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CONSTRUCTION WASTE MANAGEMENT PRACTICES IN PRIVATE AND PUBLIC PROJECTS IN ABUJA, NIGERIA

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ABSTRACT

This research aims to investigate waste management practises in private and public construction projects in Abuja, Nigeria, with a view to improving project performance as well as producing environmentally friendly projects and serving as a guideline for good waste management on sites. There is no database of private building projects executed in the study area, which makes the establishment of a population difficult. Therefore, two professionals each were purposively selected from each of the thirty (30) public and thirty private projects visited in the study area. The study utilised closed-ended questionnaires and adopted both descriptive and inferential methods of analysis. The findings classified factors contributing to waste generation on construction sites into four categories: procurement, handing, operation, and cultural factors. Damages due to transportation (MIS = 3.70) are identified as the most important overall factor contributing to waste generation on construction sites. This was followed by rework, variation, and negligence (MIS = 3.62). The Pearson Chi-square statistic (f) = 1.833a p-value = 0.400 (p 0.05) yielded this result. This shows that the variables are interdependent, implying that there is a statistically significant difference in the amount of trash created in private and public building projects. Based on the findings of this research, it is concluded that proper waste management practises in private and public construction projects when adhered to help in improving project performance, as well as producing environmentally friendly projects and serving as a guideline for good waste management on sites. The study recommends, based on challenges, that professional bodies should work with

university bodies so as to inculcate sustainable building education into their various academic curricula.

Keywords: *Construction, Waste Management, Practices, Private, Public Projects.*

INTRODUCTION

Construction is an industry that plays a vital role in the socio-economic growth of a country. It provides the necessary infrastructure and physical structure for activities such as commerce, services, and utilities (Khan, Liew, & Ghazali, 2014). Besides that, it also generates employment opportunities and enhances the nation's economy by creating foreign and local investment opportunities (Nor-Solehah, 2015). The construction industry involves different processes and utilises huge quantities of resources. During the extraction and processing of raw materials used in construction, these processes have a big impact on the environment. These effects happen over a wide range of timescales, from when the raw materials are extracted and processed to when the building is built, used, and eventually demolished (Horsley and Khandve, 2015).

Poor waste management is a waste contributor and serious environmental issue. Ineffective waste management practises at construction sites increase the generation of construction waste. There has been increasing construction waste attributable to insufficient waste management practises in construction projects for the last two decades (Nagapan et al., 2012). The contractors are expected to behave the same under the same set of construction waste management (CWM) public policies regardless of the sector that employs them. Regardless of sector, the two sectors are expected to perform similarly in formal public policies. Waste streams vary according to the phase of construction, the method, and the type of building, making it important to adapt waste management practises to suit the specific site and phase of construction. Most waste is produced on-site through over-ordering, damage by mishandling materials, off-cuts,

inadequate storage of materials, and unnecessary packaging of construction materials, e.g. plastics and cardboard.

Similarly, waste management is made difficult in construction due to the unique nature of each project, the hostility and unpredictability of the production environment, and the intense cost and time pressure that characterise many construction projects.

The contractors are expected to behave in the same manner in both the private and public sectors under the public policies regardless of the sector that employs them. Tam et al. (2007) affirmed that private clients involved in private housing and commercial projects tend to produce the highest levels of waste when compared with other types of projects. While Lai et al. (2008) asserted that there was no difference in the performance of contractors working for different types of clients, The predominant stages in managing waste generation are: storage, collection, transfer, processing, and disposal (Rodgers, 2011). Several approaches may be adopted during each stage to ensure effective management. Although waste generation may be inevitable, management is possible and it may be achieved throughout all construction activities, from design to deconstruction. Similarly, waste management is made difficult in construction due to the unique nature of each project. None of the previous studies investigated waste management within the context of public and private projects, most especially in Nigeria. It is against this backdrop that this study will assess the management of construction waste in private and public construction projects in Abuja, Nigeria.

The following objectives were formulated:

1. To assess factors contributing to waste generation on construction sites;
2. To examine and compare the level of waste generated and construction waste management performance in private and public construction project;

LITERATURE REVIEW

Factors Contributing to Waste Generation on Construction Sites

Construction waste generation has created serious problems, both locally and globally (Tareq and Ahmed, 2018). Construction waste materials are generated in new building construction, either residential or non-residential building structures, as well as public works projects, such as roads, bridges, and dams (Abdelhamid, 2014). Many factors contribute to the generation of material waste. These factors have been grouped by Ekanayake & Ofori (2000) under four categories: (1) design; (2) procurement; (3) handling of materials; and (4) operation. They have concluded that most of the causes of waste are due to design issues. This finding has also been reported in a number of other studies (Ekanayake and Ofori, 2004; Innes, 2004; Keys et al., 2000; Rounce, 1998). It is, therefore, agreed that the process of waste minimisation must be started at the early stages of the project. A survey conducted by Saunders and Wynn (2004) showed that improper design resulting in excessive cut-offs is one of the major causes of material waste. Therefore, sources of waste revolve around four factors, namely: procurement, handling, operation, and culture. Delivery methods, delivery schedules, insufficient materials purchased, poor material quality, no take back schemes, poor supplier advice, and poor supply chain management (Lingard et al., 2000; Domingo, 2015; Ajayi et al., 2017; Holt, 2014; Wambeke et al., 2011, Gündüz et al., 2013, Aziz, 2013).Handling: damage due to transportation, inappropriate handling, poor product knowledge, and inappropriate storage (Bekr, 2014; Domingo, 2015; Ajayi et al., 2017; Holt, 2014; Wambeke et al., 2011). Operation: rework, variation and negligence, unskilled labour, time restraint, poor communication, poor coordination between trades, and inclement weather (Adewuyi and Otali, 2013; Fadiya et al., 2014; Bekr, 2014; Domingo, 2015). Lack of awareness, lack of incentives, lack of support from senior management and lack of training (Ekanayake and Ofori, 2004; Innes, 2004; Keys et al., 2000; Rounce, 1998).

Measures of Construction Waste Management (CWM) Performance

Waste generation rate (WGR) is widely used to measure construction waste management (CWM) performance. WGR can be calculated by dividing the waste in volume (m3) or quantity (tons) by either the amount of virgin materials purchased, or the amount required by the design, or per m2 of gross floor area (GFA) (Formoso et al., 2002). Methodologies adopted for data collection for estimating WGRs are diverse and typically include: direct observation (Poon et al., 2001); comparing contractors' records (Skoyles, 1976); questionnaire and telephone survey (McGregor et al., 1993); sorting and weighing the waste materials on site (Bossink and Brouwers, 1996); collecting data through consultation with construction company employees (Treloar et al., 2003; Tam et al., 2007); and tape measurement and truck load records (Poon et al., 2001, 2004). There are two prevailing approaches: classifying waste materials into different categories or treating them as a whole. Many studies (Bossink and Brouwers, 1996; Treloar et al., 2003) investigated WGRs by differentiating material waste, while others (Poon et al., 2004) investigated C&D waste by treating the waste stream as a whole. All the studies derived a general rate such as volume (m3) or quantity (tons) of waste generated per m2 of GFA.
WGR indicator:
WGR=Waste quantity/contract sum (ton/Naira)

RESEARCH METHODOLOGY

A quantitative research approach was adopted in this study. The use of structured questionnaires was employed for data collection in order to achieve the study's objectives. The collected data was analysed using the Mean Index Score (MIS) and Chi-Square and cross tabulation to compare the level of waste generated in private and public construction projects.
Data was collected from construction practitioners (such as project managers, site managers, and supervisors) working on government-financed projects and selected private developer's projects sites in Abuja.
The population constituted the number of building and engineering construction firms operating within Abuja and registered with the Abuja business directory. The register of Abuja's business directory has 255

construction firms registered business addresses. This makes up the population size for the study. According to Boddy (2016), there are several approaches for determining the number of participants or observations in a study. The research adopted an approach of using a fraction or percentage of a large population of the professionals met at the site during the field survey. Therefore, 2 professionals from each of 30 public and private construction projects domiciled in Abuja were sampled, amounting to a total of 120 respondents in the study area. The questionnaire (designed in a five-point Likert scale format) addressed issues relating to the research objectives respectively. A purposive sampling technique, which is a non-probability sampling, was adopted for the selection of 2 professionals at each construction site.

RESULTS AND DISCUSSION

Result and Discussions on the Factors Contributing to Waste Generation On Construction Sites

This section of the thesis reports the results of analysis carried out in pursuance of Objective One, namely, the factors contributing to waste generation on construction sites as described previously. It was also gauged through the use of mean score analysis. The factors were categorised into four categories: procurement, handing, operation, and cultural factors contributing to waste generation on construction sites.

Table 1: Factors Contributing to Waste Generation On Construction Sites

SN	Factors Contributing to Waste Generation	Overall		Public		Private	
		MIS	Rank	MIS	Rank	MIS	Rank
1	Damages due to transportation,	3.70	1st	3.69	1st	3.70	2nd
2	Time restraint	3.09	14th	3.69	1st	2.70	19th
3	Poor product knowledge	3.49	5th	3.58	3rd	3.40	11th

4	Inappropriate handling	3.55	4th	3.54	4th	3.57	7th
5	Lack of awareness,	3.48	7th	3.48	5th	3.48	8th
6	Poor communication	3.22	13th	3.45	6th	3.00	15th
7	Inappropriate storage	3.56	3rd	3.43	7th	3.69	3rd
8	Delivery methods	3.42	8th	3.40	8th	3.45	10th
9	No take back schemes	3.09	14th	3.39	9th	2.80	16th
10	Poor quality of materials	3.49	5th	3.38	10th	3.60	6th
11	Lack of incentives,	3.07	16th	3.35	11th	2.80	16th
12	Lack of training	3.38	10th	3.27	12th	3.48	8th
13	Lack of support from senior management and	3.23	12th	3.25	13th	3.20	13th
14	Rework, variation and negligence	3.62	2nd	3.23	14th	4.00	1st
15	unskilled labour	3.42	8th	3.22	15th	3.62	5th
16	Purchase of inadequate materials	2.78	19th	3.06	16th	2.50	20th
17	Inappropriate handling	3.35	11th	3.04	17th	3.65	4th
18	Delivery schedules	3.06	17th	2.98	18th	3.15	14th
19	Poor advice from suppliers	2.78	19th	2.85	19th	2.70	19th
20	Poor supply chain management	3.04	18th	2.78	20th	3.30	12th

Source: Author's field work (2021)

Table 1 reveals the respondent's perception of factors contributing to waste generation on both public and private construction sites. Going by the overall ranking of the two categories of construction sites damaged due

to transportation, the MIS of 3.70 was ranked 1st. While it was also ranked 1st with an MIS of 3.69 at public construction sites and 2nd with an MIS of 3.70 at private construction sites, rework, variation, and negligence were ranked 2nd with an MIS of 3.62. The same factor was ranked 14th at public construction sites, with an MIS of 3.23, and first at private construction sites, with an MIS of 4.00. Inappropriate storage was ranked 3rd with a MIS of 3.56 going by the overall ranking of the two categories of construction sites. This factor was also ranked seventh at public construction sites, with an MIS of 3.43, and third at private construction sites, with an MIS of 3.69. Inappropriate handling was ranked 4th overall, with a MIS of 3.55. Public construction sites ranked it 4th with MIS 3.54, while private construction sites ranked it 7th with MIS 3.57. Poor product knowledge and poor quality of materials had an overall ranking of 5th with MIS 3.49 and 3.49, respectively. Public construction sites ranked 3rd and 10th with MIS 3.58 and 3.36; private construction sites ranked 11th and 6th with MIS 3.507 and 3.60, respectively. The least ranked factors contributing to waste generation on both public and private construction sites were the purchase of inadequate materials and poor advice from suppliers, with an overall ranking of 19th and 19th with an MIS of 2.78 and 2.78, respectively. This factor was also ranked 16th and 19th with MIS 3.06 and 2.85 at public construction sites, and 20th and 19th with MIS 2.50 and 2.70 at private construction sites. The findings here agree with the studies of Domingo, 2015; Ajayi et al., 2017; and Holt, 2014, where it was revealed that sources of waste revolve around the following procurement factors: delivery methods, delivery schedules, purchase of inadequate materials, poor quality of materials, no take-back schemes, poor advice from suppliers, and poor supply chain management. Bekr (2014) and Wambeke et al. (2011) also found that waste comes from the following handling factors: damage during transportation, improper handling, poor product knowledge, and improper storage. This is also in line with the findings of those studies. Lack of awareness, incentives, support from senior management, and lack of training are all cultural factors that can lead to waste in the workplace. This is in line with the studies of Ekanayake and Ofori, 2004; Innes, 2004;

Keys, et al., 2000; and Rounce, 1998, which found that these factors are to blame.

Result and Discussions on the Level of Waste Generated and CWM Performance in Private and Public Construction Project

Average volume of waste generated per day per project

Table 2 shows the average volume of waste generated per day per project in tonnes at both private and public construction sites in Abuja. The findings revealed that on private construction sites in Abuja, an average of 1–5 tonnes of timber waste, less than 1 tonne of concrete waste, 1–5 tonnes of tile waste, less than 1 tonne of screed waste, more than 5 tonnes of reinforcement bar waste, 1–5 tonnes of plied wood waste, and less than a tonne of plastics and packaging materials were generated per day and per project. At Abuja public construction sites, more than 5 tonnes of timber waste, 1 to 5 tonnes of concrete waste, 1 to 5 tonnes of tile waste, less than 1 tonne of screed waste, more than 5 tonnes of reinforcement bar waste, more than 5 tonnes of plied wood waste, and less than a tonne of plastics and packaging materials were generated per day and per project at Abuja public construction sites.

Table 2: Average Volume of Waste generated Per Day Per Project

SN	Type of waste	Private (tonnes)	Public (toones)
1	timber,	1-5 tonnes	> 5 tonnes
2	concrete,	< 1 ton	1-5 toon
3	tiles,	1-5 tonnes	1-5 toon
4	screeds,	< 1 ton	< 1 ton
5	reinforcement bar,	> 5 tonnes	> 5 tonnes

6	plywood,	1-5 tonnes	> 5 tonnes
7	Plastics	< 1 ton	< 1 ton
8	packaging materials	< 1 ton	< 1 ton

Source: Author's field work (2021)

Table 3 was used to calculate the difference between the levels of waste generated in private and public construction projects. The two variables were measured as nominal data. The output of the Chi-square analyses presented in Table 3 shows that the Pearson Chi-square statistic (f) = 1.833a p-value = 0.400 ($p < 0.05$). This derivation denotes that the variables are dependent, thus providing enough evidence to infer that there is a significant statistical difference between the level of waste generated in private and public construction projects.

Table 3: Chi-Square Tests

Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.833[a]	2	.400
Likelihood Ratio	1.843	2	.398
Linear-by-Linear Association	.709	1	.400
N of Valid Cases	100		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 3.68.

Source: Author's field work (2021)

The cross-tabulation executed and presented in Table 4 supports the outcome of the Chisquare test and buttresses the situation in the study areas. According to the data, 7.4 percent of private projects generated a large volume of waste, 48.1% of private projects in the same category generated a moderate volume of waste, and 44.4 percent of private projects in the study area generated a low volume of waste. Furthermore,

8.7% of public projects generated a large volume of waste, 34.8% of public projects generated a moderate volume of waste, and 56.5 percent of public projects generated a low volume of waste in the study area.

Table 4.8: Type of projects * Volume of waste Cross tabulation

			Volume of waste			
Crosstabulation			Large	Moderate	Low	Tota
Type of projects	Private	Count	4	26	24	54
		% within Type of projects	7.4%	48.1%	44.4%	100.
	Public	Count	4	16	26	46
		% within Type of projects	8.7%	34.8%	56.5%	100.
Total		Count	8	42	50	100
		% within Type of projects	8.0%	42.0%	50.0%	100

Source: Author's field work (2021)

CONCLUSION AND RECOMMENDATIONS

The study assessed waste management practises in private and public construction projects in Abuja, Nigeria, with a view to improving project performance, as well as producing environmentally friendly projects and serving as a guideline for good waste management on sites. As a result, the study concluded that proper waste management practises in private and public construction projects, when followed, aid in improving project performance, producing environmentally friendly projects, and serving as a guideline for good waste management on construction sites.In view of the findings and conclusions of this study, the following recommendations were made:

Based on the environmental challenges, these professional bodies should work with university bodies so as to inculcate sustainable building education into their various academic curricula.

Construction companies should try to make sure that their workers get enough training on how to deal with waste.

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