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The Impact of Green Buildings on the Development of a Sustainable Environment in Nigeria

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Abstract

The construction sector is essential for driving socio-economic development in every nation. Much advancement in sustainable construction technologies and practices are widely recognized and embraced throughout all sectors of the construction field. However, Nigeria is faced with substantial barriers hindering the widespread adoption of this current pool of research progressive architectural approach. The objectives of this study is to provide an extensive analysis of contemporary trends and prospects in green building practices, highlighting the significance of implementing sustainable techniques to reduce the environmental footprint of the industry. The assessment process involved the analysis of documents available on three reputable scientific databases, including review articles, conference proceedings, and journal publications. Some of the findings include the absence of adequate institutional frameworks for policy development and guideline establishment, restricted access to information on eco-friendly products and building systems that offer superior performance, insufficient knowledge regarding sustainability concerns, limited expertise among personnel and clients, poor understanding of green building technologies. Industry professionals' lack of knowledge among professionals in the industry and the perceived increased costs associated with sustainable construction in comparison to conventional methods also present a significant challenge for clients. There is no strong collaboration between professionals and clients throughout all phases of the projects. The technologies and practices related to sustainable construction in Nigeria are deemed unsustainable and do not align with the core principles of ideal sustainability.

Keywords: Green construction, eco-materials, cost-effectiveness, greenhouse gas, renewable energy, aesthetics

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INTRODUCTION

The construction sector has experienced a consistent expansion due to the rising population and increasing urbanization [1–43] (Nilimaa, 2023) [33]. The construction industry responsible for 34.0% total energy consumption and 37% of process-related emissions, highlighting the urgent need to address greenhouse gas emissions (GHG) in this sector. It is approximately 36% of total energy usage and 40% raw material consumption worldwide. It is evident that construction activities directly impact both humans and the environment (Chan et al., 2016) [17]. Therefore, it is crucial for construction professionals to adopt environmentally sustainable practices to avert environmental challenges arising from construction projects (Oluwole, 2015) [35]. Traditionally, the construction of industrial and domestic buildings

heavily relied on conventional materials like limestone, water, glass, minerals, timber, sand and steel, and concrete as well as energy-intensive manufacturing processes (Omole and Ndambuki, 2014) [36]. The construction industry's activities have resulted in emission of carbon dioxide and other greenhouse gases into the atmosphere, contributing to the widespread issue of global warming and climate change (Thong and Hao, 2019) [40]. Indirect emissions from activities like electricity generation and commercial heating also impair the sector's environmental footprint.

Buildings, known for their high energy consumption are identified major source of GHG, particularly domestic buildings (Haigh and Amaratunga, 2010) [27]. According and Akadiri et al. (2012) [7] reiterated negative impact of activities in building construction on the environment, highlighting issues such as considerable amount of energy, water, and raw materials, resulting in a substantial volume of waste, site dereliction, depletion of natural resource, land misuse and habitat destruction. Moreover, construction practices on-site can lead to health and comfort disturbances for individuals residing in close proximity to construction sites.

The construction sector in developing has a significant impact on environmental, economic and social aspects of society. On average, it contributes about 10 percent to the GDP, over 50 percent to domestic fixed capital, and provides job opportunities for approximately 10 percent of the workforce in Nigeria (Saka and Adegbembo, 2022) [39]. Many researchers obliged that construction industry is one of the foremost consumers of environmental resources and a significant contributor to greenhouse gas emissions and other forms of pollution. Buildings, being a major product of the construction industry, greatly manifest these effects throughout their lifespan (Liu, 2006) [32]. The construction sector also brings about positive outcomes such as meeting human needs by providing buildings and facilities, generating employment opportunities both directly and indirectly, expertise, supplies of materials, machinery, and equipment needed for infrastructure growth and making valuable contributions to the nation Chan et al., 2016. It is crucial to prioritize and encourage the adoption of renewable energies across all sectors that have the greatest impact on environmental degradation. The construction industry's heavy reliance on substantial amounts of energy and natural resources engender environmental deterioration, increase temperatures, and substantial GHG emissions (Saka and Adegbembo, 2022) [39].

Regardless of these challenges, the future prospects for the Nigerian construction industry are promising, especially with the increasing public construction expenditure. Moreover, considering the significant housing and infrastructure deficit, the construction sector plays a vital role in bolstering the economic growth and development of the nation. The contribution of the construction sector in Nigeria to the GDP continues to be relatively modest.

SUSTAINABLE CONSTRUCTION

The upsurge in the world population has necessitated development of buildings and persistent degradation of the ecological environment, Green Building (GB) is seen as a solution to developing countries' persistent issues of inefficient energy, significant waste management and CO_2 emissions. GB, being a novel building concept, faces challenges in public acceptance and adoption due to crawling green construction technologies, lengthy investment payback periods, and limited public awareness, all of which are critical factors in the sustainable development of green buildings. Many researchers opined that it is imperative to provide designers, builders, and operators with innovative expertise. Building encompasses the construction and implementation of methods that prioritize environmental sustainability and resource efficiency from the initial planning stages through to completion (Chan et al., 2016 [17]. There should be strong collaboration between contractors, architects, engineers, and homeowners throughout all phases of the project (Perdan, 2011 [37]. Green building technology emphasizes maximizing efficiency, promoting sustainability and resource conservation (Coombs et al., 2016 [18] Arif et al. 2009) [12]. Many researchers opined that green buildings comprise the utilization of construction materials, processes, operations, and maintenance, energy-efficient, optimization of

renewable energy resources that are environmentally friendly while providing a high level of comfort for environment (Geng et al., 2017) [25].

Green building or sustainable construction is a contemporary approach in building design that aims to improve the connection between the structures and its environments. Architects employ tactics to reduce energy usage, particularly within buildings, by utilizing sustainable energy sources like solar power, wind power, and other resources that aid in the conservation (Devine and Kok 2015 [21] Arif et al. 2009) [12]. According to Geng et al. (2017) [25] asserted that environmental sustainability extends beyond merely avoiding detrimental impacts on the environment through prudent resource utilization and waste reduction. They emphasized that it also involves endeavors to improve the overall quality of the environment.

The implementation of eco-friendly construction methods is widely accepted as a practical approach to attaining sustainability objectives in the realms of ecology, finances, and community It is widely recognized on a global scale that buildings play a significant role in consuming approximately 50% of energy, while greenhouse gas emissions make up to 42% of the total emissions over the lifespan of a building (Lazzerini et al., 2016) [31].

Residential and non-residential buildings are associated with activities such as cooking, lighting, heating and cooling. With the rise in population, income levels, and urban development, the need for energy in both types of buildings is expected to increase (Coombs et al., 2016) [18]. Conserving energy usage in these buildings will significantly reduce the GHG releases. The acceptance and adoption of green building practices offers many private and public advantages, including lower life cycle costs, energy and water savings, improved comfort and health benefits (Ahn et al. 2013 [6] Aktas and Ozorhon 2015) [8].

The advancements in sustainable construction technologies and practices in developed nations are widely recognized and embraced as a global priority throughout all sectors of the construction field. Nigeria, on the other hand, continues to fall significantly behind due to various key challenges (Dahiru et al., 2014) [19]. These include the absence of adequate institutional frameworks for policy development and guideline establishment, restricted access to information on eco-friendly products and high-performance building systems, insufficient awareness about sustainability issues, limited expertise among personnel and clients, poor understanding of green building technologies, lack of awareness among industry professionals and perceived higher cost of sustainable construction compared to traditional methods also poses a major obstacle for clients (Akadiri et al., 2012 [7] and Davies and Davies, 2017) [20].

Some Problems of Green Building Practice

- *Deficiency in Policies, Regulations and Legislation:* Amuda-Yusuf (2020) [10] highlighted the significant challenge posed by the absence of crucial support in terms of policies, regulations, implementation, legislation, or incentives for sustainable construction. This is in sharp contrast to developed countries, where the government spearheads the construction of public buildings using the GB concept. The participation of every level of government is necessary because of the environmental challenges presented by the construction industry in Nigeria.
- *Uncertain Economic Environment:* The majority of contractors in the construction industry in Nigeria heavily depend on government projects because of the restricted market opportunities in the private sector. The reduction in public spending and the privatization of previously government-run services have impacted construction activities. These factors hinder long-term strategic planning and limit access to investment capital. Construction companies face challenges such as payment delays and difficult contract conditions, which can greatly constrain the industry. According to Dahiru (2014), [19] many local companies have encountered financial difficulties and even bankruptcy as a result of payment delays commonly associated with government contracts.

- *Technological Barriers:* The progress of native technology is limited by the dependence on foreign technology. Developing countries requires expertise and technology tailored to its unique resources, rather than relying on those obtained from more advanced countries (Akadiri et al., 2012) [7]. An illustration of this is the abandonment of traditional earth and timber construction techniques that were prevalent prior to colonialism. At present, workers are facing challenges in keeping pace with the constantly evolving technology and new construction methods. The shortage of skilled professionals and labor poses a significant barrier to the widespread adoption of green building practices in Nigeria. Policymakers, architects, engineers, contractors, and workers all lack the essential knowledge and expertise in green building construction (Williams and Dair, 2007) [41]. Sustainable construction practices can be difficult to implement in areas with low demand, as green materials and technologies may not be easily accessible.
- *Lack a Comprehensive Approach:* Many studies in the fields of building technologies and urban planning tend to lack a comprehensive approach. Research institutions, development agencies, and other organizations frequently focus on specific issues in isolation, neglecting the interconnectedness between them. Numerous research endeavors in building technologies and planning fall short of taking a holistic view (Davies and Davies, 2017) [20]. These entities address each problem separately and autonomously, failing to recognize its associations with other relevant issues.
- *Lack of Synergy among the Stakeholder:* The construction industry, along with its clients and other stakeholders, demonstrates a significant lack of interest in matters pertaining to sustainability. This indifference is evident among the different entities involved in Nigeria. Amuda-Yusuf, 2020) [10].
- *Lack of Awareness:* Many stakeholders within the construction industry lack the necessary information regarding sustainable practices (William and Dair, 2007 [41] Abolore, 2012) [3]. The construction industry encounters a major challenge due to insufficient knowledge regarding the creation and implementation of sustainability plans in Nigeria. Despite the increasing emphasis on sustainability, many construction professionals continue to have limited understanding of green construction practices and their benefits. According to the study conducted by Abolore (2012) majority of respondents revealed alluded to lack of basic understanding of sustainable building practices within the construction sector. Consumers and developers in Nigeria are not yet well-acquainted with the benefits and importance of sustainable building practices. Some view it as an expensive option, while others are more comfortable with traditional building materials. Resistance to change and reluctance to adopt new techniques hinder green building initiatives in Nigeria.

Developers often hesitate to invest in green certification due to the significant costs involved. Despite the well-documented financial advantages and long-term savings provided by green infrastructure, these expenses discourage many developers. It is essential to raise awareness regarding the advantages of green building among architects and real estate developers in Nigeria.

Clearances and Approvals

Builders and developers may encounter challenges when seeking approvals. The process of obtaining approvals can become more intricate due to the various approvals needed to comply with green building standards, potentially impeding the widespread adoption of environmentally friendly buildings. Developers and consumers are reluctant to allocate additional funds towards this endeavor. Furthermore, the requirement for specialized equipment for constructing green buildings further amplifies developers' apprehensions regarding the incorporation of eco-friendly elements into their projects. Builders and developers could face hurdles in obtaining approvals. The approval process might become more complicated due to the various approvals necessary to adhere to green building standards, potentially hindering the widespread acceptance of green buildings.

Cost

The initial expenses associated with adopting green construction practices may surpass those of conventional methods, potentially discouraging developers and investors from undertaking green

construction projects (Davies and Davies, 2017 [20] and Amuda-Yusuf et al., 2020) [10]. The substantial expenses associated with green building practices, including the cost of sustainable construction materials, present a major challenge. Developers and clients are hesitant to invest additional funds in this initiative. Additionally, the requirement for specialized equipment in constructing green buildings only adds to developers' concerns about integrating eco-friendly elements into their projects. The upfront expenses of implementing green construction practices could be higher than traditional methods, which might deter developers and investors from pursuing green construction projects (Amuda-Yusuf et al., 2020) [10].

Regulations and Policies

According to a study conducted by Abisuga and Okuntade (2020), [2] the implementation of the green policy in Nigeria is hindered by several factors. These include the government's lack of political drive and leadership, non-compliance and enforcement issues with policies, and a general lack of public awareness regarding the advantages of adopting green practices.

- *Lack of Standardization:* It can be challenging to assess and compare green construction projects due to the absence of uniform practices and metrics for measuring effect of environment on buildings. (Khoshnava et al., 2018) [30].
- *Resistance to Change:* Conventional construction techniques have become firmly established in the industry, resulting in a hesitancy to embrace innovative approaches, even if they lead to the reduction of structures' environmental impact (He et al., 2018) [29].
- *Coordination and Collaboration:* Effective communication and collaboration is important in green building projects. It encompasses a wide range of stakeholders including architects, contractors, engineers, and building owners. Neglecting to synchronize efforts can result in escalated costs and project setbacks, which may impede forthcoming investments in sustainable construction (Amuda-Yusuf, 2020) [10].

Cultural and Social Barriers

Developing countries might demonstrate diverse cultural and social perspectives on environmental sustainability, which could lead to resistance or reluctance in adopting environmentally friendly construction techniques (Amuda-Yusuf, 2020) [10].

Lack of Skilled Workforce

The adoption of eco-friendly construction techniques often requires a skilled labor force with specific knowledge and training. Less developed countries might encounter difficulties because of the lack of trained workers and educational programs aimed at promoting the use of sustainable building methods. (Djokoto et al., 2014) [22].

Political Instability and Corruption

- *Political Instability and corruption:* This can pose significant obstacles to the acceptance of green building practices. These factors have potential to create an environment of uncertainty for businesses and impede the establishment of regulatory frameworks and standards.
- *Lack Green Materials and Technologies:* Sustainable construction methods may face challenges in regions with low demand due to the limited availability of green materials and technologies. This can hinder developers who are looking to incorporate environmentally-friendly practices into their projects.
- *Concept of Sustainability Construction:* The Figure 1 depicts the diagram of Concept of sustainability in the construction industry by Abidin (2005) [1]. Sustainability is a complex concept that can have an impact on and be influenced by all aspects of growth. Development entails modifications and frequently necessitates the utilization of natural resources to attain the intended outcomes (Liu, 2006) [32]. According to Amuda-Yusuf (2020) [10] the concept of sustainable development involves the efficient management of the balance between human needs and the environment. The objective of this approach is to avoid exceeding critical environmental limits

while also upholding modern principles of social justice and fundamental human rights. It is imperative to grasp the fundamental principles of sustainable development within the realm of construction projects in order to align with the primary objectives of sustainable development. Sustainable construction involves minimizing the use of resources, specifically carbon-based energy, water, materials, and land, in order to promote environmental preservation. It emphasizes the reuse and recycling of resources, prioritizes renewable resources over non-renewable ones, and ensures the sustainable extraction of fossil fuels and minerals without surpassing their gradual redisposition. Sustainability is frequently defined as the act of preserving and enhancing the well-being and variety of our planet. This entails creating a secure and environmentally friendly atmosphere through the reduction of pollution, the pursuit of excellence in construction, and the minimization of harm to vulnerable ecosystems. Amuda-Yusuf (2020) [10] argue that GB development covers both the physical structure and the entire process. The significance of environmental stewardship is emphasized in the complete lifespan of a building. Okwandu et al. (2024) [34] further emphasize the significance of GB, particularly in minimizing environmental effect on design, material use, construction, and maintenance. Their objectives consist of optimizing resource utilization, protecting the health and welfare of residents, and minimizing adverse impacts such as waste and pollution. Abidin (2005) [1] provide an in-depth analysis of sustainability within the construction industry, dividing it into three key pillars: environmental, social, and economic sustainability, Posits that sustainability is a holistic concept, where environmental, social, and economic aspects are interconnected. Sustainable development is a principle that can be applied across various disciplines and sectors.

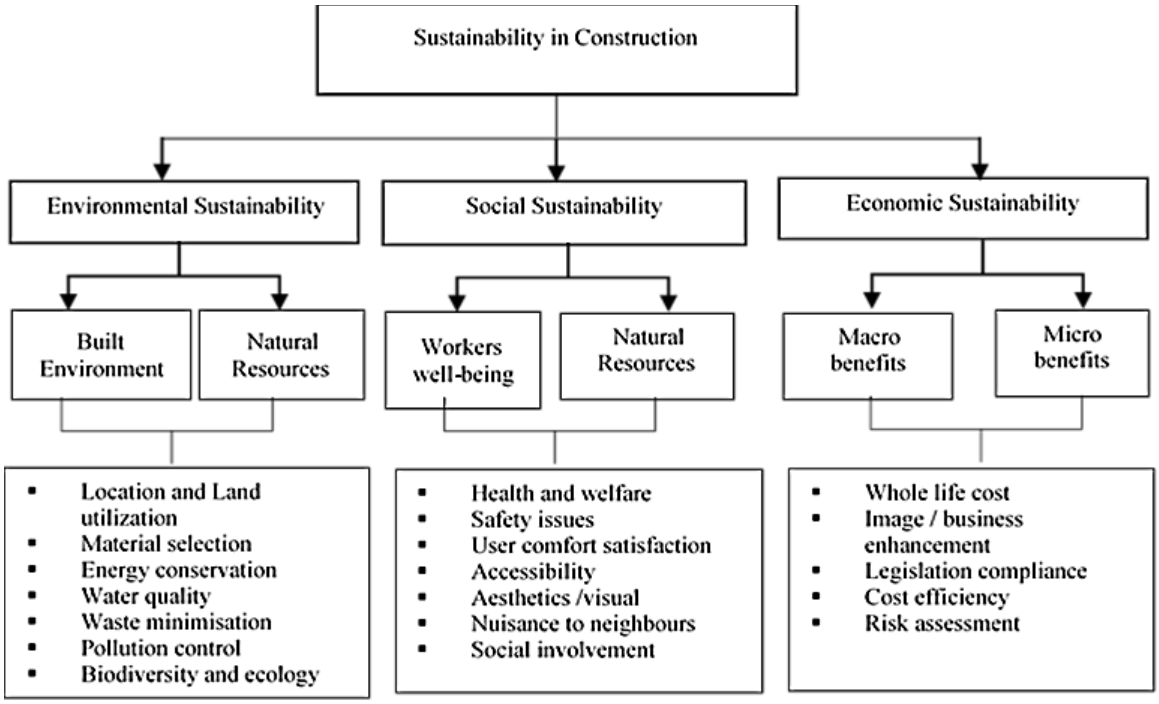

Figure 1. Concept of sustainability in the construction sector (Source: Abidin, 2005).

Green Construction Principles

Green building practices place a strong emphasis on energy efficiency and reducing adverse effects on the environment while simultaneously improving the general welfare of the building occupants (Aghimien et al., 2019) [5]. These guidelines are crucial for architects and builders to construct energy-efficient buildings that support a sustainable future. Green buildings incorporate various elements and innovations to minimize environmental harm and encourage sustainable growth. The following points outline the key features of green buildings (Zhang et al., 2011 [43] and Aktas and Ozorhon 2015) [8]. Prioritizing energy effectiveness by incorporating renewable energy sources during the building design

stage is crucial in reducing energy consumption for heating, cooling, and lighting. It includes minimizing total energy consumption by utilizing insulation, energy-saving appliances, and lighting, along with meticulous planning of the building's structure. It includes minimizing the use of fossil fuels, incorporating sustainable energy technologies like solar panels and geothermal heat pumps, and sourcing eco-friendly electricity to decrease greenhouse gas emissions.

The primary objective is to design and construct safe and secure homes and communities. Builders need to consider multiple elements, including enhanced inside air quality, safety of electrical installation and accident prevention measures. It is crucial to provide protection against different type disasters such as hurricanes, wildfires, floods, earthquakes, and tornados. Additionally, the increasing preference for gated and/or guarded communities might require specific maintenance and equipment arrangements.

Green constructions provide not only economic and environmental benefits. However, it can also have a beneficial influence on different facets of society. The well-being of individuals working in eco-friendly workplaces or living in sustainable homes is significantly improved by the serene and optimal surroundings offered by these buildings. Research indicates that improved indoor air quality, featuring minimal CO_2 and pollutants along with high ventilation rates, can boost worker productivity by as much as 8 percent.

Green buildings can utilize renewable energy sources such as solar, geothermal power, wind and thus reduce their reliance on fossil fuels and benefit from clean, sustainable energy.

Water conservation entails the responsible utilization of water and decrease water intake in buildings through implementing techniques like low-flow fixtures and rainwater harvesting. It encompasses multiple facets, including the management, control, and treatment of runoff on-site, the design and construction of water-efficient homes for both indoor and outdoor use, and the prevention of leaks through comprehensive inspections during the construction phase (Hashemi et al., 2015) [28].

Considerations regarding materials and resources are crucial in construction and building operation. Focusing on sustainable materials and minimizing waste is important. This encompasses the utilization of reclaimed goods, recycled materials, easily dismantled items for reuse or recycling, preservation of natural resources, decreasing material consumption, long-lasting or low-maintenance materials, minimally processed items, energy and water-efficient products, and waste minimization (Bribián et al., 2017 [16] and Ahn et al., 2013) [6].

Interior environmental quality encompasses various elements aimed at enhancing the well-being and health of inhabitants. This includes features like natural ventilation, sufficient natural light, and ensuring good indoor air quality. Various measures are put into action to guarantee ideal acoustics, thermal satisfaction, and visual attractiveness, all of which have a pivotal impact on enhancing well-being, convenience, and efficiency (Awadh, 2017) [14]. Furthermore, it is crucial to take into account the optimization of natural light, adequate airflow, effective moisture control, and the utilization of low volatile organic compound materials (Liu, 2006 [32] Coombs et al., 2016) [18].

Considering some factors, including the suitability of the location, evaluate existing infrastructure to maximize solar benefits, placement of access roads and parking areas, identification of potential risks, and preservation of key resources like trees, well-planned urban layouts, water bodies, wildlife habitats, and natural features when selecting locations.

Innovation and design procedure will advance the implementation of green building like loose fit and long-life concept. It considers and accommodates potential future modifications that might be required to extend the useful lifespan of a building.

When considering future implications, the concept of Design for End of Life focuses on creating structural components and materials that are easily disassembled, repurposed, or recycled once they have fulfilled their function (Liu, 2006) [32].

Targets of Eco-Friendly Building Practices

Table 1 shows the objectives of eco-friendly building practices. The primary objective is to design and construct safe and secure homes and communities. Builders need to consider multiple elements, including enhanced inside air quality, safety of electrical installation and accident prevention measures. It is crucial to provide protection against different type disasters such as hurricanes, wildfires, floods, earthquakes, and tornados. Increasing preference for gated and/or guarded communities might require specific maintenance and equipment arrangements.

Table 1. Targets of eco-friendly building practices.

Characteristics	Descriptions	Authors
Planning for sustainable development.	This pertains to the awareness of environmental conservation during the initiation of the project.	Al-Saleh and Taleb, (2010); Awadh, O. (2017); Davies and Davies (2017).
Accessibility	This design objective considers ensuring that everyone has equal access to the home, including the stairs and the width of interior doors.	Amuda-Yusuf (2020)
Water Resources and management	Water conservation is essential during construction, as well as optimizing water usage in completed projects.	Hashemi et al. (2015); Abidin (2005)
Aesthetics	The scope of architecture encompasses more than just the outward facade of a structure; it also encompasses interior design, the surrounding natural environment, neighboring buildings, and the broader community as a whole.	Hwang & Tan, (2012); Devine and Kok 2015; GABC et al. (2019), Arif et al. (2009).
Cost Effectiveness	Certain customers consider cost as top priority, whether it be focusing on the upfront costs or the ongoing expenses related to operations and maintenance. This is especially true for residences that serve multiple purposes, such as functioning as a home office.	Qian et al., 2015; Yun, 2020; Arif et al. (2009); Ahn et al. (2013)
Intelligent approach to energy	Enhancing the comfort and affordability of new and refurbished structures by reducing energy consumption at each phase of a building's lifespan.	Ahn et al. (2013); Akadiri et al. (2012); GABC et al., 2019); Aktas and Ozorhon 2015; and Zhang et al. (2011)
Renewable energy	After optimizing inbuilt and natural efficiencies in their design, renewable and low-carbon technologies can be integrated to meet the energy requirements of buildings.	Ye et al. (2013); Ahn et al. (2013); Ajayi and Oke (2017); Grebenkov (2022).
Safety and Security	Safety and security should be given utmost priority. Builders must consider a range of factors, such as improving indoor air quality, guaranteeing electrical safety, and implementing measures to prevent accidents.	Abidin (2010); GABC et al., 2019); Aktas and Ozorhon 2015;
Functionality	It is crucial to determine the dimensions of the building and the proximity of different spaces needed for activities and equipment to accommodate its occupants.	GABC). (2016); Al-Saleh and Taleb, (2010); Hwang & Tan, 2013; Ajayi and Oke, 2017).
Reduction in greenhouse gas emissions	Considering the biophysical factors of construction is crucial.	Lazzerini et al., (2014); Hertwich et al. (2016); Kapoor et al. (2021); Lazzerini et al. (2014); Liu (2006); (Ahn et al. (2013); CIB (2004); Geng et al. (2017)
Resources conservation and management	The preservation of energy, materials, and all necessary resources needed for construction.	Chan, et al. (2017); GABC et al., 2019; Liobikiene et al. (2016) Perdan, 2011; Coombs et al., 2016)
Material reuse	The optimization of expenses and conservation of materials, energy and resources required for construction.	Ginga et al. (2020); Gao (2019); Oh et al., 2014; Abisuga.and Oyekanmi (2014); Bribián et al., 2017); Ahn et al. (2013); Akadiri (2015)
Promoting Health and well-being	Enhancing the quality of life for residents has been carefully strategized.	Ajayi and Oke, 2017; Abidin, 2005; MacNaughton et al. (2016); GABC et al., (2019); Chan, et al. (2017).
Historic preservation and certification	It enhances the market value of properties while preserving history and paying tribute to the past.	Aktas and Ozorhon. (2015); Yun (2020)
Indoor environmental quality	It is of utmost importance for builders to carefully strategize the design, construction, and maintenance processes to guarantee the seamless operation of the building enclosure, systems, equipment, and appliances, ultimately resulting in the creation of a truly conducive environment for human well-being.	Coombs et al., (2016); Gao (2019); Akadiri et al., (2012); Davies and Davies (2016).

Green Building Materials

Sustainable building materials play a crucial role in advancing eco-friendly practices within the construction sector. Architects, construction workers, and homeowners are increasingly embracing sustainable materials to reduce their environmental impact Qaidi et al. (2022) [38] have outlined the essential characteristics that sustainable materials should possess the following attributes such as:

Establishing acceptable levels of environmental performance properties is crucial. The entire life cycle of materials must be taken into account.

There should be no lasting environmental pollution throughout material's lifespan.

- It is important to avoid combining materials into compositions that are not easily disassembled. Materials should not be mixed in ways that prevent disassembly.
- Third-party certification for certain products is recommended.
- Sustainable materials are frequently more cost-effective than commonly believed.
- They contribute to enhanced indoor air quality.
- Deconstruction should be feasible after the building's use.
- It should be smart strategy friendly for energy consumption.
- Preserving water resources and reduces all forms of losses.
- Materials should reduce waste and maximizing recycling
- Promoting health and wellness of the inhabitants.
- Minimizing energy usage throughout the entire lifespan of a building, resulting in improved Materials should engender comfort and reduced operational costs for both new and renovated structures, while also encouraging occupants to adopt energy-efficient practices.
- Materials that are renewable and low-carbon emitters to meet the energy demands of buildings after optimizing their design to maximize inherent and natural efficiencies.

Policies, Codes and Standards for Green Building

The government at different levels of countries of the world established policies, codes and standards to regulate the construction of green building for sustainability development.

Policy and Regulation in Promoting Green Buildings

The emergence and evolution of the green building crusade at local, national, and international levels can be traced back to the heightened environmental consciousness that arose during the 1960s and 1970s. This era underscored the importance of designing and constructing buildings that minimize environmental impact while advocating for sustainable practices and the use of renewable energy sources (Adekanmbi et al., 2024) [4]. Throughout these decades, concerns regarding pollution, resource depletion, and environmental degradation became increasingly significant, leading to a greater focus on sustainable development and various certification initiatives (Atadoga et al., 2024) [13]. The adoption of energy-efficient materials and technologies in federal buildings, facilitated by the enforcement of building codes and regulations, has encouraged participation from the private sector. This effort was designed to ensure that new constructions and major renovation projects complied with established sustainability standards. In response, numerous countries around the globe have developed national strategies and policies to promote green buildings and sustainable construction practices.

Building Codes and Standards

Ayinla et al. (2024) [15] emphasize the significant impact of building codes and standards in fostering green buildings. These regulations establish essential benchmarks for energy performance, outline criteria for water efficiency, and set standards for indoor environmental quality. Furthermore, they encourage the utilization of renewable energy sources, as noted by Economidou et al. (2020) [23]. Building codes support the incorporation of energy-efficient materials, insulation, and windows, which are vital for minimizing heat loss and enhancing overall energy efficiency. The enforcement of these codes and standards promotes the adoption of innovative technologies and practices that bolster energy efficiency, including passive solar design and solar panel installation, while also advocating for sustainable water management strategies.

Another critical component of building codes and standards is the focus on indoor environmental quality. These standards aim to enhance the health and well-being of occupants by ensuring sufficient ventilation, access to natural light, and maintaining high indoor air quality. Building codes may mandate the use of non-toxic materials, efficient heating, ventilation, and air conditioning systems, as well as the availability of outdoor spaces to improve indoor environmental quality. By upholding these standards, building codes contribute to the creation of healthier and more comfortable indoor environments, ultimately leading to increased productivity, reduced absenteeism, and an improved quality of life for occupants.

Regulations establish an equitable framework for all buildings, ensuring compliance with essential standards for energy efficiency, water conservation, and indoor environmental quality. This framework stimulates the demand for green building technologies and practices, fostering innovation and transforming the market. Furthermore, mandatory standards offer clarity for developers and investors, as they are aware of the requirements necessary for regulatory compliance (Adekanmbi, et al., 2024 [4] and Emeka-Okoli, et al., 2024) [24]. The enforcement of these codes and standards promotes investment in green building initiatives, accelerates the integration of sustainable building practices, and enhances indoor environmental quality.

Advantages of Green Buildings

Many researchers have asserted that there are many advantages associated to green building. Among these are:

Lower Building Maintenance and Operation Cost

Sustainable building methods have the potential to provide substantial financial advantages and enhance overall financial outcomes through reducing expenses related to building upkeep and operations. GB plays a crucial role in reducing the environmental impact caused by conventional buildings, thereby fostering sustainability within both households and communities (GABC et al., 2019; Aktas and Ozorhon 2015) [8]. Eco-friendly constructions are recognized for their minimal maintenance demands and diminished reduced necessity for repairs when juxtaposed with conventional buildings. This is a result of utilizing resilient and eco-friendly materials that have extended lifespans and require minimal maintenance. For example, materials such as repurposed steel framing and bamboo flooring possess extended lifespans and necessitate minimal upkeep compared to conventional materials. Consequently, this results in reduced maintenance expenses over time. Additionally, Sustainable structures are specifically designed to maximize energy efficiency, leading to reduced operational costs. Designing of an effective Energy systems incorporate elements such as efficient lighting, insulation, high-efficiency HVAC systems, and water management measures. These features not only help to reduce water consumption but also contribute to sustainable practices. Green buildings often incorporate sustainable landscaping techniques, such as rain gardens, to minimize the reliance on costly irrigation schemes and decrease overall water utilization.

Energy Efficiency and Passive Design

Sustainable building designers focus on minimizing the consumption of energy derived from non-renewable sources like coal. They accomplish this goal by incorporating methods such as the installation of solar panels for utilizing solar power and creating windows that optimize natural light, consequently decreasing the reliance on electrical lighting. These techniques, among various others, guarantee the efficient operation of the building in relation to energy usage. Energy effectiveness is crucial not just for individuals residing in the building, but also for the broader community, as it results in cost savings and environmental preservation (Ahn et al., 2013 [6] and Akadiri et al., 2012) [7] Green building principles also highlight the significance of reducing energy waste through Eco-friendly designs and constructions methods. For instance, sustainable structures frequently integrate strategies such as air sealing and insulation to mitigate energy losses related to heating and cooling. Additionally, energy-efficient doors and windows are utilized to improve comfort levels and reduce heat transfer. Green buildings possess the capacity to greatly decrease energy usage in the long run by minimizing energy wastage (Ahn et al. 2013) [6].

Well-Being and Health

The practice of sustainable constructions has progressed to endorse not only physical well-being but also mental and emotional well-being. The quality of the indoor environment within a building significantly impacts the occupants' overall health and wellness. It focus on ensuring a safe and comfortable atmosphere by implementing elements such as windows and drop in the utilization of harmful substances. Unlike traditional buildings, green constructions use materials with fewer toxic chemicals, which is crucial in preventing health issues caused by volatile organic compounds released from items like paint, glue, sealants, and carpet fibers (Abidin, 2005) [1]. Green construction is essential for promoting a healthier environment for both workers and residents. By emphasizing natural materials, enhancing ventilation, and maximizing natural light, green buildings aim to create a space that reduces stress and boosts productivity (Abidin, 2005) [1].

Improved Water Efficiency

Water efficiency involves the conscientious handling of water resources to safeguard water and guarantee a consistent provision of fresh water for present and future generations. Sustainable building encourages the utilization of alternative water sources like rainwater, as well as the minimization of water wastage by incorporating effective plumbing fixtures and systems that manage and reuse wastewater (Hashemi et al., 2015) [28].

Utilization of Eco-friendly

Some sustainable materials undergo recycling and reuse for particular purposes. In particular, construction firms focused on environmental sustainability aim to build structures with reduced material usage, incorporating methods that preserve natural resources, energy, and water. The adopting eco-friendly materials in green buildings ensures that they are safe for the environment.

Cost Efficiency

Sustainable constructions, despite having a higher upfront cost compared to traditional buildings, demonstrate greater cost efficiency over time. Sustainable building is an environmentally conscious building method that enhances property value while promoting resource conservation, enhancing indoor air quality, and lowering energy expenses. Green construction offers property owners and investors a substantial return on their investment through the reduction of operational expenses, enhancement of energy efficiency, and establishment of a sustainable ecosystem (Al-Saleh and Taleb, 2010) [9]. Green buildings have higher asset values than their traditional counterparts, making them a valuable investment. Although the upfront expenses associated with constructing green buildings may be higher, they provide long-term savings and are a prudent financial decision.

Environmental Benefits

Green buildings enhance the visual appeal of a property, adding to its aesthetic value. Green buildings offer numerous environmental advantages, including a significant reduction in carbon emissions by almost 40%.

Efficiency of Resources

The growing population exerts significant pressure on communal resources like water and energy. Green buildings utilize cutting-edge technologies and techniques to improve their efficiency in using these resources, ultimately easing the strain. Through the construction of green buildings, we can successfully reduce energy usage and promote a more sustainable type of growth.

Other Advantages

Many researchers have emphasized some advantages associated with GB, such as decreased operational energy, reduced water consumption, reduced production of wastewater, mitigated water pollution, minimized material usage, prolonged building lifespan, decreased maintenance costs, and reduced dependence on natural resources in comparison to conventional buildings (Chan et al., 2016) [17]. They utilize fewer resources, boost occupant productivity, and elevate property value. Additionally, occupants can enjoy savings on utility expenses.

CONCLUSION

The technologies and practices related to green building in Nigeria are deemed unsustainable and do not align with the core principles of ideal sustainability. The green building suffered crucial support in terms of adequate institutional frameworks for policy development and guideline establishment, regulations, implementation, legislation, or incentives for sustainable building due to various factors such as the absence of political determination from the government and leadership, along with the failure to adhere to and enforce policies, lack of political will from the government and leadership, non-compliance and enforcement of policies. There is no collaboration among all stakeholders throughout various construction phases and this made it difficult to prioritizing environmental friendliness by utilizing energy-saving technologies and best practices improving waste and water efficiency is integral to upholding the key principles of Green Building. Some other findings include lack of information regarding environmentally friendly products and advanced building systems, insufficient knowledge regarding sustainability concerns, limited expertise among professionals, limited comprehension of sustainable construction practices, a lack of awareness among industry professionals, and the perception that sustainable construction is more expensive than traditional methods. Clients encounter substantial obstacles when it comes to embracing environmentally-friendly construction technologies owing to a scarcity of information regarding the potential benefits. There is lack of standardized procedures and criteria for assessing the ecological consequences of constructions. Traditional construction methods are deeply rooted in the industry, causing a reluctance to adopt new strategies, even if they contribute to the conservation of natural resources and have a beneficial effect on both the built environment and the ecosystem.

Recommendation

To promote the acceptance and adoption of green building practices in the construction sector, it is pertinent to engage universities, research institutes, and relevant professional bodies in awareness programs. Enhancing organizational capabilities prioritize must be enthroned through education and training to ensure the integration of sustainable practices in construction. The government must support this initiative by enacting policies that facilitate the growth of sustainability skills in the construction industry. Collaboration with concern professional bodies to incorporate sustainable principles and ideal is advocated. Government should float markets for green products and services can raise awareness and promote the use of sustainable construction practices through effective green marketing strategies that emphasize environmental benefits. Concerted efforts should be steered towards conducting research on locally sourced building materials and technologies. Recognizing the possibilities presented by these materials can significantly enhance the sustainability of housing projects within communities. Locally sourced materials are typically economical and readily available. Furthermore, there exists a gap in research concerning eco-friendly construction methods that integrate information communication technologies. It is essential to acknowledge the viewpoints of both green building users and owners, as neglecting them would be detrimental. Despite the increasing number of green buildings, there is a lack of research on their post-occupancy assessment. There is a necessity for research on a holistic stakeholder approach to green building design and execution. Given the social hurdles associated with adopting global green building standards, it is essential to cater to the requirements and anticipations of each stakeholder.

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