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# DETERMINING EXTENT OF STRUCTURAL MATERIAL WASTAGE IN BUILDING CONSTRUCTION SITES IN EBONYI STATE OF NIGERIA

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***Abstract***
*Structural materials constitute basic ingredients of building projects. There have been reports of abandoned building projects especially in the developing nations probably because of inadequate waste management practices in construction sites. Effects of uncontrolled structural material wastes in the building construction sites are periodic and financial project failures. This paper determines extent of structural material wastage in building construction sites to guide future studies on waste management in developing nations. The descriptive survey design was used for the study. The target population was all consultants and project managers that supervise building projects in Ebonyi state. A structured questionnaire in line with the formulated research questions was used to guide the study. The statistical mean, standard deviation, and t-test analysis were used to analyze the data. Findings of the study showed that cement mortar, Portland cement, nails, bracing and scaffolding members are structural materials that are wasted to very high extent in building construction sites in Ebonyi state. The paper recommended that personnel involved in material usage should be trained and motivated properly to ensure effective handling of the materials and minimize wastage in building construction sites. The findings of the study could be applied in building technology and engineering economics, and in waste management and control for sustainable building projects.*

***Keywords.*** *Structural material, Material waste, Building construction, Waste generation, Construction site.*

## Introduction

Structural materials are common construction substances like iron, timber, concrete, cement, aggregates, blocks, roofing sheets, glasses, synthetic materials, aluminium, plastics, composites and so on used in the erection of building and other civil engineering structures. They are construction materials that have the ability to withstand both internal and external forces considered in the design of a structural framework (Adedeji, 2012). Structural materials are basic ingredients of the building projects (Kumar, 2010). The cost, quality and durability of building and civil engineering projects depend largely on the type, quality, and quantity of structural material used. Most times, workers that handle the materials during construction process cause wastage of the structural materials.

The manner at which these materials are handled in construction sites affects the overall cost of any building project (Patel and Vyas, 2011). Skoyles and Skoyles (1987) noted that careless handling of these materials in the sites lead to extravagant loss, which in turn attracts unnecessary cost and incurs time too. Materials wastage occurs at all stages of material handling on the sites: on arrival, when stacked, when moved and when fixed in position (Shen et al., 2002; Barbuta et al., 2015). In addition, structural material wastage occurs during various construction activities: the masonry, carpentry, iron bending, decorating and finishing operations. The implication of construction material wastage could be financial failure of the project, a scenario that is disastrous to the building and civil engineering industry in particular and the society in general. In attempts to address the situation, Adewuyi and Otali (2013) evaluated the causes of construction material waste on building sites in River state of Nigeria using review of related literature and questionnaire methods of data collection. Their analysis revealed that rework contrary to drawing and specification, design changes and revision, and waste from uneconomical shapes are the most common factors that contribute to material waste generation on building sites.

Whyte, Isaac and Lilly (2018) studied the sources and causes of material waste and effect on cost overrun at preconstruction and construction phases of building projects on some selected construction companies in Nigeria. They used the relative importance index method to analyze the primary data gotten from the responses to the structured questionnaire sent to the respective

selected construction companies. Their submission affirms that last minute client requirement, which leads to design variation is the major source of material waste in the building industry.

Aiyetan and Smallwood (2013) assessed levels of selected materials waste and method of minimization of waste in building construction activities in Lagos state. They used the random sampling technique to select the respondents of the questionnaire, and analyzed the collected data with descriptive statistics statistical tool. They discovered that the main sources of construction waste are rework / improvement, materials handling and storage, damage to work by other trades, transportation, last minute client requirements, weather, equipment, and familiarity with construction technology. They implied that materials wastage increases construction duration and cost, which jeopardizes the chances of a contractor in winning further projects.

Although previous researches have been conducted on causes of material waste and waste management in construction sites, the studies are not sufficient to draw reasonable inference on issues bordering construction wastes. In this paper, the extent of structural material wastage in building construction sites in Ebonyi state of Nigeria was determined. Emphasis was laid on the masonry based, carpentry based and iron bending based structural material wastages in the building construction sites. The study is significant in building technology and engineering economics, and waste management and control towards sustainable building projects.

## Statement of the Problem

Waste management is an essential aspect of cost control in both production and construction industries. There are alarming reports of abandoned building projects especially in the developing nations probably because of inadequate waste management practices in construction sites. Effects of uncontrolled material wastes in the building construction sites are periodic and financial project failures. Although researchers in the past have conducted studies on causes of material waste and waste management in construction sites, the studies are not sufficient to draw reasonable inference on issues bordering construction wastes. A study on extent of structural material wastage in building construction sites calls for urgent research

attention to lessen the above-mentioned problems. The research could guide future studies on effective waste management in the developing nations.

## Research Objectives

i. To determine extent of masonry based structural material wastage in building construction sites in Ebonyi state.
ii. To determine extent of carpentry based structural material wastage in building construction sites in Ebonyi state.
iii. To determine extent of iron bending based structural material wastage in building construction sites in Ebonyi state.

## Research Questions

i. What is the extent of masonry based structural material wastage in building construction sites in Ebonyi state?
ii. What is the extent of carpentry based structural material wastage in building construction sites in Ebonyi state?
iii. What is the extent of iron bending based structural material wastage in building construction sites in Ebonyi state?

## Hypothesis

Ho There is no significant difference in the mean responses of respondents on structural material wastage in building construction sites in Ebonyi state based on gender, age, and status variables.

## Methodology

The survey research design was adopted for the research. The study was conducted in Ebonyi State of Nigeria. The target population was all supervisors in building construction sites in Ebonyi State of Nigeria, which comprised of consultants and project managers. The consultants and project managers participate in building construction projects in the state. A questionnaire survey that contained 23 item statements was administered to 200 respondents over a period of four weeks. The respondents were selected from the three geopolitical zones of the state. The questionnaire sought for information from the respondents on extent of masonry based structural material, carpentry based structural material, and iron bending based

structural material wastage in building construction sites in the state. The research instrument exhibited a Cronbach's alpha reliability coefficient of 0.81.

The general characterises of the respondents are shown in Table 1. The percentage distribution of the respondents was as follows, namely: gender - 75 % males, 25 % females; age – 68.75 % ≤ 50 years old, 31.25 % ≥ 50 years old; status – 21.88 % consultants, 78.12 % project managers. The submission of the respondents was studied in line with the general characteristics of the respondents, namely: gender, age, and status. 160 survey answers were returned, found reliable and used in the data analysis.

The statistical mean, standard deviation and t-test were used to analyse the data. The decision rule for the mean statistics was 3.0. A mean of 3.0 and above was accepted, while a mean below 3.0 was rejected.

**Table 1.** General characteristics of the respondents

| *Variables* | *Category* | *Person (%)* |
|---|---|---|
| *General Characteristics* *gender* | male | 120(75) |
| | female | 40(25) |
| | **total** | **160(100)** |
| *age* | ≤ 49 | 110(68.75) |
| | ≥ 50 | 50(31.25) |
| | **total** | **160(100)** |
| *status* | consultant | 35(21.88) |
| | Project manager | 125(78.12) |
| | **total** | **160(100)** |

## Results

Table 2 shows the results of the mean and standard deviation analysis of the respondents on extent of masonry based structural material wastage in building construction sites in Ebonyi state. Table 3 contains results of the mean and standard deviation analysis of the respondents on extent of carpentry based structural material wastage in building construction sites in Ebonyi state. Table 4 shows the results of the mean and standard deviation analysis of the respondents on extent of iron bending based structural material wastage in building construction sites in Ebonyi state. Table 5

contains the test analysis of the variable, namely; gender, age and status on structural material wastage.

**Table 2**

*Mean and standard deviation responses of the respondents on extent of masonry based structural material wastage in building construction sites in Ebonyi state.*

| *S/N* | Item Statements | X | SD | Remarks |
|---|---|---|---|---|
| *1* | Green concrete material | 3.32 | 0.84 | High extent |
| *2* | Fine aggregate – sharp sand | 3.96 | 1.07 | High extent |
| *3* | Fine aggregate – plaster sand | 3.74 | 1.02 | High extent |
| *4* | Cement blocks | 3.46 | 1.16 | High extent |
| *5* | Portland cement | 4.10 | 1.04 | High extent |
| *6* | Water | 3.80 | 1.13 | High extent |
| *7* | Cement mortar | 4.25 | 0.97 | High extent |
| *8.* | Coarse aggregate | 2.49 | 1.03 | Low extent |
| | **Grand mean** | **3.64** | | **High extent** |

**Table 3**

*Mean and standard deviation responses of the respondents on extent of carpentry based structural material wastage in building construction sites in Ebonyi state.*

| *S/N* | Item Statements | X | SD | Remarks |
|---|---|---|---|---|
| *9* | Planks | 3.34 | 1.13 | High extent |
| *10* | Nails | 4.38 | 0.80 | High extent |
| *11* | Binding wire | 3.21 | 1.15 | High extent |
| *12* | Plywood | 3.06 | 1.26 | High extent |
| *13* | Bamboo | 3.66 | 1.11 | High extent |
| *14* | Bracing members | 4.04 | 1.08 | High extent |
| *15* | Roofing members | 3.98 | 0.96 | High extent |
| *16* | Ceiling members | 3.56 | 1.01 | High extent |
| *17* | Scaffolding members | 4.01 | 0.94 | High extent |
| | **Grand mean** | **3.69** | | **High extent** |

**Table 4**

*Mean and standard deviation responses of the respondents on extent of iron bending based structural material wastage in building construction sites in Ebonyi state.*

| *S/N* | Item Statements | X | SD | Remarks |
|---|---|---|---|---|
| *18* | Reinforcement bars | 3.22 | 1.13 | High extent |
| *19* | Binding wires | 3.31 | 1.06 | High extent |
| *20* | Metal angles | 2.28 | 1.17 | Low extent |
| *21* | Metal plates | 2.14 | 1.04 | Low extent |
| *22* | Metal pipes | 2.23 | 1.01 | Low extent |
| *23* | Electrode | 3.34 | 1.08 | High extent |
| | **Grand mean** | **2.75** | | **Low extent** |

**Table 5.** Test analysis between the variables; gender, age and status on structural material wastage

| Division | | Masonry based structural material wastes | Carpentry based structural material wastes | Iron bending based structural material wastes |
|---|---|---|---|---|
| Gender | Male n = 120 ± (S. D) | 3.65 ± (1.04) | 3.70 ± (1.06) | 2.76 ± (1.09) |
| | Female n = 40 ± (S. D) | 3.61 ± (1.01) | 3.66 ± (1.02) | 2.70 ± (1.06) |
| | t-value cal. | 0.22 | 0.21 | 0.30 |
| | t-value table | 1.96 | 1.96 | 1.96 |
| Age | ≤ 49 n = 110 ± (S. D) | 3.67 ± (1.00) | 3.72 ± (1.04) | 2.75 ± (1.10) |
| | ≥ 50 n = 50 ± (S. D) | 3.59 ± (1.09) | 3.62 ± (1.10) | 2.73 ± (1.05) |
| | t-value cal. | 0.44 | 0.54 | 0.11 |
| | t-value table | 1.96 | 1.96 | 1.96 |
| Status | Consultant n = 35 ± (S. D) | 3.60 ± (1.11) | 3.68 ± (1.08) | 2.74 ± (1.13) |
| | Project manager n = 125 ± (S. D) | 3.66 ± (0.99) | 3.72 ± (1.04) | 2.79 ± (1.04) |
| | t-value cal. | -0.29 | -0.20 | -0.24 |
| | t-value table | 1.96 | 1.96 | 1.96 |

@ 95 % confidence level

## Discussion of Findings

The mean rating and standard deviations results presented in Table 2 showed that seven out of eight categories of masonry based structural materials in the item statements are wasted to high extents in building construction sites with a grand mean of 3.64. The coarse aggregate is the only masonry structural material that is not wasted much in the building construction sites. The extents of masonry based structural material wastage in decreasing order are cement mortar (4.25), Portland cement (4.10), fine aggregate – sharp sand (3.96), water (3.80), fine aggregate – plaster sand (3.74), cement block (3.46), green concrete material (3.32), and coarse aggregate (2.49). The low extent status of wastage of coarse aggregate could be attributed to caution taken in the usage due expensive nature of the material. The findings of the study portray possibility of high cost of undertaking housing projects in Ebonyi state as a result of large extent of structural material wastage. The finding of the study is in line with the submission of Anyigor-Ogah and Egba (2018) who pointed out that workmen generate material wastes that have adverse impacts on the environment and economy of a given society.

Analysis of the results in Table 3 revealed that nails, bracing, and scaffolding members are carpentry based structural materials that are wasted to very high extents in building construction sites with mean scores of 4.38, 4.04 and 4.01 respectively. Other carpentry based structural materials that are wasted to high extents are roofing members, ceiling members, bamboo, planks, and plywood. The results indicated that all carpentry based structural materials are wasted to high extents in building construction sites in Ebonyi state with a grand mean of 3.69. It corresponds to the assertion of Katz and Baum (2011) that large quantity of structural material wastes are generated in construction works.

The mean rating and standard deviations results presented in Table 4 showed that three out of six categories of iron bending based structural materials in the item statements are wasted to high extents in building construction sites. The electrode, binding wires, and reinforcing bars are wasted to high extents with mean values of 3.34, 3.31 and 3.22 respectively; whereas, metal angles, metal pipes, and metal plates are wasted to low extents with mean values of 2.28, 2.23 and 2.14 respectively. The results indicated that iron bending based structural materials is the least wasted structural material in building construction sites in Ebonyi state with a grand mean of 2.75.

Table 5 shows the test analysis between the variables; gender, age and status on structural material wastage. The analysis revealed that: for the gender factor, the male group had a higher positive inclination for the masonry based, carpentry based, and iron bending based structural material wastage than the female group. For the age factor, the below 50 years old group showed higher

feelings for structural material wastage than the age group above 50 years old; while for the status factor, the consultants had lower inclination for structural material wastage than project managers. The null hypothesis, that there exists no significant difference in the opinion of the respondents on structural material wastage in building construction sites in Ebonyi state was upheld at 95 % confidence level.

## Conclusion and Recommendation

The paper discussed extent of structural material wastage in building construction sites in Ebonyi state of Nigeria. The study used the questionnaire research instrument to collect data from 200 respondents on extent of masonry based structural material, carpentry based structural material, and iron bending based structural material wastage in building construction sites in the state. The questionnaire contained 8 item statements for masonry based structural material wastage, 9 item statements for carpentry structural material wastage, and 6 item statements for iron bending structural material wastage. 160 out of the 200 questionnaire survey were returned, found reliable and utilized in the study. The response of the respondents was studied based on three major groups, namely: gender, age, and status. The statistical mean, standard deviation and t-test were used to analyze the data. The following deductions were made, namely:

- Cement mortar and Portland cement are masonry based structural material that are wasted to very high extents in building construction sites in Ebonyi state of Nigeria..
- Nails, bracing, and scaffolding members are carpentry based structural materials that are wasted to very high extents in building construction sites in Ebonyi state.
- Iron bending based structural materials is the least wasted structural material in building construction sites in Ebonyi state
- Males have a higher positive inclination for the masonry based, carpentry based, and iron bending based structural material wastage than females.
- Age has a higher negative influence on structural material wastage.
- Consultants have lower inclination for structural material wastage than project managers do.
- There is no significant difference in the opinion of the respondents on structural material wastage in building construction sites in Ebonyi state at 95 % confidence level.

Based on the findings of the study, it was recommended that personnel involved in material usage and control should be trained properly and

motivated adequately to ensure effective handling of the materials towards minimization of structural material wastage in building construction sites.

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