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SUSTAINABILITY IN THE USE OF TIMBER FOR BUILDING CONSTRUCTION IN ILE-OLUJI, A SELECTED TOWN IN SOUTHWEST NIGERIA.

ABSTRACT

Despite the prominence of timber as construction materials, one of the greatest challenges facing it is environmental sustainability. The rediscovery of wood as a building material has placed an intense increase in the demand of wood on the world forest reserve even though it is naturally replenished; the rate of depletion has evoked a quest for an efficient, innovative and sustainable practice in the use of the material. Nigeria, like many countries of the world needs to keep up with the technological changes, especially in a world that has become a global village where distances between countries is shrinking at an exponential rate facilitating a relatively easy transportation of man and materials. In the present time professionals in the building industry are called upon to consider the ecological consequences of their actions. In the world of Architecture, this translates s to the efficient use of raw materials in the building industry at our disposal with care and economy. The research assessed sustainability in the use of timber for building construction in Ile-oluji. The research design was descriptive in which questionnaires was administered to the population of study comprises of (80) eighty member of staff a chosen sawmill in Ile-Oluji.. Data obtained were analysed and presented with percentage frequency table. This research sought to know if the practice is sustainable. The research submits that enlightens in the current practice regarding the use of timber in the building industry would be beneficial to the state and country both economically and ecologically.

KEYWORDS*: *Sustainability, Use, Timber, Building Construction

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INTRODUCTION

Sustainability in a broad sense is the capacity to maintain a certain process or state. It is now most frequently used in connection with biological and human systems. In an ecological context, sustainability can be defined as the ability of an ecosystem to maintain ecological processes, functions, biodiversity and productivity into the future. (Khatib, 2009).

Sustainability has become a complex term that can be applied to almost every facet of life on earth, particularly the many different levels of biological organization, such as; wetlands, prairies and forests and is expressed in human organization concepts, such as; eco-villages, eco-municipalities, sustainable cities, and human activities and disciplines, such as; sustainable agriculture, sustainable architecture and renewable energy.

For humans to live sustainably, the Earth's resources must be used at a rate at which they can be replenished. However, there is now clear scientific evidence that humanity is living unsustainably, and that an unprecedented collective effort is needed to return human use of natural resources to within sustainable limits (UN Brunt land Commission Reports.) . Since 1980s, the idea of human sustainability has become increasingly associated with the integration of economic, social and environmental spheres. In 1989, the United Nations Brunt land Commission articulated what has now become a widely accepted definition of sustainability; to meet the needs of the present without compromising the ability of the future generations to meet their own needs.

Building construction refers to the way in which buildings are built especially with regard to the quality of structures, materials and workmanship. (Wikipedia, the free encyclopedia).The use of steel, glass, cement, plastics, bricks etc. are examples of energy intensive materials commonly used for construction activity. Extensive use of these materials can drain resources and have adverse affect on the environment. Hence, there is a need for optimum utilization of available resources and raw materials to produce energy-efficient, environment friendly and sustainable building alternatives and techniques to satisfy the increasing demand for buildings. According to Raw Materials Research and Department council materials. (RMRDC 1998), local building and construction materials. Report of the multi-disciplinary task force on the survey of sustainable building materials. Below is a list of the guiding principles to sustainable, alternative building technologies;

Energy conservation: minimize the use of high energy materials.

Use of environmentally friendly materials and technology.

Maximize the use of local materials.

Timber has been used as a building material for over 400,000years (Calkins,2009.). It is the most common and best known material for construction including framing of logs, walls and roofs. In Nigeria the roof structures and ceiling noggins of most buildings are constructed from timers using mainly Abora. Aye and afara (Tectonis grandis) species because of their workability (RMRDC, 1998). Opepe (Nauclea diderrichii), a yellowish, very hard wood is used for doors and windows frame because of its natural resistance to insects attacks. Timber is easy to form, saw, nail, and fit; even with simple hand tools.

Presently, timber is undoubtedly one of the most fashionable construction materials around, certainly interest across wider construction industry has never been higher and its growth over the last three has been phenomenal.

Architects and specifiers are using more timber, not just for its aesthetic and structural properties but for the materials energy efficient and sustainable impact as well. Indeed, timber has even been tagged the ‘New steel’ surely a sign that as a construction material, it is being given full recognition as a real alternative for designers, if not a first choice decision for use (Bowyer, Bratkovich, Lindberg and Fernholz, 2008).

As a sustainable building material timber is naturally renewable. It has a high strength to weight ratio and it is easy to work with making it especially useful where only basic technology and procedures are available (Apu, 2003). Recently, timber has become one of the most widely used materials and it is found in large quantity in Nigeria.Hence, the need to construct buildings with elegance, performance, durability and low maintenance worthy of international recognition using locally sourced and readily available material has come to the fore. Timber is a universal building material and is one of the oldest known to man.

This research seeks to assessed the uses of timber in the construction of buildings in Ile- Oluji, Ondo State, Nigeria to find out if the practice is sustainable.

These issues engender three important Research Questions (RQ):

RQ1- What is the nature of timber and timber types in Ile-Oluji?

RQ2- What is the levels of sustainability in the use of timber for construction of buildings in Ile-Oluji?

RQ3- What are the merits and demerits of the use of timber in the construction of buildings in Ile-Oluji?

These relationships were based on the statistical test of three null hypotheses (H0) as follows:

H01 - There is no significant relationship between nature of timber, timber types in Ile-Oluji and sustainable practice.

H02 - There is no significant sustainable practice in the use of timber for construction of buildings in Ile-Oluji.

H03 - There is no merits and demerits of the use of timber in the construction of buildings in Ile-Oluji.

LITERATURE REVIEW

Timber is the harvested material most commonly used in buildings and building products. Dimensional lumber is used in framing the majority of residential buildings and many commercial structures. Timber products such as plywood, particleboard, and paper are used extensively throughout the construction industry(Birdsey and Lewis, 2002).

Until recent years, the most common method of harvesting wood was clear-cutting, a process wherein all vegetation within a given area is removed for processing. Now, where clear-cutting takes place, lumber companies are required to replant the area. Some lumber is now being produced on tree farms (“plantations”). However, replanting alone does not replace the natural biological diversity that existed before harvesting. Monoculture (same-species) plantings are particularly vulnerable to disease and insects. More companies now practice “selective cutting”: choosing only those trees large enough or valuable enough to remove and leaving the surrounding vegetation intact. Sustainable forestry practices include a professionally administered forestry management plant growth equals or exceeds harvesting rates in both quantity and quality. In addition, rivers and streams are protected from degradation, damage to the forest during harvesting is minimized, and biodiversity and fair compensation to local populations is emphasized (Lippke, Wilson, Perez-Garcia, Bowyer, and Meil, ,2004).

Few building materials possess the environmental benefits of wood. It is not only our most widely used building material but also one with characteristics that make it suitable for a wide range of applications. Efficient, durable, and useful wood products produced from trees can range from a minimally processed log at a log-home building site to a highly processed and highly engineered wood composite manufactured in a large production facility. As with any resource, we want to ensure that our raw materials are produced and used in a sustainable fashion. One of the greatest attributes of wood is that it is a renewable resource. If sustainable forest management and harvesting practices are followed, our wood resource will be available indefinitely.

2.1 WOOD AS A GREEN BUILDING MATERIAL.

Over the past decade, the concept of green building1 has become more mainstream and the public is becoming aware of the potential environmental benefits of this alternative to conventional construction. Much of the focus of green building is on reducing a building's energy consumption (such as better insulation, more efficient appliances and heating, ventilation, and air-conditioning (HVAC) systems) and reducing negative human health impacts (such as controlled ventilation and humidity to reduce mold growth). However, choosing building materials that exhibit positive environmental attributes is also a major area of focus. Wood has many positive characteristics, including low embodied energy, low carbon impact, and sustainability. These characteristics are important because in the United States, a little more than half the wood harvested in the forest ends up as building material used in construction.

2.2 EMBODIED ENERGY.

Embodied energy refers to the quantity of energy required to harvest, mine, manufacture, and transport to the point of use a material or product. Wood, a material that requires a minimal amount of energy-based processing, has a low level of embodied energy relative to many other materials used in construction (such as steel, concrete, aluminum, or plastic).

The sun provides the energy to grow the trees from which we produce wood products; fossil fuels are the primary energy source in steel and concrete manufacture. Also, over half the energy consumed in manufacturing wood products in the United States is from biomass (or bio-energy) and is typically produced from tree bark, sawdust, and by-products of pulping in papermaking processes. The U.S. wood products industry is the nation's leading producer and consumer of bio-energy, accounting for about 60% of its energy needs (Murray and others 2006, EPA 2007). Solid-sawn wood products have the lowest level of embodied energy; wood products requiring more processing steps (for example, plywood, engineered wood products, flake-based products) require more energy to produce but still require significantly less energy than their non-wood counterparts.

In some plantation forest operations, added energy costs may be associated with the use of fertilizer, pesticides, and greenhouses to grow tree seedlings. During the harvesting operation, energy is used to power harvesting equipment and for transporting logs to the mill. Lumber milling processes that consume energy include log and lumber transport, sawing, planning, and wood drying. Kiln drying is the most energy-consumptive process of lumber manufacture; however, bio-energy from a mill's waste wood is often used to heat the kilns. Unlike burning fossil fuels, using bio-energy for fuel is considered to be carbon neutral. Also, advances in kiln technologies over the past few decades have significantly reduced the amount of energy required in wood drying. Overall, the production of dry lumber requires about twice the energy of producing green (undried) lumber.

The Consortium for Research on Renewable Industrial Materials (CORRIM) found that different methods of forest management affect the level of carbon sequestration in trees (Perez-Garcia and others 2005). They found that shorter rotation harvests can sequester more total carbon than longer rotation harvests.

CORRIM also calculated differences in energy consumed and environmental impacts associated with resource extraction, materials production, transportation, and disposal of homes built using different materials and processes. Their calculations show that the energy consumed in the manufacture of building materials (mining iron and coal for steel or harvesting wood for lumber) and the construction of a steel-framed house in Minneapolis is 17% greater than for a wood-framed house (Lippke, Wilson, Perez-Garcia, Bowyer, Meil,2005). The difference is even more dramatic if one considers the use of bio-energy in the manufacture of wood products. By this comparison, the steel-framed house uses 281% more non-bio-energy than the wood-framed house (Lippke, Wilson, Perez-Garcia, Bowyer, Meil,2005). Global warming potential, air emission index, and water emission index are all higher for steel construction than for wood construction

These analyses indicate that the amount of energy necessary to produce wood products is much less than comparable products made from other materials. If wood is substituted for these other materials (assuming similar durability allows equal substitution), energy is saved and emissions avoided each time wood is used, giving it a distinct environmental advantage over these other materials.

2.3 CARBON IMPACT.

The role of carbon in global climate change and its projected negative impact on ecosystem sustainability and the general health of our planet have never been more elevated in the public's consciousness.

Forests play a major role in the Earth's carbon cycle. The biomass contained in our forests and other green vegetation affects the carbon cycle by removing carbon from the atmosphere through the photosynthesis process. This process converts carbon dioxide and water into sugars for tree growth and releases oxygen into the atmosphere:

energy (sunlight) + $6H_2O$ + $6CO_2$ ===> $C_6H_{12}O_6$ + $6O_2$

A substantial amount of carbon can be sequestered in forest trees, forest litter, and forest soils. Approximately 26 billion metric tonnes of carbon is sequestered within standing trees, forest litter, and other woody debris in domestic forests, and another 28.7 billion tonnes in forest soils (Birdsey and Lewis 2002). According to Negra and others (2008), between 1995 and 2005 the rate of carbon sequestration in U.S. forests was about 150 million tonnes annually (not including soils), a quantity of carbon equivalent to about 10% of total carbon emissions nationally.

Unfortunately, deforestation in tropical areas of the world is responsible for the release of stored carbon, and these forests are net contributors of carbon to the atmosphere. Tropical deforestation is responsible for an estimated 20% of total human-caused carbon dioxide emissions each year (Schimel and others 2001).

Carbon in wood remains stored until the wood deteriorates or is burned. A tree that remains in the forest and dies releases a portion of its carbon back into the atmosphere as the woody material decomposes. On the other hand, if the tree is used to produce a wood or paper product, these products store carbon while in use. For example, solid wood lumber, a common wood product used in building construction (the building industry is the largest user of sawn wood in the United States), sequesters carbon for the life of the building. At the end of a building's life, wood can be recovered for re-use in another structure, chipped for use as fuel or mulch, or sent to a landfill (usual fate). If burned or mulched, stored carbon is released when the wood decomposes, essentially the reverse process of photosynthesis:

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

Carbon contained in wood products currently in-use and as wood debris in landfills is estimated at 2.5 billion tonnes and accumulates at a rate of about 28 million tonnes per year (Skog, 2008). Much of the carbon contained within wood products resides in the nation's housing stock, estimated at 116 million units in 2000. Skog (2008) estimated that in 2001, about 680 million tonnes of carbon was stored in the nation's housing stock, nearly a third of the total carbon (2.5 billion tonnes) cited above. Carbon emitted to produce a tonne of concrete is about eight times that emitted to produce a tonne of framing lumber. A similar comparison for steel indicates that its production emits about 21 times as much carbon as an equal weight of framing lumber. Wood products also mitigate carbon emissions to the degree that they substitute for steel or concrete, which emit more greenhouse gases in their production.

Also, because wood products have this low level of embodied energy compared with other building products and because wood is one-half carbon by weight, wood products can actually be carbon negative (Bowyer et al 2008).

Comparisons of the environmental impact of various wood products have also been made using life cycle analysis software (Calkins 2009). The more processing involved in the manufacture of wood products (such as flaking, veneer cutting, added heat for pressing, gluing, kiln drying), the more impact on energy use, solid waste production, pollution production, and global warming potential (carbon).

2.4 SUSTAINABILITY.

Unlike metals and fossil-fuel-based products (such as plastics), our forest resource is renewable and with proper management a flow of wood products can be maintained indefinitely. The importance of forest-based products to our economy and standard of living is hard to overemphasize—half of all major industrial raw materials used in the United States come from forests. However, the sustainability of this resource requires forestry and harvesting practices that ensure the long-term health and diversity of our forests. Unfortunately, sustainable practices have not always been applied in the past, nor are they universally applied around the world today. Architects, product designers, material specifiers, and homeowners are increasingly asking for building products that are certified to be from a sustainable source. For the forest products sector, the result of this demand has been the formation of forest certification programs. These programs not only ensure that the forest resource is harvested in a sustainable fashion but also that issues of biodiversity, habitat protection, and indigenous peoples' rights are included in land management plans.

2.5 THE NEED FOR SUSTAINABLE PRACTICE IN THE USE OF TIMBER.

There is a need for optimum utilization of available resources and raw materials to produce energy-efficient, environment friendly and sustainable building alternatives and techniques to satisfy the increasing demand for buildings. Materials like steel, glass, cement, plastics, bricks etc. are examples of energy intensive materials commonly used for construction activity. Extensive use of these materials can drain resources and have adverse affect on the environment. According to Murray, Nicholson, Ross, Holloway and Patil, (2006). local building and construction materials. Report of the multi-disciplinary task force on the survey of sustainable building materials. Below is a list of the guiding principles to sustainable, alternative building technologies;

i. Energy conservation: minimize the use of high energy materials.

ii. Use of environmentally friendly materials and technology.

iii. Maximize the use of local materials.

I. Energy Conservation: minimize the use of high energy materials.There is an increasing awareness of the need to conserve scarce resources by using products and practices that are energy efficient. Much of the energy consumed in everyday living is derived from fossil fuels and this use can have significant environmental impacts by increasing green house emissions.

Until recently, efforts to improve the energy efficiency of building targeted their operational energy. That is, the energy used in the operation of the building (heat, power, and light). As a result, strategies focused on improving the performance of existing buildings and developing better practice for the design of new buildings.

More recently, emphasis has been placed on the energy invested in the materials used to construct and maintain the building over its lifetime that is their embodied energy. This is also referred to as life cycle energy consumption. Recent studies have shown that over its lifespan, the embodied energy of a building can be grater then the operating energy. To obtain the best long term result, building design must consider both embodied energy and operational energy. *(Patil S. 2006.)*

The stages considered in an assessment of the energy consumed over the life of a building material are similar to the stages of a life cycle analysis and include the energy required to:

- Mine/extract/harvest the raw material and transport to the processing centre;
- Manufacture the building materials;
- Transport to construction site;
- Maintenance and refurbishment of the building; and
- Demolish, recycle and finally dispose of waste material.

The consumption of energy during each of these stages can have similar environmental impacts to the consumption of energy in the operation of the building.

The raw material for timber is wood from trees. Sunlight provides the energy that drives the biological process that produces wood. As this is a natural source without negative environmental impact, the embodied energy quotient is ignored. Once harvested, relatively little energy is required to transform the logs into timber compared to other building materials. For example, the fossil fuel energy required to manufacture rough sawn timber is 1.5MJ/kg while the manufactured of aluminum requires 435MJ/kg.

Harvested logs are usually transported by road to the mill or plant. Sometimes the trucks transport the logs to a rail yard for further transport by rail. Logs are harvested from varied locations and the distances for transport may be considerable. The location and proximity of the forest and building site to the mill or plant will have a significant impact on the energy requirements for transport. However, timber is a light material and requires less energy to transport than heavier materials like concrete.

The energy use in the construction of a building using timber requires much less energy than other building materials. For example, brick cladding for houses uses significantly more energy than wood cladding. Also, the amount of other materials used in a timber building may be considerably less than other forms of construction. For example, as a timber frame is lighter than a steel or masonry one and it generally need smaller and simple foundations.

II. Use Of Environmental Friendly Materials And Technology.

Until recently, much of the development of building materials has predominantly focused on producing cheaper, stronger and more durable construction materials. More recently, attention has been given to the environment issues in manufacturing, using, disposing and recycling of construction materials (Dr. Khatib, 2009).

Many materials used in building are from finite sources so it is important to use those that are sustainable. Timber and bio-crops (straw etc) are generally considered to be the most renewable resource provided they are grown and harvested in a sustainable way. Timber can also be recycled and re-use.

III. Maximize The Use Of Local Materials And Resources.

Forest of the world have undergone cycles of growth and destruction through time by various causes, such as fire, disease, other natural causes and excessive felling by man. It is however interesting to note that, in the absence of mankind on earth, most of the earths' surface will become forest once again (Calkins, 2009). Important coniferous regions of the world include Scotland, Scandinavia, and the Baltic countries, Russia, Siberia, Alaska, U.S.A and Canada. The major construction softwoods are European redwood or Scots pine (pinus sylvestrus) and European white wood (picea abies).

The tropical forests, where broad-leaved trees dominate abound in Africa. West Africa forests covers about 500,000km² and is one of the world most important sources of hardwoods. Some 700,000km² of forests exists in Central Africa, but its location in the continent makes it less accessible. Some notable hardwood used for interior design purposes are mahogany, Ekki (Lophira alata), Iroko(Chlorophora excels) and Opepe (Nauclea diderrichi). Other important forest regions are tropical Asia (Malaysia, Indonesia, Thailand, China and the Philippines), central and south America, Mexico, New Zealand and Australia which is specially noted for its eucalypts.

Timber is one of the most commonly used building materials in Australia with a wide range of application in both private and commercial buildings. Timber and associated timber products such as plywood are produced from trees that can be grown, harvested and re-grown in perpetuity to provide an ongoing supply of timber (Negra, Sweedo, Cavender-Bares and Malley, 2008).

Groups of trees or forests form a significant part of the larger ecosystem and provide a wide range of benefits to the community, in addition to timber. The harvesting of trees to produce timber may cause adverse effects to the other forest outputs particularly at a local level. This has focused attention on the effects of harvesting operations and together with the long term objective of conserving resources led to complex planning and management systems to achieve a balanced outcome between the competing demands on forests called sustainable forest management.

Using locally produced building materials shortens transport distances, thus reducing air pollution produced by vehicles. Often, local materials are better suited to climatic conditions, and these purchases support area economies. It is not always possible to use locally available materials, but if materials must be imported they should be used selectively and in as small a volume as possible. For instance, the decorative use of quarried halfway around the world is not a sustainable choice. Steel, when required for structural strength and durability, is a justifiable use of a material that is generally manufactured some distance from the building site .(Murray, Nicholson, Ross, Holloway and Patil, 2006).

I. Reduction of Construction Waste

Minimal construction waste during installation reduces the need for landfill space and also provides cost savings. Concrete, for example, has traditionally been pre-mixed with water and delivered to the site. An excess of material is often ordered, to prevent pouring delays should a new shipment be needed (Murray, Nicholson, Ross, Holloway and Patil, 2006). This excess is usually disposed of in a landfill or on-site. In contrast, concrete mixed on-site, as needed, eliminates waste, and offers better quality control. Designing floor intervals to coincide with the standard lengths of lumber or steel framing members also reduces waste. Taking advantage of the standard sizes of building materials in the design phase reduces waste produced by trimming materials to fit, as well as the labor cost for installation.

II. Reusability.

Reusability is a function of the age and durability of a material. Very durable materials may have many useful years of service left when the building in which they are installed is decommissioned, and may be easily extracted and reinstalled

in a new site. Windows and doors, plumbing fixtures, and even brick can be successfully reused. Timber from old barns has become fashionable as a reclaimed material for new construction. The historic preservation movement in this country has spawned an entire industry devoted to salvaging architectural elements of buildings scheduled for demolition. These materials are used in the renovation of old buildings as well as in new construction. In many cases, the quality of materials and craftsmanship displayed by these pieces could not be reproduced today.

III. Recyclability

Recyclability measures a material's capacity to be used as a resource in the creation of new products. Steel is the most commonly recycled building material, in large part because it can be easily separated from construction debris by magnets. Many building materials that cannot be reused in their entirety can be broken down into recyclable components. Often, it is the difficulty of separating rubble from demolition that prevents more materials from being recycled. Once separated, glass is very easy to recycle: post-consumer glass is commonly used as a raw material in making window glass, ceramic tile, and brick. Concrete, unlike steel and glass, cannot be re-formed once set, but it can be ground up and used as aggregate in new concrete or as road bedding. (Negra, Sweedo, Cavender-Bares and Malley, 2008). Currently, very little concrete and glass from site demolition is recycled because of the difficulty in separating these materials from construction debris. Plastics alone are easy to recycle but are often integrated into other components which make separation difficult or impossible. Plastic laminates are generally adhered to plywood or particleboard, making these wood products also hard to recycle. Some foam insulation can be reformed, but the majority cannot. Foam insulation can, like glass, be used as filler in concrete and roadbeds.

IV. Biodegradability.

The biodegradability of a material refers to its potential to naturally decompose when discarded. Organic materials can return to the earth rapidly, while others, like steel, take a long time. An important consideration is whether the material in question will produce hazardous materials as it decomposes, either alone or in combination with other substances.

3.0 FINDINGS

Base on the fact and data analyzed in this write up precisely on the level of sustainability in the use of timber for building construction in Ile- oluji, Ondo state. The following list of findings have been drawn up to back up a complete assessment of the level of sustainability in the use of timber for building construction in Ile- oluji, Ondo state :

Timber is readily available for building construction in Ile- oluji, Ondo state in which people can source it from their own farms and as well purchase it with money. Timber can be replenished, as evident in the fact that it is been replanted after felling. Timber is relatively durable and timber components can last for many years in building. The cost of timber and the maintenance cost of timber components are cheaper compared to other materials for building construction. Timber's workability is evident in the fact that people find it easier to work upon. The aesthetics quality of timber is also pleasant enough to be used in construction of building since people are satisfied with the level of aesthetic. Timber is biodegradable. Timber can also be re-used. The level of comfort it helps to achieve in building when used is evident in the fact that it has high thermal insulation. The sound insulating quality of timber is also good and this can however be improved upon by gaps or spacing between timber panels. Timber or lumber work also helps to sustain life as about 50% of respondents live their life on the income from lumber work. Abundance of forest in Ile- oluji also contributes to the level of sustainability of timber in the Ondo state.

4.0 CONCLUSION.

Considering the findings in this study, it can be concluded that the sustainability of any building material has a relationship with durability, aesthetic, re-use, recyclability, cost, workability and availability of such material which has been established in the use of timber for building construction in Ile- oluji, Ondo state, Nigeria. The use of timber for building construction in Ile- oluji is sustainable. It is therefore recommended that Architects and Designers should always take the use of timber into consideration for building construction at point of choice of materials and when embarking on any form of design and construction.

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