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AN EMPIRICAL STUDY OF CONSTRUCTION WASTES IN MINNA AND ABUJA, NIGERIA

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ABSTRACT

This paper aims to analyze on-site production and sources of construction wastes through data obtained from a detailed questionnaire survey and structured interviews conducted in Minna and Abuja. A questionnaire survey was conducted to investigate the compositions of these construction waste and their sources. One hundred and ten copies were sent to governmental officers, designers, engineers, and contractors. 84 responses were received, in which the respondent rate was about 76.4 percent. According to the survey results, concrete, cement, brick, timber, tile, steel, and aluminum wastes were the main waste types produced on construction sites. The sources of these wastes were varied. Suggestions to improve the existing waste situation were also discussed.

Keyword(s): Construction Wastes; Construction Works; On-Site Production; Waste Minimization; Waste Generation.

INTRODUCTION

Various types of construction wastes are generated during construction activities. Expansion of construction wastes not only represents an enormous dissipation of resources but also results in serious environmental pollution, thus creating negative effects to the sustainable development of environmental industry and society. With the developing of economy and industry, waste problems have become more serious in recent years; therefore, waste management is becoming a pressing issue (Jia-yuan et al, 2008). Hong Kong Government-Environmental Protection Department (2006), reported that Construction waste is a serious environmental problem in many large cities all over the world. A daily average of about 7,030 tonnes of construction and demolition (C&D) wastes were disposed off at landfills in 1998 in Hong Kong, representing about 42 percent of total waste intake at landfills, and most of which can be reclaimed; and in 1999, there were about 7,890 tonnes of C&D wastes disposed daily off at landfills, representing about 44 percent of total waste intake at landfills. Lu, (1999) in his own words explained that Construction wastes are made up of about 40 percent of overall solid waste generation in Mainland China contrast to the figures in other advanced countries. Construction activities are generating various types of construction wastes, including soil, sludge (surplus materials and abandon materials), steel and timber. The proportion of recyclable wastes can be up to 95 percent; only about 5 percent of the overall waste is unrecyclable. Construction activities convinced about 40 percent of the natural resources and used about 40 percent of energy (Wu, 2003). To save energy and resources, solid waste management is a necessary procedure.

Construction wastes include concrete, cement, steel, aluminum, tile, timber, glass, packaging, and plastic. There have been many research work, carried out on construction waste minimization methods. These methods emphasized on the use of modern technologies in building construction, such as pre-cast concrete, steel form and scaffold and drywall partition panel ((Chen et al,(2000), Poon,(2000), Poon, et al. (2001a), Poon, et al. (2001b), Shen, et al (2002)). Waste prevention can only be achieved if the following strategies are adopted in construction activities: usage of efficient purchasing and ordering of materials system, using efficient timing and delivery of materials, using efficient material storage, minimizing material losses, maximizing material reuse, preventing undoing and redoing, reducing packaging waste, and using prefabrication. In addition, it is encouraged to adopt low-waste construction technologies during construction processes, including concreting

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Table 1: ***The major types, reasons and causes of construction waste.***

S/N	TYPES OF CONST. WASTE	REASONS FOR WASTE GENERATION	CAUSE
A	CONCRETE AND CEMENT WASTE	Flow of plastering, demolished concrete, over-order and template leakage	Human behavior including on-site management, materials ordering, operating machines, cutting materials and materials protection.
B	BLOCK WASTE	Transportation damage and cutovers	Human behavior, cutting materials and materials protection, transportation.
C	TIMBER WASTES	Wasted timber and cutovers	Cutting materials and materials protection.
D	TILE WASTES	Wasted tile and cutovers	Human behavior, transportation, cutting materials and materials protection.
E	STEEL AND ALUMINIUM WASTES	Off-Cut steel bars from basement activities, roof works, raft & pad foundation, floor slabs and damages from construction tools (such as scaffolding, handrails etc),and machine	Cutting materials and materials protection.
F	GLASS	Deformation during transportation and delivery. Obstruction and deformation work, used waste from non-standardized design	Human behavior, transportation, cutting materials and materials protection(packaging) .
G	PLASTICS	Over supply of PVC pipe for piping and drainage, Over supply of water proofing materials,	Human behavior, transportation, cutting materials and materials protection
H	PACKAGING MATERIAL	Packaging from tiles, glass, cement bags, constr. materials.	Human behavior, transportation, cutting materials and materials protection

Source: *Authors field work (2009)*

Frequencies of occurrence of the sources of different types of construction waste collected from the 8 projects including concrete and cement, block, timber, tile, steel and aluminum , glass, plastics, packaging material are summarized in Table 2 to 6.

Table 2: The *Sources and levels of concrete wastes*

S/N	SOURCES OF THE CONSTRUCTION WASTE	FREQUENCIES OF OCCURRENCE OF SOURCES (%)
1	Chisel For Leveling	100
2	Flow Of Plastering	100
3	Cleaning Of Construction Tools	100
4	Template Leaking	100
5	Poor Plastering Works	100
6	Over-Order	23
7	Variations Between Drawings And Construction Work	32
8	On-Site Concreting Activities	62
9	Default From Design Drawings	0
10	Design Variations	47
11	Default From Delivering	0

Source: *Authors field work (2009)*

Table 3: The *Sources and levels of Block wastes*

S/N	SOURCES OF THE CONST.WASTE	FREQUENCIES OF OCCURRENCE OF SOURCES (%)
1	Deformation During Transportation And Delivering	100
2	Cut-Corner Of Construction Formwork	100
3	Lack Of Communication Among Contractors	50
4	Over-Order	5
5	Design Variations	20
6	Default From Design Drawing	20
7	Default From Drainage	30
8	Unqualified Quality Requirements	0
9	Default Of Materials	5

Source: *Authors field work (2009)*

Table 4: The *Sources and levels of Timber wastes*

S/N	SOURCES OF THE CONSTRUCTION WASTE	FREQUENCIES OF OCCURRENCE OF SOURCES (%)
1	Attained Periodic Of Using Formwork	100
2	Cut-Corner Of Construction Activities	35
3	Default From Storage	100
4	Default From Operations	5
5	Used Wastage From Non-Standardized Design	23

Source: *Authors field work (2009)*

Table 5: The *Sources and levels of Tile wastes*

S/N	SOURCES OF THE CONSTRUCTION WASTE	FREQUENCIES OF OCCURRENCE OF SOURCES
1	Attained Periodic Of Using Formwork	42
2	Cut-Corner Of Construction Activities	42
3	Default From Storage	25
4	Default From Operations	3
5	Used Wastage From Unstandardized Design	3

Source: *Authors field work (2009)*

Table 6: The *Sources and levels of Steel wastes*

S/N	SOURCES OF THE CONSTRUCTION WASTE	FREQUENCIES OF OCCURRENCE OF SOURCES (%)
1	Off-Cut Steel Bars From Basement Activities/Steel Scaffolding	70
2	Damages From Construction Tools/Machines	0
3	Default From Construction Processes	100
4	Upsized Steel Bars	100
5	Default From Drawings	0

Source: *Authors field work (2009)*

From the results shown in Table 2, Concrete wastes contribute the major proportions of the total waste generation, it should be highlighted that the major reasons in the concrete waste generation is flow of plastering, demolished concrete, over-order and template leakage, which included about 80 percent to 90 percent of the total waste generation. Chisel for leveling, template leaking, flow of plastering, poor plastering works and cleaning of construction tools appeared at all the 8 projects. Over-order, variations between drawings and construction work, lack of communication among contractors, on-site concreting activities, default from design drawings, design variations and default from delivering can mainly be affected by human behavior including on-site management, materials ordering, operating machines, cutting materials and materials protection. Table 3 shows the Major sources of block wastes as transportation damage and cutovers, which included about 80 percent of the total waste generation. Deformation during transportation and delivering) and cut-corner of construction formwork appeared in all projects. Deformation during transportation and delivering, cut-corner of construction formwork, lack of communication among contractors, over-order, design variations, default from design draining, default from drainage, and unqualified quality requirements can be affected by human behavior. As block is a brittle material, it is easy to be damaged during transportation. Table 4 shows the Major sources of timber wastes as wasted timber and cutovers. Attained period of using formwork and cut-corner of construction activities have an "occurrence of frequency" of 100 percent from the survey. Default from storage, cut-corner of construction activities, default from operations, and used wastage from non-standardized design can be affected by human behavior. Timber formwork can only be used for less than ten times. As concreting structure is not commonly adopting other forms of formwork to enhance the reusable time, waste problems are difficult to control. Similar results as block wastes are encountered in tile wastes. Attained period of using formwork and default from storage have a relatively high "occurrence of frequency", and all sources can be affected by human behavior. The "relatively high" occurrence of frequency is mainly due to half of the projects are during its structural work activities. Since tile is a brittle material, and easy to cause damages during transportation, protections during transportations should be provided to reduce these unnecessary wastes (Table 5).

The dominant sources of steel wastes are, off cuts steel bars from basement activities, large concrete works and damages from construction tools (Table 6). Default from construction processes and upsized steel bars have an "occurrence of frequency" of 100 percent. While default from construction processes and default from drawings can be affected by human behavior. This is due to the specialty of this material and its economic property.

Tips to improve Construction waste management

Based on the interview discussions, there are several recommendations suggested to improve the existing waste management.

(a) Legislative Enforcement

To improve waste minimization or management, a comprehensive environmental law must be enacted and a legislative enforcement adhered to religiously. Through these, waste generation can be greatly reduced and it would also accelerate industrialization of disposition of construction wastes.

(b) Staff Training and education/awareness

Proficiency and environmental awareness of operation workers have a direct effect on waste generation. Thus, training schemes should be provided for all levels of employees with the objectives to improve the environment. Educating frontline staff is a necessary step to improve environmental awareness. During the survey, most interviewed supervisors and construction managers argued that most workers are employed without any training, while few are trained only for less than a week.

(c) Involving environmental consideration in design stage

Involving environmental protection consideration in the design stage and implementing waste minimization design are necessary to reduce waste generation. Variations in design are one of the main reasons on the huge construction waste generation. At the same time, design process should be considering strategies in minimizing construction wastes, including adoption of prefabrication and modular design and use of durable construction materials. On the other hand, it can be learnt from the promotions of innovative technologies from other countries including using low-waste construction technologies during design processes, using drywalls instead of traditional structural walls, using prefabricated slabs instead of on-site plastering and using off-site prefabricated building services systems.

(d) Involving environmental consideration in tendering reports

Tenderers are required to consider the environment and waste minimization systems into tendering reports, such as techniques applied to avoid construction waste generation. It is necessary to assess waste management systems in the tendering stage and include waste minimization systems as one of the project objectives.

(e) Adopting On-site management systems

Waste generation can be effectively minimized by adopting on-site management systems through the reuse of construction materials in the construction processes, Implementing responsibilities on waste management with clear directions and adequate supervision of each employee, including technical staff and frontline staff. Furthermore, reward schemes can be used to encouraged employees in waste minimization, e.g. for staff that propose a useful method which could help to reduce waste generation. And also a penalty is passed on employees with low environmental awareness.

(f) Communication Improvement between subcontractors

Most subcontractors argued that there is no ground for them to freely acquire or exchange information with other subcontractors, which in most times lead to unnecessary waste generation. For example, a contractor in a project with frequent variations in design drawings did not communicate with other contractors with the change of dimensions of holes for equipments and dimensions of concrete walls, other contractors have to cut their materials to suit reserved holes or reorder their materials, thus generating some unnecessary waste on-site.

CONCLUSIONS

This paper investigated the major reasons and causes of different types of construction wastes. A series of detailed questionnaire survey and structured interviews were conducted in Abuja and Minna, Nigeria. Concrete, cement, brick, timber, tile, steel and aluminum were the main waste sources. It was found that major reasons of the huge waste generation were lack of management skills, lack of environmental awareness, lack of training, lack of legislative enforcement, and lack of supervision. Recommendations to improve waste minimization were suggested, including:

- Enforcement of legislation;
- Training and education;
- Involving environmental consideration in design stage;
- Involving environmental consideration in tendering reports;
- On-site management systems; and
- Improvement of communication.

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