International Journal of Civil Engineering, Construction and Estate Management,14(4),45-52,2026
Print ISSN: 2055-6578(Print)
Online ISSN: 2055-6586(online)
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development -UK

Perceived Types and Causes of Building Material Wastage on Construction Sites in Jos Metropolis, Nigeria

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doi: https://doi.org/10.37745/ijcecem.14/vol14n44552 Published November 15, 2026

Citation: Simon G.G., Mohammed I.Y., Ya'u J. (2026) Perceived Types and Causes of Building Material Wastage on Construction Sites in Jos Metropolis, Nigeria, *International Journal of Civil Engineering, Construction and Estate Management*,14(4),45-52

Abstract: *Building material wastage raises project costs and depletes resources, yet evidence from northern Nigeria is scarce. This study examined construction professionals' perceptions of the types and causes of building material wastage in Jos metropolis, and whether the perceived causes are related to the perceived wastage of specific materials. A structured questionnaire using a five-point Likert scale was administered to 175 professionals selected by proportionate random sampling from five construction companies; 143 usable responses (81.7%) were analysed with SPSS using means, standard deviations, rankings and Pearson correlation. The scales were reliable (Cronbach's alpha .81–.88). Ceramics and tiling works (M = 3.64), glass works (M = 3.51) and metal works (M = 3.47) were perceived as the most wasteful, and steel works and plumbing works (both M = 2.66) as the least. The leading causes were lack of options for ordering small quantities (M = 3.34), poor site management and supervision (M = 3.26) and improper handling (M = 3.26). Of 48 correlations between eight causes and six materials, four were significant at the 5% level, all weak (r = .17–.27), so the data give limited evidence of material-specific causal links. All mean scores lay between 2.47 and 3.64, indicating that perceived differences between items are small. The findings support better ordering and site supervision practices and point to the need for site-record-based studies, including data-driven prediction of wastage.*

Keywords: building materials; material wastage; construction waste; site management; Jos;Nigeria

INTRODUCTION

The construction industry provides the roads, housing and public facilities on which social and economic development depend, but it also consumes large quantities of resources, and a considerable share of the materials delivered to sites is wasted through poor material control (Poon et al., 2004). Studies of building sites have found that material waste is high, varies widely between sites, and is largely avoidable through management measures (Formoso et al., 2002). Wastage raises project costs, depletes resources and increases the amount of waste to be disposed of (Tam et al., 2007).

Waste arises from design, procurement, material handling and site operations (Bossink & Brouwers, 1996; Ekanayake & Ofori, 2000; Osmani et al., 2008), and the attitudes of the workforce influence how much is generated (Kulatunga et al., 2006). In Nigeria, waste on construction sites has been studied in the south-west (Akinkurolere & Franklin, 2005), at firm level (Dania et al., 2007), among

professionals (Ameh & Itodo, 2013) and in Rivers State (Adewuyi & Otali, 2013). Reported contributors include poor supervision, rework and poor material handling. To our knowledge, no comparable study has been reported for Bauchi metropolis, where the perceptions of construction professionals on which materials are wasted and why are not documented.

Material control on many sites still relies on manual records and experience, so wastage is often discovered only after it has occurred (Navon & Berkovich, 2006). Data-driven methods are now being used to predict waste; for example, Gulghane et al. (2024) used data from 134 sites to build K-nearest neighbour and decision tree models for waste generation in residential projects. Such methods need to be targeted at the materials and causes that matter locally. This paper therefore addresses three questions: (i) which types of building works are perceived as the most wasteful in Jos metropolis; (ii) what are the major perceived causes of wastage; and (iii) are the perceived causes related to the perceived wastage of particular materials?

LITERATURE REVIEW

Concept and magnitude of material waste.

Construction waste is commonly classified as direct waste, in which materials are physically lost, damaged or used in excess, and indirect waste, which represents monetary loss without physical loss of material (Formoso et al., 2002; Poon et al., 2004). Reported levels vary widely between countries and sites. Bossink and Brouwers (1996) found that waste in the Netherlands lay between 1% and 10% of the amount of each material purchased, and Formoso et al. (2002) observed very high variability of waste indices between sites, which suggests that a considerable part of wastage can be avoided. Tam et al. (2007) showed that wastage levels are affected by sub-contracting relationships and project types.

Causes of material waste.

Studies group the causes of waste into design, procurement, material handling, site operations and external factors (Bossink & Brouwers, 1996; Ekanayake & Ofori, 2000; Osmani et al., 2008). Formoso et al. (2002) concluded that most waste results from flaws in management systems rather than from the qualifications or motivation of workers, and that a significant portion arises in stages preceding production, such as design and planning. Kulatunga et al. (2006) found that the attitudes and perceptions of the workforce strongly influence waste generation. In Nigeria, Akinkurolere and Franklin (2005) and Dania et al. (2007) examined waste management practices on sites and in firms; Ameh and Itodo (2013) examined professionals' views of wastage and cost overruns, and Adewuyi and Otali (2013) evaluated the causes of material waste in Rivers State.

Material management and data-driven approaches

Manual materials management is slow and error-prone, and it provides little early warning of excessive use (Navon & Berkovich, 2006). Automated models that track purchase orders and material movements were shown to be feasible on a building project by Navon and Berkovich (2006), and more recent studies apply machine learning to predict waste generation from project data (Gulghane et al., 2024). These approaches depend on site data that many Nigerian contractors do not systematically record, which makes local evidence on the materials and causes of waste a necessary first step.

METHODOLOGY

A quantitative, cross-sectional survey design was adopted. The study area is Jos metropolis, the capital of Plateau State in north-central Nigeria. The population comprised 317 professionals working in five construction companies: 59 architects, 66 quantity surveyors, 68 civil engineers, 47 mechanical engineers, 26 structural engineers, 16 electrical engineers and 35 builders. A sample of 175 was determined from the table of Krejcie and Morgan (1970) and allocated to the professional groups in proportion to their size (simple random selection within groups). Of the 175 questionnaires distributed, 143 were returned and usable (81.7%).

The questionnaire used closed-ended items rated on a five-point Likert scale. Sixteen items measured the perceived level of wastage in types of building work, 28 items measured the perceived causes of wastage, and the perceived wastage of individual materials was also rated. Reliability was assessed with Cronbach's alpha, and normality with skewness and kurtosis, using ±2 as the acceptable range (George & Mallery, 2010). Data were analysed with SPSS (version 22) using means, standard deviations and rankings, and Pearson product-moment correlation. Correlation strength was interpreted with the Burris (2005) descriptors: .01–.09 negligible, .10–.29 weak, .30–.49 moderate, .50–.69 substantial and .70 and above very strong.

RESULTS

Reliability, normality and respondents

Cronbach's alpha was .876 for the 16 types-of-wastage items, and .814 for the 28 causes items, both above the .70 threshold (Pallant, 2011). Skewness ranged from −0.604 to 0.642 and kurtosis from −1.346 to −0.411, within the acceptable range; the consistently negative kurtosis indicates flat distributions, with responses spread across the scale. Table 1 shows that quantity surveyors formed half of the respondents (50.3%), followed by architects (23.8%), builders (9.8%), electrical engineers (8.4%), civil engineers (4.2%) and mechanical engineers (3.5%); no structural engineers responded. Over half (53.8%) held a master's degree or higher, and 52.4% had fewer than seven years of experience.

Table 1: Profile of respondents (N = 143)

Characteristic	Category	n	%
Profession	Architect	34	23.8
	Quantity surveyor	72	50.3
	Builder	14	9.8
	Electrical engineer	12	8.4
	Civil engineer	6	4.2
	Mechanical engineer	5	3.5
Qualification	Secondary certificate	1	0.7
	Diploma	6	4.2
	Degree	59	41.3
	Master's degree or above	77	53.8
Experience	Less than 7 years	75	52.4
	8–14 years	42	29.4
	More than 14 years	26	18.2

Types of building works perceived as wasteful

Table 2: Perceived wastage in types of building work (n = 143; 1 = very low, 5 = very high)

Rank	Type of building work	Mean	SD
1	Ceramics and tiling works	3.64	1.292
2	Glass works	3.51	1.378
3	Metalworks	3.47	1.368
4	Painting works	3.46	1.423
5	Casting works	3.36	1.269
6	Formwork (from steel/metal)	3.33	1.215
7	Foundation works	3.31	1.207
8	Ceiling works	3.29	1.167
9	Brick workings	3.27	1.306
10	Formwork (from wood/timber)	3.24	1.368
11	Concrete mixing	3.13	1.244
12	Electrical works	3.02	1.270
13	Roofing works	2.87	1.089
14	Sandcrete Block works	2.81	1.156
15	Plumbing works	2.66	1.144
16	Steel works	2.66	1.210

Ceramics and tiling works (M = 3.64, SD = 1.29), glass works (M = 3.51), metal works (M = 3.47) and painting works (M = 3.46) ranked highest. Roofing works (M = 2.87), sandcrete block works (M = 2.81), plumbing works (M = 2.66) and steel works (M = 2.66) ranked lowest. The full range of means is only 0.98 points, so the ranking identifies relative, not large, differences.

Causes of building material wastage

Table 3: Perceived causes of building material wastage (n = 143)

Rank	Cause	Mean	SD
1	Lack of options for ordering small quantities	3.34	1.198
2	Poor site management and supervision	3.26	1.266
3	Improper handling	3.26	1.191
4	Contractors negligence	3.25	1.386
5	Wrong specifications	3.25	1.147
6	Poor quality control	3.12	1.071
7	Damage during transportation	3.07	1.202
8	Changes in drawing	3.07	1.367
9	Over-order	3.03	1.239
10	Accidents	2.98	1.354
11	Inaccurate cost estimation	2.94	1.226
12	Non-use of leftover materials	2.93	1.220
13	Loss during concreting	2.92	1.345
14	Theft and pilferage	2.91	1.210
15	Frequent equipment breakdown	2.90	1.224
16	Poor design and design delays	2.84	1.276
17	Poor housekeeping & storage condition	2.83	1.035
18	Adhoc procurement	2.79	1.215
19	Late delivery of materials	2.75	1.240
20	Poor quality of construction materials	2.74	1.124

21	Excess mortar/concrete preparation for cement, sand and aggregates	2.74	1.137
22	Improper use of equipments	2.71	1.249
23	Adverse climatic condition	2.67	1.166
24	Inaccurate time estimation and planning	2.65	1.257
25	Lack of a material management system	2.60	1.133
26	Shortage of skilled workers	2.59	1.177
27	Change orders	2.48	1.244
28	Lack of experience of the client in construction	2.47	1.203

The three leading causes were lack of options for ordering small quantities (M = 3.34, SD = 1.20), poor site management and supervision (M = 3.26, SD = 1.27) and improper handling (M = 3.26, SD = 1.19), followed by contractors' negligence and wrong specifications (both M = 3.25). The lowest-ranked causes were change orders (M = 2.48) and lack of client experience in construction (M = 2.47). Only nine of the 28 causes had means above 3.00, the neutral point.

Relationship between causes and the wastage of materials

Table 4: Pearson correlations (r) between perceived causes and perceived wastage of materials (n = 143)

Cause	**Timber**	**Electrical fittings**	**Tile fittings**	**Cement**	**Mortar**	**Pipes**
Lack of options for ordering small quantities	-.026	.006	.024	.080	.028	.182
Poor site management and supervision	.167	-.116	.044	-.145	.128	.056
Improper handling	.097	-.066	-.155	-.056	.019	.064
Wrong specifications	-.115	-.008	-.011	.045	.023	.031
Poor quality control	.008	-.005	.035	-.181	.054	.014
Damage during transportation	.146	.021	.096	.004	.148	.138
Changes in drawing	.037	-.043	.020	-.267	.121	-.026
Over-order	.012	.048	-.040	.126	.039	.111

Note: *p < .05; p< .01 (two-tailed).*

Four of the 48 correlations were significant. Lack of options for ordering small quantities was weakly and positively related to pipes (r = .182, p = .029); poor site management and supervision to timber (r = .167, p = .046); poor quality control was weakly and negatively related to cement (r = −.181, p = .031); and changes in drawings were weakly and negatively related to cement (r = −.267, p = .001). With 48 tests at the 5% level, two to three significant results would be expected by chance alone, and after a Bonferroni correction (threshold .05/48 ≈ .001) only the last, at p = .001, comes close to remaining significant. Improper handling, wrong specifications, damage during transportation and over-ordering showed no significant relationship with any material.

DISCUSSION

The ranking of ceramics, tiling and glass works as most wasteful is consistent with the view that finishing and fragile materials are prone to breakage and cutting losses, and with Ameh and Itodo's (2013) finding that mortar, formwork, sandcrete blocks and concrete are the most wasteful materials among those used on Nigerian sites. It partly differs from Eze et al. (2017), who found that blockwork,

rendering mortar, formwork and concrete generate the most waste, and from Ugochukwu et al. (2017), who reported timber as the most wasted material in Anambra State. Differences in which materials rank highest probably reflect different building types, specifications and survey instruments, and show that waste patterns are local. Perception-based rankings should therefore be checked with measured site data.

The three leading causes – ordering in quantities that do not match need, weak supervision and improper handling – are management-related. This agrees with Formoso et al. (2002), who concluded that most causes of waste are flaws in the management system, and with Haruna et al. (2015), who reported poor material planning and management as the highest factor (95.2%) in Nigerian building sites, followed by poor workmanship. It also agrees with Adewuyi and Otali (2013) and Ameh and Itodo (2013), who identified poor supervision, rework and handling as major contributors. The low rank of change orders and client inexperience contrasts with Bekr (2014), who ranked frequent design and client changes first, and with Formoso et al. (2002), who found that a considerable share of waste originates before production, in design and planning. A possible explanation is that respondents, most of whom were quantity surveyors and architects with under seven years of experience, attributed waste to site activities rather than to upstream decisions.

The weak and mostly non-significant correlations suggest that perceived causes do not map neatly onto individual materials. Because the causes and materials were rated by the same respondents on similar scales, and because all means cluster near the scale midpoint, these correlations are likely to be attenuated; they should not be read as evidence that the causes have no effect. Establishing effects requires measured waste quantities per material and site, which is the kind of data that data-driven prediction models, such as those of Gulghane et al. (2024), depend on. A practical implication is that contractors in Jos should begin recording deliveries, usage and waste by material, since this would allow both control and later prediction.

CONCLUTION AND RECOMMENDATIONS

Professionals in Jos metropolis perceive ceramics and tiling, glass, metal and painting works as the most wasteful types of building work, and the main causes of wastage as ordering constraints, poor site management and supervision, and improper handling. Perceived causes showed only weak links to the wastage of specific materials. Based on these findings: (1) firms should negotiate delivery arrangements that allow materials to be ordered in smaller quantities, and plan procurement against bills of quantities; (2) experienced supervisors should be assigned to sites and trained operatives engaged, with handling procedures set for fragile finishing materials; (3) firms should keep records of material deliveries, usage and wastage, which will support future analysis and prediction; and (4) estimators should base waste allowances on measured site data rather than a fixed percentage.

Limitations. The study relies on the perceptions of 143 professionals in a single metropolis, so the results cannot be generalised statistically. Perception scales had small differences between items, no structural engineers responded, and no measured waste quantities were collected. Future research should combine perception data with site measurements, extend the sampling to other cities, and test machine-learning prediction of wastage using site records.

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