https://dx.doi.org/10.4314/dujopas.v11i1b.17
ISSN (Print): 2476-8316
ISSN (Online): 2635-3490
Dutse Journal of Pure and Applied Sciences (DUJOPAS), *Vol. 11 No. 1b March 2025*

Designing Sustainable Futures: The Role of Architecture in Combating Global Warming in Nigeria, (Paper Review).

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Abstract

This paper explores the role of sustainable architecture in combating global warming and addressing climate change challenges in Nigeria. Drawing on a range of relevant references, the study investigates various aspects of sustainable design principles, energy efficiency, climate adaptation strategies, case studies of sustainable architectural projects, policy and governance, and future directions for sustainable architecture in Nigeria. The findings highlight the significance of sustainable architecture in mitigating the impact of the built environment on climate change, reducing energy consumption, and promoting environmental sustainability. The paper emphasizes the integration of passive design strategies, renewable energy sources, efficient building envelope design, water conservation techniques, and the use of sustainable materials and construction practices. Additionally, it examines case studies, such as the Pyramid-I-City project, which exemplify successful implementations of sustainable architectural solutions in Nigeria. The study also underscores the importance of government regulations, incentives, and collaborations between architects, policymakers, and stakeholders in

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promoting sustainable architectural practices. Despite the existing barriers, such as limited awareness and technical expertise, the paper recommends strategies for promoting awareness and education within the architectural community and highlights future directions for sustainable architecture in Nigeria. Overall, the research underscores the critical role of sustainable architecture in combating global warming, providing recommendations for further research and action to foster a more sustainable and resilient future for Nigeria and beyond.

Keywords: Global warming, Climate change, Architecture, sustainability, energy efficiency

INTRODUCTION

Global warming and climate change pose significant challenges to the environment and society, demanding urgent action to mitigate their impacts (Gissen, 2014). As one of the major contributors to greenhouse gas emissions, the built environment plays a crucial role in exacerbating climate change. However, it also presents an opportunity to implement sustainable architectural practices that can effectively combat global warming and promote a more sustainable future (Pachauri *et al.*,2014).

The significance of sustainable architecture in mitigating climate change impacts cannot be overstated. By adopting environmentally conscious design principles, architects can reduce energy consumption, minimize carbon emissions, and create buildings that are resilient to changing climatic conditions. Sustainable architecture encompasses a wide range of strategies, including energy-efficient design, use of renewable energy sources, water conservation, and the use of sustainable materials.

The research objective of this paper is to explore the role of architecture in combating global warming specifically in the context of Nigeria. Nigeria, as a developing nation experiencing rapid urbanization and population growth, faces unique environmental challenges that require innovative architectural solutions. By examining the existing literature and drawing insights from relevant studies, this paper aims to identify the strategies, technologies, and design principles that can be employed to promote sustainable architecture in Nigeria.

The scope of this research includes a comprehensive review of the literature related to climate change, sustainable architecture, and their intersection. The paper will analyze the findings from various studies, reports, and academic publications, including references such as "Climate change, environment and development" by Okereke and Massaquoi (2017), "Sustainable Construction in the Nigerian Construction industry: Unsustainable Practices, barriers and strategies" by Omopariola et al. (2022), and "The Architecture of Global Climate Change" by Emmanuel (2010), among others.

By examining the existing body of knowledge and drawing insights from case studies and best practices, this paper aims to contribute to the understanding of how architecture can effectively combat global warming in Nigeria. The findings will provide valuable guidance to architects, policymakers, and stakeholders in formulating strategies and implementing sustainable design practices that can mitigate the environmental impact of the built environment and create a more sustainable future.

Climate Change and the Built Environment

The impact of the built environment on climate change: The built environment, including buildings, infrastructure, and urban spaces, has a significant impact on climate change.

Buildings are responsible for a considerable portion of global energy consumption and greenhouse gas emissions. According to the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (Pachauri et al., 2014), the construction and operation of buildings account for approximately 32% of global final energy use and 19% of energy-related greenhouse gas emissions. This highlights the crucial role that the built environment plays in contributing to climate change.

Energy consumption and greenhouse gas emissions in the architectural sector: The architectural sector is a major contributor to energy consumption and greenhouse gas emissions. Traditional building design and construction practices often prioritize aesthetics and functionality over energy efficiency and environmental sustainability (Umoh et al., 2024). This results in high energy consumption for heating, cooling, lighting, and operating buildings, leading to increased greenhouse gas emissions (Li et al., 2019). However, sustainable architectural practices offer solutions to reduce these environmental impacts.

Sustainable architecture emphasizes energy-efficient design, the use of renewable energy sources, and the integration of environmentally friendly technologies and materials. Studies such as "Architecture and Energy: Performance, Design, and Building Practices" by Steemers and Yannas (2018) and "Building Environmental Assessment Methods: Applications and Development" by Cole (2005) discuss various strategies and assessment methods that can improve energy efficiency and reduce greenhouse gas emissions in the architectural sector.

Environmental challenges specific to Nigeria: Nigeria faces unique environmental challenges that require specific attention in addressing climate change in the built environment. As a developing nation with rapid urbanization and population growth, Nigeria experiences increased pressure on natural resources, urban infrastructure, and the environment. Challenges such as inadequate waste management, deforestation, air pollution, and water scarcity pose significant threats to the country's sustainable development (Omisore, 2018).

In the Nigerian context, research studies such as "Sustainable Construction in the Nigerian Construction Industry: Unsustainable Practices, Barriers, and Strategies" by Omopariola et al. (2022) and "Pyramid-I-City: Mutual Symbiosis and Thermal Comfort in the Hot-Humid Context of Lagos" by Ogbuokiri (2008) shed light on the environmental challenges specific to Nigeria's built environment. These challenges require innovative architectural solutions that consider local climate conditions, cultural contexts, and sustainable practices to minimize negative environmental impacts and promote resilience.

By understanding the impact of the built environment on climate change, addressing energy consumption and greenhouse gas emissions in the architectural sector, and recognizing the specific environmental challenges of Nigeria, architects, policymakers, and stakeholders can work towards developing sustainable architectural practices that mitigate climate change impacts and promote a more environmentally conscious built environment in Nigeria.

Sustainable Design Principles for Climate Adaptation

Integration of passive design strategies for energy efficiency: Passive design strategies involve utilizing the natural elements of the environment to optimize energy efficiency and thermal comfort in buildings. Techniques such as orientation, shading, natural ventilation, and daylighting can significantly reduce the need for mechanical heating, cooling, and lighting systems, thereby reducing energy consumption and greenhouse gas emissions. The book "Architecture and Energy: Performance, Design, and Building Practices" by Steemers and

Yannas (2018) explores various passive design strategies and their benefits in improving energy efficiency.

Use of renewable energy sources in architectural design: Incorporating renewable energy sources into architectural design is crucial for reducing reliance on fossil fuels and mitigating climate change. Technologies such as solar panels, wind turbines, and geothermal systems can be integrated into buildings to generate clean and sustainable energy. The concept of incorporating renewable energy sources in architectural design is discussed in the book "Climate Considerations in Building and Urban Design" by Givoni (2014).

Efficient building envelope design and insulation techniques: The building envelope, including walls, roofs, windows, and insulation, plays a vital role in minimizing energy loss and maintaining thermal comfort. Designing and constructing an efficient building envelope with proper insulation can significantly reduce heating and cooling demands, resulting in lower energy consumption. The doctoral dissertation by Oginni (2017) titled "Thermal Performance of Building Envelopes of Public Primary School Classrooms in Lagos Metropolis, Nigeria" explores the thermal performance of building envelopes and the potential for energy savings.

Water conservation and rainwater harvesting in building design: Water scarcity is a significant concern in many regions, including Nigeria (Yannopoulos et al., 2019). Sustainable architectural design should prioritize water conservation strategies and rainwater harvesting systems to reduce reliance on freshwater sources and minimize water wastage. Implementing efficient plumbing fixtures, graywater recycling systems, and rainwater harvesting techniques can contribute to water conservation. The study "Sustainable Construction in the Nigerian Construction Industry: Unsustainable Practices, Barriers, and Strategies" by Omopariola et al. (2022) discusses the importance of water conservation in the Nigerian construction industry.

Use of sustainable materials and construction practices: Sustainable architecture promotes the use of eco-friendly materials and construction practices that minimize environmental impact. This includes selecting materials with low embodied energy, considering their life cycle analysis, and using recycled or locally sourced materials (Minunno et al., 2021). Sustainable construction practices also involve minimizing waste generation, implementing efficient construction techniques, and considering the social and environmental implications of the construction process (Carvajal-Arango et al., 2019). The book "Contemporary Sustainable Design and Practices in Architecture: Sustainable Building Concepts" edited by Boswell and Deakin (2016) provides insights into sustainable materials and construction practices.

By integrating passive design strategies, utilizing renewable energy sources, optimizing building envelope design, implementing water conservation measures, and adopting sustainable materials and construction practices, architects can contribute to climate adaptation and create buildings that are energy-efficient, environmentally friendly, and resilient to climate change.

Case Studies of Sustainable Architectural Projects in Nigeria

Pyramid-I-City: A case study on mutual symbiosis and thermal comfort in Lagos: The study titled "Pyramid-I-City: Mutual Symbiosis and Thermal Comfort in the Hot-Humid Context of Lagos" by Ogbuokiri (2008) explores the Pyramid-I-City project in Lagos, Nigeria. This case study focuses on achieving mutual symbiosis between humans and the environment through

sustainable architectural design. The project incorporates passive design strategies, such as orientation, shading, and natural ventilation, to optimize thermal comfort and reduce energy consumption. The study highlights the importance of context-specific solutions that consider the unique climate conditions of Lagos.

Sustainable construction practices in Nigerian projects: The research article "Sustainable Construction in the Nigerian Construction Industry: Unsustainable Practices, Barriers, and Strategies" by Omopariola et al. (2022) provides insights into sustainable construction practices in Nigeria. The study discusses the challenges and barriers faced in implementing sustainable practices in the Nigerian construction industry. It also explores strategies for overcoming these barriers, such as improving awareness, capacity building, and integrating sustainability considerations into construction policies and regulations. The article showcases the need for sustainable construction practices to mitigate the environmental impact of building projects in Nigeria.

Innovative architectural solutions for climate adaptation: Architects play a crucial role in developing innovative solutions to address climate change impacts. The book "Adapting Buildings and Cities for Climate Change: A 21st-Century Survival Guide" by Fleming and Honnef (2013) provides a comprehensive guide to adapting buildings and cities to climate change. While it does not specifically focus on Nigerian projects, it offers valuable insights into innovative architectural solutions that can be applied in various contexts. The book explores strategies for designing climate-resilient buildings, urban green spaces, and sustainable infrastructure systems to enhance adaptability to changing climate conditions.
These case studies demonstrate the application of sustainable architectural practices in Nigerian projects. The Pyramid-I-City project showcases the integration of passive design strategies to achieve thermal comfort in the hot-humid climate of Lagos. The study on sustainable construction practices highlights the importance of implementing sustainable approaches in the Nigerian construction industry. Additionally, the book on adapting buildings and cities for climate change provides broader insights into innovative architectural solutions that can be adapted for climate adaptation in Nigeria. These case studies serve as examples of how sustainable design principles can be effectively applied to address environmental challenges and promote climate resilience in architectural projects in Nigeria.

Policy and Governance for Sustainable Architecture
Role of government regulations and incentives in promoting sustainable architecture: Government regulations and incentives play a crucial role in promoting sustainable architecture. The study "Climate Change, Environment and Development" by Okereke and Massaquoi (2017) emphasizes the importance of policy frameworks that encourage sustainable practices in the built environment. Governments can implement building codes and standards that prioritize energy efficiency, renewable energy integration, and sustainable materials. Incentives such as tax breaks, grants, and certifications can encourage architects and developers to adopt sustainable design principles.

Collaboration between architects, policymakers, and stakeholders: Effective collaboration between architects, policymakers, and stakeholders is essential for driving sustainable architectural practices. The article "Just Energy Transition Partnerships in the Context of Africa-Europe Relations" by Hege et al. (2022) highlights the significance of partnerships and collaborations in achieving sustainable energy transitions. Architects can collaborate with policymakers, government agencies, community organizations, and other stakeholders to develop policies and strategies that promote sustainable architecture. This collaboration can

facilitate knowledge sharing, capacity building, and the formulation of effective policies to address climate change challenges.

Challenges and opportunities for sustainable architectural practices in Nigeria: Nigeria faces specific challenges and opportunities in promoting sustainable architectural practices. The study of Sustainable Construction in the Nigerian Construction Industry" by Omopariola et al. (2022) sheds light on the challenges faced in implementing sustainable practices in Nigeria. These challenges include limited awareness and understanding of sustainable design principles, inadequate technical expertise, and the dominance of conventional construction practices. However, the study also highlights opportunities, such as increasing awareness and capacity-building initiatives, integrating sustainability into policy frameworks, and leveraging innovative technologies and materials.

Furthermore, the book "Contemporary Sustainable Design and Practices in Architecture" edited by Boswell and Deakin (2016) explores sustainable building concepts and provides insights into policy and governance aspects. It discusses the role of government regulations, public-private partnerships, and community engagement in fostering sustainable architectural practices. It emphasizes the need for holistic approaches that address economic, social, and environmental aspects of sustainability.

In summary, government regulations and incentives can play a pivotal role in promoting sustainable architecture. Collaboration between architects, policymakers, and stakeholders is essential for effective implementation. Nigeria faces challenges in adopting sustainable practices but also presents opportunities for awareness raising, capacity building, and policy integration. The cited references provide valuable insights into the policy and governance aspects of sustainable architecture and highlight the importance of concerted efforts to address the challenges and leverage the opportunities for sustainable architectural practices in Nigeria.

Implementation and Future Directions

Barriers to adopting sustainable architectural practices: Several barriers hinder the widespread adoption of sustainable architectural practices. The study on "Sustainable Construction in the Nigerian Construction Industry" by Omopariola et al. (2022) identifies unsustainable practices, lack of awareness, and limited technical expertise as significant barriers. Resistance to change, cost concerns, and limited access to sustainable materials and technologies also pose challenges. Additionally, the book "Contemporary Sustainable Design and Practices in Architecture" edited by Boswell and Deakin (2016) highlights the influence of cultural norms, regulatory constraints, and market forces as barriers to sustainable architecture. Overcoming these barriers requires a multi-faceted approach involving policy interventions, education, and awareness campaigns.

Strategies for promoting awareness and education in the architectural community: Raising awareness and providing education to the architectural community are crucial for promoting sustainable practices. The book "Contemporary Sustainable Design and Practices in Architecture" emphasizes the role of education in instilling sustainability principles early in the architectural curriculum. Continuing professional development programs, workshops, and seminars can help architects stay updated with the latest sustainable design strategies. Collaborations between academic institutions, professional associations, and industry stakeholders can facilitate knowledge exchange and capacity building. The article "The Architecture of Global Climate Change" by Emmanuel (2010) emphasizes the importance of

incorporating climate change considerations into architectural education to foster a sustainability mindset among future practitioners.

Future directions for sustainable architecture in Nigeria: The future of sustainable architecture in Nigeria holds immense potential for transformative change. The article "Sustainable Construction in the Nigerian Construction Industry" by Omopariola et al. (2022) outlines strategies to address the barriers and promote sustainable practices. These include integrating sustainability into policy frameworks, incentivizing sustainable design through tax breaks and certifications, fostering collaborations among stakeholders, and promoting research and development of sustainable technologies. Additionally, the study on "Pyramid-I-City" by Ogbuokiri (2008) highlights the importance of mutual symbiosis and thermal comfort in the hot-humid context of Lagos, showcasing innovative design approaches that respond to local climate conditions.

Moreover, the involvement of government agencies, professional associations, and community organizations is crucial for driving sustainable architecture forward. The continuous development of green building rating systems, such as LEED (Leadership in Energy and Environmental Design) or BREEAM (Building Research Establishment Environmental Assessment Method), can provide frameworks and guidelines for sustainable design and construction practices. The integration of smart technologies, such as sensors and networks, as discussed in the book "The City of Tomorrow" by Ratti and Richens (2012), can contribute to creating energy-efficient and resilient cities.

In conclusion, addressing barriers to adopting sustainable architectural practices, promoting awareness and education, and exploring innovative strategies are essential for the future of sustainable architecture in Nigeria. The cited references provide valuable insights into these areas and highlight the importance of collaboration, policy interventions, and technological advancements. With concerted efforts from architects, policymakers, academia, and industry stakeholders, Nigeria can embrace sustainable architecture and contribute to mitigating the impacts of climate change while fostering sustainable development.

Conclusion

In conclusion, the discussed references have shed light on various aspects of sustainable architecture in combating global warming and addressing climate change challenges in Nigeria. Key findings and contributions from these studies highlight the following

i. The built environment significantly impacts climate change, with energy consumption and greenhouse gas emissions being major concerns in the architectural sector. It is crucial to adopt sustainable design principles and practices to mitigate these impacts.
ii. Passive design strategies, renewable energy sources, efficient building envelope design, and water conservation techniques are essential elements of sustainable architectural projects. These strategies help enhance energy efficiency, reduce resource consumption, and promote climate adaptation.
iii. Case studies, such as the Pyramid-I-City project, exemplify the successful implementation of sustainable architectural solutions in Nigeria. They demonstrate the importance of mutual symbiosis, thermal comfort, and innovative design approaches in addressing local climate challenges.
iv. Policy and governance play a vital role in promoting sustainable architecture. Government regulations, incentives, and collaborations between architects,

policymakers, and stakeholders are crucial for creating an enabling environment for sustainable practices.

v. However, several barriers hinder the widespread adoption of sustainable architecture, including limited awareness, technical expertise, and access to sustainable materials. Overcoming these barriers requires targeted interventions, including education, awareness campaigns, and policy support.

In light of these findings, it is evident that sustainable architecture plays a critical role in combating global warming and promoting environmental sustainability. It offers an opportunity to mitigate climate change impacts, reduce energy consumption, and foster resilient communities.

To further advance the field of sustainable architecture in Nigeria, additional research and action are recommended. This includes:

i. Conducting more studies on the specific environmental challenges faced by Nigeria and exploring context-specific design strategies to address these challenges effectively.
ii. Encouraging interdisciplinary collaborations among architects, engineers, policymakers, and researchers to develop innovative solutions and integrate sustainability into architectural education and professional practice.
iii. Promoting research and development of sustainable technologies, materials, and construction practices that are locally sourced, affordable, and culturally appropriate.
iv. Advocating for stronger policy frameworks, incentives, and certifications to incentivize sustainable architectural practices and ensure compliance with environmental standards.

By implementing these recommendations and fostering a collaborative and knowledge-sharing environment, Nigeria can continue to make significant strides in sustainable architecture, effectively combat global warming, and contribute to a more sustainable and resilient future for its communities and the planet as a whole.

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