A STUDY OF CONSTRUCTION MATERIAL WASTE MANAGEMENT PRACTICES BY CONSTRUCTION FIRMS IN NIGERIA

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Abstract: Construction Waste Management is an aspect of Sustainable Development, which is fuelled by the growing concern for the effect of man's activities on the environment. The management of Construction processes to reduce, reuse, recycle and effectively dispose of wastes has a serious bearing on the final cost, quality, time and impact of the project on the environment. This research studied the practice of Construction Material Waste Management by firms in Nigeria by the use of structured questionnaires to senior construction-professional personnel of construction firms. The study found out that specific Government legislation on wastes from construction sites were non-existent and that the respondents considered other project goals of timely project delivery, quality and cost as more important than the impact of the project on the environment. Most respondents displayed a poor understanding of waste management and most companies did not have a policy on Material Waste Management. The paper recommends that the Nigerian Government puts in place legislation regarding construction site waste management. Professional bodies and academic institutions in the country should seek to further educate their members on the importance of effective material waste management strategies.

Keywords: Construction Waste Management, Government Legislation, Nigeria, Policy, Sustainable Development.

1. INTRODUCTION

The building or construction industry involves different processes and utilizes huge quantities of resources. These processes have severe impacts on the environment which according to Horsley (2003), occur over a variety of timescales from the extraction and processing of raw materials used in construction, through the duration of the construction process, the operation of the building, up to the eventual demolition of the structure at the end of its operative life.

Construction activities have been known to generate large and diverse quantities of waste. According to the US Green Building Council, (2001), it accounts for up to 30% of total waste output in the United States alone, put at about 136 million tons per annum. As a result, construction and demolition waste management has become one of the major environmental problems in many municipalities (Faniran and Caban, 1988; Kibert, 1994; Ferguson et al., 1995; Graham and Smithers, 1996; Guthrie et al., 1999; Symonds, 1999; Lawson and Douglas, 2001, cited in Poon et al, 2004).

In some more advanced countries, the concern for the effect of Man's endeavours on the environment and rising project costs has increased the drive for the application of Construction Waste Management. There has been a strong drive to 'do more with less' by reducing waste at all stages of construction as identified by the '*Rethinking*

Construction' task force in the UK (DETR, 2000). There is also a need to improve material handling by contractors as the DETR also noted that about 13 million tonnes of the estimated 70 million tonnes of construction and demolition materials comprise of materials delivered to site and thrown away unused.

1.1 The Effect of Construction Activities

Construction can be defined as the activity involving creation of physical infrastructure, superstructure, housing and other related facilities (Watuka and Aligula, 2003). The physical substance of a structure is an assembly of materials from widely scattered sources. They undergo different kinds and degrees of processing in large numbers of places, require many types of handling over periods that vary greatly in length, and use the services of a multitude of people organized into many different sorts of business entity.

The Construction industry, while contributing to overall socio-economic development of any country, is a major exploiter of natural non-renewable resources and a polluter of the environment whereby it contributes to the environmental degradation through resource depletion, energy consumption air pollution and generation of waste in the acquisition of raw materials (Watuka and Aligula, 2003).

Construction activities generate a large amount of waste compared to other industries. In EC countries, about 200 to 300 million tons of construction and demolition waste is produced annually, which translates to roughly a 400 km^2 area covered with demolition debris one meter high (Pieterson and Fraay, 1998, cited in Elias-Ozkan and Duzgunes, 2002). In the United States alone, about 136 million tonnes of construction waste is generated (US Green Building Council, 2001).

1.2 Sustainable Construction

According to Harman and Benjamin, (2004) the built environment is the heart of any economy; providing the infrastructure necessary to enhance productivity, but the manner in which it consumes natural resources makes it responsible for some of the most serious local and global environmental changes. Sustainable construction is an integrative and holistic process of construction which aims to restore harmony between the natural and the built environment (Agenda 21, 2001).

The California Integrated Waste Management Board (2003) described Sustainable Construction as a whole building approach to design and construction that saves or reduces resources in five categories: site, water, energy, materials and environmental quality. Sustainable construction, according to Watuka and Aligula (2003) can also be said to be "the set of processes by which a profitable and competitive industry delivers built assets: building structures, supporting infrastructure and their immediate surroundings which:

i. Enhance the quality of life and offer customer satisfaction
ii. Offer flexibility and the potential to cater of user changes in the future
iii. Provide and support desirable natural and social environments
iv. Maximize the efficient use of resources while minimizing wastage."

1.3 Material Waste in Construction

There are differing views held by researchers as to what constitutes Construction waste. Cheung, (1993) stated that Construction Waste can be defined as the by-product generated and removed from construction, renovation and demolition workplaces or sites of building and civil engineering structures. According to Formoso, (1999), it should be understood as any inefficiency that results in the use of equipment, materials, labour, or capital in larger quantities than those considered necessary in the production of a building. Shen et al,(2003) defined building material wastages as the difference between the value of materials delivered and accepted on site and those properly used as specified and accurately measured in the work, after deducting the cost savings of substituted materials transferred elsewhere, in which unnecessary cost and time may be incurred by material wastages.

Serpell et al, (1995), cited in Alwi et al, (2003) asserted that Construction Managers have to deal with many factors that may negatively affect the construction process, producing different types of wastes. There are several causes of material wastes which in most cases are dependent on the type of construction methods employed, the specific materials in use, and/or the stage of the construction itself. Waste can be generated by mistakes, working out of sequence, redundant activity and movement, delayed or premature inputs and products or services that do not meet customer needs (Construction Industry Board, 1998).

Construction and Demolition waste is a complex waste stream, made up of a wide variety of materials which are in the form of building debris, rubble, earth, concrete, steel, timber, and mixed site clearance materials, arising from various construction activities including land excavation or formation, civil and building construction, site clearance, demolition activities, roadwork, and building renovation. It also includes incidences of wastages in labour and energy used in construction works. However, material waste has been recognized as a major problem in the construction industry that has important implications both for the efficiency of the industry and for the environmental impact of construction projects (Formoso et al, 2002). Most construction wastes which were previously regarded as inert have been found to generate harmful leachates which have negative effects on the environment (Apotheker, 1992, cited in Lingard et al, 2000). As such, it is absolutely imperative for the construction industry to adopt ecologically sound planning and construction practices for the purpose of creating a healthy and sustainable built environment (Poon et al, 2004).

1.4 Construction Waste Management

The practice of waste management for construction activities has been promoted with the aim of protecting the environment and the recognition that wastes from construction and demolition works contribute significantly to the polluted environment (Shen et al, 2002, cited in Shen et al, 2004). This increasing awareness of environmental impacts from construction wastes has led to the development of waste management as an important function of construction project management (Shen et al 2004).

There are several approaches to construction waste management. The process of managing construction waste goes far beyond the disposal of the wastes itself. It is an all-encompassing strategy to effectively utilize construction resources, with the view to reducing the quantity of waste and also utilizing the generated waste in the most effective manner. The most common approach to management of construction waste is dumping in landfill sites. However, decreasing landfill space has led to increasing costs of landfill disposal to the contractor (BIE, 1993, cited in Lingard et al, 2000). Also, a relatively large amount of materials is being wasted because of poor material control on building sites (Poon, et al, 2004). This has prompted the need for alternatives for waste prevention and the initiatives to reduce, reuse and or recycle waste produced which are referred to as the three R's of construction waste management. A waste hierarchy has been widely adopted as a guide for construction managers, in line with the principles of sustainable construction. The Waste hierarchy suggests that:

i) The most effective environmental solution may often be to **reduce** the generation of waste.
ii) Where further reduction is not practicable, products and materials can sometimes be **re-used,** either for the same or a different purpose.
iii) Failing that, value should be recovered from waste, through **recycling**, composting or energy recovery from waste.
iv) Only if none of these solutions is appropriate should waste be **disposed** of, using the best practicable environmental option.
(Source: Department of the Environment, Transport and Regions, 2000)

According to Coventry and Guthrie, (1998), there are two fundamental reasons for reducing, reusing and recycling waste: the economic advantages, and the environmental advantages. The environmental advantages include the minimization of the risk of immediate and future environmental pollution and harm to human health while the economic advantages include lower project costs, increased business patronage, lower risk of litigation regarding wastes amongst others. In view of these advantages and the negative impact of construction wastes on successful project delivery, this paper identifies major causes of waste, the position of construction firms and professionals in the Nigerian construction industry on construction waste management and constraints to effective site waste management such as policy and legislative issues.

2. METHODOLOGY

The research work was carried out by administering a well structured questionnaire to a sample of the population for the study. The population was all professionals in the construction industry, i.e. Architects, Builders, Engineers and Quantity Surveyors who were managing construction projects at a senior cadre level in all categories of construction firms duly registered with the corporate affairs commission in Nigeria. Twenty-Seven (27) of the returned questionnaires were administered at a conference on Sustainable Construction, while the other Thirty-Five (35) were administered to professionals handling projects in large cities like Kaduna, Lagos and Abuja.

The questionnaire was designed in such a manner to elicit responses that could be easily analysed by the use of closed ended questions with suggested answers on ordinal scales. In addition, the opinions of the respondents were also sought with relevant open ended questions a view to finding suitable recommendations on the findings of the research. The questionnaire was used to gather information on the respondents' knowledge of Construction Waste Management, legislation and the respondents' company's policy of waste management.

3. FINDINGS AND DISCUSSION

A total of 120 questionnaires were administered for this survey, of which 62 were returned with valid responses. This showed a response rate of 51.6%. From the results of the analysis, it was observed that about 12.9% of the respondents were of the opinion that no attention at all was paid to construction waste management. About 77.4% felt it was fairly given as much attention as other functions of a construction manager, while only 9.7% opined that sufficient attention was paid to construction waste management.

The research also showed that a fairly high percentage of the respondents were able to identify the most appropriate description of construction waste management from a list of options. From column 3 in Table 1, it can be seen that 52.5% chose option 4 which encompassed about all aspects of construction waste management. All other options contained only some aspects of waste management. On the level of wastes encountered on site, 61.3% of the respondents regarded the level of waste generated on their sites as Moderate. Approximately twenty three percent felt it was low while 12.9% regarded it as high. The summary of these responses are presented into Table 1.

Table 1: Awareness on Construction Waste Management Issues

Understanding		**Waste Level**		**Waste Management Attention**	
Option	***%***	***Rank***	***%***	***Response***	***%***
1	0.0	Very Low	1.6	Surely	9.7
2	14.8	Low	22.6	Fairly	77.4
3	26.2	Moderate	61.3	None	12.9
4	52.5	High	12.9		
5	6.6	Very High	1.6		

Legend: 1 = Supervising workers thoroughly to reduce waste, 2 = Proper material scheduling and handling to reduce waste, 3 = Proper disposal of wastes in landfills and suitable areas, 4 = Efficient material handling and reduction, reuse, recycling and disposal of wastes, 5 = Reduction and disposal of construction wastes

Further analysis showed that the project goals of cost and quality were considered by the respondents as most important; more important than timely delivery of the project or minimizing the impact of construction on the environment as shown in Table 2.

Table 2: Level of Importance of Project Goals to Construction Professionals

Factor	**1 (%)**	**2 (%)**	**3 (%)**	**4 (%)**	**Mean**	**Std. Deviation**
Cost	0.0	0.0	19.4	80.6	3.81	0.40
Quality	0.0	0.0	19.4	80.6	3.81	0.40

Time	0.0	0.0	40.3	59.7	3.60	0.49
Impact on Environment	4.9	9.8	50.8	34.4	3.15	0.79

Legend: 1 = Indifferent, 2 = Not Important, 3 = Important, 4 = Very Important

Many of the respondents showed a poor adoption of different methods of managing construction wastes. The most widely adopted methods were reusing and sale as scrap, largely due to the high use of timber in construction and its high scrap value for uses such as firewood. This was buttressed by the observation that only 42.6% were satisfied with the methods of waste management on their sites. Roughly 20% were neutral while 32.8% expressed that they were dissatisfied with their methods.

The low level of adoption may be explained by the fact that respondents showed a poor understanding of the benefits of an effective construction waste management scheme. Majority felt lower project costs (69.4%) and cleaner environment (66.1%) were the principal benefits of construction waste management as shown in the table below. Other factors such as increased business patronage and longer lifespan of non-renewable sources of materials were not widely thought to be important (See Table 3 below).

Table 3: Benefits of Construction Waste Management

Response	Cleaner Environment	Lower Project Costs	Longer Lifespan of Materials	Increased Patronage	Other
Agreed	66.1	69.4	3.2	11.3	12.9
Neutral	33.9	30.6	96.8	88.7	87.1

Of the respondents who practised some form of waste management, 56.7% cited the reduction of the project cost reduction as the main motivation, followed by concern for the environment of which 43.3% attested to. Thirty percent cited conditions of contract, while other factors such as legislation, client requirement and government incentives had only 13.3%, 6.5% and 0% respectively. Table 4 below shows the percentages and rankings of the various factors, while Table 5 shows the percentages and ranking of some factors that hinder the practice of waste management on site.

Table 4: Factors Influencing the Practice of Construction Waste Management

Factor	Agree (%)	Neutral (%)	Rank
Project procurement cost reduction	56.7	43.3	1
Concern for the environment	43.3	56.7	2
Conditions of Contracts	30.0	70.0	3
Legislation	13.3	86.7	4
Client Requirement	6.5	93.5	5
Government incentives	0.0	100.0	6

Table 5: Factors Hindering the Practice of Construction Waste Management

Factor	Agree (%)	Neutral (%)	Rank
Lack of awareness	46.7	53.3	1
Weakness in legislation	23.3	76.7	2
Insignificant cost of handling waste	20.0	80.0	3
Waste not a problem on site	13.3	86.7	4
Other factors	10.0	90.0	5
Abundance of landfill	6.7	93.3	6

The general observation from the results of the analysis was that the practice of waste management by construction firms in Nigeria is poor. Seventy-two percent claimed they were not aware of any legislation on construction wastes, and only 48.4% said they worked in companies with policies on construction waste management. Seventy-two percent claimed to be in a position to influence policy making in their organisations but only 45.8% of them attested to have formulated one (See Table 6).

Table 6: Policy and Legislation Issues on Waste Management

Response	Waste Legislation (No = 58)	Company Waste Management Policy (No = 62)	Influence on Policy (No = 62)	Formulation of Policy (No = 48)
	%	*%*	*%*	*%*
Yes	27.6	48.4	72.6	45.8
No	72.4	51.6	27.4	54.2

With respect to the causes of waste on site, several factors were obtained from the work of Tam et al, (2003) and the respondents were requested to rank from 1 through to 5 (i.e. from strongly disagree to strongly agree as shown in the legend below the Table). The means for each of the factors were computed and used to rank the factors with respect to their significant contribution to waste generation. From the results which are shown in Table 7 below, Poor supervision, workmanship and storage facilities were regarded as the most common causes of waste on site, while equipment malfunction, weather and force major were the least common.

Table 7: Causes of Waste on Construction Sites

Factors	N	Min	Max	Mean	Std. Deviation	Rank
Poor Supervision	61	2	5	4.31	0.79	1
Poor Workmanship	60	1	5	4.15	0.95	2
Poor Storage Facilities	61	1	5	4.08	0.80	3
Improper Handling	60	1	5	4.07	0.82	4
Improper Storage	59	1	5	4.05	0.99	5
Design Error	59	1	5	3.98	0.84	6
Design Changes	60	1	5	3.97	0.97	7
Human Error	61	1	5	3.75	1.03	8
Material Deterioration	60	1	5	3.43	1.18	9
No Waste Management	59	1	5	3.37	1.24	10

Personnel						
Ordering Errors	58	1	5	3.36	1.00	11
Force Majeure	55	1	5	3.29	1.20	12
Weather	61	1	5	3.20	1.08	13
Equipment Malfunction	60	1	5	2.83	1.25	14

Legend: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree

The research also attempted to find out factors which may impact on the effectiveness of a solid construction waste management scheme and as such, several factors adopted from the work of Lingard et al, (2000), were included in the questionnaire and they were ranked according to their perceived impact on waste management by the respondents. Table 8 shows the distribution of the responses, the means, standard deviation and rank (based on mean) for each factor.

Table 8: Factors Which May Affect the Effectiveness of Solid Construction Waste Management

Factors	N	Min	Max	Mean	Std. Deviation	Rank
Management Support for Waste Management	57	2	4	3.74	0.55	1
Staff Knowledge of Waste Management	57	2	4	3.68	0.57	2
Waste Minimization Motivation	55	2	5	3.56	0.69	3
Material Storage Practice	57	2	5	3.46	0.71	4
Estimating/Ordering Practice	55	1	4	3.25	0.75	5
Recycling Infrastructure	56	1	4	3.20	1.02	6
Design Issues	55	1	4	3.20	0.87	6
Sustainable Development Awareness	57	1	4	3.16	0.73	8
Material Supply Issues	56	1	5	3.14	0.80	9
Cost of New Materials Against Recycled	54	1	5	3.02	0.86	10
Individual Value Judgement	56	1	4	3.00	0.76	11
Waste Disposal Costs	55	1	5	2.91	0.99	12

Legend: 1 = No Impact, 2 = Minor Impact, 3 = Moderate Impact, 4 = High Impact

It can be observed from the Table that managements' support for waste management initiatives, staff knowledge on waste management and workers motivation to minimize waste were considered to have the highest impacts, while waste disposal costs, the individuals' (site worker) value judgement and the comparative cost of new materials against recycled materials were considered to have the lowest impacts of all the factors.

4. CONCLUSIONS AND RECOMMENDATIONS

The survey results show that the general practice of Solid Construction Waste Management and site waste management as a whole is very poor and has room for a lot of improvement. The construction Professionals' understanding of construction

waste management was found to be deficient, and the adoption and practice further hampered by lack of sufficient legislation or Government incentives to encourage the teachings of sustainable construction. The following recommendations are made against the backdrop of the research findings:

i. Educational institutions should include the teachings of sustainable construction in the curriculum of professionals in the construction industry. Also, professional bodies should use conferences and workshops to educate practising professionals.
ii. Government should introduce specific legislation governing the handling and disposal of construction wastes and follow up with strict monitoring to ensure compliance.
iii. Incentive schemes should be set up by Government to reward firms who embrace construction waste management wholly.

5. REFERENCES

Alwi, S., Hampson, K. and Mohammed, S., (2002), Waste in the Indonesian Construction Projects, *Proceedings of the CIB W107 1st International Conference: Creating a Sustainable Construction Industry in Developing Countries*, 11 – 13 November, Stellenbosch, South Africa.

CIB Publication 237 (2001) *Agenda 21 for Sustainable Construction in Developing Countries*, First Discussion Document, Version 2

California Integrated Waste Management Board, (2003), *Rebuilding Green*, http//:www.ciwmb.ca.gov/GreenBuilding/ pg 2 (Accessed 21-06-2006)

Coventry, S. and Guthrie, P. (1998) *Waste Minimisation and recycling in construction – Design Manual* CIRIA London

Department of the Environment, Transport and Regions, (2000), *Building a Better Quality of Life: A Strategy for More Sustainable Construction*, DETR, London

Elias-Ozkan S.R. and Duzgunnes, A. (2002) Recycling of Construction Material and the Reuse of Building Components: An Overview, *Proceedings of the CIB W107 1st International Conference: Creating a Sustainable Construction Industry in Developing Countries*, 11 – 13 November, Stellenbosch, South Africa.

Horsley A., France C. and Quartermass B., (2003), 'Delivering Energy Efficient Buildings: A Design Procedure to Demonstrate Environmental and Economic Benefits', *Journal of Construction Management and Economics*, Vol. 21, Pg 345

Lingard, H, Graham, P. and Smithers, G. (2000) 'Employee Perceptions of the Solid Waste Management System Operating in a large Australian Contracting Organisation: Implications for Company Policy Implementation', *Construction Management and Economics*, Vol. 18, pp 383.

Poon C. S., Ann T. W. and Jaillon L., (2004), 'Reducing Building Waste at Construction Sites in Hong Kong' *Construction Management & Economics*, vol. 22, issue 5, pp 461-470

Poon C. S, Wan Yu, A. T, Wong S. W and Cheung E. (2004), 'Management of Construction Waste in Public Housing Projects in Hong Kong', *Journal of Construction Management and Economics*, Vol. 22, Issue 5, Pp 461-470

Shen, L. Y, Tam, V. W, Tam, C. M, and Drew, D, (2004), 'Mapping Approach for Examining Waste Management on Construction Sites', *Journal of Construction Engineering and Management*, Vol. 130, No. 4, July/August 2004, pp. 472-481

Shen, L. Y., Tam, V. W. Y and Tam, C. M., (2002), Material Wastage in Construction Activities – A Hong Kong Survey, *Proceedings of the CIB W107 1st International Conference: Creating a Sustainable Construction Industry in Developing Countries*, 11 – 13 November, Stellenbosch, South Africa.

Watuka, J., and Aligula, E. M., (2002), Sustainable Construction Practices in the Kenyan Construction Industry: The Need for a Facilitative Regulatory Environment, *Proceedings of the CIB W107 1st International Conference: Creating a Sustainable Construction Industry in Developing Countries*, 11 – 13 November, Stellenbosch, South Africa.