SUSTAINABLE ENVIRONMENT: LATERITE AS SUSTAINABLE BUILDING MATERIALS IN CONSTRUCTION INDUSTRY

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Abstract— The objective of this paper is to identify the significant of social, economic and environmental factors affecting the sustainability of laterite as building material in the construction industry. Building materials are considered as the largest input in any project thus has a great influence on the total cost of any projects. High cost of projects led to a call for incorporating laterite in most past and present projects. The research is aimed to identify the most significant factor to be used for effective utilization of laterite as sustainable building material in the construction industry. The research was carried out in suitable civil and building construction companies in Katsina, Kano and Kaduna states in northern Nigeria. The research findings identified that economic factors has the highest significant as sustainable building materials in the construction industry.

Keywords— Building Materials, Construction Industry, Environmental, Sustainability. Economic, Significant.

I. INTRODUCTION

Laterite, known as 'green' or environmental friendly construction materials can easily be re-cycled, have low energy consumption and toxicity in production and applications. Building professionals have the responsibility to ensure that laterite used is environmentally friendly and sustainable. This is part of construction, environmental designs and sciences. One of The main aims of Millennium Development Goals is to provide friendly environmental sustainable infrastructures. It is evident that environment is adversely affected, trees are cut down bushes, grass is cleared, and soils are excavated randomly while construction activities generate noise and environmental pollution (Gonchar, 2007).

Laterite has been the most widely known and used construction materials in construction industry, are successfully used as sustainable construction materials in various aspects of civil and building construction projects. The material is also employed in the construction of rural feeder roads, townships roads, intercity link roads, dams, airport runways, highways roads (Abdurrahman, 2010). United Nation Centre for Human Settlements stated that, about half of the world's populations are still living in laterite buildings mostly in Africa and Asia. The materials are economically effective, easy to work, mostly abundant universal and inexpensive, they eliminate transportation costs and workers with prior knowledge and experience can be employed in the construction (UNCHS 2011). Laterite buildings are resistance to sound transmission, fire resistance and insect damage and provide coolness during hot weather. It requires little energy in the extraction, processing, and also environmentally friendly construction materials in the construction industry.

II. LITERATES AS SUSTAINABLE BUILDING MATERIALS

Generally, people are discovering the benefits of having literate and clay buildings in developing countries especially in tropical regions, the benefits ranges from warming rooms during cold and cooling in hot seasons, availability in most areas, low cost of extraction and processing and production of building products such as bricks, blocks, tiles pipes and sanitary appliances. Another benefit is better properties and beauty can be obtained by adding colour additives these materials. It is important to ensure that the materials meet all the specifications in every respect. This means that all relevant properties must be checked and certified properly before used as building materials (Abbas, 2011).

The principal reason for using literate is its excellent sustainable characteristics in building constructions and recycling process. These include, the efficient use of finite resources, minimizing pollution, waste and low carbon emissions especially in industrial countries. Literate as a building material is available everywhere in the world and exists in many different compositions. Other benefits for energy requirement, to produce literate block or brick is only 5 (kWh)/cubic meter, while it is about 1000 (kWh)/ cubic meter for fired brick and 400 to 500 (kWh)/ cubic meter for concrete block (Adamson, 2010).Literate buildings are completely recyclable in many forms without environmental pollution, using laterite for such environmental buildings will be a strong component in the future of humankind.

Laterite which can be extracted and applied to the local production of low cost housing construction products Okereke (2003) identified sources of materials on which laterite can be categorized as sustainable construction materials. Nigeria one of the laterite producing country, but not effectively utilized. Fig.1 shows some states in Nigeria where laterite materials are abundant. One of the disadvantages of these materials is

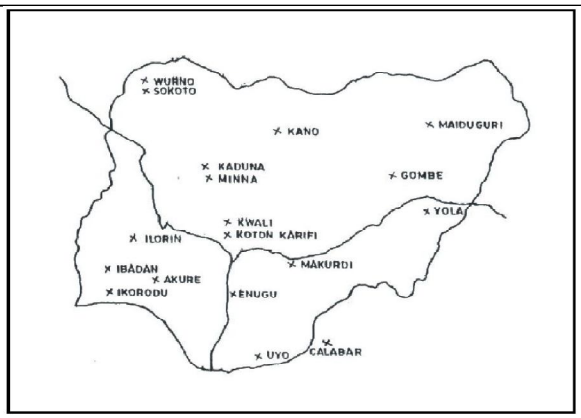

Fig 1; Laterite Areas in Nigeria

lack of standards that leads to non acceptability making the materials as second class or inferior materials.

Building materials, in general should aim at providing the most desirable levels of climatic comfort. By implication, the thermal characteristics of the building materials used are as important as their durability. In countries with harsh weather conditions, especially where there are extreme seasonal daily variation in temperature, climate conditions of countries such as Africa, the Middle East, the Arabian Peninsula and Asia, although, generally, hot and dry, tend to vary sharply between summer periods and winter months, thus making climatic conditions of utmost importance in the choice of materials. Fig2; Historical gobarau minerate built with laterite over 1000 years. Sustainable building materials by definition are materials that are locally produced and sourced which reduces transportation costs and carbon emissions, they can include recycled materials, that have a lower environmental impact, they are thermally efficient, they require less energy than more modern, conventional materials, they make use of renewable resources, they are lower in toxic emissions and they are financially viable (Dai, 2006

Figures 2: historic minerate building made of laterite 1000 years in northern Nigeria.

According to Abourizk (2010) literate can also be used for major parts of the building such as, foundations for small buildings in dry regions also as aggregate in concrete walls and foundation base. Traditional rural house floors Asia, Africa made of compacted stone or laterite and smoothened with a mixture of soil and cow dung, or only cow dung for resistance to abrasion, cracks and insects. Traditional flat roof with timber sub-structure covered with the dry literate same as for rammed walls and compacted well, only suitable for dry regions. Literates are widely available in some parts of the world, especially in rural areas; it is the only material available and easy to extract, suitable for construction in many building components, foundations, brick and block walls, floors, fencing and wall claddings. It is also used on road pavements tiles and corrugated roofing slates as it uses only about 1% of the energy required to manufacture and process the same volume of cement, concrete or roofing sheets (Lemougna *et al.*, 2011).

They are practically devoid of calcium carbonate, acidic in reaction (PH 5.0 to 6.5) and sandy clay loam to clayey in texture. The sesquioxides constitute more than 95 % of the total chemical constituents. They are of special interest in conjunction with building construction. They are highly weathered soils, which contain large, though extremely variable, proportions of iron and aluminum oxides, as well as quartz and other minerals, therefore can be utilizing for building and civil engineering projects. Table 1 presents the advantages of laterite usage in developed and developing countries.

The benefits of having laterite as construction materials in tropical regions are warming rooms during cold and cooling in hot seasons, availability in most areas, low cost of excavation, processing and production of building products such as bricks, blocks, floor tiles, roofing tiles, water pipes and sanitary appliances. Another benefit is better properties while beauty can be obtained by adding colour additives to these materials. It is important to ensure that the materials meet all the specifications in every respect. This means that all relevant properties must be checked and certified properly before used as construction materials.

Other benefits is energy requirement; to produce literate block or brick is only 5 (kWh)/cubic meter, while it is about 1000 (kWh)/ cubic meter for fired brick and 400 to 500 (kWh)/ cubic meter for concrete block (Adamson, 2010).Literate buildings are completely recyclable in many forms without environmental pollution, using laterite for such environmental buildings will be a strong component in the future of humankind. Laterite is most efficiently used in developing countries to house greatest number of people with the least cost. However, it must be noted that laterite buildings are not a phenomenon only of the third world countries, but also in developed countries. (Lemougna *et al.*, 2011). Different types of literate are suitable for use in building and civil engineering works.

Depending on the degree of preparation before use, building materials are conventionally classified as

building materials proper, such as binders and aggregates, and structural components, which are prefabricated units and elements to be installed in buildings at the construction site, such as reinforced concrete panels, toilet stalls, and door and window units. Sustainable materials are evaluated by the impact they have on the environment and on occupants over the life time of the materials and generally incorporate characteristics that contribute to:

i. Resource efficiency,
ii. Indoor air quality,
iii. Energy efficiency,
iv. Affordability.

Therefore, sustainable materials can be either natural or synthetic. In both cases, there is a cost involved throughout the life cycle of the materials that includes extracting resources, processing, producing, shipping, installation and discarding. Choosing the best materials for a project and the anticipated activities in a space can have a positive impact on the environment and building occupants while also costing less. Renovating and retrofitting existing buildings is generally more sustainable than constructing a new building, as fewer new materials are consumed. Choosing sustainable materials ensure that a building is not only constructed with but also furnished and maintained with sustainable building materials.

Table 1: presents the advantages of laterite usage in developed and developing countries.

Advantages of literate buildings	Advantages and Importance to Countries					
	Developing			Developed		
	High	Med	Low	High	Med	Low
Low cost & availability.	*			*		
Lower pollution,			*	*		
Ease of constructions	*					*
Employed low skilled labour.		*				*
Flexibility in use		*			*	
Saves energy	*				*	
Sustainable characteristic	*			*		
Easy to be recycled.		*			*	
Saves transportation costs			*		*	

III. CHARACTERISTICS OF SUSTAINABLE BUILDING MATERIALS

Laterite as sustainable building materials are characterized as being environmentally friendly, sustainable materials that meets the needs of the present without compromising the ability of future generations to meet their own needs. Such development requires the selection and judicious application of materials in building that minimize the social, environmental, and economic impact on the occupants. Some characteristics of sustainable building materials include (Park & Meier, 2007):

(i) Local extraction and production to minimize transportation costs
(ii) Contains recycled materials
(iii) Manufactured with little pollution or does not itself pollute
(iv) Minimum amount of energy required to produce
(v) Reusable on projects
(vi) Easily renewable and capable of being used to lessen social, environmental and economic impacts.

Sustainable building materials are evaluated based on their characteristics such as their reused and recycled content, durability, efficiency, longevity and zero or low harmful emissions. Recycled-content materials are available to replace just about every traditional building material. Another material efficient strategy is dimensional planning, conforming room design to standard-sized building materials; reducing the amount of construction by-product when materials are cut. Closely managing the handling of materials throughout the demolition, construction and cleanup phase will also ensure minimum waste and maximum utilization (Standard, 2007). Other characteristics of sustainable building materials are:

(i) Toxic free
(ii) Anti-decay
(iii) Shock and force absorbent rate
(iv) Created from recycled materials
(v) Easy to trim, cut, drill, and plane
(vi) Multi-purpose materials
(vii) Suitable for both indoors and outdoors
(viii) Moth/mildew, water, and rust resistant.

IV. RESEARCH METHODS

Qualitative and quantitative research methodologies were adopted for data collection in this research, which incorporates some aspects of the mixed method approach in some selected construction companies in Katsina, Kano and Kaduna states in Nigeria.

V. DATA COLLECTION

The research was conducted based on economic, social and environmental factors affecting the utilization and sustainability of laterite as sustainable construction materials in the construction industry.

VI. RESEARCH FINDINGS

The findings are based on the Likert scale statistics that any mean below 3.0 of the Likert scale is considered as ***not Significant*** and mean above **3.0** to **4.5** is considered as ***significant***, whilst **4.5** to **5.0** is

considered for this analysis as ***highly significant***. Therefore, the majority of the respondents indicate ***highly significant*** on factors affecting utilization of literate and clay as sustainable building materials and ***agree*** for improving factors.

Table3: Identified Significant Factors

Identified factors for laterite as sustainable building Materials	**Mean (x)**
Economic factors	4.25
Environmental factors	4.24
Social factors	4. 01
Mean average	**4.17**

CONCLUSION

In conclusion this research has identified sustainable factors of laterite as sustainable building materials in the construction industry. The research findings established significant factor which is economic factor with a ***significant mean of 4.25, which has higher mean that*** operates on the basis of statistical sampling considering that only professionals are considered in this research (Fellows and Liu, 2010). Procedure employed in this research is interview questions and the questionnaire which were self-administered.

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