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An Evaluation of Material Waste and Supply Practice on Construction Sites in Nigeria

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Abstract—The Construction activities involve use of materials supplied from many sources. They can be produced on site or supplied from different source. Improper management of construction materials results to wastages in the construction site especially in developing countries like Nigeria where the automated and mechanical means of handling and management of construction materials is too expensive or not available. To identify how effectively the construction materials be handled, this paper was aimed at identifying the major source of material supply and the storage and examine the major sources of material wastages in building construction sites. A total of 100 questionnaires were administered randomly to construction managers in building construction sites in Bauchi and Gombe States. The data collected was critically analyzed using descriptive statistics tools. The findings shows that materials supply to construction sites was majority through suppliers and sub-contractors and that wastage in construction sites was attributed to double handling, environmental factor and poor storage. This implies that an adequate waste management mechanism is required in minimizing construction waste.

Keyword—Construction sites, materials, construction waste, perceptions and storage.

INTRODUCTION

Universally, the assumption is that there is high level of waste in construction. even though systematic measurement of all waste in construction site is difficult however, studies from several countries established that relatively large percentage of production costs is attributed to waste (Madhavi et al., 2013). In order to in monitor construction waste, several measures adopted include excess consumption of materials (Skoyles 1976; Bossink and Brouwers 1996), quality failure costs (Cnudde 1991), and maintenance and repair costs, accidents, and nonproductive time (Oglesby et al. 1989). The importance of waste control in construction industry is not only viewed from the perspective of productivity, but also on the adverse effect of the waste on the environment. This kind of waste was found to accounts for between the ranges of 15 to 30% of urban waste (Brooks et al.1994; Bossink and Brouwers 1996). Due to high levels of contamination and a large degree of heterogeneity, waste from building materials is difficult to recycle (Bossink and Brouwers 1996), and often there is inadequate space for its disposal in cities. The consequences of high levels of waste results into reduction availability of building materials and energy in future, thereby creating unnecessary demands on the transportation system. In fact, large amounts of nonrenewable sources of energy, as well as endangered resources that are depleted are mostly from building materials and components, such as timber, sand, and crushed stone (Bossink and Brouwers 1996). Measuring waste is anThe effective way of assessing the production systems performance is through measuring waste because it usually allows areas of potential improvement to be pointed out thereby identifying the main causes of inefficiency. Waste measures are proved to be more effective in supporting process management when compared to traditional financial measures. The measures enable some operational costs to be properly modeled and information that is usually meaningful for the em factors is generated. Of all the three factors identified, material has shown to have greater influence on successful completion of any project on a construction site. Due to the various materials on sites, the improper handling of most of the materials results into wastage and become an obstruction on sites.

The main aim of this research is to identifying the major source of material supply to construction sites and the form of storage and examine the major sources of material wastages in building construction sites.as these will minimize materials wastage on construction site as well as reducing health hazard in the environment. The study will cover some selected medium construction company within Bauchi and Gombe metropolis. Certain materials selected as a sample for the purpose of the research and these are; cement, sand, and aggregate, timber, block, and reinforcement.

LITERATURE REVIEW

CONSTRUCTION WASTE

Constructions waste has been described by the building research establishment (Vijoen, 2010) as‘’the difference between the quantity of materials used in a

project to that purchased. Furthermore, construction waste according to Vijoen (2010) is the by-product generated and removed from construction, renovation and demolition or sites of building and civil engineering works.Construction waste have been principally categorized as, material, labour, and machinery waste where most of the construction waste comes from non-renewable sources (Ekanayaka and Ofori, 2000).

The generation of construction waste is mostly due to lack of appreciation of the value of material, cutting and application waste, transporting delivery waste, residue waste, succeeding trade waste, specification, and design waste, learning waste, supervisory waste and management waste (Ohiomah,2006).Waste associated with a construction site has been categorized asfour principal types, natural, direct, indirect'' and consequential waste (Carlos et al.,2002). Waste is to a certain extent is inevitable on a building site,however, it is a common norm in the construction industry.The acceptable level of waste according to Vijoen (2010) is the natural waste or total loss of materialsbecause they irreparably damaged or just lost. In this case is distinguished from, direct'' waste in that the materials not usually lost physically, but the payment for part or whole of the value is lost.

WASTE REDUCTION STRATEGIES

Since waste materials are becoming so common within the construction sites various means were identified on how to reduce or prevent construction wastes, the following method could adopted as revealed by Adeagbo and Kunya (2005)

- Re-use of waste such as off-cuts from reinforcement bars for other minor fixing application and welding fabrication should be encouraged.
- Useful material should be sorted out instead of dumping the general waste together. Thisfacilitates re-use.
- Standardize material should be specified and utilize to reduce cutting waste.
- Allowance made for waste by estimators should be scrutinized to avoid excess.
- Site management techniques like proper supervision, employing skill tradesmen and tightening security loopholes would reduce waste generation on site.
- Qualified purchasing officer who is knowledgeable in the construction process and interpretation of material specification should assigned the responsibility of ordering team.
- Operational waste generated due to the nature of construction process, fame pressure, poor craftsmanship and lack of adequate supervision could reduced through theintroduction of incentive schemes.
- Checking materials on arrival to site to ensure that quantity are according to specification. Couple with proper supervision during handling of materials would help reduce material waste in the industry.

Moreover, Keal (2007) suggest the following guide for best waste management practice and waste reduction on thesite. These include;

- Develop logistic strategies that minimize wastage:- is a major contributor to waste.
- Use suitable, safe and secure storage:- for trades or materials were just in time deliveries cannot be setup, proper, safe and secure storage should provide so that damage during storage and movesavoided.
- Consider mechanical system and machinery for moving material:- this is particularly useful for trades where materials delivered in large quantity (brickwork, block work) are using mechanical handling of material damage and lost during material movement on site is minimized.
- Program and monitor construction activities:- this can achieve by creating metrics that allow monitoring of performance and control of construction process.
- Use packaging in an efficient way:-packaging is one of the largest waste streams in construction. There is asituation where too much packaging and sometimes too little packaging provided. Contractor and sub-contractor should investigate ways of eliminating or reducing packaging.
- Train/ educate people on how to reduce waste:-raising awareness of the relationship between design, waste and impact on the environment and also allocating personal responsibility on site for waste reduction (e.g., appoint a waste manager).

METHODOLOGY

Both primary and secondary source data used in the study. The population of the study is mainly construction professionals in Bauchi and Gombe state, Nigeria and the respondent selected at random. A structured questionnaire used in sourcing a primary data within the study area and the data collected was critically analyzed using descriptive statistics tools such as percentage distribution and bar chart. A total of 100 questionnaires distributed to building construction sites in Bauchi and Gombe states and only 80% retrieved. The result of the administered questionnaire can seen in the table one below;

Table 1: Questionnaire administered

Construction site	No of Questionnaires	Filled questionnaires	Percentage of filled questionnaires (%)
Tertiary institutions projects in Gombe	25	20	25
Fadamanmada, Bauchi	25	19	23.8
Federal Lowcost, Gombe	25	22	27.5
Wuntin dada, Bauchi	25	18	22.5
Total	100	80	100

Source; field study, 2015

The demography of the respondent revealed that most of the respondents' possess atleast BSc/B.Tech qualification. The distribution with respect to professions within the construction sites indicates that the majority of the respondents present 43.8% are Architects then followed by 26.3% Quantity Surveyors. The years of experience of the respondent range from (2- 15) years, as shown in table two below;

TABLE 2 Demographic of the Respondents

Qualification	Respondent' Frequency	Percentage %
Msc	24	30
Bsc	35	43.7
HND	9	11.2
Others	12	15.0
Total	80	100
Respondents professions		
Builder's	15	18.8
Architect	35	43.8
Quantity Surveyor	21	26.3
An Engineer	9	11.3
Others	None	O
Total	80	100
Year of experiences		
Less than two years	12	18
2-5 years	25	31.3
11-15 years	21	26.3
Above 15 years	22	27.5
Total	80	100

Source; field survey, 2015

ANALYSIS AND DISCUSSION OF RESULTS

In order to achieve the stated objectives of the study, the following analysis were carried out based on the retrieve questionnaires from the respondents as follows;

Table 3 Data on Supply of Cement, Sand/Aggregate and Block on Site

Variables	Cement	Sand/ aggregate	Block	Total Freq	Percentage (%)
Through manufacturer	-	-	12	12	15
Open market	15	-	-	15	10.8
Through Sub-contractor	4	5	3	12	15
Through suppliers	13	-	12	25	31.3
Produce on site	-	-	6	6	7.5
Total	-	-	-	80	100

Source: Field survey 2015

From the above table three. The cement mostly supplied from open market, the aggregate were supply through sub- contractors and the blocks were supply from either through supplier or manufacturer but viewing the general supply of sites, the materials are supply through sub-contractors and through suppliers where the common one is through sub-contractors that account 31.3%. It can concluded that materials are mostly providedby sub-contractors and suppliers respectively.

Table 3.1: Data Collected on Supply of Reinforcement and Timber.

Variables	Reinforcement	Timber	Total Freq	Percentage (%)
Through manufacturer	-	12	12	15
Open market	25	13	28	35
Through Sub-contractor	4	7	11	13.8
Through suppliers	16	13	29	36.3
Total	-	-	80	100

Source: Field survey 2014

From the table 3.1 it depicts that reinforcement and timber mostly supply through open market and sub-contractors. However, it can be concluded that are usually supply through sub-contractor accounting for about 36.8% followed by open market.

Table 4: How the Materials Stored on the construction Sites

Variables	Total Frequency of the respondent	Percentage of respondents (%)
On a raised platform covered with polythene	10	12.5
On a bear floor	12	15
Stack above the ground level	13	16.3
By stacking	17	21.3
In an open area	8	10
On hard surface	12	15
On a dry surface	9	10
Total	80	100

Source: Field Survey, 2015.

From the figure above indicate that materials are mostly stored by stacking accounting for 21% followed by stacking above the ground level, accounting for 16% and 15% on hard surface, storage on site and in an open area 10%, while on a raised flat form covered with polyethene sheet respectively as shown in the chart one below;

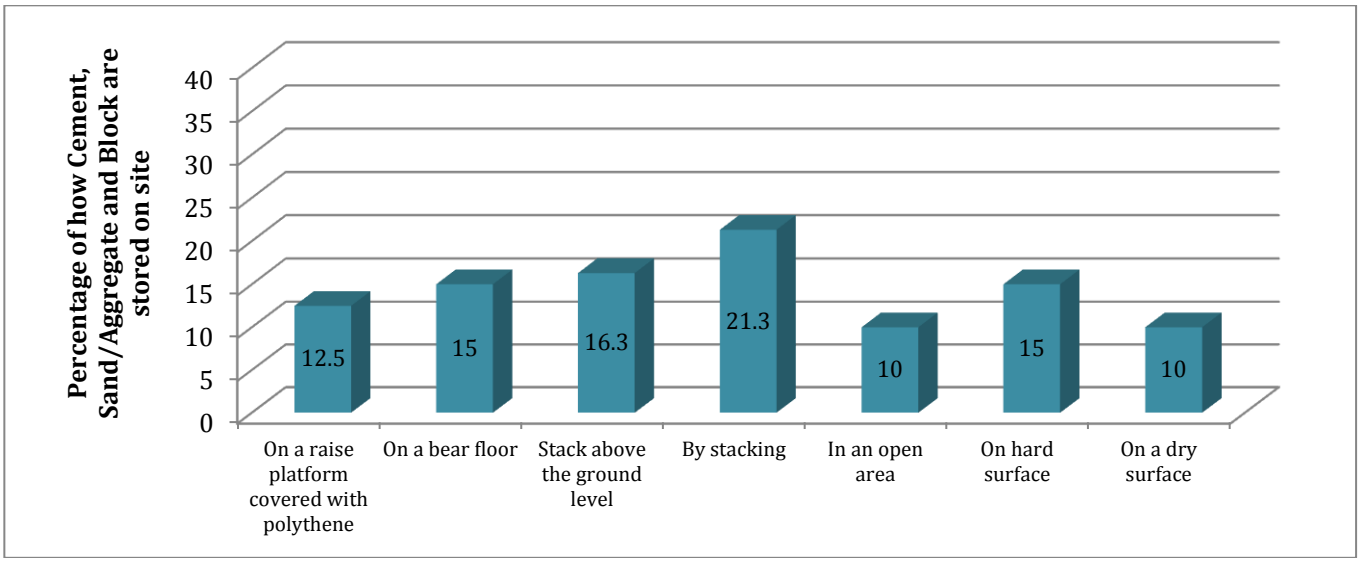

chart 1: percentage how materials stored on site against the means of storage

Table 5: Sources of Waste on Construction Site due to materials supplied

Factors	Cement	Sand/ aggregates	Block	Total Frequency	Percentage %
Poor storage	12	7	3	22	27.5
Insufficient Quantities Supplied	-	-	1	1	1.3
In The process of Laying	-	-	5	5	6.3
Environmental Factors	9	8	3	20	25
Remedial Work	1	1	2	4	5
Double Handling	-	12	16	28	35
Total				80	100

Source: Field survey 2015

From above, environmental factors, poor storage, double handling are the most common factors responsible for materials waste on site where environmental factors having 25%, poor storage 27.5%, and double handling 35% and insufficient quantities supply having only 1.3% waste in all the site visited respectively as shown below;

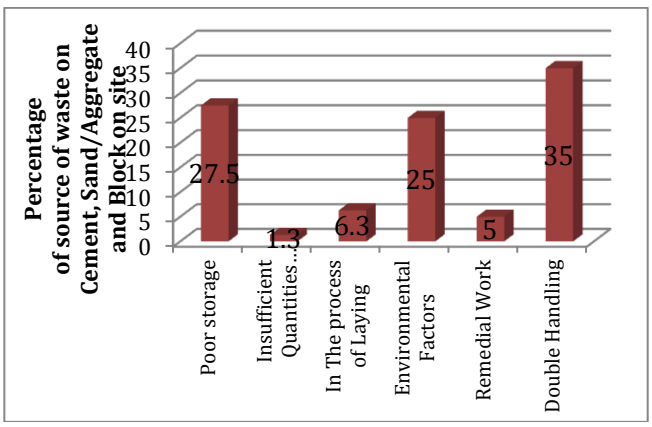

Chart 2. Percentage of sources of waste materials on construction sites

Table 6 Data Obtained on How to Manage Waste on Construction Site

Factors	Total Freq.	Percentage (%)
Obtaining the material in exact quantity	30	37
Provision of protection facilities	15	19
work are carried out according to specification	10	13
Recycle	09	11
Following strict supervision	16	20
Total	80	100

Source: Field survey 2015

From above analysis, the most effective means of manage waste on construction sites are obtaining the materials in exact quantity with 37%, following strict supervision of the supplied materials with 20% and then provision of protection facilities with 19% and indicates that the analysis of materials waste can be avoided and managed on construction site by obtaining the materials in exact quantities can highly avoid and manage waste.

The respondents were asked to indicate whether there're quality control measures of materials provided on the sites and the responses represented in the bar chart below;

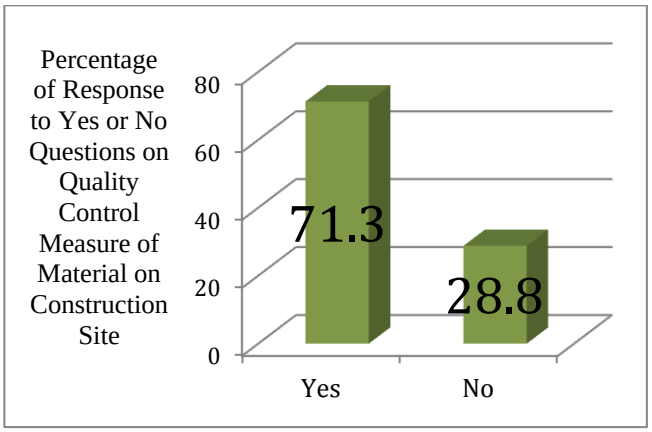

Chart 4: Percentage of responses on quality measure of materials on site

From the figure shown above indicates that 71.3% have engaged in quality control measure onmaterial, and 28.8% have not engaged in any quality control in aconstruction site.

Table 7: Data of Quality Control Measures of Material

Factors	Cement	Sand/ Aggregate	Block	Total Frequency	Percentage (%)
Inspection of material	13	12	14	39	40.7
Engineer/ professional to certify material	12	-	13	25	31.2
Conducting experiment	-	-	1	1	0.01
Testing strength by crushing	-	-	5	5	6.25
Monitoring during production	1	3	6	10	12.5
Total				80	100

Source: Field survey 2015

From above indicates that inspection of material has 40.7%, followed by engineer/ professional to certify material having 31.2% while monitoring during production has 12%, testing strength by crushing 6.25% in term of block testing. It can conclude that inspection of material on the site will be the best way to quality control measures.

Table 8 Data of Quality Control Measures of Material concerning Timber and Reinforcement.

Factors	Timber	Reinforcement	Total Freq.	Percentage%
Inspection of material	14	15	27	33.8
Laboratory testing	-	13	13	16.3
professional to certify thematerial	12	26	32	40.0
Monitoring during production	8	-	8	10.0
Total			80	100

Source: Field survey 2015

The above indicates monitoring during production has the less percentage of 10.0% supported by 8 personnel, 32 respondents responded that profession to certify the material on site before construction can take place presenting 40.0%, also respondents to inspection of material is not significant presenting 33.8% while laboratory testing is very rare presenting only 16.3%. It can concluded that professional to certify the material on thesite can be the best way of quality control measures of material on thesite.

Conclusion and Recommendation

Base on the outcome of the research within the study area, the followings are the major findings as revealed by the respondents;

- The material supply practice to sites are either through supplier or sub- contractors and also the means of storage of materials on the sites is through stacking of materials as well as stacking above the ground levels on sites.
- The most common responsible factor for material waste revealed as double handling, environmental factor and poor storage. These factors are paramount important to take note of so as to avoid or minimize waste materials to bearest minimum on construction sites.
- Obtaining the materials on exact quantity couples with strict supervision of the supplied materials identified base on the respondents' perception as the top effective means of managing waste materials on construction sites.
- On whether the respondent is applying some quality measure on material on the site. It revealed that inspection and monitoring of materials, as well as materials certification by professions, are the top quality measures practicing by respondents on sites.

Therefore, In conclusion, it can be seen that certain factors are responsible for waste on site and the result obtained from the analyses of data shows that the waste mostly occur during the process of incorporating these materials into the construction structures such mixing, cutting, laying e.t.c best on the fact that waste that occur through the abovementioned processes cannot avoided, it is necessary that allowance should be giving or made up at the onset of any project to cover this waste through bill of quantity and also precaution should taken as to minimize wasted and shortages on construction site, it will go a long way to reducing, if not totally prevent the waste that arises as a result of other factors discussed above.

5.2 RECOMMENDATION

From the data analyzed and observation carried out within the study area, the following recommendations were giving:-

- There should be an excellent storage facility for all these materials on site.
- Prior to the start of the projects, Proper schedule of materials toused on site for particular activities must assess and estimated by the quantity surveyor so as to avoid bringing materials in higher quantity than required.
- There should be a continues weekly check of these materials on site as well as proper supervision of the work as it progress so as to ensure that the work are carried out according to the specification.
- Adequate security measures should be taken such as fencing of the construction site and employing watchman so as to prevent an unauthorized person from gaining entrance into the constructions site.
- Adequate quality control measures must be taken such as inspection of materials as they been supplied to the site and employing a material engineer so as to ensure that what quantity materials are used.

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