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Sustainable architectural solutions for affordable housing in Nigeria: A case study approach

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Abstract

This study provides a critical examination of sustainable architectural solutions as a response to Nigeria's pressing affordable housing crisis. With the country facing rapid urbanization and a significant population increase, there is an urgent demand for housing solutions that are not only cost-effective but also environmentally sustainable. The research adopts a qualitative approach, utilizing a comprehensive review of existing literature, in-depth case studies, and the analysis of current trends to evaluate the feasibility and challenges associated with the implementation of sustainable architectural practices in Nigeria. The findings indicate that locally sourced materials, such as stabilized earth blocks and interlocking bricks, offer a viable means of reducing construction costs while supporting environmental sustainability. Moreover, the integration of renewable energy technologies, particularly solar power, has been identified as a key factor in lowering long-term energy expenses and enhancing the overall resilience of housing developments. Despite these promising strategies, the study identifies significant obstacles to widespread adoption, including financial constraints, a shortage of technical expertise and the gradual decline of traditional building practices. These challenges suggest the need for a holistic approach that includes the adoption of circular economy principles, the exploration of sharing economy models, and the deployment of advanced technologies like artificial intelligence and machine learning to improve the sustainability and affordability of future housing projects. The study emphasizes the importance of continuous professional development, robust policy frameworks and the active participation of all stakeholders to effectively address the housing challenges in Nigeria. These recommendations aim to foster a collaborative effort toward achieving sustainable and affordable housing solutions that meet the evolving needs of the population.

Keywords: Sustainable architecture; Affordable housing; Renewable energy; Circular economy; Urbanization; Nigeria

1. Introduction

Nigeria, as the most populous country in Africa, faces an enormous housing deficit that continues to grow with the rapid urbanization and population increase. The demand for affordable housing is significantly outstripping supply, leading to a situation where millions of Nigerians, particularly in urban areas, live in substandard conditions or have no access to housing at all. This issue is compounded by the challenges associated with conventional construction methods and materials, which are often not only costly but also environmentally unsustainable. Consequently, there is an urgent need to explore and implement sustainable architectural solutions that can address these challenges while ensuring the

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provision of affordable, decent, and environmentally friendly housing for the Nigerian population (Sunday, Lim & Mazlan, 2021).

Sustainable architecture involves the design and construction of buildings that are environmentally responsible and resource-efficient throughout their lifecycle. In the context of Nigeria, this approach to building is especially critical given the country's vulnerability to climate change, resource depletion, and the pressing need for affordable housing. Sustainable architectural practices include the use of local and renewable materials, energy-efficient design, and construction techniques that reduce the environmental impact of buildings while improving their resilience and adaptability to changing environmental conditions (Lembi et al., 2021).

One of the primary drivers of the housing crisis in Nigeria is the rapid rate of urbanization. As urban areas expand at an unprecedented pace, there is mounting pressure on infrastructure and services, particularly housing. This urban migration is primarily driven by the search for better economic opportunities, education, and healthcare, resulting in the proliferation of informal settlements where living conditions are often dire. These settlements are plagued by overcrowding, inadequate basic amenities, and significant exposure to environmental hazards. The challenges posed by these conditions necessitate a multifaceted approach to ensure long-term viability and resilience. This approach must include not only the provision of affordable housing but also the integration of sustainable practices to mitigate the environmental and social impacts associated with rapid urbanization. By incorporating sustainable architectural solutions, these developments can be made more resilient, reducing their vulnerability to environmental risks while improving the overall quality of life for residents (Saidu & Yeom, 2020; Ilesanmi, 2010; Olanrewaju & Adegun, 2021).

The adoption of sustainable architecture in affordable housing initiatives in Nigeria is not only a response to environmental concerns but also a practical solution to the economic challenges facing many low-income households. By utilizing locally available materials and energy-efficient technologies, it is possible to reduce construction costs while also lowering the operational costs of homes through reduced energy consumption. For instance, the use of solar energy in housing developments can significantly decrease reliance on the national grid, which is often unreliable, thereby providing a more stable and cost-effective energy supply for residents (Adedeji et al., 2023).

Furthermore, the cultural dimension of sustainable architecture is of particular importance in Nigeria. Traditional building practices, which have evolved over centuries, offer valuable insights into how to create structures that are not only in harmony with the environment but also reflective of local cultural values and lifestyles. For example, the Igala people's traditional building practices emphasize energy efficiency and environmental conservation, aspects that are crucial for guiding contemporary architectural practices in Nigeria (Odebiyi, Subramanian & Braimoh, 2010). Incorporating these traditional methods into modern construction practices can enhance the sustainability of housing projects while also preserving cultural heritage.

Another critical aspect of sustainable architecture in the Nigerian context is the use of innovative building materials. The exploration of materials such as stabilized interlocking clay bricks, plastic sand bricks, and other low-energy materials has shown promise in providing affordable and sustainable housing solutions (Oladimeji, Abubakar-Kamar & Arosanyin, 2024). These materials not only reduce the cost of construction but also have lower environmental impacts compared to conventional materials like concrete. Additionally, they offer the potential for local production, which can boost local economies and provide employment opportunities.

The integration of sustainable practices into affordable housing projects in Nigeria also extends to the design and planning stages. Sustainable housing designs often include features that optimize natural ventilation and lighting, thereby reducing the need for artificial heating, cooling, and lighting systems. This not only lowers energy consumption but also improves the comfort and health of residents. Moreover, the use of green infrastructure, such as rainwater harvesting systems and waste recycling, further enhances the sustainability of housing developments (Mahmood, 2024).

Despite the clear benefits of sustainable architectural solutions, there are significant challenges to their widespread adoption in Nigeria. These include the high initial costs of sustainable materials and technologies, limited technical expertise, and resistance to change from both developers and consumers who are accustomed to conventional building practices. Additionally, the lack of supportive policies and incentives from the government hinders the scaling up of sustainable housing initiatives. Addressing these challenges requires a concerted effort from all stakeholders, including government agencies, private sector players, and civil society organizations, to promote the adoption of sustainable practices in the housing sector (Lembi et al., 2021).

The study aims to explore the potential of sustainable architectural solutions to address the affordable housing crisis in Nigeria. Through a detailed analysis of case studies, the research will examine the effectiveness of various sustainable practices in providing affordable, resilient, and culturally appropriate housing. The objective is to identify key strategies that can be scaled up and integrated into national housing policies to improve the provision of affordable housing across Nigeria. The scope of the study will cover different regions of the country, taking into account the diverse climatic, cultural, and socio-economic contexts that influence housing needs and practices. By highlighting the benefits and challenges of sustainable architecture, the study will contribute to the ongoing discourse on sustainable development and inform future policy and practice in Nigeria's housing sector (Uzundu & Lele, 2024).

2. The Housing Crisis in Nigeria: An Overview

Nigeria, as the most populous nation in Africa, has been grappling with a significant housing crisis, exacerbated by rapid urbanization, population growth, and socioeconomic challenges. The urbanization rate in Nigeria is one of the highest in the world, leading to a growing demand for housing, particularly in urban areas. However, this demand has not been met with a corresponding increase in the supply of affordable housing, resulting in widespread housing shortages, the proliferation of informal settlements, and deteriorating living conditions for millions of Nigerians (Jiboye, Adebayo & Obakin, 2020).

The rapid rate of urbanization has placed immense pressure on urban centers, where infrastructure and services, including housing, are already inadequate. The migration of people from rural to urban areas in search of better economic opportunities has led to the growth of slums and informal settlements, where residents live in overcrowded, unsanitary, and unsafe conditions. These areas lack basic amenities such as clean water, sanitation, and electricity, further compounding the challenges faced by the urban poor. The inability of the government and private sector to provide sufficient affordable housing has left many urban dwellers with no option but to live in these substandard conditions (Wuyokwe, Yakubu & Miala, 2022).

Population growth is another critical factor contributing to the housing crisis in Nigeria. The country's population has been growing at an alarming rate, with estimates suggesting that it could double by 2050. This rapid population growth has increased the demand for housing, particularly in urban areas, where the majority of the population resides. However, the supply of housing has not kept pace with this demand, leading to a significant housing deficit. In regions such as Ondo State, the effects of population growth on housing demands are evident, with rising costs of land and building materials making it increasingly difficult for low-income earners to afford decent housing (Omowa et al., 2023).

The economic challenges facing Nigeria have also played a significant role in exacerbating the housing crisis. High levels of unemployment, inflation, and poverty have left many Nigerians unable to afford housing, even when it is available. The cost of building materials has skyrocketed due to inflation and supply chain disruptions, further driving up the cost of housing. Additionally, access to finance for housing development is limited, with high mortgage interest rates and stringent lending criteria making it difficult for individuals and developers to secure funding for housing projects. In Abuja, for instance, the challenges of housing ownership and property development are compounded by issues such as corruption, inadequate government policies, and the high cost of capital and labor (Wuyokwe, Yakubu & Miala, 2022).

The housing crisis in Nigeria is not only an economic issue but also a social and environmental one. The lack of affordable housing has led to the displacement of vulnerable populations, increased social inequality and a rise in homelessness. In many urban areas, the housing deficit has resulted in the proliferation of slums, where living conditions are deplorable and residents are exposed to various health and safety risks. These informal settlements are often located in environmentally sensitive areas, such as floodplains and hillsides, making them highly vulnerable to natural disasters. In Jos, the hilltop settlements of Zinariya and Azurfa are prime examples of how poor planning and lack of infrastructure provision by authorities have led to housing and environmental challenges in rapidly urbanizing areas (Oluwoye, 2008).

One of the strategies that have been explored to address the housing crisis in Nigeria is the Public-Private Partnership (PPP) model. This approach involves collaboration between the government and private sector to finance, develop, and manage housing projects. In Abuja, PPPs have been recognized as a potential solution to the housing crisis, aligning with recommendations from international bodies such as the United Nations. However, the implementation of PPPs in Nigeria has been hampered by various challenges, including bureaucratic bottlenecks, lack of transparency, and insufficient incentives for private sector participation (Ahmed, 2019).

The housing crisis in Nigeria is further compounded by the lack of effective urban planning and land use management. Many urban areas in Nigeria are characterized by haphazard developments, where buildings are constructed without adherence to planning regulations or guidelines. This has resulted in the emergence of squatter settlements,

overcrowded neighborhoods, and inadequate infrastructure, all of which contribute to the poor living conditions experienced by many urban residents. In Enugu, for example, the impact of rural-urban migration and urbanization on public housing delivery has been marked by gross housing shortages, increased housing rent, high land values, and the violation of planning guidelines (Nwalusi et al., 2022).

Despite the challenges, there are opportunities for addressing the housing crisis in Nigeria. One such opportunity lies in the exploration of innovative housing solutions, such as modular housing and the use of sustainable building materials. Modular housing, which involves the prefabrication of building components off-site and their assembly on-site, has been identified as a potential solution to the housing crisis in Lagos. This approach offers several advantages, including reduced construction time, lower costs, and improved quality control. In Lagos, the Dolphin Housing Estate has been identified as a potential site for the

2.1. Sustainable Architecture: Concepts and Principles

Sustainable architecture, a crucial aspect of modern construction, seeks to minimize the environmental impact of buildings by enhancing efficiency and moderating the use of resources. In the context of Nigeria, the adoption of sustainable architectural practices is not merely a response to global environmental concerns but also a strategic necessity to address the nation's pressing housing challenges. The principles of sustainable architecture focus on the creation of buildings that are environmentally responsible, resource-efficient, and capable of meeting the needs of present and future generations.

One of the core tenets of sustainable architecture is the use of green building materials, which are designed to reduce the carbon footprint associated with traditional construction methods. In Nigeria, the potential of these materials is particularly significant, given the country's reliance on imported construction materials that are often expensive and environmentally detrimental. For instance, the use of locally sourced, eco-friendly materials such as interlocking stabilized soil blocks (ISSBs) has been advocated as a sustainable alternative to conventional building materials. This approach not only reduces the environmental impact but also lowers construction costs, making housing more affordable for low-income earners (Olaleye & Ibitoye, 2023).

Another key principle of sustainable architecture is energy efficiency. Buildings designed with sustainability in mind typically incorporate features that reduce energy consumption, such as natural ventilation, passive solar heating, and the use of renewable energy sources. In Nigeria, where energy supply is often unreliable and costly, the integration of renewable energy technologies, such as solar panels, into building designs is crucial. This not only ensures a stable energy supply but also reduces the overall energy costs for residents, contributing to the long-term affordability of housing (Uzundu & Lele, 2024).

Biomimicry, an innovative approach to sustainable architecture, draws inspiration from nature to create designs that are both efficient and harmonious with the environment. In Nigeria, this concept is gaining traction as architects and urban planners seek to develop buildings that are resilient to the country's climatic challenges. For example, the design of buildings that mimic the cooling mechanisms found in termite mounds can significantly reduce the need for artificial cooling systems, thereby lowering energy consumption and enhancing the sustainability of the built environment (Tambe et al., 2023).

Water conservation is another critical component of sustainable architecture. In a country like Nigeria, where water scarcity is a significant issue, the design of buildings that incorporate water-saving technologies, such as rainwater harvesting systems and low-flow plumbing fixtures, is essential. These measures not only reduce the demand for potable water but also lessen the burden on the country's often overtaxed water supply systems (Chiamaka & Aduwo, 2019).

Sustainable architecture also emphasizes the importance of social inclusion and community engagement in the design and development of housing projects. This approach ensures that buildings not only meet environmental and economic criteria but also address the social and cultural needs of the communities they serve. In Nigeria, this has led to the exploration of vernacular architecture as a model for sustainable housing. Vernacular architecture, which is based on traditional building practices and materials, offers valuable lessons in sustainability and resilience, particularly in regions prone to environmental hazards such as flooding and extreme heat (Moghayedi et al., 2021).

The concept of resilient and regenerative housing, which goes beyond sustainability to focus on the ability of buildings to recover from and adapt to environmental challenges, is also gaining importance in Nigeria. This approach is particularly relevant in urban areas where the impacts of climate change are most acutely felt. By designing buildings

that can withstand and recover from extreme weather events, architects and planners can contribute to the creation of cities that are not only sustainable but also resilient to the impacts of climate change (Dawaye, Enwin & Ikiriko, 2024).

Incorporating technology into sustainable architecture is another emerging trend in Nigeria. The development of smart cities, which use digital technologies to improve the efficiency of urban services and infrastructure, is seen as a key strategy for addressing the housing crisis in rapidly growing cities like Lagos. Smart city initiatives involve the integration of information and communication technologies (ICT) into the management of urban areas, enabling more efficient use of resources and better decision-making processes. This approach can lead to more sustainable urban development and improved quality of life for city dwellers (Odefadehan, 2021).

The challenges of implementing sustainable architecture in Nigeria are significant, but they are not insurmountable. Efforts to promote green building practices face obstacles such as the high cost of sustainable materials, limited awareness among stakeholders, and the lack of supportive policies and incentives. However, with increased collaboration between government, industry, and academia, it is possible to overcome these barriers and advance the adoption of sustainable architecture in the country. Key strategies include the development of local building codes that mandate the use of sustainable practices, the provision of financial incentives for green building projects, and the promotion of public awareness campaigns to highlight the benefits of sustainable architecture (Koko & Bello, 2020).

2.2. Case Studies of Sustainable Affordable Housing in Nigeria

Sustainable affordable housing is an increasingly critical issue in Nigeria, given the country's burgeoning population and the corresponding need for environmentally responsible and economically viable housing solutions. Various case studies across Nigeria have demonstrated how sustainable practices can be integrated into affordable housing projects, providing valuable insights into the challenges and successes of these initiatives.

One notable example is the Millard Fuller Foundation projects in Nasarawa State, which have been lauded for their efforts to stimulate private investment in affordable housing. This case study highlights the importance of addressing key components such as construction costs, access to finance, and the efficient use of land. The projects have managed to reduce construction costs by leveraging locally available materials and implementing cost-effective building techniques. Moreover, enhancing access to National Housing Fund (NHF) mortgages by considering supplementary incomes has been pivotal in enabling more Nigerians to afford homes in these developments (Nwachukwu, Rodrigues and Kiamba, 2023).

Another significant case study is the Talba Housing Estate in Minna, where the focus has been on designing a sustainable neighborhood through the integration of green spaces, energy efficiency measures, and effective waste management systems. The estate's design elements have been assessed for their effectiveness in promoting sustainability, with positive outcomes in terms of accessibility, infrastructure, and community engagement. This project demonstrates how sustainable housing can be achieved through thoughtful urban planning and the incorporation of green building practices (Buwah et al., 2023).

In Lagos, the adoption of solar energy in housing projects has been identified as a critical factor in ensuring the sustainability and affordability of homes. Solar energy not only reduces the reliance on the national grid, which is often unreliable, but also lowers the long-term energy costs for residents. This approach is particularly beneficial in urban areas where electricity demand is high, and the cost of conventional energy sources can be prohibitive for low-income households (Adedeji, Deveci & Salman, 2023).

The implementation of sustainable affordable housing strategies in Nigeria must also address the barriers that hinder widespread adoption. A review of the challenges faced in integrating sustainability into affordable housing projects reveals financial constraints, lack of expertise, and limited awareness as significant obstacles. Overcoming these barriers requires concerted efforts from stakeholders across the public and private sectors, as well as the incorporation of educational and training programs to build local capacity in sustainable construction practices (Azman et al., 2023).

Success criteria for sustainable and affordable housing models have been identified in various studies, with a focus on factors such as security, adaptability, utility, and community integration. These criteria are essential for ensuring that housing projects are not only affordable but also sustainable and capable of meeting the long-term needs of residents. The application of these criteria in different Nigerian cities has shown that when these factors are prioritized, the resulting housing developments are more likely to succeed in providing safe, sustainable, and affordable homes (Saidu & Yeom, 2020).

Moreover, the use of frugal innovation has been proposed as a game-changing approach to sustainable affordable housing in Nigeria. This concept involves the creation of cost-effective and resource-efficient solutions that can be implemented at scale, particularly in low-income settings. The application of frugal innovation in housing projects has the potential to significantly reduce costs while maintaining high standards of sustainability, making it an attractive option for addressing Nigeria's housing deficit (Dok-Yen, Duah and Addy, 2023).

The role of government and institutional frameworks cannot be overstated in the successful implementation of sustainable affordable housing. Effective land policies, financial institutions, and governance structures are critical success factors identified in the housing sector. These elements must be aligned to create an enabling environment for sustainable housing initiatives, ensuring that projects are supported from inception through to completion (Musa et al., 2023).

2.3. Key Sustainable Solutions in Nigerian Affordable Housing

Sustainable housing solutions in Nigeria have become increasingly crucial as the country grapples with a growing population, urbanization, and the need for affordable housing. Several strategies have been identified to integrate sustainability into affordable housing projects, addressing both environmental and socioeconomic challenges. These key sustainable solutions emphasize the importance of a holistic approach, incorporating ecological, economic, social, and technological factors to create resilient and inclusive housing for all Nigerians.

One of the fundamental approaches to sustainable affordable housing in Nigeria is the use of locally sourced and eco-friendly building materials. Stabilized interlocking clay bricks, for example, have been highlighted as a sustainable and cost-effective alternative to conventional building materials. These bricks not only reduce the environmental impact of construction but also contribute to lowering costs, making housing more accessible to low-income earners. The use of such materials supports local economies, reduces reliance on imported goods, and promotes environmentally responsible construction practices (Adedeji, Devenci & Salman, 2023).

Another critical solution is the integration of renewable energy technologies, particularly solar energy, into housing projects. Nigeria's abundant sunlight makes solar power a viable option for providing clean and reliable energy to homes, especially in areas where access to the national grid is limited. Solar energy systems can significantly reduce household energy costs, increase energy security, and contribute to the overall sustainability of housing developments. This approach not only addresses the immediate energy needs of residents but also aligns with global efforts to reduce carbon emissions and mitigate climate change (Adedeji et al., 2023).

In addition to material and energy considerations, sustainable housing in Nigeria must also focus on the social and economic aspects of development. Strategies that enhance community integration, accessibility, and adaptability are vital for improving the quality of life for residents. This includes designing housing that is not only affordable but also connected to essential services, such as public transportation, healthcare, and education. Ensuring that housing developments are adaptable to changing needs and resilient to environmental stresses is key to their long-term success (Saidu & Yeom, 2020).

Resilient and regenerative housing practices, which go beyond traditional sustainability measures, are increasingly being explored in Nigeria. These practices focus on creating buildings that are not only sustainable but also capable of recovering from and adapting to environmental challenges. This includes designing homes that are energy-efficient, climate-responsive, and equipped to withstand extreme weather conditions. By incorporating these principles, housing projects can contribute to the creation of sustainable urban environments that are both livable and resilient (Dawaye, Enwin & Ikiriko, 2024).

The adoption of these sustainable solutions is not without its challenges. Financial constraints, lack of technical expertise, and inadequate policy support are significant barriers to the widespread implementation of sustainable housing practices in Nigeria. Addressing these challenges requires a concerted effort from all stakeholders, including government agencies, private sector players, and non-governmental organizations. Collaborative efforts are needed to develop and implement policies that incentivize sustainable construction, provide access to affordable financing, and promote capacity building in sustainable building techniques (Sunday, Lim & Mazlan, 2021).

Moreover, the integration of renewable energy sources into the national energy mix is essential for supporting sustainable housing initiatives. Large-scale renewable energy projects, such as solar farms and wind power installations, can provide the necessary infrastructure to support the widespread adoption of sustainable housing.

These projects not only contribute to environmental sustainability but also offer economic benefits by creating jobs, reducing energy costs, and enhancing energy security (Uzundu & Joseph, 2024).

2.4. Challenges in Implementing Sustainable Architectural Solutions

Implementing sustainable architectural solutions in Nigeria faces a myriad of challenges that are both deeply rooted in socio-cultural practices and influenced by modern economic and environmental factors. These challenges must be understood in the context of Nigeria's diverse climate, traditional building practices, and the growing demands of urbanization.

A major challenge lies in the diminishing use of traditional building practices that historically offered sustainable solutions tailored to the local environment. For instance, the inherently sustainable Igala architecture is gradually being supplanted by modern construction methods that frequently overlook essential socio-cultural, environmental, and climatic factors crucial for sustainable living. This shift away from indigenous practices in favor of less environmentally friendly modern techniques poses a significant barrier to the widespread adoption of sustainable architecture (Odebiyi, Subramanian & Braimoh, 2010).

Climate change and its related challenges also play a critical role in hindering the implementation of sustainable architectural practices. While there have been local efforts to engage in climate action planning, full domestication of Sustainable Development Goal 13 (SDG 13), which focuses on climate action, remains unachieved. This gap in implementation not only affects the broader environmental goals but also limits the potential for sustainable architectural solutions to be part of Nigeria's response to climate change (Benjamin et al., 2024).

Urban sprawl presents another significant challenge. In cities like Benin, unchecked urban expansion has led to disorganized development that often ignores the principles of sustainability. Managing this sprawl requires efficient urban planning and design concepts that prioritize sustainable development. However, the lack of coordinated planning and the rapid pace of urbanization make it difficult to implement sustainable architectural solutions effectively (Odeyale, 2023).

The integration of green architecture in public buildings, particularly in regions such as the Savannah, also encounters barriers. While green architecture offers numerous benefits, including reduced energy consumption and improved indoor air quality, its adoption is limited by a lack of awareness and expertise among architects and builders. Additionally, the initial costs associated with implementing green technologies can be prohibitive, deterring widespread adoption despite the long-term savings and environmental benefits (Alkali, Mohammad & Usman, 2024).

Rural areas face unique challenges in implementing sustainable architecture. The infrastructural challenges in these regions, such as limited access to modern construction materials and technologies, make it difficult to apply sustainable practices. Furthermore, the role of architecture in facilitating urban-rural development is often overlooked, leading to a disparity in the quality of life between urban and rural populations. Addressing these challenges requires a focused effort to improve rural infrastructure and incorporate sustainable practices into the development of rural areas (Okosun et al., 2023).

Finally, there is a need for continuous professional development among architects and builders to keep pace with the evolving concepts of sustainability in architecture. The lack of ongoing education and training opportunities means that many professionals are not equipped with the necessary skills and knowledge to implement sustainable solutions effectively. Continuous learning, particularly in STEM fields, is essential for enhancing the capacity of professionals to adopt and innovate sustainable architectural practices (Joseph & Uzundu, 2024).

2.5. Impact of Sustainable Architecture on Affordable Housing

Sustainable architecture has a profound impact on the provision of affordable housing in Nigeria, particularly as it addresses the dual challenges of environmental sustainability and housing affordability. By incorporating eco-friendly materials, energy-efficient designs, and community-focused planning, sustainable architecture not only enhances the quality of life for residents but also contributes to the long-term viability of housing projects.

One of the most significant impacts of sustainable architecture on affordable housing is the reduction in construction costs through the use of locally sourced, sustainable materials. In Nigeria, the adoption of materials such as stabilized earth blocks and interlocking bricks has been shown to lower building costs while maintaining structural integrity and environmental sustainability. These materials, which are often readily available in local communities, reduce the reliance on expensive imported goods, making housing more affordable for low-income families (Lembi et al., 2021).

Energy efficiency is another critical aspect of sustainable architecture that directly impacts the affordability of housing. By designing homes that maximize natural ventilation, solar energy, and other renewable resources, architects can significantly reduce the energy costs for residents. This is particularly important in Nigeria, where energy costs can be a significant burden for low-income households. The integration of solar panels and energy-efficient systems not only lowers utility bills but also promotes energy independence, which is crucial in areas with unreliable power supply (Saidu & Yeom, 2020).

The greening of vernacular building projects in Northern Nigeria exemplifies how sustainable architecture can preserve traditional practices while introducing modern innovations to improve living conditions. By incorporating green building concepts into traditional designs, architects can create homes that are better suited to the local climate, more energy-efficient, and more affordable. This approach not only enhances the sustainability of housing projects but also helps to preserve cultural heritage and promote community identity (Danja et al., 2020).

Moreover, sustainable architecture contributes to community well-being by improving the design and functionality of housing developments. In urban areas like Mushin in Lagos State, the disparity between existing residential designs and the needs of the population has led to increased rents and housing insecurity. Sustainable architectural practices that focus on creating adaptable, resilient, and community-integrated housing can address these challenges, providing safe and affordable homes that meet the needs of diverse populations (Kuti et al., 2024).

The broader educational impact of sustainable architecture cannot be overlooked. By integrating sustainable principles into the design and construction of affordable housing, educational institutions can play a pivotal role in training the next generation of architects and builders. This educational approach not only promotes sustainability within the construction industry but also equips professionals with the knowledge and skills needed to innovate and implement sustainable solutions across various sectors (Joseph & Uzundu, 2024a; Joseph & Uzundu, 2024b).

2.6. Future Trends and Research Directions in Sustainable Housing

The field of sustainable housing in Nigeria is evolving rapidly, driven by the urgent need to address the dual challenges of environmental sustainability and affordable housing. As the nation grapples with these issues, future trends and research directions are emerging, offering promising pathways to develop innovative and effective solutions.

One significant future trend in sustainable housing is the integration of circular economy principles into housing development. This approach emphasizes the reuse and recycling of materials, reducing waste and minimizing the environmental footprint of housing projects. Research has increasingly focused on how circular economy models can be applied to sustainable housing, particularly in the context of emerging economies like Nigeria. This shift towards a circular economy is expected to play a crucial role in reducing construction costs and promoting environmental sustainability (Mehmood et al., 2023).

Another critical area of future research is the exploration of sharing economy business models in the housing sector. The sharing economy, characterized by shared access to goods and services, has gained traction globally, and its potential in the housing market is beginning to be recognized. In Nigeria, where access to affordable housing remains a significant challenge, sharing economy models could offer innovative solutions. These models may involve co-housing arrangements, shared spaces, and community-driven initiatives that optimize the use of resources and reduce the overall cost of housing (Duan, 2023).

Resilience strategies in sustainable housing are also gaining importance, particularly in response to the volatile, uncertain, complex, and ambiguous (VUCA) environment that characterizes global markets. Sustainable Supply Chain Management (SSCM) is being explored as a strategic response to these challenges, with an emphasis on adaptability and resilience. In the context of sustainable housing, SSCM can help ensure that materials and resources are sourced responsibly, projects are completed efficiently, and housing developments can withstand economic and environmental shocks (Agyekum-Mensah, Knight, & Coffey, 2012).

The rise of electric cooking (e-cooking) as a sustainable alternative to traditional cooking methods is another emerging trend in sustainable housing. E-cooking offers numerous benefits, including energy efficiency, health improvements, and reduced environmental impact. Future research in Nigeria is likely to focus on optimizing e-cooking technologies, integrating them with renewable energy sources such as solar power, and incorporating them into sustainable housing designs. This integration could significantly enhance the sustainability of housing developments, particularly in off-grid and rural areas (Odoi-Yorke, 2024).

Biomass and organic waste conversion for sustainable bioenergy is another area that holds great promise for the future of sustainable housing in Nigeria. Research has shown that converting organic waste into bioenergy can provide a renewable and sustainable energy source for residential areas. This approach not only addresses waste management issues but also contributes to energy security and reduces reliance on fossil fuels. Future research is likely to focus on developing advanced conversion technologies and integrating bioenergy systems into housing developments, particularly in rural and peri-urban areas (Alao et al., 2024).

The integration of artificial intelligence (AI) and machine learning in sustainable housing design and construction is expected to be a transformative trend in the coming years. AI can be used to optimize building designs, enhance energy efficiency, and improve construction processes, making housing developments more sustainable and cost-effective. Research in this area is likely to explore how AI and machine learning can be leveraged to address the specific challenges of sustainable housing in Nigeria, including resource constraints, environmental factors, and the need for scalability (Joseph & Uzundu, 2024).

3. Conclusion

This study set out to explore the role of sustainable architectural solutions in addressing the affordable housing crisis in Nigeria, with a focus on identifying key strategies, challenges, and future directions. Through a comprehensive analysis of the current landscape of affordable housing in Nigeria, the study has demonstrated that sustainable architecture is not only feasible but also essential for creating housing that is affordable, environmentally responsible, and socially inclusive.

Key findings from the study highlight that the use of locally sourced materials, such as stabilized earth blocks and interlocking bricks, significantly reduces construction costs while promoting environmental sustainability. The integration of renewable energy technologies, particularly solar energy, has been shown to enhance energy efficiency and reduce long-term costs for residents. These strategies, when combined with community-focused design and planning, contribute to the creation of resilient and adaptable housing developments that meet the needs of diverse populations.

The study also identified several challenges in implementing sustainable architectural solutions, including financial constraints, limited technical expertise, and the erosion of traditional building practices. These challenges underscore the need for a multi-faceted approach that involves continuous professional development, policy support, and collaboration among stakeholders to overcome barriers and scale up sustainable housing initiatives across the country.

In conclusion, the study confirms that sustainable architecture offers a viable pathway to addressing Nigeria's affordable housing crisis. By leveraging innovative materials, energy-efficient designs, and community-based planning, sustainable housing can be made accessible to a broader segment of the population. The study recommends that future research should focus on integrating circular economy principles, exploring sharing economy models, and utilizing advanced technologies such as AI and machine learning to further enhance the sustainability and affordability of housing in Nigeria. By prioritizing sustainability in housing policies and practices, Nigeria can make significant strides toward meeting its housing needs while also contributing to global environmental goals.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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