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Full Length Research Paper

An evaluation of waste control measures in construction industry in Nigeria

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Improper control of materials during different stages of construction has caused waste and associated environmental problems. Hence, this research assesses the forms, causes and factors incidental to waste and measures to effectively control construction waste. It is shown that among the factors incidental to waste, last minute client requirement was ranked highest as the factor that leads to design variation with relative importance index value of 3.97; cost of construction materials was ranked highest as a factor that affects selection of construction materials with relative importance index value of 4.05, and construction cost was ranked highest as the factor that leads to construction method with relative importance index value of 3.86. The research also showed that most of the firms do not calculate waste indices which could assist them to determine the amount of waste that could be generated on sites. Sorting exercise that could help firms to identify economy advantage associated with the waste streams is not adequately carried out. It was also discovered that most firms do not incorporate "waste management plan" into the collection of documents that are required of contracting firms during tendering process. To control waste, designers should be able to co-ordinate dimensions between materials specified during design and those procured for use at sites. There is need to allow proper control in the handling, storage and use of materials on site. Also, "waste management plan" should be incorporated as one of the documents dearly expected to be submitted by contracting firms during tendering process.

Key words: Construction processes, waste, factors, effects, control measures.

INTRODUCTION

In the first decade after independence, the tempo of what is referred to as modern construction was at low level in Nigeria. This was restricted to isolated urban centres that were essentially the seat of government as it marked the transitional stage of the nation's growth. Hence, the low level of economic activities was precipitated by 1967 to 1970 civil war (Wahab and Alake, 2007). Between 1971 and 1975, the industry witnessed activities motivated by the need for reconstruction and rehabilitation of programmes incidental from the massive destruction during civil war. Property investment was at its peak and indeed by 1974, the annual growth in the industry was 269.40%. The oil boom in Nigeria in the late 60s and early 70s saw the influx of both foreign and indigenous firms into the construction industry (Ogunbiyi, 1998). However, from 1976 to 1980, there was a slight decline in the growth of the industry and it got more pronounced as the years rolled by. The Nigerian construction industry evolved from the public works department (PWD) that metamorphosed into the Federal Ministry of Works and now Federal Ministry of Housing, Land and Urban Development.

The major clients of the industry are the federal, state and local tiers of government that award 70% of the contracts while the private sector awards the remaining 30% of construction works. This trend is contrary to what obtains elsewhere in the world where it is private-sector driven (Ogunbiyi, 2004). The construction industry plays a strategic role in the Nigerian economy. According to Akindoyeni (2004), in the industrialized countries, the construction industry can be responsible for up to 20% of

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the gross domestic product (GDP) and employs up to 12% of the total labour force. He stated that Nigeria is striving to reach this happy state of affairs, but even at this sub-optional state of development, the industry is responsible for 61% of the GDP and employs up to 20% of the labour force. In Nigeria, the scope of operation can be regarded as the most common criterion. Researchers use this criterion to categorise contractors into either indigenous or expatriate (Olateju, 1991; Samuel, 1999; Mayaki, 2003). Idoro (2007) describes indigenous contractors as those contractors that are fully owned and managed by Nigerians. He further describes multinational contractors as expatriate contractors who are mainly private firm that are jointly owned by Nigerians and foreigners, but solely managed by expatriates.

According to Oladapo (2007), the construction industry in Nigeria is made up of an organised formal sector and an unorganised informal sector. The formal sector comprises foreign and indigenous companies, which are classified into small, medium and large sized firms according to their level of capitalization and annual turnover.

Literature review

According to Henry et al. (2009), the construction sector represents one of the most dynamic and complex industrial developments the world over. The construction activities in the context of the Nigeria economy cannot be treated with a wave of hand. Obadan and Uga (1996) claimed that the construction industry contributes between 3 and 6% of the gross development product (GDP) in developing countries and records from the Federal Office of Statistics specifically ascertain that the contribution of construction industry to Nigeria's gross development product (GDP) has hovered around 2% for the past 15 years and this accounts for about 69% of the Nation's Gross Fixed Capital Formation (FOS, 1997). Empirical studies had also reinforced the fact that 1% increase in the stock of infrastructure generates 1% increase in the GDP across all countries.

Ilesanmi (1986) posited that the cost of materials accounted for 50 to 60% of the total cost of construction of any project, while Skoyles (2000) came out with the most recent information that cost of material alone in the building construction project is 55 to 65%. To reduce cost of construction projects, an optimum material control on site should be therefore adopted. Construction waste is a growing problem in many countries. Stokoe et al. (1999) reported that construction and demolition (C&D) waste took up about 65% of Hong Kong's landfill space at its peak in 1994/1995. According to Ferguson et al. (1995), over 50% of the waste in a typical United Kingdom landfill could be construction waste. Craven et al. (1994) reported that construction activity generates 20 to 30% of all waste deposited in Australian landfills. In the United State, C&D waste represents about one-third of the volume of materials in landfills. Serpell and Labra (2003) reported that of the 3.5 million tons of C&D waste generated in Chile, only 10% is placed in authorized and controlled landfill sites. In the European Union, it is estimated that 0.5 to 1 ton per capital of C&D waste is generated annually. At the project and corporate levels, materials waste implies loss of profit and competitiveness for the contractor. Wastage may also lead to delays that cause costly idle time for other resources (Neo and Koh, 1995). At the national level, waste causes environment-related problems (Tammemagi, 1999). The cost and environmental implications of construction activities are now well known.

The construction industry in particular and the built environment in general has been found to be among the main consumers of resources and energy. Moreover, the construction sector is reported to be generating unacceptable levels of material and manpower waste. Generally, construction activities which produce wastage can be grouped into off-site and on-site operational activities. Off-site activities include prefabrication, project design (architectural, structural, mechanical and electrical design), manufacturing and transporting of materials and components. On-site construction activities relate to construction of a physical facility which consists of the substructure and superstructure of the building. Some degrees of waste materials are inevitable in the construction process. All estimators allow wastage factors in pricing a bill of quantities. Over the years, experience has shown, however, that unless site management control is tight, wastage can frequently exceed, often by a large margin, than the figure allowed in the tender document. Enshassi (1996) buttressed the need for re-unification when he suggested that effective materials control demands concentrated and coordinated action of numerous people performing a variety of functions within the industry. He further suggested that waste seen on site is not necessarily caused by failure or inadequacy of individual functions involved in materials management system.

Control of material is relatively a new practice in the construction industry. In the present situation, the management and the designers are mainly concerned on how to control cost without any emphasis on waste control measures. Generally, it is accepted that cost of materials accounted for a great percentage of the total cost of construction projects. Therefore, a critical control of materials on site should be adopted. Materials wastage on site cannot be treated fully without materials control. In fact, material waste level on site is a measure of site management. It is also one of the enemies of contractors. Most loss of materials occurs as a result of the decision of the site management. Decision taken at the initial stage of any project that is the design stage, either by the manufacturer or supplier of materials are capable of increasing waste level. This can occur as a result of

manufacturers not following strictly the buyers' specification and supplier not packaging the product for easy transportation. Since all the burden of waste lies solely on the contractor, it is important that the site management should ensure a good supervision of materials and apply an effective method of controlling waste. Waste normally emanates during different stages of construction which can be during planning, estimating or construction stage. In Nigeria, not all the materials procured are used during construction and this indicates that the left-overs may remain as waste that may not be accounted for.

Over the years, there has been an increase in the rate of construction activities in the country. This has inevitably led to the generation of waste at different stages of projects. Currently in Nigeria, little consideration has been paid to the control of generation of construction and demolition waste (C & D) in the last decade. This can be attributed to the availability of relatively low means of waste disposal and the generally, low environmental awareness of the construction industry wastes in the country. And despite being a major generation of considerable waste, the construction industry in Nigeria, has been slow to embrace environmental friendly practices. The study aims at identifying the sources of waste on construction sites, determine the current waste control measures and assess the effectiveness of the waste control measures with a view to seeking for ways to control waste generation in future construction projects.

RESEARCH METHODOLOGY

The scope of coverage of this work was limited to construction companies in Lagos to determine issues related to waste management and control on construction sites. The restriction to Lagos state was informed by the fact that the vast majority of construction activities in the country take place in the state. Also, Ajanlekoko (2001) confirmed that Lagos state accounted for 60% of prospective clients that patronize construction industry in Nigeria. The sample frame for this study was gotten from the Building/Construction Industry Directory (2003). From the sample frame, construction companies that are based in Lagos state, Nigeria were selected. For research purposes, different types of sampling techniques could be appropriate; hence, for the purpose of this study, simple random method was used from the study population of construction firms in Lagos State, Nigeria. Researchers have used different methods to evaluate wastes generated during construction process. Bossink and Brouwers (1996) used brainstorming technique. Serpell and Labra (2003) used the interview approach. In the study of Poon et al. (2004) on construction waste management in Hong Kong public housing projects; there was the use of questionnaires that covered a wide range of topics concerning construction waste minimization; regular visits to know the scope of work done where wastes were generated by using a checklist of information and the quantities of waste estimated by visual inspections, tape (that is volume) measurments and truck load records.

In this study, primary data was obtained using structured questionnaires, interviews and site visits. Questionnaires were designed on structural basis to get information about personal data of the respondents to depict their profile that may let them have experience on issues relating to waste management in construction process. The questionnaires were also designed in line with the method adopted by Poon et al. (2004), but also made to cover various factors that lead to wastages on construction sites, waste control measures, effectiveness of the waste control measures and existence of waste management plan in contractual process. Eighty (80) structured questionnaires were administered to the core practitioners in the industry who had knowledge of waste generated during construction process. The reliability and validity of the questionnaire is based on the use of measurement scale to assess the causes of construction waste, and a total of seventy-five (75) questionnaires were returned and found useful which amounts to a return rate of 93.75%. Interviews were conducted to complement the questionnaires. Personal interviews were conducted to complement the questionnaires administered to the respondents. The interviews were conducted among construction personnel namely architects, builders, engineers and foremen by covering issues related to the order of site activities, waste handling methods, problems of waste management, waste reduction measures and likely suggestions to avoid and minimize waste. Site visits were carried out to physically identify the methods used at the construction sites to manage streams of waste generated.

The data collected were analysed with the use of descriptive and inferential statistical methods. The relative importance index (RII) method was used to show the level of the factors contributing to waste generation on construction sites. The RII for each factor was computed from the analysis of the rating indicated by the respondents with the use of five-point likert scale. The value of 5, 4, 3, 2, and 1 were respectively to very important, more important, important, fairly important and not important. The RII is the ratio of the "summation of the weight value" (SWV) and the total number of respondents from all ratings. The nearer RII to 5, the higher the degree of importance of the categorized factors. The SWV is the addition of the product of value attached to each rating and respective number of respondents that is:

$SWV=\sum x_i y_i$, and $RII=SWV/\sum x_i$.

Where;
x_i = number of response to rating i_j,
y_i= the value of rating i (i = 1 to 5).

RESULTS OF FINDINGS

Respondents' profile

A total number of eighty questionnaires (80) were administered and seventy-eight (78) were retrieved and this ought to be useful to depict issues concerning waste generation during construction process. Out of the retrieved questionnaires, two were rejected for the analysis due to inconsistency and errors observed in the data contained therein. Table 1 shows that 12.00% of the respondents were builders, architects 48.00%, quantity surveyors 21.33% and engineers 18.66%. Some 89.86% of the respondents were from indigenous firms while 10.14% were from foreign firms. Some 50.66% of the respondents possess 0 to 5 years of experience; the period of the experience of the remainder were; 6 to 10 years 16.21%; 11 to 15years 9.33% and 16 to 20 years 8.00%. Some 78.60% of the respondents were in the employment of the medium sized construction firms and the remainders, 11.40% were in small sized firms and

Table 1. Respondents' profile.

Respondents' characteristics	Frequency	Percentage
Designation of respondents		
Builder	9	12.00
Architect	36	48.00
Engineer	14	18.66
Quantity Surveyor	16	21.33
Total	75	100.00
Structure of ownership		
Indigenous	62	89.86
Foreign	8	10.14
Total	70	100.00
Years of experience		
0 to 5	38	50.66
6 to 10	24	16.21
11 to 15	7	9.33
16 to 20	6	8.00
Total	75	100.00
Types of firm		
Medium	55	78.60
Large	7	10.00
Small	8	11.40
Total	70	100.00

10.00% in large sized firms.

The small, medium and large-sized firms are categorized based on their level of capitalization and annual turnover (Oladapo, 2007). Also, from the interview conducted it was gathered that about half of the respondents had executed sizeable number of projects in the last four years. This implies that they would have reasonable understanding on issues concerning waste generated on construction sites.

Sources of construction wastes

Table 2 shows that 19 respondents indicated that over-consumption of resources accounted for the causes of waste by 0 to 20%, while about 28 respondents showed that it was by 21 to 40%. About 34 respondents indicated that composite and deep design of building accounted for 0 to 20%, while about 13 respondents showed that it was by 21 to 40%. It is shown that about 15 respondents indicated that material damage due to weather and in-appropriate storage accounted by 0 to 20% of the causes of waste on construction site, about 26 respondents showed that it was by 21 to 40% and about 7 respondents showed that it was by 41 to 60%. About 10 respondents indicated that material damage on site due to mishandling or careless delivery accounted for 20% of the causes of waste on construction site; about 12 respondents showed that it was by 21 to 40%, while about 28 respondents indicated that it was by 41 to 60%. It is shown that 9 respondents indicated that vandalism accounted by 0 to 20% of the causes of waste on construction site; about 29 respondents showed that it was by 21 to 40%, and about 9 respondents showed that it was 41 to 60%. About 13 respondents showed that it was rework/improve that accounted for 0 to 20% of the causes of waste on construction site, about 9 respondents indicated it was by 21 to 40%, and about 28 respondents showed that it was 41 to 60%.

About 9 respondents showed that lack of recording materials supplied on site and used on site accounted for 0 to 20% of the causes of waste on construction site, about 22 respondents showed that it was 21 to 40%, and about 19 respondents indicated that it was 41 to 60%. About 6 respondents indicated that site office waste accounted for 0 to 20% of the causes of waste on

Table 2. Sources of construction waste.

Causes of waste	0 to 20%	21 to 40%	41 to 60%	61 to 80%	81 to 100%
	Freq (%)	Freq (%)	Freq (%)	Freq (%)	Freq (%)
1. Over consumption of resources.	19 (40.40)	28 (59.60)	------	------	------
2. Composite and the design of building	34 (72.34)	13 (27.66)	------	------	------
3. Materials damage due to weather and inappropriate storage	15 (31.25)	26 (54.17)	7 (14.58)	------	------
4. Material damage on site due to mishandling or careless delivery	10 (20.00)	12 (24.00)	28 (56.00)	------	------
5. Vandalism	9 (19.15)	29 (61.70)	9 (19.15)	------	------
6. Rework/Improve	13 (26.00)	9 (18.00)	28 (56.00)	------	------
7. Lack of recording					
8. Materials supplied on site and used on site	9 (18.00)	22 (44.00)	19 (38.00)	------	------
9. Site office waste	6 (12.77)	31 (65.96)	10 (21.27)	------	------

Table 3. Relative importance index of causes of design variation.

Factors	VI (5)	MI (4)	I (3)	FI (2)	NI (1)	SWV = $\sum x_i y_i$	RII	Ranking
Last minute client requirement	32	22	14	7	2	306	3.97	1
Complex design	22	33	14	6	2	298	3.87	2
Lack of design information	14	22	36	3	2	274	3.56	3
Unforeseen ground condition	3	11	13	31	19	179	2.32	4
Lack of communication	3	4	9	43	18	162	2.10	5
Long project duration	6	8	7	18	38	157	2.04	6

Table 4. Relative importance index of causes of selection of construction materials.

Factors	VI (5)	MI (4)	I (3)	FI (2)	NI (1)	SWV = $\sum x_i y_i$	RII	Ranking
Cost	33	22	16	2	3	312	4.05	1
Ease of construction	14	20	29	11	3	292	3.79	2
Client requirement	20	23	10	12	3	285	3.70	3
Materials availability	10	33	19	12	3	266	3.45	4
Site space	6	14	33	15	9	224	2.91	5
Availability of equipment	6	7	20	28	16	190	2.47	6
Efficiency	7	6	7	27	30	164	2.13	7
Production of waste	6	7	2	23	39	149	1.93	8

construction site; about 31 respondents indicated it was 21 to 40%, and about 10 respondents indicated that it was 41 to 60%.

Factors affecting wastages on construction sites

Design variation

Table 3 shows that last minute client requirement has the highest index value (3.97) that falls between 3 and 4 that is (more important and important) levels of waste generation. Complex design and lack of design information have relative importance index values of 3.87 and 3.56 that are between more important and important levels of waste generation. While unforeseen ground condition (2.32), lack of communication (2.10) and long project duration (2.04) have relative importance index values as indicated and are between important and fairly important levels of waste generation on construction sites.

Selection of construction materials

Table 4 shows that cost has the highest index value (4.05) that falls between 4 and 5 that is (important and very important) levels of waste generation. Ease of construction, Client requirement, and material availability have relative importance index values of 3.79, 3.70 and 3.45 respectively that are between more and important

Table 5. Relative importance index of factors affecting construction method selection.

Factors	VI (5)	MI (4)	I (3)	FI (2)	NI (1)	SWV = $\sum x_i y_i$	RII	Ranking
Construction cost	27	25	15	7	3	297	3.86	1
Construction time	22	33	14	6	2	283	3.67	2
Developer's requirement	8	23	33	10	3	254	3.30	3
Familiarity with the construction technology	4	4	22	27	20	176	2.28	4
Labour dependence	4	4	10	47	12	172	2.23	5
Waste reduction	4	4	8	23	38	144	1.87	6

levels of waste generation. While site space (2.91), available equipment (2.47), and efficiency (2.13), have relative importance index values as indicated and production of waste has index value (1.93) that falls within 'not important level' of waste generation.

Construction method

Table 5 shows that construction cost has the highest index value (3.86) that falls between 3 and 4 (that is more important and important) levels of waste generation. Construction time and developer's requirement have relative importance index value of 3.67 and 3.30 respectively that are between more important and important levels of waste generation. While familiarity with the construction technology (2.28) and labour dependence (2.23) have relative important index values as depicted that fall between important and fairly important levels of waste generation. Waste reduction index value (1.87) falls between fairly important and not important levels of waste generation on construction sites.

Waste control measures

Table 6 shows that 9.10% of the respondents used prefabricated elements while 90.90% of the respondents did not use it. Table 7 indicates that 14.29% of the respondents carried out sorting on waste generated while 85.71% do not carry out sorting exercise. Table 8 indicates that 70.5% of the respondent carried out open dumping, 16% carried out open burning and 13.5% carried out composting disposal method. The interview conducted revealed that due to congested and limited site areas in most building sites in the study area, site space is the most prominent factor affecting the choice of on-site sorting. The site visits and personal interviews conducted showed that most sites did not carry out sorting out of streams of waste generated during construction process and there was unplanned deposition of waste on sites. Table 9 indicates that 100% of the respondents had in the past never calculated waste generated through waste indices that could serve as guide to know the volume of waste in (m^3) generated per surface area (m^2).

Table 6. Use of prefabricated elements.

Response	Frequency	Percentage
Yes	4	9.10
No	40	90.90
Total	44	100.00

Table 7. Sorting out of Construction waste streams.

Response	Frequency	Percentage
Yes	2	14.29
No	12	85.71
Total	14	100.00

Table 8. Disposal method for the waste generated.

Method	Frequency	Percentage
Open dumping	31	70.50
Open burning	7	6.00
Compositing	6	13.50
Total	44	100.00

Table 9. Calculations of waste indices.

Response	Frequency	Percentage
Yes	0	0.00
No	50	100.00
Total	50	100.00

Table 10 indicates that 100% of the respondents were not mandated to incorporate waste management plan into the required tender documents during tendering process.

DISCUSSION OF RESULTS

It was discovered from the data collected that 78.60% of the respondents were in medium sized firm, 10.00% in

Table 10. Incorporation of waste management plan (WMP) into the tendering document.

Response	Frequency	Percentage
Yes	0	0.00
No	35	100.00
Total	35	100.00

large-sized firm and 11.40% in small- sized firm. The ownership structure of the firms of the respondents showed that 89.86% were in indigenous firms and 10.14% in foreign firms. The years of experience of 50.66% of the firms were 0 to 5yeras, some 16.21% of the firms had 6 to 10 years, about 9.33% of the firms had 11 to 15 years and about 8% of the firms had 16 to 20 years. The information about the profile of the respondents indicates that they had been in practice for a number of years that would have given them opportunity to have understanding about issues concerning waste on construction sites. Craven et al. (1994) and Gavilan and Bernold (1994) categorized waste sources into:

Design; material procurement; material handling; operation; residual related and others.

The result from the research showed that some 59.60% of the respondents indicated that over consumption of resources accounted by 21 to 40% as the cause of waste, some 72.34% of the respondents indicated that composite and deep design of building accounted by 0 to 20%. About 52% of the respondents indicated that material damage due to weather and inappropriate storage accounted by 21 to 40%, some 56% of the respondents indicated that it was material damage on site due to mishandling or careless delivery that accounted by 41 to 60% as the cause of construction waste. Some 61 to 70% of the respondents indicated vandalism accounted by (21 to 40%) as the cause of waste. About 56% of the respondents showed that rework/improve accounted by 41 to 60% as the causes of waste, some 44 respondents indicated that lack of recording materials supplied on site and used on site accounted by 21 to 40% as the cause of waste and about 65.90% of the respondents indicated that site office waste accounted by 21 to 40% as the cause of waste on construction site.

Poon et al. (2003) identified the factors that affect the selection of construction materials as cost, client's requirement, material available, efficiency of construction method (time/quality) ease of construction, available equipment, site space and production of waste. The result of the research revealed that the factors affecting the selection of construction materials that are incidental to wastages are (in order of importance) as:

(1) Cost, (2) ease of construction, (3) client requirement, (4) materials availability, (5) site space, (6) availability of equipment, (7) efficiency, and (8) production of waste which is the least important.

Poon et al. (2003) also identified the factors that cause design variations as last minute requirement, complex designs, lack of communication between designer, contractors and engineers, lack of design information, unforeseen ground condition and long project duration. The result of the research revealed that the factors that cause design variations that are incidental to wastages are (in order of importance) as:

(1) Last minute client requirement, (2) complex design, (3) lack of design information, (4) unforeseen ground condition, (5) lack of communication, and (6) long project duration.

Poon et al. (2003) also identified the factors that determine the selection of construction method as construction time, construction cost, and familiarity with the construction technology, developer's requirement, labour dependence and waste reduction. The result of the research showed that the factors that affect selection of construction method that are incidental to wastages are (in order of importance) as:

(1) Construction cost, (2) construction time, (3) developers requirement, (4) familiarity with the construction technology, (5) labour dependence, and (6) waste reduction.

The results of the study showed that majority (90.9%) of the respondents do not use prefabricated elements while 9.09% of the respondents use it. This practice necessitated the use of wet trade (on-site production process), which is a major contributor to waste on construction sites. Interviews conducted revealed that more time is spent on work sections during wet-trade process and it leads to generation of more wastes than in dry trade construction process. The result obtained from the analysis showed that majority (85.72%) of the respondents do not carry out sorting exercise on waste generated on site while 14.28% of the respondents carried out sorting exercise. This practice has led to indiscriminate dumping of refuse on landfill by construction worker without considering the environmental implications of the materials on health and safety of the public. The economic importance of the materials was not considered by the respondents on how wasted material could be sorted out to obtain natural materials that can still be used for construction work or sold out to companies that recycle materials. According to Poon et al (2001), the calculation of waste index aims at helping the project manager of a building project to anticipate the quantities of waste that will be produced in order to establish awareness of the management, to develop good planning

on resources and environmental management, and to reduce waste generation during all stages of the construction project.

The result findings showed that none of the respondents carry out calculation of waste index. This practice has lead to the inability of project managers to determine ahead the amount of waste in (m^3) that can be generated per (m^2) in a project. Mcdonald and Smithers (1998) indicated that Waste Management Plan list is required to be produced by contractors while bidding for projects to show how wastes generated would be handled. The result of the study shows that majority of the respondents' firms do not incorporate Waste Management Plan (WMP) in the bidding or construction planning documents. Besides, WMP was not required to be submitted with tender documents and equally not demanded from contacting firms during tendering process. The practice has not really prepared the minds of the contractors on how to fashion out programmes on how to deal with wastes generated on sites in a sustainable manner.

Conclusion

The study showed that last minute client requirement was ranked most as a factor due to design variation (Table 3), construction cost of a project was ranked most as a factor affecting construction methods selection (Table 5) and cost of construction materials was also ranked most, as a common cause of waste due to the selection of construction materials (Table 4). Management placed emphasis on materials that have significant impact on the project cost. The study showed that most of the respondents did not use prefabricated elements during construction processes; instead, wet-trade process was used on most of the construction sites. This has led to the generation of enormous amount of waste. The survey showed that project managers of the respondents' firms did not calculate waste index because they were not aware of the importance of waste index calculation on the past projects they executed relative to present and future projects. The calculation of waste index could have helped them have a prior understanding of the volume of waste to be generated, develop good planning of resources, and control the waste that may be generated by taking similar projects earlier handled as points of reference.

Based on the results and findings of this study, the following recommendations are made to foster effective waste management practice of construction projects in Nigeria:

1. The contractors should ensure effective control of materials from design to construction stage so as to adequately reduce processes that can lead to wastages in construction.

2. Contracting firms need to evolve better means and facilities in which building materials could be well-stored with pallets at the base or as may be applicable to prevent undue damage which may lead to wastages.

3. There is need to ensure that when wet trades are used, sorting exercise is adequately carried out on site.

4. The use of prefabricated elements must be encouraged amongst contracting firms so as to reduce the amount of waste that may be generated.

5. There is need for a policy that would mandate contracting firms to carry out the calculation of waste indices to determine the amount of waste that will be generated so that proper measures will be in place to control the waste.

6. The designer should co-ordinate dimensions between materials specified during design and those procured for use at sites so as to guide site personnel on how to prevent avoidable waste in the use of various types of materials during execution of construction projects.

7. There is need for a policy that would mandate contracting firms to incorporate Waste Management Plan (WMP) into one of the documents dearly expected to be submitted by contracting firms during tendering process.

8. The contracting firms should create a functioning section that would see to the appraisal of the plan and compliance with its provisions through capacity building and manpower development.

9. The site worker should be enlightened about the environmental and health risks associated with waste generated from materials used during construction process.

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