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Examining the Criteria for the Selection of Green Building Materials in the Construction Industry in Nigeria

Nnaemeka S. A.*[1], Fadumo D. O.[1], & Okolie E. N[1]

[1]Department of Building, Faculty of Environmental Sciences, Nnamdi Azikiwe University Awka, Nigeria

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Abstract: This study examined the basic criteria for the selection of Green Building Materials in the Construction industry in Nigeria with a view to recommending the basis for wise selection of building materials that have optimal sustainability. The study was conducted through a descriptive survey method where Ninety (90) well-structured questionnaires were distributed to professionals in Architecture, Building and Quantity Surveying. Documented data from available records like journals and books were also reviewed as secondary data source. The data obtained were analysed using Weighted Average Mean method, the result suggest that the best criteria for selecting green materials is to consider the health and needs of the occupants of a house. This is because the welfare and state of health of the users of a building is the most important thing in carrying out any project, to ensure that the materials do not cause sick building syndrome. The materials must meet the basic needs of users or the purpose for which they were procured .The durability cost of maintenance and the amount of energy used in manufacturing the materials ranked next in order of criteria. While the geographical source of materials and production and cost of materials and labour ranked average. Emission of toxic chemicals and gases, recyclability and reusability of materials and rate of renewal of the source of material ranked low.

Keywords: Green Buildings, Construction, Architecture, Materials, Reusability.

INTRODUCTION

Shelter is needed amongst other things, for protection against the inclement weather and for healthy living. What is needed is a dynamic equilibrium; in other words, production process that is friendly to the ecosystem, yet competitive and possess no form of threat especially to the environment (Zubairu, 2012). Green Buildings refers to a structure that uses all processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from Site selection to Design, Construction, Operation, Maintenance, Renovation, and Demolition. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort (EPA, 2016). Buildings not only require energy but also materials of construction, which in turn require energy for their production and transportation (Pearce, 1998). The ideal situation would be to produce buildings with natural sustainable materials collected on site; these buildings should also be able to generate their own energy from renewable sources, such as solar or wind, and manage their own waste.

LITERATURE REVIEW

The Need for Sustainable Development in Nigeria

Creating sustainable working environments is not just about reducing carbon emissions. Truly sustainable buildings should be designed to improve the wellbeing of the people who work in them and the communities that surround them. “Going green” is the phrase referring to corporate and individual action consciously taken to curb the harmful effects on the environment through consumer habits and lifestyles. Access to clean modern energy services is an enormous challenge facing the African continent because energy is fundamental for socioeconomic development and poverty eradication. Today, 60% to 70% of the Nigerian population does not have access to electricity (Oyedepo, 2012). Security, climate change, and public health are closely interrelated with energy (Ramchandra & Boucar, 2011). Future economic growth crucially depends on the long-term availability of energy from sources that are affordable, accessible, and environmentally friendly. The common Nigeria man does not understand the concept of “conservation of energy” and this is the guiding principle behind sustainability. That every home should be able to utilize energy, either water, air, electricity, etc. conservatively, without causing harm to the environment. The recent world's energy crisis is due to two reasons: the rapid population growth and the increase in the living standard of whole societies. In Nigeria today, most structures are constructed using cement based materials. Cement during its manufacture and use is responsible for the emission of greenhouse gasses which are harmful to the environment. The production of cement also causes the depletion of non-renewable natural resources. The incremental rate of construction has pervaded most urban centers in Nigeria, with most of such buildings inhabited with the barest facilities in place (Ijatuyi *et al.,* 2013). Architects, planners,

***Corresponding Author:** Nnaemeka S. A.

environmentalists and engineers should be oriented on issues such as energy consumption, use of environmental friendly materials and design concepts that reduce environmental impacts and ensure sustainability. Energy and poverty reduction are not only closely connected with each other, but also with the socioeconomic development, which involves productivity, income growth, education, and health (Nnaji & Uzoma, 2010).

Criteria for selecting Sustainable Building Material

According to Patil & Patil (2017) For Selection of Sustainable building materials the following criteria are commonly used:

- **Local availability of Materials:** The availability of construction materials has a strong impact on costs as well as on the construction time of a building. Thereby, on the one hand, a high availability reduces purchasing effort and on the other hand leads to quick lead times, even if orders are made on short notice. Low availability would present an obstacle for construction contractors to use these materials. Furthermore, the availability refers to local aspects. It might be beneficial to use local materials rather than materials which have to be delivered from far distances, with respect to transportation effort and costs which in turn is beneficial for the environment due to reduced emissions during transport (Halliday, 2008) As far as possible locally sourced materials are to be preferred so as to minimize the energy spent in transportation of the building materials. Energy consumed in transportation should be considered as total energy spent on transporting materials starting from the place of manufacturing
- **Embodied Energy of Materials:** Embodied energy is an assessment of the energy required to manufacture any building material. This include energy required to extract raw materials from nature, energy used to transport raw materials to manufacturing unit and the energy used in manufacturing activities to provide a finished product. Every building is a complex combination of many processed materials, each of which contributes to the building's total embodied energy. Embodied energy is a reasonable indicator of the overall environmental impact of building materials, assemblies or systems. (Jagdish *et al.*, 2003)
- **Percentage of Recycled/Waste Materials Used:** Building materials can be manufactured using recycled materials or using waste materials. Use of recycled materials helps the environment and the economy in several ways. A significant effect is that of lessening the need for manufacture with virgin, non-renewable resources, which saves precious resources, energy and cost. Waste materials that would have ended in landfills after its useful life instead can be reprocessed for use in other products. Use of various types of waste materials such as fly ash, blast furnace slag, red mud, waste glass, marble dust, cinder, rice husk, coconut husk, banana leaves, jute fibers, rubber from automobile tires, etc. is demonstrated by research
- **Use of Rapid Renewable Resources:** Materials manufactured with resources that are renewable (i.e. wood or solar power) rather than non-renewable (i.e. fossil fuels) shall be preferred. Depletion of the earth's resources is occurring at an alarming rate. Entire ecosystem is affected due to continuous extraction of raw materials from the earth. As stock of fossil fuel is limited, it may get exhausted very soon. By utilizing renewable energies, such as wind, solar, tidal, as well as renewable materials, such as wood (certain certified species which are rapidly renewable), grasses or sand, impact on biodiversity and ecosystems can be lessen.
- **Durability:** Materials which are long lasting and needing little maintenance are preferred. Material replacement puts a strain on the earth, its resources and inhabitants. In making materials more durable and easy to maintain, manufacturers can help in eliminating a costly, damaging and time-consuming process of replacement. Although high life time expectancy might as well be an ecological requirement in terms of reduced material use due to longer replacement intervals, construction materials and components with a long life cycle and low maintenance effort reduce investments for maintenance, replacement and renovation. (Sunke & Schultmann, 2008)
- **Environmental Impact and Indoor Air Quality:** All materials used for construction of buildings must not harm the environment, pollute the air or water, or cause damage to the earth, its inhabitants and its ecosystems during manufacturing process, and also during use or disposal after end of life. Material should be non-toxic and contribute to good indoor air quality. Worldwide industrial production uses billions of tons of raw materials every year. Pollution caused in excavation, manufacturing, use or disposal of a product can have far reaching consequences on the Earth's ecosystem. Poor indoor air quality caused by VOC emission costs billions in medical bills and lost productivity to companies every year. (Jagdish *et al.*, 2003)
- **Recyclability:** The recyclability of the materials can be judged from quantity of materials recovered for re-use after the useful life of materials/products or after demolition of the building. The construction industry is the

***Corresponding Author:** Nnaemeka S. A.

second largest consumer of raw materials after the food processing industry (Halliday, 2008). Construction materials are highly diversified and accumulate in huge amounts at the end of the life cycle either of the material or of the building or its components. In Germany, the Waste Management and Recycling Act defined a hierarchy for waste treatment as the highest priority assigned to the avoidance of waste. Second ranked is recovery or recycling of materials. However, construction materials can still not lead back into the material cycle without any processing, or even have to be disposed of. Hence, the ability of recycling of a construction material is a prerequisite for the establishment of closed-loop material flows.

- **Contamination from Gases and Toxic Emissions:** The aspect of contamination refers to the environmental burden caused by construction materials but also to its impact on the wellbeing and health of the living environment. In the past, construction materials were used for interiors without giving cause to possible negative effects. However, nowadays, several of the construction materials used in the past is now known to be hazardous to health and environment. The use of numerous substances is already interdicted, however, the number of negative symptoms caused by indoor Algren's and toxins in the interior of buildings has risen significantly (Jorissen *et al.*, 2005)
- **Manufacturing and Price:** In addition to a high availability, construction materials and components ought to be cheap in production, hence, should not be significantly or even cheaper than it's less sustainable substitutes. Keeping the idea of closed-loop material cycles in mind, subsidies for the use of recycled or renewable raw materials should be encouraged, whereas the price for primary resources should be increased, which however, has a positive impact on the environment. (Sunke & Schultmann, 2008)
- **Cost of Transportation:** Transportation of materials is a major factor in the cost and energy of a building. Bulk of the building materials in urban and semi-urban centers are transported using trucks in India. The transportation distance may vary depending upon the location of construction activity. (Jagdish *et al.*, 2003). The cost of transporting building materials depends on its distance from the place of production to where it is to be used.

METHODOLOGY

The research adopted descriptive research survey design in building up this research work. The choice of this research design were considered appropriate because of its advantages of identifying attributes or items by collecting data from the members of a population in order to determine their opinion regarding the subject matter under discussion. The sampling technique employed in the course of this research is Purposive randomly sampling. The data for this research will be collected from both primary and secondary sources. The data obtained for the study were analyzed using weighted mean and data were presented in Tables and percentages.

RESULT

Table 1. Questionnaire Response Rate

Questionnaires	Frequency	Percentage (%)
Number of questionnaires Shared	90	100
Number of questionnaires returned	85	94%
Number of useful questionnaires	85	94%

Source: Researcher's field survey, 2019.

From Table 1 on questionnaire Administration and Response Rate, a total of ninety (90) questionnaires were prepared and administered to the three categories of respondents. However, not all the questionnaires were retrieved.90 questionnaires were administered to selected registered professionals in Building, Architecture and Quantity surveying in the study area in Awka South. Out of the 90 that were administered 85 questionnaires which represents 94% were returned while 6% were not returned. This return rate indicates that there was a high rate of response from the respondents (Fincham, 2008).

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Criteria for Selection of Green Building Materials in Awka South

Table 2. Level of Agreement of Identified Criteria for Selecting Green Building Materials

Criteria	Mean Score	Ranking
Consideration of the Occupants Health and Needs	4.48	1
How Durable is the Material?	4.46	2
Cost of Maintaining the Material	4.26	3
The Amount of Energy Required for Manufacturing the Material	4.18	4
Is the Material Locally Sourced and Produced	4.15	5
The Cost of Materials and Labor for Installation	4.13	6
Negative Effect of Material on the Environment and Indoor Air Quality	4.13	6
Toxic Chemical or Gases Emitted by Material	4.12	8
The Level to which Material can be Recycled and Re-used	4.11	9
Rate at which Source of the Material Renewed	3.92	10
The Amount of Waste Generated in Manufacturing the Material	3.91	11
The Cost of Transportation	3.78	12
Average Mean	**4.13**	

Source: Researcher's Field work, 2019

On Criteria for Selection of Green Building Materials in Awka South, Table 2, shows that the best criteria for selecting green materials is to consider the health and needs of the occupants of a house. This is because the welfare and state of health of the users of a building is the most important thing in carrying out any project, to ensure materials do not cause them to be ill and meets their basic needs for which they were used (4.48).Durability cost of maintenance and the amount of energy required for the manufacturing of the materials ranked next in order of criteria. The geographical source of materials and production and cost of materials and labor ranked average. Emission of toxic chemicals and gases, recyclability and reusability of materials and rate of renewal of the source of material ranked low.

The amount of waste generated during manufacture and cost of transportation ranked the lowest. This is because the waste generated does not directly affect sustainability of material, since they can be reused or recycled and transportation is usually added to the cost of a material.

CONCLUSION

The study suggests that the best criteria for selecting green materials is to consider the health and needs of the occupants of a house. This is because the welfare and state of health of the users of a building is the most important thing in carrying out any project, to ensure materials do not cause sick building syndrome and meet the basic needs of users for which they were procured (Jagdish *et al.*, 2003).The durability cost of maintenance and the amount of energy used in manufacturing the materials ranked next in order of criteria. While the geographical source of materials and production and cost of materials and labor ranked average. Emission of toxic chemicals and gases, recyclability and reusability of materials and rate of renewal of the source of material ranked low.

Compliance with Ethical Standards

Conflicts of Interest: The authors declare that there is no conflict of interest regarding the publication of this manuscript.

Ethical Approval: Ethical approval is not required.

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***Corresponding Author:** Nnaemeka S. A.