eze *et al.* (2017), who concluded that the most wasteful materials in the construction industry include blocks and concrete.

Factors Influencing Waste in Building Materials

Table 2 presents the results of the analysis of data on the factors influencing waste in building materials. Out of 13 variables investigated, six are shown to be very influential (Mean Score 3.51 to 3.86, approximately 4.0) on a 5-point Likert scale, while the other seven are moderately influential (Mean Score 3.09 to 3.41, approximately 3.0).

Overall, the Table shows that transportation of materials is the leading factor influencing material waste generation, with a mean score (MS) of 3.86 on a 5-point Likert scale. It is followed by on-site management (MS=3.84), site accessibility (MS =3.70), skill of operatives (MS=3.70), supervision (MS=3.61) and defects in materials (MS =3.51), among others.

Table 2: Factors Influencing Building Materials to Waste

		Overall			QS Firms			Construction Firm			T-Test	
S/N	**Factor**	**MS**	**SD**	**R**	**MS**	**SD**	**R**	**MS**	**SD**	**R**	**F**	**Sig**
1	Transportation	3.86	1.195	1	3.87	0.915	1	3.85	1.268	2	1.979	0.164
2	on-site management	3.84	1.14	2	3.60	1.242	3	3.91	1.110	1	0.796	0.376
3	Site Accessibility	3.70	1.147	3	3.33	1.047	9	3.80	1.161	3	0.001	0.978
4	Skill of Operatives	3.70	1.159	4	3.67	1.047	2	3.71	1.197	4	0.293	0.590
5	Supervision	3.61	1.107	5	3.53	1.407	4	3.64	1.025	5	5.135	**0.027**
6	Defect in Material	3.51	1.164	6	3.40	0.828	5	3.55	1.245	6	4.426	**0.039**
7	Weather	3.41	1.324	7	3.40	1.404	6	3.42	1.315	8	0.009	0.924
8	Quality of materials	3.40	1.160	8	3.13	0.915	11	3.47	1.215	7	5.102	**0.027**
9	Project planning	3.36	1.352	9	3.33	1.496	7	3.36	1.324	10	0.437	0.511
10	Training on waste	3.30	1.208	10	2.93	1.163	12	3.40	1.211	9	0.600	0.441
11	Storage facility	3.29	1.331	11	3.27	1.163	10	3.29	1.383	11	0.573	0.452
12	Changes in design	3.16	1.247	12	3.33	1.113	8	3.11	1.286	13	0.548	0.461
13	Waste Reduction Knowledge	3.09	1.39	13	2.93	1.53	13	3.13	1.36	12	0.348	0.557

MS= Mean Score; SD= Standard Deviation; R= Rank; F= Statistic Value; P= Probability Value
***significant at 5% level**

The least influential factor influencing material waste is waste reduction knowledge (MS=3.09). The t-test further shows that there is no statistically significant difference at the 95% confidence level between the two groups of respondents in their scoring of ten (10) out of 13 variables. This means that their assessment of the ten (10) variables is the same, meaning that the 10 variables influence material waste in the same way. However, there is a statistically significant difference, at the 5% level, between the two groups in their scoring of three variables. These variables are supervision, defects in materials, and quality of materials. In other words, the two groups disagree that these three variables influence building material waste in the same way. Findings on factors influencing building material waste partly align with Formoso *et al*. (2002), Khaled *et al*. (2015), Ja'far *et al*. (2023), and Ifeoma *et al*. (2024). These studies concluded that incompetence, design changes and damage during transportation are the major causes of material waste.

To further explore the influence of these factors on waste in building materials, a Factor Analysis was conducted. To assess the suitability of the data for Factor Analysis, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity were conducted. The KMO value of

0.575, as shown in Table 3, is above the recommended minimum threshold of 0.50 (Field, 2013), indicating that the sample size and data are adequate for Factor Analysis, though the value suggests mediocre adequacy. Bartlett's test of sphericity was statistically significant (Chi-square = 124.743, degrees of freedom = 78, p = 0.001), confirming that the correlation matrix is not an identity matrix. This means the variables are sufficiently correlated to justify the use of factor analysis. Overall, these results demonstrate that the data collected are valid and appropriate for Factor Analysis.

Table 3: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.575	
Bartlett's Test of Sphericity	Approx. Chi-Square	124.743
	Df	78
	Sig.	0.001

Having established that the data collected were suitable, Factor Analysis was conducted, and the results are presented in Table 4 and Figure 1. The Eigenvalues of the components were extracted, and those with Eigenvalues equal to or greater than 1 were retained for interpretation. Five components met this criterion, as shown in Table 4.

Table 4: Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	2.495	19.189	19.189	2.495	19.189	19.189
2	1.671	12.855	32.044	1.671	12.855	32.044
3	1.421	10.929	42.973	1.421	10.929	42.973
4	1.249	9.610	52.583	1.249	9.610	52.583
5	1.159	8.912	61.495	1.159	8.912	61.495
6	0.945	7.271	68.765			
7	0.866	6.661	75.426			
8	0.665	5.116	80.542			
9	0.612	4.707	85.249			
10	0.577	4.436	89.684			
11	0.541	4.165	93.849			
12	0.430	3.307	97.156			
13	0.370	2.844	100.000			

The first component explained 19.189% of the total variance, indicating it is the most influential factor group among the variables studied. The second component accounted for 12.855% of the variance, bringing the cumulative variance explained by the first two components to 32.044%. The third, fourth, and fifth components explained 10.929%, 9.610%, and 8.912% of the variance, respectively. Collectively, the five components accounted for a cumulative total of 61.495% of the variance in the data. This implies that these five factors effectively summarise over 60% of the information contained in the original data set related to factors influencing the proneness of building materials to waste.

Extraction Method: Principal Component Analysis.

Components six through thirteen had eigenvalues below 1, and so were not retained according to the Kaiser criterion. Their variances contributed modestly to the total variance but were not considered significant enough for inclusion. From the Component Matrix in Table 5, five distinct components were extracted through Principal Component Analysis, representing key clusters of factors influencing building materials waste. These components explain a cumulative variance of 61.495% in Table 4, indicating that together they capture a substantial proportion of the complexities associated with material wastage on construction sites as presented in Table 5. Component 1 accounted for the largest share of variance (19.189%) and included variables such as low-quality materials (loading: 0.547), material defects (0.546), improper handling during transportation (0.529), insufficient training on waste reduction (0.527), poor on-site material management (0.519), and site accessibility issues (0.472).

Table 5: Component Matrix

		Component				
SN		1	2	3	4	5
8	Quality Materials	0.547				
6	Defect Material	0.546				
1	Transportation	0.529				
10	Training Waste	0.527				
2	On-site Management	0.519				
3	Site Accessibility	0.472				
12	Changes Design		0.493			
4	Skill Operatives			0.603		
11	Storage Facility			0.407		
9	Project Planning				0.689	
5	Site Supervision				0.490	
7	Weather					0.463

This cluster underscores the pivotal role that material quality, handling practices, and site conditions play in determining waste levels. The prominence of improper handling and on-site management aligns with findings by Adewuyi and Odesola (2020) and Adebayo *et al*. (2022), who highlighted that fragile materials such as tiles and blocks suffer significant breakage and damage due to careless transport and handling, exacerbated by difficult site access. Oyebanjo *et al*. (2023) similarly identified inadequate material control and poor management as leading causes of resource inefficiency, stressing that poor handling procedures during transport and on-site lead to direct material losses. Inadequate training, grouped here, also resonates with Akinade *et al*. (2020), who pointed out that insufficient worker education on waste minimisation practices contributes directly to overconsumption and spillage.

Component 2, explaining 12.855% of the variance, was predominantly represented by frequent variation in design content (loading: 0.493). This finding highlights how unexpected or last-minute design changes disrupt procurement cycles and cause wastage through surplus or incompatible materials, a factor strongly supported by Oyebanjo *et al*. (2023). These authors noted that client-driven variations are often overlooked in waste analyses yet critically trigger material surpluses and rework.

Component 3 accounted for 10.929% of variance and grouped variables connected to workforce competence: inadequate skilled labour (0.603), insufficient training (0.506), and storage (0.407). The dominance of labour-related factors reflects the well-established link between skilled workforce availability and waste reduction (Ezeokoli *et al*., 2023; Akinade *et al*., 2020). Poor cutting, handling, and installation techniques stemming from skill gaps lead to excessive offcuts, material spillage, and rejects. Storage here also relates to the workforce's ability to properly manage materials and aligns with Oyebanjo *et al*. (2023)'s emphasis on the need for adequate storage alongside skilled handling to prevent deterioration and waste.

Component 4, explaining 9.610% of the variance, comprised inadequate project planning (loading: 0.689) and poor site supervision (0.490). These results echo Olawumi *et al*. (2021) and Agyekum *et al*. (2019), who identified poor supervision and planning deficiencies as key contributors to resource wastage. Ineffective planning causes scheduling conflicts and procurement misalignments, while weak supervision leads to lax enforcement of material handling and storage protocols, facilitating waste escalation. The high loading for inadequate planning aligns with Perez *et al*. (2024), who showed how poor project coordination exacerbates surplus ordering and on-site resource mismanagement.

The final component accounted for 8.912% of variance and contained weather conditions (loading: 0.463), highlighting environmental impacts on waste generation. This supports Adebayo *et al*. (2022a) findings that exposure to adverse weather—humidity, rainfall, temperature extremes—accelerates deterioration of moisture-sensitive materials such as cement and timber, particularly when storage is inadequate. Such environmental vulnerabilities elevate spoilage and replacement costs.

In summary, the Factor Analysis classified the multifaceted causes of building material waste into five broad factor domains: material quality and handling; design variation; labour skills and training; project planning and supervision; and environmental exposure. These components corroborate the interplay of managerial inefficiencies, human factors, operational practices, and environmental conditions in driving waste (Oyebanjo *et al*., 2023; Ezeokoli *et al*., 2023; Olawumi *et al*., 2021). The prominence of handling and material quality issues within the first factor highlights the critical need for stringent material control and skilled workforce engagement. Concurrently, the identification of project planning and supervision as distinct factors reaffirms calls for enhanced oversight and scheduling coherence to reduce waste (Agyekum *et al*., 2019; Perez *et al*., 2024). Lastly, the factor comprising environmental conditions reinforces the necessity of resilient storage infrastructure and protective strategies against weather-induced damage (Adebayo *et al*., 2022b).

CONCLUSION

This study assessed the proneness of building materials to waste and examined the factors influencing waste in building materials on construction sites. From the findings of this study, it is concluded that the seven building materials investigated are moderately prone to waste on site due to handling, variations, competence, planning, and environmental causative factors. However, cement, timber, and masonry blocks are the top three materials prone to waste in the study area. Consequently, it is recommended that, to minimise materials waste on sites, attention should be paid to these causative factors. Findings from this study may have limited application to other States of the Federation due to variations in experience, practice and exposures of different firms. Moreover, the generalisation of the findings may also have limited applicability due to the sample size. This study, nevertheless, provides implications for enhancing the delivery of construction projects in other study areas. It is hence recommended that further studies be carried out with larger sample sizes for enhanced generalisation.

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