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Building Professionals' Perspectives on the Implementation of Green Building for Climate Change Mitigation in Nigeria

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ABSTRACT: *The building and construction sector is responsible for as much as one third of total global green house gas (GHG) emissions and about 80 percent of these emissions take place during the operational phase of buildings. This results in damage and destruction of buildings and infrastructure, delayed construction and increased costs. Through the practice of green building, these emissions especially CO2 can be significantly reduced in both developed and developing countries. The green building concept considers many ways that building services ner aq as well as other GHG impacts associated with the built environment, including the effects of alternative urban designs, the use of on-site power generation and life-cycle GHG emissions from building construction, materials, and equipment. This study reviewed green building practice in developed countries considering building professional's perspectives of climate change mitigation in Nigeria through green building and found that despite the many benefits of green building such as enhancement of the comfort and health of occupants, improvement in air quality, occupants" satisfaction, reduction of aggregate future capital and maintenance costs, creation of job opportunities in the construction industry and protection of the ecosystem among others, there are numerous obstacles that prevent these benefits from being achieved. Some of the obstacles are lack of green building awareness by developers, unavailability of green building materials locally, lack of policy or guidelines for green building, and lack of adequate knowledge and technical know-how of green building among building professionals. It recommends public enlightenment of green building by government and non-governmental organizations, request for green building guidelines, and funding for green building research, development and implementation.*

KEYWORDS: climate change, greenhouse gas, green building, mitigation, construction, building industry

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INTRODUCTION

A Green Building is a building which is energy efficient, resource efficient and environmentally responsible. It incorporates designs, construction and operational practices that significantly reduce or eliminate the negative impact of development on the environment and it's inhabitants. The sustainability of green buildings is hinged on four main elements which are, materials, energy, water and health. There are two types of green buildings, passive and active green buildings. While the passive green buildings are eco- friendly and take advantage of natural conditions such as sun, rain and wind, active green buildings use technology to retain heat generated by a building and thus reduce the carbon footprint.

Climate change is the sustained increase in the average temperature of the earth‟s atmosphere caused by global warming. Both natural and anthropogenic factors significantly contribute to global warming and climate change which has become a global concern threatening human lives and livelihoods. Buildings are hugely responsible for climate change contributing over 40 percent of global energy consumption and as much as one third of total global green housegas (GHG) emissions in both developed and developing countries, primarily through the use of fossil fuels during the operational phase (UNEP, 2009). The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report estimated building-related GHG emissions (including the use of electricity in buildings) at about 8.6 million metric tons CO2 growing at a rate of 2.5 percent per annum for commercial buildings and at 1.7percent per annum for residential buildings between 1971 and 2004 (Levine et al., 2007). The building and construction sector is also a major emitter of other non-CO2GHGs such ashalocarbons, fluorocarbons, chlorofluorocarbons (CFCs), hydrochloro fluorocarbons (HCFCs), and hydrofluorocarbons (HFCs) due to their applications for cooling, refrigeration, and in the case of halocarbons, insulation materials.

The leading source of GHG emissions from buildings is energy consumption mainly from consumption of fossil-fuel based energy through the direct use of fossil fuels and through the use of electricity which has been generated from fossil fuels. Construction materials also generate significant GHG emissions particularly insulation materials, cooling and refrigeration systems through the following building processes:

- Manufacturing of building materials(embedded or embodied energy)
- transportation of these materials from production plants to building sites(grey energy)
- construction of the building(induced energy)
- operation of the building(operational energy)and
- demolition of the building (and recycling of the building parts)

Using a life-cycle approach, Graham (2003) linked GHG emissions to the different stages of a building's life to show that emissions are greatest during the building's operational phase. Studies indicate that over 80 percent of GHG emissions take place during this phase to meet various energy needs such as heating, ventilation, and air conditioning (HVAC),water heating, lighting, entertainment and telecommunications (Adalberth, Almgren & Petersen, 2001; Junnila, 2004). About 10 to 20 percent GHGs are emitted during materials manufacturing and transport, construction, maintenance and demolition. Therefore, the greatest reductions in GHG emissions in building can be achieved by targeting the operational phase.

Despite being a major contributor to climate change, the building and construction sector also has the greatest potential for significantly reducing GHGs compared to other major emitting sectors such as transportation, energy supply, industry, agriculture, forestry, and waste through green building (UNEP,

2009). Green building is the use of environmentally-friendly and resource-efficient processes throughout the building life-cycle from siting to design, construction, operation, maintenance, renovation, and demolition (Paola, 2006; Roy, 2008). According to the United States Environmental Protection Agency (USEPA, 2011), green building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. Green building practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. Green building (also called green construction or sustainable building) address building design, construction, and operation in a comprehensive manner to reduce the overall environmental impact of the built environment, increase the efficiency of energy, water, and other resource use, and reduce waste, pollution, and environmental degradation. Green buildings are buildings that are designed to meet specific objectives such as sustainable site development, energy and water efficiency, healthy indoor environment quality, sustainable use of materials and resources with minimal negative impacts on human health and the environment (Yeang, 1995). The potential for GHG reductions from buildings is common for both developed and developing countries, as well as countries with economies in transition (IPCC, 2007). This study focuses on building professional's perspective of climate change mitigation in Nigeria through green buildings.

LITERATURE REVIEW

Effects of Climate Change on the Building and Construction Sector

Climate change and its challenges cuts across every country and its impacts affect every aspect of human livelihood and development globally (IPCC, 2007). This creates significant problems for the building and construction sector especially in developing economies like Nigeria as they are less able to cope with the effects of climate change compared to developed economies (OECD, 2009). Climate change causes desertification in the Sahel savannah and serious flooding in the coastal lines. Flooding makes construction more expensive because the type of foundation suitable for wet soils has greater cost implications (UNEP, 2009). Extreme weather events hamper construction processes causing delay and extra expenses (Hertin, Berkhout, Gann & Barlow, 2003). It also affects the health and safety of site workers and laborers, especially those working outdoors at the construction sites and this result in delay in the construction process and increased costs. In addition, extreme weather events delay transport and delivery of building materials affecting site programming and costs. Also, the availability of various building materials changes because climate change risks, increased regulations and carbon taxes affects the cost feasibility of some materials more than others (Carbon Disclosure Project, 2010). Long term climate change impacts such as rising sea level, coastal erosions, and droughts, and short term weather-related effects such as high winds and flooding influence the choice of site construction, building techniques, and materials for construction (Bello, Adekunle & Ogunsanmi, 2012).Risks of severe weather and climatic conditions associated with changing climate also influences planning and project completion timelines (Laurencine, 2014).

In summary, the effects of climate change are highlighted as follows:

Choice of site location: Climate change events such as sea level rise, drought, and increased flooding influence the siting of construction projects. Rising sea level and flooding events discourage development on low lying or coastal areas and encourage construction on higher, often steeper elevations.

Damage and destruction of buildings and infrastructure: The increased frequency of extreme weather

events and natural disasters due to climate change has negative impact on infrastructure. Extreme wind causes damage to buildings, especially to roofs and windows, and damage to infrastructure such as power and telephone lines (Camilleri, Jaques & Isaacs, 2001).

Changing weather conditions: Frequent and severe spells of extreme weather events affect buildings and the occupants. For instance, increase in temperature will significantly affect the comfort of people living in the building. This may lead to increase in air conditioning costs for existing buildings, but for building systems to be constructed, increase in temperature may signify tighter legislation that impose building designs and orientation that may help in keeping the building cool. Building will also suffer accelerated degradation if changes in weather patterns increase their exposure to agents that may potentially be harmful to the building materials such as acid rains. Construction projects that require dry conditions, such as laying roads or foundations, may be delayed indefinitely if there are heavy rains and floods until the weather subsides. A decrease in rainfall (drought) may necessitate connection of all dwelling homes and office buildings to a rainwater harvesting system. Increases in rainfall can lead to severe flooding and cause extensive damage to buildings and other infrastructure. Also, changes in relative humidity will affect buildings (Laurencine, 2014). Buildings will become moldy due to high relative humidity. In addition, weather conditions can cause delay in the transportation of building materials.

Health and Safety of workers: Extreme weather events will directly affect the health and safety of site workers and labourers (COM, 2009). Weather conditions such as heavy rainfall, high wind raffles and high heat may cause injury due to slipping or hyperthermia. Diseases such as malaria abound in wet weather (Oladipo, 2010). Other weather conditions such as flash floods pose high risk of injury to workers and damage to plant and equipment. Changes in temperature may also increase wear and tear of equipment due to expansion and contraction and also cause timber weathering which is a high risk factor.

Delay in construction and increased costs: The above-mentioned factors eventually results in delays in the construction process and this affects the cost of construction. Increase in construction costs due to delays occurs in the form of fines to the developer, especially in government projects and other big projects. Also, delay in construction process increases the cost of labour and non-functioning equipment.

Contribution of the Building and Construction Sector to Climate Change

The construction of buildings and infrastructure just like many other activities undertaken by humans has various impacts on the environment and contributes significantly to climate change. With rapid urbanization and economic growth fuelled by an increasing population, the construction industry has become one of the world's biggest emitters of GHGs. The main greenhouse gas, CO2 is emitted in the built environment from the material production and construction stage to the operational stage. The emissions are categorized into direct and indirect missions. Direct CO2 emissions are those from on-site operations such as construction. Construction emissions are emissions resulting from the supply of materials such as upstream operations like manufacture of bricks, cement and other building materials (Kokoni & Skea, 2014).

Building is a major consumer of energy from building material, construction and operation resulting in carbon emissions. The energy consumption and emissions of the building and construction sector are influenced by building type, type of structure, type of product and source of fuel (Peñaloza et al., 2018). Similarly, the level of emissions from buildings is strongly correlated with the level of demand, supply and source of energy (UNEP, 2009).Recent studies show that urban areas consume over 67 percent of global energy and release more than 70 percent of global CO2 emissions (Wang et al., 2018). As countries develop, traditional fuels are complemented by and replaced by electricity and gas, and the potential for

GHG emissions increases immensely because access to electricity stimulates demand for electrical appliances, thereby increasing demand for energy over and beyond the level it had been before. Moreover, the generation of electricity itself is a major source of GHG emissions, except it comes from renewable sources such as hydroelectric power, solar energy or nuclear energy. However, using proven and available technologies, buildings emissions can be cut by an estimated 30 to 80 percent with potential net profit during the building life-span (UNEP, 2009). The potential for GHG emission reductions from buildings is applicable to developed and developing countries, as well as countries with economies in transition.

Climate Change Mitigation in Nigeria through Green Building

The emissions associated with conventional buildings have given room for the emergence of the green building concept. Climate change experts see energy efficient buildings as the least-cost method to mitigating GHG emissions (Brown & Southworth, 2007). Green building can be defined as "a building whose construction and operational lifetime assure the healthiest possible environment while representing the most efficient and least disruptive use of water, energy and resources" (Alam & Haque, 2016). The main aim of green building is to reduce the overall impact of the built environment on human health and the natural environment. The green building concept does not only consider the many ways that building services could be provided in a more energy efficient manner but also other GHG impacts associated with the built environment, including the effects of alternative urban designs, the use of on-site power generation and the life-cycle GHG emissions from building construction, materials, and equipment. Therefore, green building addresses how future buildings should be constructed and used as well as how they will interface with the electric grid and where they will be located in terms of urban densities and access to employment and services. In Nigeria, green building practice is hardly getting any attention as conventional buildings are still very dominant despite the fact that they negatively affect the environment and the wellbeing of the populace. Very few buildings in Nigeria try to introduce some element of green design in their construction through the introduction of solar panels as an alternative power supply to provide energy for cooling, lighting and for the installation of other energy-efficient fixtures to increase the level of insulation in the building. Edeoja and Edeoja (2015) revealed that there is yet to be any green building policy or guidelines for Nigeria's construction industry. This is unlike in industrialized nations, for instance, Leadership in Energy and Environmental Design (LEED)developed by the U.S. Green Building Council (USGBC), Building Research Establishment Environmental Assessment Method (BREEAM) introduced in the UK by the Building Research Establishment (BRE) and the Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) established by the Japan Sustainable Building Consortium (JSBC) (Potbhare, Syal & Korkmaz, 2009).

Several strategies can be adopted for the implementation of green building, for example, Chan, Darko & Ameyaw (2017) emphasized finance, market-based incentives, government policies and regulations, availability of better information on cost and benefits, green rating and labeling as strategies that can enhance the promotion of the adoption of green building technology in the construction industry.

Green building practice in Nigeria is still at the very early stages and its application is shrouded by challenges despite the significant potentials of mitigating climate change. A review of studies by Allu (2015); Alohan and Oyetunji (2021); Dahiru, Dania and Adejoh (2014); Isa, Bajere, Jimoh and Shittu (2016) on green building practice in Nigeria among building professionals identified many benefits and obstacles to implementing green building in Nigeria for climate change mitigation.

Below is a summary of the perspectives of building professionals (Estate Surveyors & Valuers, Quantity Surveyors, Land Surveyors, Architects and Building Engineers) on the benefits and obstacles of

implementing green building from the above-mentioned studies.

Benefits

- Enhancement of the comfort and health of the occupants.
- Improvement in air quality, productivity and occupants satisfaction.
- Reduction of aggregate future capital and maintenance costs
- Creation of job opportunities in the construction industry
- Protection of the ecosystem.
- Reduction of GHG emissions including CO_2.
- Conservation of natural resources.
- Support for the use of renewable energy technologies.
- Reduction in operational cost of building.
- Encourages long-term economic life of building.

Obstacles

- Lack of awareness by developers.
- Unavailability of green building materials locally
- Lack of policy or guidelines for green building
- Lack of adequate knowledge and technical know-how of green building among building professionals
- Lack of interest in sustainable building
- Deficiency in research on green building
- High cost of imported green building materials
- High initial construction cost of green building
- Divergent views and interests of built environment professionals
- Lack of enabling laws to promote green building implementation

CONCLUSION

From the review of existing studies on the implementation of green building in climate change mitigation in Nigeria, it is evident that there is no enabling environment in the form of legislation or policy on green building practice though construction industry professionals are aware of the new trend and the enormous benefits it offers. The general awareness regarding the concepts of green building in Nigeria is low among building users and occupants.

Therefore, a greater and more conscious effort is required to raise awareness which will in turn accelerate the growth, adoption, and implementation of green building concepts. It is important to convey the goals and benefits of green construction methods to individuals who are relevant to the construction sector in order to achieve successful implementation of sustainable construction projects.

Recommendations

The following measures are recommended for an efficient implementation of green building in Nigeria:

1. Public enlightenment of green building should be done by government and professional

development(CPD). Non-governmental organizations(NGOs)should also assist in this respect.
2. Government should request green building guidelines from contractors as part of the tender documents for the environmental management plan of buildings.
3. Construction materials manufacturers should include life-cycle considerations in materials development of environmentally-friendly construction materials.
4. There should be partnerships with research firms to provide funding for research, development ,and implementation of green concepts in building.
5. Government should lead by example through the use of green building concepts in the construction of public buildings and providing incentives for green building construction.
6. Part of the corporate social responsibility (CSR) of multinationals in Nigeria especially oil companies should include the building of schools, clinics, libraries, community halls etc. from green materials..

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