Waste minimization with Architectural Design Practices in Lagos

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Abstract

Waste is a global problem causing substantial environmental impact. In the building industry, waste minimisation and management practices have become an essential measure in construction; due to the concern of impact caused by construction waste. The aim of this paper is to examine the feasibility of waste reduction during the design stage of an architectural project. Its main objective is to create an awareness on the possibility of determining waste to be generated before it is generated and managing it from the design stage (source). In light of these, the paper evaluates current waste minimisation schemes in Lagos architectural firms, identify barriers and possible incentives for effective waste reduction practice using questionnaires administered specifically to architects, based on minimization issues in design and construction. This paper also stresses the use of the waste hierarchy 3R’s (Reuse, Reduce, Recycle) that have been adopted for waste reduction in general. The research concludes by stating that management of waste within the building industry in Nigeria comes up when actual physical waste has been produced and little has been done concerning managing waste from its source. The paper therefore recommends that waste management be addressed from its source and architects, other professionals should adopt an effective waste management practice and implement it in all stages of development.

Keywords: Waste, Management, Minimization, Architectural Design, Architectural Practice

1. Introduction

The globe is striving towards achieving sustainability. Sustainability in architecture according to Littman (2009) is understood by modern society today as an inadequate measure for current and future architectural design, for it aims no higher than trying to make a building ‘less bad’. He said the current standard of building requires very little in regard to the environment and the standard set for what is considered a sustainable building is extremely low. Over the years, sustainable design and construction practices has increased due to advancement in technology and economic development. Waste management is a major problem towards achieving sustainability owing to the ever increasing population, material usage and energy consumption which leads to increased waste production and pollution (Zhen L et al., 2011). Waste is any substance discarded after use. Waste minimisation is a process which avoids, eliminates or reduces waste at its source or permits the reuse, recycling of waste for beneficial purposes (Guthrie and Mallett, 1995). Reduction at source for construction involves both design concepts, building technology applied and building materials selected (Poon and Jaillon, 2008). When a structure is built, it is celebrated if it employs any level of environment acknowledgement (Littman, 2009). The increasing awareness of environmental impacts from construction waste has led to the development of waste management as an important function of construction project management in the building industry (Shen and Vivian, 2001). As the rate of construction in Lagos increases, there is a pressing need to reduce waste at all stages of design (source). This increase makes the need for an effective waste management practice essential. Several research works have developed various guides to managing waste but according to Osmani (2007), the recommendations do not relate waste to all areas of the designers’ environment, including the complex design process. The researchers also agree with other literary works which stated that current researches in waste management addresses various issues relating to waste only when it has already been produced. It was against this foundation that the researchers embarked on this research to analyze how architectural design practice in Nigeria can be deployed from the onset to address waste minimisation, disposal and management right from the source-design stage.
2. Literature

Literatures reviewed give insight into current and ongoing researches on waste and waste management, waste origin, waste management plans, waste management from source and waste minimisation procedures.

2.1 Waste Research Spectrum; Construction related

Current and ongoing research in the field of construction waste management and minimisation can be broadly categorized into the following eleven clusters.

- a. Attitudes towards waste (Lingard et al., 2000; Teo and Loosemore, 2001; Sanders and Wynn, 2004).
- c. Construction waste quantification and source evaluation (Faniran and Caban, 1998; Ekanayake and Ofori, 2000; Poon et al., 2004).
- d. Comparative waste management studies (Chen et al., 2002).
- e. On-site waste auditing, assessment tools and improvements of waste management practices (McGrath, 2001; Chen et al., 2002, McDonald and Smithers, 1998).
- g. Management mapping, to help with the handling of on-site waste (Treloar et al., 2003; Shen et al., 2004).
- h. On-site construction waste sorting methods and techniques (Poon et al., 2001).
- i. Reuse and recycle in construction (Emmanuel, 2004; Lawson et al., 2001).

In simple terms as put forward by the researchers, Waste is any substance discarded after use. Gutberlet (2008) defines waste as portable objects that have being abandoned by their owners. Zaman and Lehmann (2013), rephrased it saying in a modern society, waste is a symbol of inefficiency and a representation of misallocated resources. Building construction activities have been reported to generate approximately 20-30% of waste deposited in landfills (Craven et al, 1994) and Poon (2000) noted that construction waste takes a considerably large share among all types of solid wastes; and his study reveals that construction waste resulting from demolition makes up a large proportion of the whole waste quantity. All these proves that the construction business is a large contributor to waste generation.

2.2 Construction waste, Minimisation

The European Council directive 91/156/EEC, defines construction waste as any substance or object which the holder discards (Directive 91/156/EEC. Article 1, letter a). Likewise, Construction waste minimisation as defined by Envirowise (1998) is the process of systematic waste reduction at source, by preventing and reducing waste before its physical generation, and encouraging reuse, recycling and recovery. In any case, the preferred definition of construction waste minimization to this paper is the reduction of waste at source, by understanding and changing processes to reduce and prevent waste (Environmental Agency, 1997). Hence, construction waste minimization is a process which avoids, eliminates or reduces waste at its source or permits reuse and recycling of the waste for beneficial purposes in construction (Reimer and Kristoffersen, 1999).

2.3 Construction waste origin

Construction waste originates from design; materials procurement; materials handling; operations; which results in residual and leftover scraps (Craven et al, 1999). Waste can occur during the design stage due to errors in contract clauses or incomplete contract documents (Craven et al, 1999; Bossink and Brouwers, 1996). Furthermore, construction waste from the pre-construction and construction phase occurs during: planning and designing through lack of coordination with standardization of materials, and ordering of extra materials. Finally, manufacturers and suppliers contribute to this problem when goods are damaged during delivery and loading. Baldwin (2006), stated that waste generated at the design stage is also caused by: ‘building complexity’, through the emergence of a variety of design specialties and responsibilities within the same project leading to design changes; ‘co-ordination’ and ‘communications’ problems due to the multi-disciplinary nature of design projects where the information that passes to contractors is highly variable and open to misinterpretation contributing inevitably to waste generation. Faniran and Caban (1998), also specified that design changes and detailing errors lead to waste generation. In a study conducted by Osmani et al., (2006), regarding the attitudes of architects and contractors towards origin of construction waste indicated also that construction waste is linked to design. This reveals that improper scaling of design and scale conversions of design leads to waste generation.

2.4 Construction waste minimization practices
Several research works have developed management methods that can be used to control waste. Spivey (1974), suggested to sort out wastes into specific categories which allows the adoption of specific techniques in dealing with different types of wastes, such as demolition materials, packaging materials, wood, concrete, asphalt, garbage and sanitary waste, scrap metal products, rubber, plastic and glass, and pesticides and pesticide containers. Petts (1995), promoted the proactive community involvement in implementing waste management, and suggested consensus building of the public in order to control waste generation and mitigate the waste impacts to the environment. Coffrey (1999), pointed out that construction waste management is generally seen as a low priority when financial constraints are present, and suggested that considerable waste reduction can be achieved if waste management is implemented as part of project management functions. He said further that even the most favorable waste handling methods should be determined by considering the cost implications, and any practices which will induce waste reduction must be encouraged. Lingard et al. (2000), considered it is more effective to provide training and education among staff, and involve employees’ participation in implementing waste management.

In recent years also, waste reuse and recycle have been promoted in order to reduce wastes and protect the environment, but the effectiveness of their application has been said to be limited and subject to experience, employees and knowledge of environmental and safety regulations (Chun et al., 1997). In terms of guideline, the ‘three Rs’ principle of waste (reduction, re-use and recycle), otherwise known as the waste hierarchy also has been widely adopted. This waste hierarchy broadly used as guidance for designers to adopt a waste minimization approach in their projects (Kramer et al., 2012). Another, in the waste hierarchy, waste avoidance and reduction is the prior choice of measures in the management of waste. Department of Environment Affairs stated that the waste cannot be avoided, rather it should be recovered, reused, recycled and treated as well as it should only be disposed of as a last resort (Osmani M, 2012). Faniran & Caban (1998), thought that, among various existing waste management methodologies, the typical methodology is to adopt a waste management hierarchy, which classifies and prioritizes waste management options in descending options of (a) reducing waste; (b) re-using waste; (c) recycling waste; and (d) disposing waste where the first three options are not possible. However, the 3R strategy did not relate to all parameters of the designers’ environment and it is discredited because the waste occurrence during the architectural design stages is different and unpredicted.

2.5 The Role of Architects and other professionals in Waste Generation and Management

In summary, some of the causes of waste during the construction phase of the project develop from the errors made right from the design planning stage (Ola-Adisa et al., 2015).

The significance of the Architect should not be disregarded in the aspect waste management. One of the initial stage in reducing the sum spent on waste disposal is to reduce the amount of waste produced or made. The primary step in waste minimisation strategy is good planning. Design should be planned according to standard sizes and materials should be ordered accurately. Also, it is vital that the architect ensures the client knows about all levels of the waste management hierarchy to optimize the resources used on building projects. So as to encourage waste reduction and recycling practices, architects and engineers can develop pertinent language to incorporate in their specifications (Ola-Adisa et al., 2015).

3. Methodology

The research methodology is the means through which facts, data and information are gathered to support the aim of this project. Primary and Secondary sources of data were used. Various key issues were gathered from literatures and a qualitative means of research was employed in the project. The population of the study were Architects within the sample area as they are regardless the head of the construction team. The sampling frame was confined to 5 Architectural firms randomly selected in Lagos. The sample size in total incudes thirty (30) respondents, comprising of managing directors, associate architects and employed architects in the selected companies. The sampling technique used for the study is the purposive sample technique. This technique was used for the study because the study is restricted to Architectural firms in Lagos Nigeria and how architectural design practices can influence waste generation and management. The respondents were selected with the purpose of getting a valid response. One research instruments was developed; an open- ended structured questionnaires for professional architects in the respective Architectural firms. The questionnaires were divided into six sections: background information; origin of waste; waste responsibilities; policies and minimization plans; and barriers and incentives, some of which were purposely duplicated to obtain diverse insights into common and interrelated issues. This questionnaire was used to collect data from the respondents. Respondents were required to indicate their opinion on each item based on Likert five-point scale of ‘1’, lowest level, to ‘5’, highest level. At the end of each thematic section, a space was provided as an option for respondents to provide additional information. An optional information question was added at the end of the questionnaire to capture informants’ views in regard to other waste minimization issues that were not covered in the survey.
4. Data Analysis and Discussion

4.1 Origin of building construction waste
Architects considered that 'design changes' and 'lack of information on drawing' were the underlying causes of waste on site from the pre-design and design stages. This research also identified other significant design waste contributors to, not working to standard dimensions and not designing with waste minimisation in mind. Architects raised concerns regarding last minute design changes by contractors and time limitations. Architects also held the contractor responsible for 'poor reading of information', including failure to follow specification and details. The research addressed waste being inevitable and factors responsible for its creation and it has been made obvious from the response that various last minutes, unplanned changes occurs which could lead to waste been generated.

4.2 Insight into what activities during each design stage was responsible for waste
Based on the architects' responses, it is clear that waste was not considered a priority in the design process; More than 50% claimed that no waste was generated during the planning and design stages. This shows that architects do not believe that waste is generated during the early stages of design, which is a concerning denial. Architects kept saying that waste was an issue for contractors as it generates on site mainly. They did not want to accept the fact that they were the primary source of these waste from their design. Poon et al. findings also revealed that there had been very few attempts by architects to adopt waste minimisation strategies, 'which were thought to be the responsibility of the contractor'.

<table>
<thead>
<tr>
<th>Stages</th>
<th>Responses rate (%)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning stage</td>
<td>Yes: 46.67</td>
<td>No: 53.33</td>
</tr>
<tr>
<td>Design stage</td>
<td>Yes: 53.33</td>
<td>No: 46.67</td>
</tr>
<tr>
<td>Construction stage</td>
<td>Yes: 90</td>
<td>No: 10</td>
</tr>
<tr>
<td>Occupancy stage</td>
<td>Yes: 40</td>
<td>No: 60</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
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</tbody>
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<table>
<thead>
<tr>
<th>Stages</th>
<th>Responses rate (%)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analyzing site waste to be generated</td>
<td>Yes: 20</td>
<td>No: 80</td>
</tr>
<tr>
<td>Designating waste disposal operation</td>
<td>Yes: 83.33</td>
<td>No: 16.67</td>
</tr>
<tr>
<td>Waste management goal setting</td>
<td>Yes: 73.33</td>
<td>No: 26.67</td>
</tr>
<tr>
<td>Organizing waste management meetings</td>
<td>Yes: 60</td>
<td>No: 40</td>
</tr>
<tr>
<td>Implementing guidelines for waste segregation</td>
<td>Yes: 80</td>
<td>No: 20</td>
</tr>
<tr>
<td>Preparing a list of materials to be used, salvaged or recycled</td>
<td>Yes: 83.33</td>
<td>No: 16.67</td>
</tr>
<tr>
<td>Implementing the guidelines for hazardous waste management</td>
<td>Yes: 83.33</td>
<td>No: 16.67</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.3 Waste minimisation policies and practices
Architects confirmed that waste minimization strategies are hardly ever implemented. They also noted down that they hardly thought of: waste when designing, estimating waste that could generate from their design and using minimization strategies in the design process. This exposed the truth that there are no standard waste management policies and practices adopted by architectural firms in Lagos. Their responses are shown in Table 12 and 13.
Table 4: Waste minimisation versus other design requirements

<table>
<thead>
<tr>
<th>Design requirements</th>
<th>N</th>
<th>Rating frequency</th>
<th>Mean</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste minimisation against other design requirements</td>
<td>30</td>
<td>0 2 6 18 4</td>
<td>3.8</td>
<td>3</td>
</tr>
</tbody>
</table>

4.4 Barriers and Incentives

About 70% of architects believed that legislation was a major incentive to improving waste minimization followed closely by financial rewards and waste management strategy enforced as criteria were key incentives to promote waste minimization from the inception of the design.

Architects from their responses specified that poorly defined responsibilities, lack of interest from client, and the idea of waste is inevitable were the root barriers of waste management and these act as catalysts for change in design practices.

5. Conclusion

The research project has attempted to assess waste minimisation potential from source by specifying that there is a possibility to eliminate construction waste before it is generated. Therefore, this research entitled, ‘Waste minimisation with architectural design practices’, endeavors to track site waste backwards and relate it to the design stage where it occurs. The results show that most architects were aware of the importance of waste minimisation, but few serious attempts had been made to reduce waste during the design process. Also, most architects acknowledged that waste minimisation is not considered during design. In addition, architects believed waste was produced primarily during site operations and rarely generated during the design stages. Architects considered waste reduction measures to contribute to a cleaner environment by effectively addressing waste from the start of the design process (source) and that architects likewise other professionals should adopt an effective waste management practice and implement it in all stages of a development; the use of education to address waste reduction, the use of prefabricated materials to reduce cut offs, and redefining the contract laws. Also, clients should be made by law to bear the cost of waste disposals/waste management. This would help control their design changes tendencies.

References

singing prefabrication in building construction in Hong Kong. 