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MODEL FOR PREDICTING THE QUANTITY OF PLASTERING WASTE IN BUILDING CONSTRUCTION WORKS IN ABUJA, NIGERIA

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ABSTRACT
Construction waste has been identified as global environmental problem that have great effects on the progress of projects. Statistical data relating to the quantities of material waste for building works have not been well documented, and there is no known model for predicting the quantities of onsite material waste for different materials, such as plastering mortar. This study was aims to develop a model for predicting volume of plastering waste in building works. The population for the study consisted 1345 residential construction project sites within Abuja, Nigeria. The sample frame constituted a total of twenty 3-bedroom bungalow buildings and twenty 3-bedroom duplex buildings using stratified random sampling method. The volume of the mortar wasted and mortar used are determined by using bucket as the most commonly used on construction sites. Linear-regression analytical tool was used for the analyses. The study revealed relationships between variables considered are statistically significant in this study. The study concludes that relationship between volume of plastering mortar to be used and volume of plastering waste are statistically significant in both bungalow and duplex works. This means that any change in any of the variables would bring a similarly change in the other variables. Based on these, the research recommends the use of these models by the building construction professionals at the early stage in order to have an ideal record of likely waste.

Keywords: *Model, Nigeria, Plastering waste, Used plaster.*

1 INTRODUCTION

Construction waste has been identified as a global environmental problem which can have great effects on time, cost, quality and sustainability, as well as the progress of projects (Nagapan et al., 2012; Hassan et al., 2012; Saidu, 2016; Saidu et al., 2017).

Material wastage has become a serious challenge all over the world, which needs immediate action in the construction industry and it has affects the completion of many projects (Adewuyi and Otali, 2013);(Saidu et al., 2017). Studies from around the world have revealed that material waste from the construction industry contributes to higher percentage of the production costs. Hence, inadequate management of materials and waste leads to an increase in the total cost of construction projects (Ameh and Itodo, 2013). During the construction process extra construction materials are purchased as a result of material wastage (Ping et al., 2009). The issue of material waste all over the nation remains unresolved in the construction industry. For instance, in the United Kingdom (UK) 10% of the materials supplied to construction sites end up as waste that may not be explained (Osmani, 2011). Ameh and Itodo (2013) stated that in Nigeria in every 100 houses built; there is sufficient waste material to build another 10 houses. Adewuyi and Otali,(2013); Saidu, (2016) discovered that during the process of preparing an estimate for a construction project the quantity of material waste generated on some construction sites is over the 5 percent allowance for material wastage on construction sites. Thus, construction cost estimation methods play crucial roles in the completion of projects (Oyedele, 2015). Masudi et al. (2012);Saidu and Shakantu (2017) noted that while quantification of material waste is very important for construction waste control, accurate calculation can be accomplished by developing waste quantification model that is applicable to national and regional construction waste generation.

Material wastage on construction sites can have impact on the quantity of materials delivered/used but objective researches to provide evidence of such impact of its cost are suboptimal (Saidu and Shakantu, 2017). In Nigeria, not all materials supplied to site are used during construction process; the leftover may remain as waste that may not be explained (Ameh and Itodo, 2013; Saidu, 2016). This is despite the fact that construction professionals allow some percentage of wastage figures during the process of pricing a bill of quantities, but sites experience has revealed that wastage are often more than the amount allowed in the bid document, if site management is not tight (Saidu, 2016). In the last decade, management of waste generation has received less attention in the Nigerian construction industry (Wahab and Lawal, 2011). This could be as a result of the low level or lack of proper quantification of material waste and this is evident in the amount of waste generated at construction sites; low level of awareness of the construction workers; a low level of available

means of waste disposal; or the slow adoption of environmentally sustainable practices (Saidu and Shakantu, 2017). Yuan and Shen (2011) highlighted that the insufficient attention given to material-waste generation in developing nations during the past decades has meant that the statistical data on the quantity of material-waste generation are not readily available. This is supported by Babatunde (2012), who believes that the situation is not any different in the Nigerian construction industry and these are important for the construction professionals to properly manage their disposal thereof. The statistical data relating the quantities of material waste for projects have not been well documented in the construction industry (Saidu, 2016; Saidu and Shakantu, 2017). There is no known model for predicting the quantities of onsite material waste for different materials, such as plastering mortar, block works and so forth; and also statistics on the waste generated are minimal in the Nigerian Construction industry (Babatunde, 2012).

Adewuyi and Otali (2013) argue that despite the allowance of 5 percentages usually made to take care of material waste when preparing estimate for project is inadequate because waste is found in several ways in project in Nigeria. Several researches evidence has revealed that previous studies from around Nigeria centered mostly on waste-control in the industry; as well as the necessary means for their control. Nonetheless, these studies have failed to develop a model for predicting material waste in building construction works. Hence, this study seeks to develop a model for predicting the volume of plastering waste in building works. To achieve this aim, null hypothesis was set as: there is non-statistically relationship between the volume of plastering material to be used and the volume of plastering waste recorded.

1.1 MATERIAL WASTE IN BUILDING WORKS

Construction waste is a well-known issue internationally and has adverse impact on overall progress of a project as well as the building society and nature (Nagapan et al., 2012). As result of this construction activity during the acquisition of raw materials has contributes to the generation of waste in the construction site (Saidu, 2016). In the cost of carrying out these construction activities during construction works has pose negative effects to the environment and the generation of waste, changes in living environment, sewage, reduction in environmental resources and energy usage (Mahayuddin et al., 2013).Due to the fact that the majority of this waste has not been properly controlled, thus causing considerable health and environmental challenges (Imam et al.,2008) and affecting the progress of many projects in Nigeria (Adewuyi and Otali 2013); (Saidu and Shakantu 2016).

According to Al-Hajj and Hamani (2011) construction waste is described as 'the difference between materials supplied to construction site and those materials placed for use on construction projects'. Nagapan et al. (2012) therefore, confirm that waste is any surplus or unwanted material constantly causing environmental difficulties.

On other hand, Construction waste was viewed by many scholars as construction process that generate waste but creates no value, such as rework , incorrect choice, programme of work and poor constructability that leads to waste generation in construction sites (Ma, 2011; Nagapan et al., 2012; Nagapan, Abdul Rahman and Asmi, 2012; Chikezirim and Mwanaumo, 2013 and Saidu, 2016).

Nugroho et al. (2013) also noted that construction waste is leftover material as the residue of construction activities and is caused by many factors, such as over production, handling error, accidents. Baldwin et al. (2010) further considered construction waste as the difference between the materials requested and those materials placed on construction projects. Gulghane and Khandve, (2015)later considered that construction waste involved unnecessary material produced directly or incidentally by the construction or industries which leads to waste generation in the construction sites.

Kwan et al. (2001) and Swinburne et al. (2010) contended that construction waste can be categories into; waste generated due to design and specification, and waste generated during construction activities. Formoso et al. (1999) and Swinburne et al. (2010) also contended that waste can be unavoidable (or natural waste), in which the necessary time to its reduction is higher than the economy produced; and waste can be avoidable when the cost of waste is greatly considerable higher than the cost to curb the waste .Construction material waste was also divided into cutting waste, application waste, transit waste and theft and vandalism (Muhwezi et al., 2012) and (Iqbal and Baig, 2016).

The plaster waste causes environmental damage that results from generating waste material and the economic and social aspects of waste that have an effects on the construction sites (Alencer et.al., 2010).

Ameh and Itodo (2013) also identified mortar from plastering/rendering as the most wasteful materials on construction sites. Eze et al. (2017) concluded that waste from mortar has the most wasteful materials on construction sites.

Material waste can also have a great effect on the progress of a construction project, since it precisely has a great effect on the construction costs (Nagapan et al., 2012). Madhavi et al. (2013);Gulghane and Khandve(2015) noted that , if management of material in construction projects is not well done it will produce a great project cost difference which also leads to waste generation on construction sites. Ameh and Itodo (2013) also identified waste from mortar as the highest cost production to the project cost and waste from concrete cost ten times the cost of mortar. Babatunde (2012) indicates that mortar from plaster has the highest cost of materials wastage on site. Babatunde (2012) further

concluded that mortar used for plaster contributed to an average of 15.32% cost in the construction sites in Nigerian.

3 METHODOLOGY

This research employed the use of field study design approach by collecting quantitative data. The data were generated from the direct measurement of the on-site plastering waste volume /measured plastering volume to be used for 20 number 3-bedroom bungalow and 3-bedroom duplex respectively, all converted to cubic metre (volume). The table containing these details is presented in Appendix 1of this research.

The population for the study consisted 1345 3-bedroom residential bungalow and duplex construction project sites within Federal Capital Territory (FCT) area of Nigeria.

In this research, total twenty (20) 3-bedroom bungalow buildings and twenty (20) 3-bedroom duplex buildings were sampled. These were the active 3-bedroom construction projects as at the time of collecting the research data and to which access was made easier.

3-bedroom bungalows and duplexes were selected, because they were the most convenient forms of residential buildings for average Nigerians today.

In order to guarantee equal representation for each of the identified groups/strata in the population, stratified random sampling method was adopted. The respondents were first categorized into two different strata (3-bedroom bungalow and 3-bedroom duplex) before they were selected and randomly sampled accordingly.

For this research, primary sources were used to generate data.

This study collected primary data through quantitative research approaches which included the use of onsite site observation, measurements of quantity of plastering waste and recording on site was employed. This research also concentrated on mortar waste for plaster only as material considered in this research.

3.1 Field inspections:

The volume of the mortar waste and mortar used are determined by using bucket as the most commonly used on construction sites.

3.2 Method of data analyses

The research adopted the use of inferential methods of analysis to analyze the data and the results were presented in Tables.

Regression analyses are used to show the statistical relationship between one dependent variable and one or more independent variables data. They are also used as a basic predictive analysis. This study was conducted between January 2018 to June 2018.

4. RESULTS AND DISCUSSION

This section presents the relationship between volume of mortar to be used for plaster and volume of plastering waste by using linear - regression analyses and its discussions.

Also before running the regression analyses, test for normality was performed to ensure that the data were normally distributed using the Shapiro Wilks Test and the results revealed a normally distributed data and this allows for further regression analyses to be conducted.

4.1 Relationship between the volume of mortar to be used for plaster and the volume of plastering waste

The two analyses in Table 1 show the result of linear regression analyses performed between the volume of plaster waste and the volume of plaster to be used on 3-bedroom bungalows and duplexes. The results depict a linear and a strong correlation with the R-square values of 83.10% and 95.10% respectively. The probability values (0.000) were less than the 5% significance level; and the hypotheses were conducted at the 95% confidence level. Therefore, relationships are statistically significant; and the null hypotheses are rejected. The results show that any change in the either of the variables (X and Y) would lead to a corresponding change in the other.

TABLE 1: RESULTS OF REGRESSION ANALYSES BETWEEN VOLUME OF PLASTER TO BE USED AND VOLUME OF PLASTERING WASTE FOR 3-BEDROOM BUNGALOWS AND DUPLEXES

s/n	variables		Type of model	observation			inference		
	X	Y		Regression Equation (Y=a+bx)	R^2	Probability value	Strength of relationship	Remarks	Action on Hypothesis
1	Volume of mortar to be used for plaster	Volume of mortar waste for plaster	Linear regression	Plaster waste =2.35+ 3.205 plaster to be used Bungalow	83.10%	0.000	Very strong	Statistically significant	Reject Ho
2	Volume of mortar to be used for plaster	Volume of mortar waste for plaster	Linear regression	Plaster waste =1.334 + 4.276 plaster to be used duplex	95.10%	0.000	Very strong	Statistically significant	Reject Ho

Therefore, to predict the volume of plaster waste using the 3-bedroom bungalows and duplexes will be determined by: adding the constant value (2.35 and

1.334 respectively) to the coefficient value of the plaster used in volume (3.205 and 4.276 respectively), and multiplied by the volume of plaster to be used for building works.

These results corroborate with the findings of Saidu and Shakantu (2017) who observed that increase in the volume of materials used would leads to increase on the quantity of material waste and would also increases the cost of materials waste for project. Also, Ameh and Itodo (2013); Teo et al. (2009); Saidu and Shakantu (2016) observed that final cost of a building project also increases as results of material wastage on construction sites. Which more so means that as more materials are wasted, more is needed, thus affecting the final project costs.

5. CONCLUSION AND RECOMMENDATIONS

Construction waste has been identified as global environmental problem that have great effects on time, cost, quality and sustainability, as well as the progress of construction projects. Statistical data relating to the quantities of material waste for building works have not been well documented, and there is no known model for predicting the quantities of onsite material waste for different materials, such as plastering mortar, block works and so forth. This study was aims to develop a model for predicting plastering waste volume in building works. The study concludes that relationship between volume of plastering mortar to be used and volume of plastering waste are statistically significant in both bungalow and duplex works. This means that any change in any of the variables would bring a similarly change in the other variables. The model was developed from the linear -regression analysis. Based on these, the research recommends the use of these models by the building construction professionals at the early stage in order to have an idea on the likely volume of waste to be recorded, so that adjustment could be made in the areas of management and supervision of project at hand.

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Appendix1

DATA COLLECTED USING TABLE PROFOMA

Plastering Mortar 3-BED BUNGALOW			Plastering Mortar 3-BED DUPLEX		
S/n	Volume of materials used (m^3)	Volume of waste (m^3)	S/n	Volume of materials used (m^3)	Volume of waste (m^3)
1.	14.31	3.43	1.	35.52	8.53
2.	34.59	9.55	2.	32.28	7.73
3.	21.72	5.40	3.	46.89	11.27
4.	32.79	8.15	4.	36.60	8.80
5.	16.68	4.61	5.	91.62	22.00
6.	44.49	11.06	6.	23.68	5.28
7.	9.54	4.05	7.	21.52	4.81
8.	23.06	9.54	8.	31.26	6.99
9.	23.06	7.29	9.	24.40	5.47
10	14.31	2.25	10	61.08	13.66
11.	14.34	3.96	11.	69.84	16.77
12.	14.40	3.58	12.	83.31	20.00
13.	19.14	4.75	13.	25.16	6.03
14.	9.56	2.64	14.	60.02	14.40
15.	14.55	4.07	15.	46.56	10.4
16.	9.70	2.67	16.	47.94	10.71
17	9.60	2.98	17	16.77	4.41
18	12.76	3.54	18	40.01	8.94
19	12.76	3.98	19	69.84	12.14
20	14.55	2.02	20	69.84	13.88

Source: Researcher's field survey, 2018.