# STUDY OF CONSTRUCTION WASTE MANAGEMENT IN KADUNA METROPOLIS, NIGERIA

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## ABSTRACT

*Waste on construction can unnecessarily be produced due to the excessive ordering or quantification of materials and the mishandling of the materials by unskilled labourers. Natural disasters can also generate construction and demolition (C&D) waste. These few activities result in several significant problems, e.g., how to transport the waste, store it temporarily before processing, and finally, where to dispose, mostly landfill sites. C&D waste has chemical properties that make it difficult to be broken down or changed by waste processing techniques like other forms of waste. The research work studied construction waste management in Kaduna metropolis. The study identified that construction waste management involves the following activities: construction waste avoidance; construction waste reduction; construction waste reuse; construction waste recycling; deconstruction and finally construction waste disposal in a responsible way as a last resort when the material cannot be reused directly or recycled for reuse. In the study, it is established that construction waste management in Kaduna metropolis is not efficient and that the following are requirements for achieving efficient construction waste management in Kaduna metropolis: availability of disposal facility and appropriate landfills licensed for construction waste; availability of facilities and technologies that will make recycling, deconstruction and reusing materials and components practicable; existence of environmental legislation; enforcement of environmental legislation and availability of market for recycled, reuse and deconstruction materials and components. The research identified the following as the main causes of construction waste on construction site: Damage by mishandling; Weather and other natural occurrences; Vandalism; Rework and alteration of designs; Lack of recycling facilities; over ordering of construction materials and components. The research further identified the following as the factors that influence construction waste management activities: role of the site manager/contractor; Designs and forms of buildings; Lack of market for recycling and reused materials; Lack of market for recycling and reused materials; Lack of interest for reuse and recycling; lack of facilities and technology for recycling, deconstruction and reusing; Poor information and partnership between parties to the contract and amount of funds available for construction waste management..*

**Keyword:** *Construction, Waste Management, and Contractor and Kaduna*

## 1. INTRODUCTION

Construction waste generation is becoming a pressing issue in Nigeria forming a significant percentage of Municipal Solid Waste (MSW), construction solid waste constituting; broken tiles, concrete debris, steel, timber, metal, glass, packaging, plastic and gypsum continues to litter construction project sites in major administrative constituencies and accumulate in landfills around Kaduna metropolis (Hammed et. al., 2019).

Waste on construction can unnecessarily be produced due to the excessive ordering or quantification of materials and the mishandling of the materials by unskilled labourers . Natural disasters can also generate construction and demolition (C&D) waste (Attia et al., 2021). These few activities result in several significant problems, e.g., how to transport the waste, store it temporarily before processing, and finally, where to dispose, mostly landfill sites. C&D waste has chemical properties that make it difficult to be broken down or changed by waste processing techniques like other forms of waste (Akhtar, A., & Sarmah, 2018).

Olemma A. (2017) Managing waste disposal has become a major concern despite several attempts by successive governments and private organisations in that direction which should be an important environmental

protection measure, the degree of sustainable management of construction solid waste through practices such as reduction, re-use and recycling in Kaduna metropolis continues to be low. Ginga, C. P. et al, (2021) opines that this emanates from lack of low-waste and recycling technology, disposal equipment and low levels of education and training among construction workers and inconsistency in design approaches and management during construction. Furthermore, the unsustainable disposal of construction waste by contractors and clients in the town continues unabated. Therefore, in view of the forgoing, the study will bridge the above gap by bringing out suggestions for improving construction waste management, to elicit knowledge on the consequences of improper construction waste management, to identify the factors contributing to improper construction waste management and to outline proper methods to be used to collect and transport construction waste. The study is based in Kaduna Metropolis as they experience such.

## 1. LITERATURE REVIEW

According to "Global Waste Management Outlook" prepared by United Nations Environmental Programme (UNEP) and International Solid Waste Association (ISWA) (2015), Solid Waste (SW) generated by areas such as commerce, households, construction industry and other industries makes up seven to ten billion tons of waste annually. Almost 85% of the waste generated worldwide is disposed to landfills and the degree of waste reuse and recycling is critically low. Jin, R.; Yuan, H.; Chen, Q. (2019), in their work, also opined that significant amount of industrial waste is created by the construction industry which is generally categorized as Construction and Demolition Waste (C&DW) which has become a concern of governments and consequently of construction companies while contributing to 13–30% to total waste generated worldwide (Thongkamsuk, P.; Sudasna, K.; Tondee, T., 2017). However, Various concerns on environmental pollution and rapid depletion of natural resources as well as sustainability programs being implemented have urged many other countries to set aside the approach of landfill disposal and rather consider alternative ways for a more efficient waste management such as: applying life cycle assessment to municipal solid waste management especially in European and some Asian countries for waste disposal reduction (Khandelwal, H.; Dhar, H.; Thalla, A.K.; Kumar, S. 2018).

Jia *et al* (2018). Postulated that reducing illegal waste via C&DW models using system dynamics and grey model theory and mixing inorganic construction wastes containing CaO (e.g., waste gypsum) to portland cement in appropriate proportions to promote recycling and thus to reduce disposal. Kim, J.; Tae, S.; Kim, R. (2018). In their research, gave an example of collection and sanitary landfill disposal costs for lower-mid income countries (such as Kazakhstan) being in the range of 30–75 USD and 15–40 USD, respectively; while for high income countries being in the range of 85–250 USD and 40–100 USD, respectively. On the contrary, companies are seeking for more efficient ways of waste management, most often in terms of economical sustainability more than in terms of environmentally and socially sustainable development, leading mainly to cost-cutting strategies (Ibrahim M., 2016). According to United Nations Environmental Programme (UNEP). Central Asia Waste Management Outlook; ZOI Environment Network: Châtelaine, Switzerland (2017). As a recently and rapidly developing area of the world, Asian countries require significant improvements in waste management including Construction and Demolition Waste (C&DW) management. Narrowing down to Central Asian countries, a projection to this part of the world indicates that particular cities with lower economic status would experience difficulties in waste management as a result of expected one-fold increase in their SW generation in the next 15 to 20 years. The region of Central Asia comprises five former Soviet republics namely: Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. They are landlocked countries on the Eurasian/Asian continents, experiencing significant development in multiple sectors with particular rising concerns on plastic waste, hazardous waste, e-waste, C&DW and overall municipal waste management practices during the last decade and are suffering from not having proper waste management systems installed in their urban environments. Among the Central Asian countries, the construction industry has been experiencing a boost especially in and around Kazakhstan since 1990's. Kazakhstan is the politically leading country in Central Asia whose economy also shows the strongest performance with a growth momentum (Makhmutova, E. V. 2018). The construction sector has been one of the drivers of the economic growth in Kazakhstan while the research that has been carried out in the area of industrial and municipal Site Waste (SW) management practices in Kazakhstan is quite limited (Gálvez- Martos, J.L.; Styles, D.; 2018).

In Nigeria, Several studies defined waste generated in building construction as construction rubbles, ruins, disaster, construction materials and building construction and demolition, site clearance and other forms of waste during the building construction process (Akhund, M. A., Ali MN, Hussain T, Memon AH, Imad HU, 2018). The waste generated has instigated serious problems both locally and globally. This is generated due to such factors as

construction preparation, site preparation, material damage, material use, over-purchased, and human error (Eze, E. C., Seghosime R, Eyong OP, Loya O., 2017).

Construction materials such as packaging materials, area cleaning and excavation materials, metal, plaster, concrete, brick, insulation, wood, plastic, glass, asphalt, composite materials, and onsite cleaning. Due to nature, certain types of wastes are not found. Liquid waste such as asbestos and lead, paint and kerosene, hazardous materials such as food waste, tires and residue containers are some of the materials. These are located at the heart of all our needs for water, energy, and materials, but at the same time, there is a waste (Adewuyi, 2015).

Adewuyi, T., Odesola I. (2015). Opined that, cost of material waste generated on building sites denotes avoidable cost in construction which is eliminated or reduced. The degree to which waste can be prevented in the construction industry has been a long-debated issue. The cost reduction achieved by preventing the generation of construction waste is equally of direct benefit to all stakeholders on a construction project.

Furthermore, Eze, *et al* (2017) assessment of materials waste in the construction industry: a view of construction operatives, tradesmen and artisans in Nigeria. The study revealed that formwork from wood/timber, Mortar from Rendering/plastering and Block work/ Brickwork are the most wasteful material generated on sites; Design (Frequent design changes and poor design), Poor materials storage system and Theft and vandalism are the most important factors that influence material waste generated during construction. The study recommends that proper site supervision and management techniques, Adequate storage of material, and Staff training and awareness on waste management are the measures of minimizing construction material waste; and saving cost of disposal and transport, increased profit and save construction time loss are the most important benefits of material waste minimization. However, Adewuyi, *et al* (2015) revealed that the levels of material wastes generated on-site are in excess of estimators' allowance for some materials studied.

Yusuf AA. Enhancement of Solid Waste Management Capacity (Planning and Policy). Country Report, Kaduna Metropolis, Nigeria; 2018. Kaduna is a state in Nigeria, located in the North-Western part of the country (10 o 20' N, 7 o 45' E). It has an area of land, with about 46,053Km2. In the North it is bounded by Zamfara, Katsina and Kano State, West by Niger state, East by Bauchi and Plateau state and in the South by Nasarawa state and Federal capital territory, Abuja. Kaduna State is the third most populous in the country, with about 6,113,503 people captured in the 2006 census. GDP of Kaduna state is about 10 billion dollars, with per capita income of 1600 dollars. About 4,931 metric tons of waste are generated daily in Kaduna, of which only about 10% is collected by waste management bodies.

## 3. MATERIAL AND METHOD

The methods to be adopted in this research work will be essentially by both theoretical and empirical study. The theoretical aspects will involve an extensive detail literature review of past-relate works using test books, journals, periodicals and internet. While the empirical aspect will concern visits to housing and urban development and other relevant government parastatals and head office of construction firms. The method was used because it has been used and adopted by (Adewusi 2012)

It will also involve visitation to construction sites for assessment of construction waste management site practices. The aim is to get firsthand information on the construction waste management site practices; the processes of salvaging materials, sorting, storage and collection for reuse, recycling and disposal of particular interest will be safety issues and regulations, economic, sustainable development and environmental protection.

A budding industry in Kaduna is construction industry; activities in this sector are in a high pitch and will continue for a while large amount is being invested by the federal government, the private sector and individuals in Real estate development especially in the provision of housing and other core infrastructural needs. The various activities of the construction industry have considerable impact on the environment as opined by Moneke (2001) that construction projects and development do not just stand on their own; they exact impact on their environment. Also, Kola wale and Achuenu (1997) noted that the environment and construction are interdependent and the need to keep a balance between them cannot be overemphasized.

One of the environmental problems posed by the construction industry activities in Kaduna metropolis is that of managing the enormous waste generated by the various construction work in the city. The need for effective construction waste management to ensure sustainable development and environmental shield in Abuja metropolis forms the thrust of this study.

### 3.1 Population for The Study

The workers from private establishments will constitute the population for this study. The sampling techniques to be employed will be mainly random sampling techniques. The only aspect of stratified sampling employed will be in the choice of organisations sample here only construction companies will be sampled since the study is on waste generated as result of construction activities.

### 3.2 DATA COLLECTION

The data for this work will be collected through questionnaires. These questionnaires will be distributed to private construction companies involved in construction work in Kaduna metropolis. The questionnaire will be designed to investigate the level of awareness of construction waste management as well as its level of practice. The questionnaire will have two sections (A and B). Section A will have questions basically requesting for personal data on the respondent covering the structure of his organisation, years of service, level of education and profession. Questions in section B will focus on the measurement of the level of awareness of construction waste management as well as its level of practice in the respondent's organization. This section will consist of questions most of which the four alternative responses listed below will be applied with corresponding scores assigned:

- Strong Agree (SA) -
- Agree (SA) -
- Disagree (D) -
- Strongly Disagree (SD) -

Responses to the questions will be in the form stating quantities.

### 3.3.1 Validation of questionnaires

The validation of questionnaire will be used using pilot survey where some questionnaires will be printed and given out to Department lecturers for validation and upward review before administration. The questions will be streamlined based on useful suggestions to ensure that they produce data relevant to the solution of the research problem. To check if the respondents understood the questions being asked and also whether the answer were being provided in their required form, a pilot survey will not be to elicit responses that would enable statistical decision to be restructured, reframed or in certain cases cancelled out.

### 3.4 DATA ANALYSIS

The data to be collected will be collated, presented and analyzed using appropriate statistical techniques notably the ranking method, correlating analysis, the two-sample test statistics and the analysis of variance. Use will be also made of pictorial presentations such as bar charts and pie charts as in (Adewusi 2012).

### 3.4.1 Ranking methods

The ranking method will be used to rank the perception of activities involve in construction waste management and the activities that is most practiced by respondents' organizations. It will also be used to rank the factors that constitute main causes of construction waste on construction site and factors that influences construction waste management activities. It will further be used to rank the benefits of efficient construction waste management. Finally, the method will be used to rank the requirements for achieving efficient construction waste management in Kaduna metropolis

The ranking method is a simple and very useful form of scale where subjects are ranked according to some specified criterion or on operationally defined characteristics or property. The point in this method will be the power visual presentations in identifying idiosyncrasies in relationships. Too often, a summary statistic such as correlating coefficient hides the distorting effect of individual response or of group variations. This limitation is overcome by the ranking method, which presents the effect of each individual response. The method is suitable for a number of measures, which is above six and less than thirty (Youngman, 1981). In using the ranking method, weights or scores of 1**……**n are assigned to the factors to be measured.

$S=\Sigma nW$ `

Where:

S= is the rank sum,

n= number of respondents

W=corresponding weight/ score of rank category

RI=is the relative index

The relative index is calculated as $RI=S/4n$

The relative index ranges for 0- 1. The item with the highest relative index is considered the first in the rank order.

### 3.4.2 Analysis of Variance Method

Analysis of variance (ANOVA) method will be used in comparing the significant or no significant variance in the percentage by volume of construction waste generated on jobs in Building Source (2008) and the generated-on jobs in Kaduna Metropolis. ANOVA will be used in comparing the significant or no significant variation in the percentage by volume of construction waste generate on jobs among the sample organizations in Kaduna Metropolis.

The analysis of variance method facilitates the total variation in a set of data, which is to be reduced to components associated with possible sources of variability whose relative importance will be assessed. This procedure employs the statistic (F) test the statistical significance of the differences among the obtained means of two or more random samples from a given population.

The possible sources of variability are between sample variations and within sample variations. Also, for each source of variability, the sum of squares is being computed together with the degree of freedom (Mason 1990). The method analysis of variance is suitable when analyzing the findings from experiments in which the effects of certain conditions are being compared. In applying this method, it is assumed that:

I. The population of interest is normally distributed
ii. The population has equal standard deviation, and
iii. The sample selected from each of the population are random and independent.

The Analysis of variance procedures are as shown below

a. A hypothesis must be formulated
b. The level of significance is selected
c. Calculate the sum of squares between groups (SSG)
d. Calculate the sum of squares within groups (SSE)
e. Calculate the degrees of freedom for SST and SSE
f. Calculate the mean of squares between groups
g. Calculate the mean of square within groups
h. Calculate the ratio of square between groups and within groups

## 4.0 DATA PRESENTATION AND ANALYSIS OF RESULTS

**Table 1. Questionnaires Distribution**

| Number Distribution | Number Completed and Returned | Number used for Analysis | Percentage used for Analysis |
|---|---|---|---|
| **55** | **50** | **50** | **90.0** |

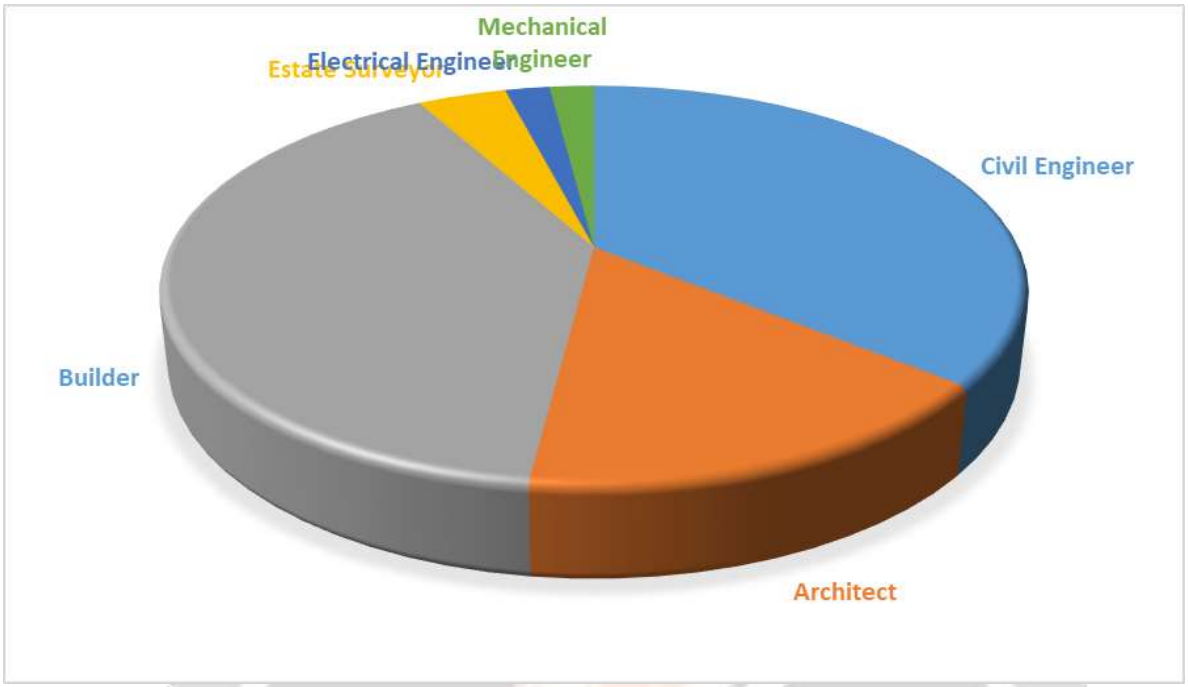


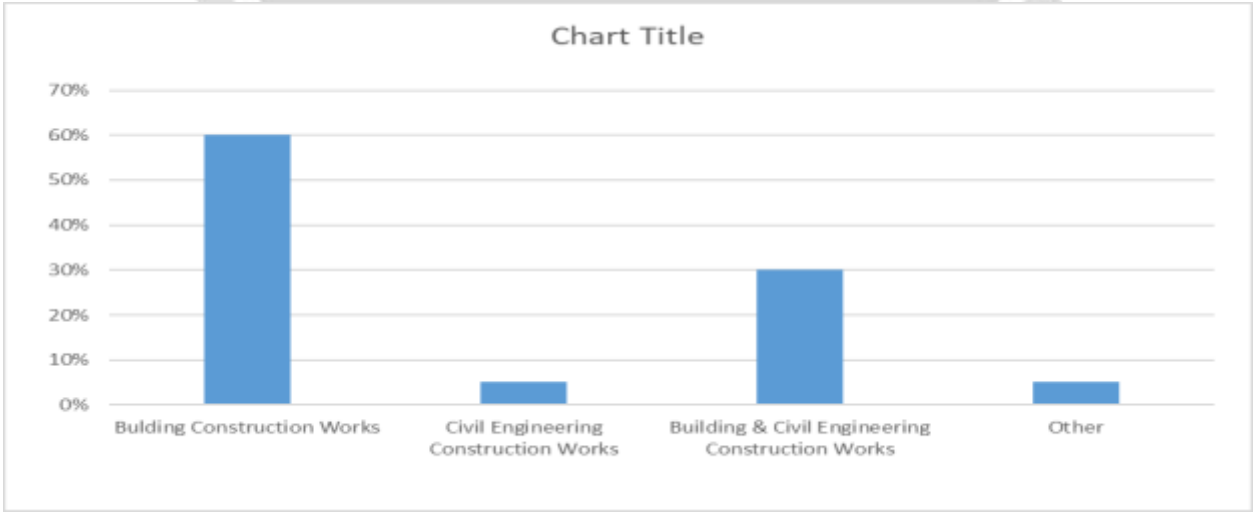

Figure 1. Professional Distribution of Respondents

**4.1 DATA PRESENTATION**

A total of fifty-five (55) questionnaires were administered to the professional staffs of construction companies in Kaduna metropolis, out of which a total of 50 duly completed questionnaires were returned (Table 1).

**4.2 PROFESSIONAL DISTRIBUTION OF RESPONDENTS**

Figure 1, shows the distribution of professionals from the number of construction companies sampled within the city. The results show the large percentages of the respondents were builders and civil engineers and amounting to 36% and 30% respectively.




**4.3 Distribution Of Construction Works Engaged In By Sampled Organizations**

Figure 2 presents the distribution of the services rendered by the sampled organizations. 60% of the respondent's organizations engage in building construction works and only 32% engage in both building and civil

engineering construction works. This result also reflects the larger percentage of respondents being builders and civil engineers as seen earlier in figure 2.

Also the larger percentage of respondent organizations engaging in building works than civil engineering works can be attributed to the high demand for housing in Kaduna as well as the ease for contractors to get engaged in building construction works than civil engineering construction works which often requires larger capitals and machinery.

Table 2 Perception of Construction Waste Management Concept

| Evaluation of Construction Waste Management Definition | Respondent | Percentage |
|---|---|---|
| Strongly Agree | 18 | 36 |
| Agree | 32 | 64 |
| Disagree | - | - |
| Strongly Disagree | - | - |

**4.4 Cosntruction Waste Management Concept**

To get the respondents perception and understanding of the concept of construction waste management, the definition of construction waste management was presented and the options "strongly Agree", "Agree", "Disagree" and "Strongly Disagree" were used to evaluate the responses as shown in table 2 above.

Table 2 indicates that 64% and 36% respondents agree and strongly agree respectively that Construction Waste Management is the management of waste arising from construction works which comprises of construction waste: Avoidance; Reduction; reuse; recycling; Deconstruction and Disposal to ensure sustainable development and environmental protection.

To further ascertain the perception of construction waste management, a range of activities entailed in construction waste management was presented to the respondents for them to decide on those they support to constitute construction waste management practices. The rating value of 4, 3, 2, and 1 were assigned to the options "Strongly Agree", "Agree", "Disagree" and "Strongly Disagree" respectively. The results are ranked in table 3.

Table 3. Ranking of Construction Waste Management Activities

| Construction Waste Management Activities | 4 | 3 | 2 | 1 | Rank Sum (S) | N | Relative Rank Index R.I=S/4n | Order |
|---|---|---|---|---|---|---|---|---|
| Waste Avoidance | - | 38 | 10 | 2 | 136 | 50 | 0.68 | 6th |
| Recycling | 5 | 32 | 9 | 4 | 138 | 50 | 0.69 | 5th |
| Disposal | 5 | 37 | 8 | - | 147 | 50 | 0.74 | 4th |
| Deconstruction | 10 | 34 | 2 | 4 | 150 | 50 | 0.75 | 3rd |
| Reduction | 14 | 32 | 2 | - | 156 | 50 | 0.78 | 2nd |
| Reuse | 35 | 15 | - | - | 185 | 50 | 0.93 | 1st |

Table 4. Ranking of Construction Waste Management Activities Practiced By Respondents Organization

| Activities | 4 | 3 | 2 | 1 | Rank Sum (S) | N | Relative Rank Index R.I=S/4n | Order |
|---|---|---|---|---|---|---|---|---|
| Waste Avoidance | 13 | 27 | 8 | 2 | 151 | 50 | 0.755 | 4th |
| Recycling | - | 9 | 37 | 4 | 105 | 50 | 0.565 | 6th |
| Disposal | 28 | 17 | 5 | - | 173 | 50 | 0.835 | 2nd |
| Deconstruction | 10 | 34 | 2 | 4 | 150 | 50 | 0.75 | 5th |
| Reduction | 14 | 35 | 1 | - | 163 | 50 | 0.815 | 3rd |
| Reuse | 35 | 15 | - | - | 185 | 50 | 0.935 | 1st |

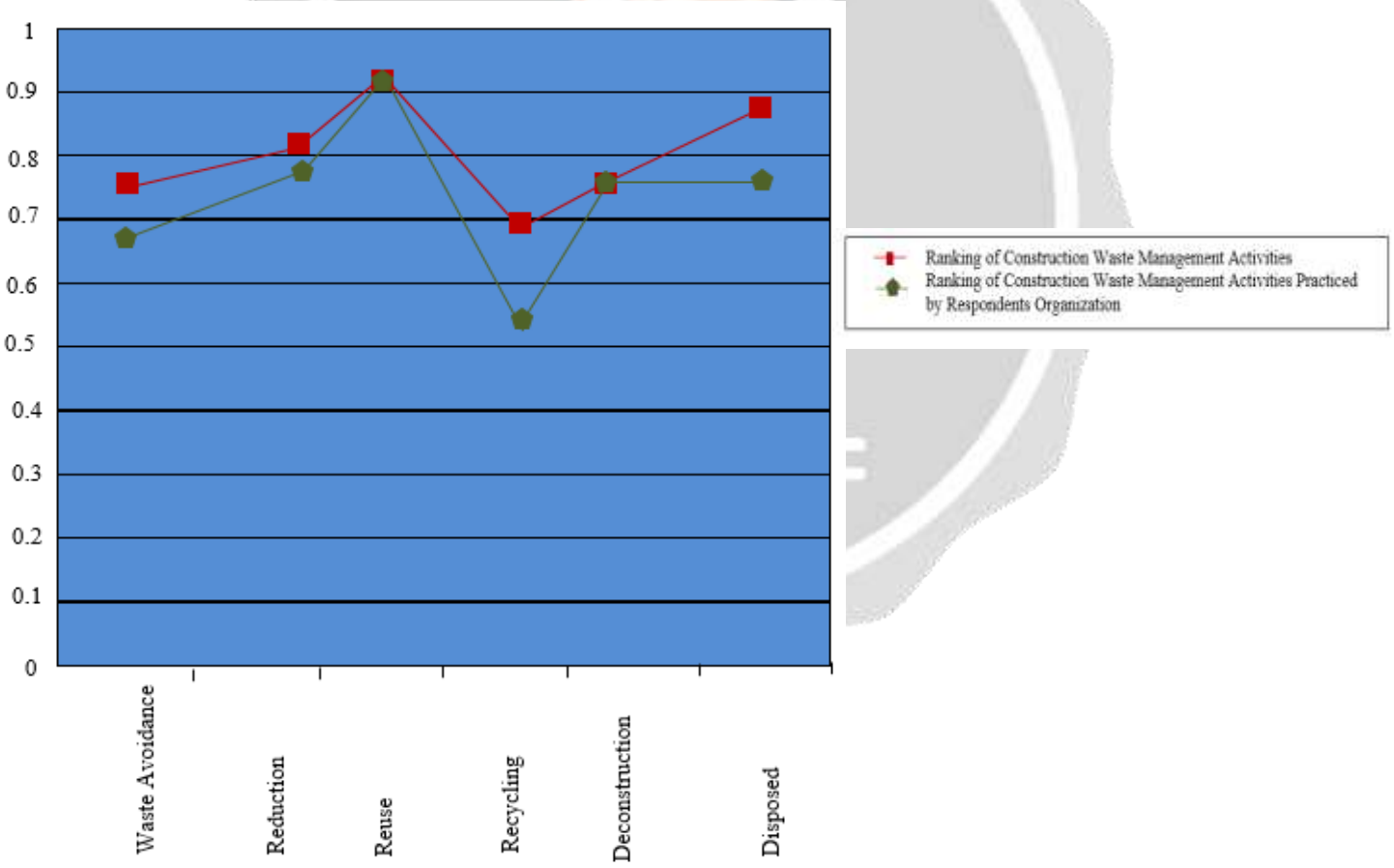



Figure 3. Ranking of Construction Waste Management Activities and the Construction Waste Management Activities Practiced by Respondents' Organization

From Table 3 and 4 and as illustrated in Figure 3, it can be seen that reusing construction waste is ranked 1st in the activities involved in construction waste management as well as in the construction waste management activities

practiced by respondent's organizations with relative indices of 0.93 and 0.925 respectively. Construction waste materials should be used as many times as possible. Common construction waste materials reused on site are as follows: wood, bricks, concrete, tiles, glass, and rubbles.

Construction waste reduction which involves minimizing the amount of waste produced is ranked 2nd with relative index of 0.98 in the activities involved in construction waste management but in the construction waste management activities practiced by respondent's organization disposal of construction waste is ranked 2nd with relative index of 0.865.

The ranked position of construction waste disposal in the activities of construction waste management practiced by respondents organization reflect the disquieting circumstances where construction wastes are not being disposed responsibly such as dumping construction waste on road side and within living premises in Kawo as shown in plate 1 and 2; dumping construction waste are just under street light and under trees in Ungwa Rimi area as shown in plate 3 and 4; dumping construction wastes around living premises and in front of a house as shown in plate 5 and 6 respectively; or where construction wastes are scattered around site, dumping on vegetation and on walkways along street in Janruwa as shown in plate 7, 8, and 9 respectively. Also from Table 4 and 5, deconstruction is ranked 3rd with relative index of 0.75 as one of the activities involved in construction waste management and 5th with relative index of 0.75 in the construction waste management activities practiced by respondent's organization. Table 4 and 5 further show that recycling of construction waste is ranked 5th and 6th in the activities involved in construction waste management and in the construction waste management activities practiced by respondent's organization with relative indices of 0.67 and 0.525 respectively. This could be as a result of lack of interest in recycling construction waste, lack of recycling facilities and technology as well as market for recycled products. The relationship between the ranking of the activities involved in construction waste management and the construction waste management activities practiced by respondent's organization is shown in figure 4.

Table 5. Ranking of factors that constitutes main causes of construction waste in respondent organization.

| Construction Waste Management Activities | 4 | 3 | 2 | 1 | Rank Sum (S) | N | Relative Rank Index R.I=S/4n | Order |
|---|---|---|---|---|---|---|---|---|
| Damaged by Handling | 8 | 25 | 14 | - | 144 | 50 | 0.72 | 4th |
| Weather and other Natural Occurrence | 18 | 20 | 12 | - | 156 | 50 | 0.78 | 3th |
| Disposal | 5 | 37 | 8 | - | 147 | 50 | 0.74 | 4th |
| Vandalism | - | 19 | 27 | 4 | 115 | 50 | 0.575 | 5th |
| Rework and alteration of Design | 21 | 18 | 11 | - | 160 | 50 | 0.8 | 2nd |
| Lack of recycling 35 | 15 | - | - | 185 | 50 | 0.93 | 1st | |
| Facilities | 27 | 15 | 4 | 4 | 165 | 50 | 0.825 | 1st |
| Over Ordering | 2 | 8 | 30 | 10 | 102 | 50 | 0.51 | 6th |

### 4.5 Factors That Constitute Main Causes Of Construction Waste

To obtain respondent's view on factors that constitute main causes of construction waste in respondents organizations, a range of factors was presented to the respondents for them to decide on those they support to be main causes of construction waste. The rating value of 4, 3, 2, and 1 were assigned to the options "Strongly Agree", "Agree", "Disagree" and "Strongly Disagree" respectively. The results are ranked and presented in Table 6 in which lack of recycling facilities is ranked 1st with relative index of 0.825, reworking and alteration of designs is ranked 2nd

with relative index of 0.8. Whether and other natural occurrences is ranked 3rd with relative index of 0.78. Damaged by mishandling, vandalism and over ordering are ranked 4th, 5th and 6th with respective index of 0.72, 0.575 and 0.51 respectively.

Table 6 Ranking of factors that influences construction waste management activities in respondents' organization

| Factors | 4 | 3 | 2 | 1 | Rank Sum (S) | N | Relative Index R.I=S/4n | Rank Order |
|---|---|---|---|---|---|---|---|---|
| Role of the site Manager/Contractor | 30 | 16 | 4 | - | 176 | 50 | 0.88 | 1st |
| Design and forms of Building | 18 | 28 | 4 | - | 164 | 50 | 0.82 | 3rd |
| Lack of Market for Recycling and Reused Materials | - | 19 | 27 | 4 | 115 | 50 | 0.575 | 6th |
| Lack of interest for Reuse and recycling | 7 | 18 | 20 | 5 | 127 | 50 | 0.635 | 5th |
| Lack of facilities and Technology for Recycling Deconstruction and Reusing | 15 | 27 | 8 | - | 157 | 50 | 0.785 | 4th |
| poor information and partnership between parties to the contract | 10 | 15 | 17 | 8 | 127 | 50 | 0.635 | 5th |
| Amount of funds Available | 25 | 17 | 8 | - | 167 | 50 | 0.835 | 2nd |
| Other | - | - | - | - | - | 50 | - | - |

**4.6 Factors That Influences Construction Waste Management Activities**

Also the rating value of 4, 3, 2 and 1 were assigned to the options "Strongly Agree"' "Agree", "Disagree", and "Strongly Disagree" respectively in obtaining respondent's perception on the factors that influence construction waste management activities by respondent's organization. Table 6 shows the ranking of the results in which the role of the site manager/contractor is ranked 1st with a relative index of 0.88, this result is an indicator that in construction waste management the site manager/contractor has a major role to play for its success. Amounts of funds available, designs of building and lack of facilities and technology for recycling, deconstruction and reusing are ranked 2nd, 3rd and 4th with respective indices of 0.835, 0.82 and 0.785 respectively. Lack of interest for reuse and recycling as well as poor information and partnership between parties to the contract are both ranked 5th while lack of market for recycling and reused materials is ranked 6th with respective index of 0.575.

Table 7 Ranking of the benefits of efficient construction waste management in Kaduna metropolis

| Benefits | 4 | 3 | 2 | 1 | Rank Sum (S) | N | Relative Rank Index R.I=S/4n | Order |
|---|---|---|---|---|---|---|---|---|
| Minimum construction Waste that leaves site For landfill | 35 | 15 | - | - | 185 | 50 | 0.88 | 1 |
| Maximum material recovery | 14 | 35 | 1 | - | 163 | 50 | 0.815 | 5 |
| Prolong supply of natural resources | 13 | 27 | 8 | 2 | 151 | 50 | 0.755 | 8 |
| Reduce liability - | 37 | 9 | 4 | 133 | | 50 | 0.665 | 10 |
| Keep job site and the environment clear and safer | 28 | 17 | 5 | - | 173 | 50 | 0.865 | 3 |
| Conserve valuable landfill space | 10 | 34 | 6 | - | 154 | 50 | 0.77 | 7 |
| Ensures sustainable development and environmental protection | 8 | 33 | 9 | - | 177 | 50 | 0.895 | 2 |
| Ensures compliance with all environmental legislation | 8 | 33 | 9 | - | 149 | 50 | 0.745 | 9 |
| Reduce cost associated with waste disposal | 14 | 35 | 1 | - | 163 | 50 | 0.815 | 5 |
| Enhance the reputation of the construction firm | 9 | 38 | 3 | - | 156 | 50 | 0.78 | 6 |
| Reduce the amount of materials sent to landfills | 23 | 23 | 4 | - | 169 | 50 | 0.845 | 4 |
| Reduce the environmental and health safety risks staff may be exposed to | 23 | 27 | - | - | 173 | 50 | 0.865 | 3 |

**4.7 Benefits Of Efficient Construction Waste Management**

Table 7 gives the responses to the list of benefits of efficient construction waste management practices in Kaduna metropolis. The rating value of 4, 3, 2, and 1 were assigned to the options "Strongly Agree", "Agree", "Disagree" and "Strongly Disagree" respectively in obtaining the responses. Efficient/effective construction waste management practices minimizes construction waste that leaves site for landfills and ensures sustainable development and environmental protection are the benefits ranked 1st and 2nd with relative indices of 0.925 and 0.885 respectively. It keeps job site and the environment cleaner and safer is ranked 3rd with relative index of 0.865, it reduces the amount of materials sent to landfills and reduces cost associated with waste disposal are ranked 4th and 5th with relative index of 0.845 and 0.815 respectively. It enhances the reputation of the construction firm; Conserve valuable landfill space; Prolong supply of natural resources and ensures compliance with all environmental

legislation are ranked 6th, 7th, 8th and 9th with relative indices of 0.78, 0.77, 0.755 and 0.745 respectively. It reduces liability is ranked 10th with relative index of 0.665. The high relative index values of the various benefits of efficient/effective construction waste management practices in Kaduna metropolis by the respondents is an indication that the need for efficient/effective construction waste management practices in Kaduna metropolis cannot be overemphasized.

Table 8 Ranking of requirements for achieving efficient construction waste management in Kaduna metropolis

| Requirement | 4 | 3 | 2 | 1 | Rank Sum (S) | N | Relative Rank Index R.I=S/4n | Order |
|---|---|---|---|---|---|---|---|---|
| Existing environmental legislation | 22 | 28 | - | - | 172 | 50 | 0.86 | 3 |
| Enforcement of environmental legislation | 14 | 33 | 3 | - | 155 | 50 | 0.775 | 4 |
| Availability of disposal facility and appropriate landfills licensed for construction waste | 35 | 15 | - | - | 185 | 50 | 0.93 | 1 |
| Availability of facilities/ equipment and technologies that will make deconstruction and recycling practicable | 32 | 14 | 4 | - | 178 | 50 | 0.89 | 2 |
| Availability of market for recycled and deconstruction materials | 2 | 10 | 34 | 2 | 4 | 150 | 0.75 | 5 |

**4.9 Efficiency Status Of Construction Waste Management Practice In Kaduna Metropolis**

Figure 3 shows the efficiency of construction waste management practice in respondent's organizations and the efficiency of construction waste management practice in Kaduna metropolis. From Figure 3, greater percentage of 32% and 64% strongly agree and agree respectively that the construction waste management practice by their organization is efficient while only 4% respondents disagree that the construction waste management practice by their organization is efficient. Also, from Figure 3 it can be seen that 8% and 20% strongly agree and agree respectively that the construction waste management practice in Kaduna metropolis is efficient while only while only 54% and 18 respondents disagree and strongly disagree respectively that the construction waste management practice in Kaduna metropolis is efficient.

Comparing the results obtained in Figure 3, it is observed that greater percentage of the respondents uphold that the construction waste management practice by their organizations is efficient. At the same time with the sampled organizations lesser percentage of respondents upheld that the construction waste management practice in Kaduna metropolis as a whole is efficient and greater percentage of respondents disagreeing and strongly disagreeing that the construction waste management practice n Kaduna metropolis is efficient.

Table 9 Quantities of construction waste in percentage volume, generated on jobs by respondents' organization

| Respondents Construction Waste | A | B | C | D | E | F | Mean |
|---|---|---|---|---|---|---|---|
| Wood 33% | 42 | 28 | 38 | 30 | 25 | 35 | 33 |
| Cardboard | 2 | 3 | 0 | 10 | 5 | 10 | 5 |
| Drywall 2.67% | 0 | 0 | 0 | 5 | 5 | 5 | 5 |
| Masonry 26.83% 30 | | 28 | 28 | 35 | 20 | 20 | 26.8333 |
| Metals 5% | 2 | 5 | 8 | 5 | 5 | 5 | 5 |
| Others 28.33 | 24 | 36 | 26 | 49 | 20 | 20 | 28.3333 |

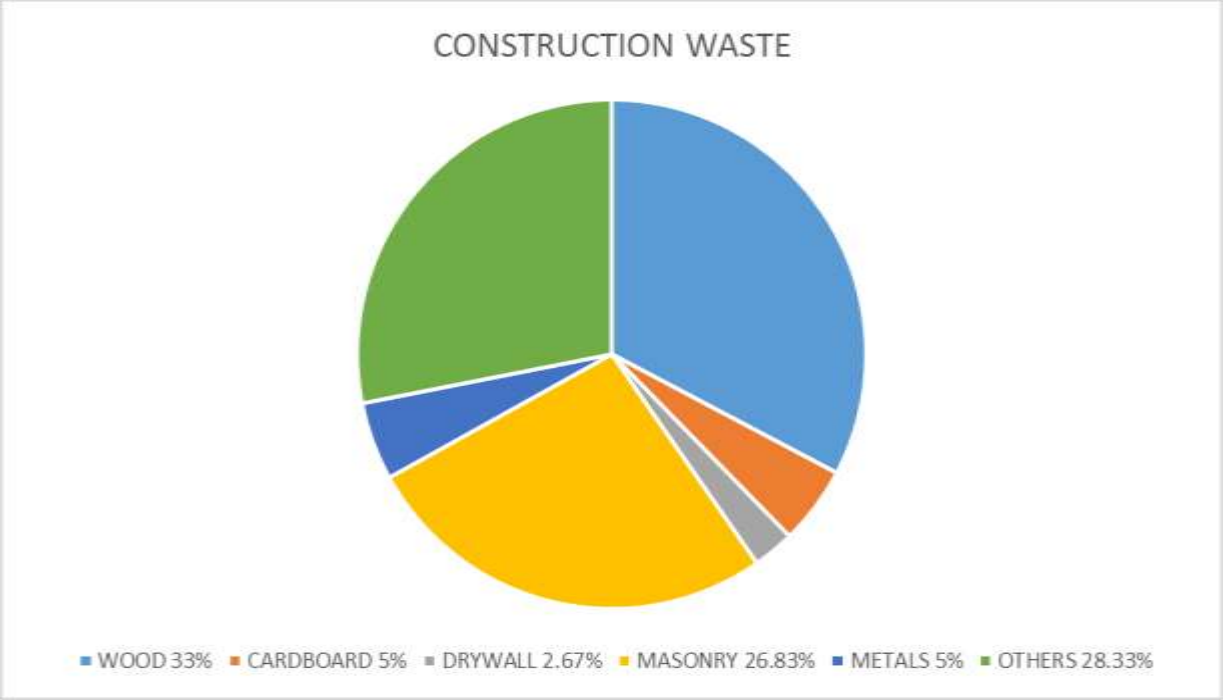



Figure 4 Quantities of construction waste in percentage volume generated on jobs in Kaduna metropolis.

**4.1 Construction Waste Quantities**

Table 10 shows quantities of construction waste generated on jobs by respondents organizations in Kaduna metropolis and Figure 4 presents the quantities of construction waste generated on jobs in Kaduna metropolis. From Figure 4, it is seen that wood waste constitutes large volume of the total quantum of construction waste generated on jobs in Kaduna metropolis by (33%); masonry waste constitutes (26.83%) by volume; other wastes like wastes from aluminum, glass, plastics, cielings, tiles and land clearing debris all make up 28.33% by volume of the total quantum; metals and cardboard constitutes just 5% each while drywall which is not a common construction materials in Kaduna constitute just 2.67% by volume of the total construction waste generated on jobs in Abuja metropolis.

However, investigation by the Green Building Source, (2008) presented in Figure 7 shows that quantities of construction waste generated by volume on jobs in the USA to be as follows: wood 24%, cardboard 38%, drywall

11%, masonry 1%, metal 4%, other wastes 22%. These quantities of construction wastes generated on jobs in Kaduna Metropolis and that generated in USA as investigated by the Green Building source, (2008) presented in Figure 8 and Figure 9 respectively. By using one-way Analysis of Variance (ANOVA) at 5% level of significance, it was observed that for hypothesis 1, Fcrittical of 2.533555 was less than Fcomputed of 26.42323 so therefore the null hypothesis of hypothesis 1 is accepted that there is no significant difference between the quantities of construction waste in percentage volume, generated on jobs by each of the sampled organization in Kaduna metropolis.

Also using one-way ANOVA at 5% level of significance, it was observed that for hypothesis 2, Fcrittical of 4.387374 was greater than Fcomputed 1.202256 so therefore the null hypothesis of hypothesis 2 is rejected hence there is significant difference between the quantities of construction waste in percentage volume, generated on jobs in United State by the Green Building Source, (2008) and that generated on Jobs in Kaduna metropolis.

## 5. CONCLUSION

The study contributed to the current state of knowledge in several ways. Identifies the activities involved in construction waste management; factors that constitute main causes of construction waste; factors that influence construction waste management activities; benefits of efficient construction waste management; the requirements for achieving efficient construction waste management and establishes quantities of construction waste generated on jobs in Kaduna metropolis. These results will help to aid good practice and better formulation of policies as it concerns construction waste management in ensuring sustainable development and environmental protection.

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