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INTEGRATING GREEN BUILDING STRATEGIES IN THE DESIGN OF RESIDENTIAL ESTATES IN MINNA NIGER STATE

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ABSTRACT

In the exploration of eco-friendly building strategies within the Bosso Estate, Minna -Niger State, this research tackles the pressing issue of integrating sustainable practices into residential housing. The study delves into the challenges and opportunities surrounding green architecture, focusing on passive design, renewable energy, energy efficiency, site and nature, and sustainable materials. Our participants comprised 133 diverse structures within the Bosso Estate, and insights were gleaned through in-depth interviews with 13 residents. The research aimed to unravel the prevailing use of passive design elements, examine renewable energy adoption, assess energy efficiency tactics, analyze the impact of site and nature strategies, and understand the dynamics of sustainable material integration. Findings revealed a commendable adoption of passive design principles, such as solar orientation and cross-ventilation, yet emphasized an untapped potential for renewable energy strategies within the estate. The study uncovered a diverse landscape in energy efficiency tactics, signaling the need for

Introduction

The subject of "green buildings" extends far beyond just structures, it encompasses comprehensive site planning, sustainable land use, and community policies that endorse resource efficiency and environmentally safe building design (Waldman, 2021; Yudelson, 2007). It involves tackling challenges such as waste management, pollution control, energy and resource consumption, and the well-being of both people and the environment. This study seeks to provide a nuanced understanding of the concept, its strategies, and effective integration into housing estates, with a particular focus on Minna, Niger State. According to the United States Environmental Protection Agency (2019), "green buildings" are intrinsic to "green architecture," emphasizing efficiency and ecological responsibility across the entire building life cycle.

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standardization and regulatory measures. Notably, the site and nature strategy emerged as a favored choice, showcasing a harmonious coexistence with the natural environment. However, sustainable material integration lagged behind, influenced by historical contexts. Interviews with residents highlighted a minimal understanding of green buildings, although residents unknowingly embraced eco-friendly strategies driven by a desire for enhanced comfort and financial considerations. In conclusion, this research advocates for enhanced communication, diversified shading strategies, government standardization, occupant education, financial incentives, research initiatives, community engagement, and curricular integration. These recommendations converge into a transformative roadmap, steering Minna towards a future where green building strategies are not just adopted but embraced as integral components of sustainable living. In summary, our study illuminates the challenges and potentials in implementing eco-friendly building strategies within Bosso Estate, offering valuable insights to shape a greener and more resilient Minna, symbolizing a paradigm shift towards sustainable residential development.

Keywords: Integrating, Building, Strategies, Design Of Residential Estates, Niger.

Characterized by Meena et al. (2022), green buildings integrate design, construction, and operational practices to minimize adverse environmental impacts. The theoretical foundation, initiated by Andrew Dobson in 1996, formulated the I=PAT indicator (capturing the Impact of Population, Affluence, and Technology on Sustainability), laying the groundwork for a straightforward sustainability measure (Wood et al., 2015; Levin, 2015).

Green buildings do more than just help the environment; they're essential for our economy and communities. They seamlessly blend with nature, saving valuable resources (Kibert,

2016). Beyond being eco-friendly, they save money by cutting overall costs, making buildings last longer, and improving the comfort and health of people inside them (Robichaud & Anantatmula, 2011; Green Built Alliance, 2018).

Architects recognize the significant impact of buildings on global carbon emissions. They rely on various green building techniques like smart material choices and energy-efficient designs to drive advancements in building technology, sustainability, and safety for both homes and businesses (Hutter Architects, 2018; Architecture 2030, 2018). This approach not only improves our

living and working spaces but also supports our goal of creating environmentally friendly and economically sound communities.

To achieve its 2020 goal of becoming a sustainable city, Nigeria must integrate green buildings into architectural strategies throughout the building process, demanding substantial effort and imperative communication (Dunne, 2020). This underscores the need to align architectural practices with environmentally conscious approaches, contributing to the broader objective of sustainable urban development.

Atanda and Olukoya (2019) highlight the crucial role of Green Building Assessment Tools (GBAT) in achieving sustainable development. While various countries have developed unique contextual building assessment tools to ensure sustainability, Nigeria lacks a significant GBAT, despite widespread awareness of its importance. This gap emphasizes the urgent need for Nigeria to incorporate GBAT to meet its global net-zero targets set for 2060. The study underscores the importance of addressing this need to pave the way for a more sustainable and environmentally conscious built environment in Nigeria.

The International Finance Corporation (IFC) anticipates a substantial investment of $24.7 trillion in green buildings by 2030, acknowledging the manifold benefits they offer. In Nigeria, there's an optimistic perspective, projecting a 53% increase in energy savings, a 42% rise in water conservation, and a 35% reduction in carbon emissions due to green building initiatives (This Day Live, 2021). Recognized as a lasting solution to energy challenges, green buildings ingeniously blend natural elements with cutting-edge technology, ensuring optimal performance throughout their lifespan.

However, key challenges persist, accentuated by rising temperatures impacting the stability of metal components in buildings, especially when exceeding predefined tolerance levels (Salimi & Al-Ghamdi, 2019; Heigl, 2018). Elevated utility costs due to heightened energy consumption (González-Torres et al., 2022), reduced resale value stemming from demanding maintenance needs, and constrained design flexibility due to rigid construction materials in non-green residential estates further compound these challenges (Horn, 2019). Despite these hurdles, the promising trajectory of green building initiatives in Nigeria suggests a transformative shift towards sustainable and energy-efficient construction practices.

Concerns over ongoing water damage to roofing materials, leading to leaks, and the degradation of external building cladding due to persistent wind and heavy rain are underscored (Brozovsky et al., 2023). Prolonged exposure to damp conditions during wet seasons has further resulted in termite infestations, leading to a decrease in the lifespan of buildings (Yadav & Upadhyay, 2023; Haider, 2019; Röck et al., 2020). Warmer summer temperatures and dry weather compound these issues, intensifying the need for adequate ventilation to enhance the overall indoor environment's quality.

In response to these challenges, Adegun et al.'s (2021) research on urban greening in Nigeria reveals that urban green infrastructure has already improved and has the potential for further enhancements. The quality of the environment and human well-being in Nigerian cities can be significantly uplifted. This emphasizes the importance of implementing urban greening master plans, not only in Nigeria but also in developing and sub-Saharan African nations. These regions can serve as sources of inspiration, demonstrating how the widespread adoption of green infrastructure can contribute to an improved built environment, fostering sustainability and resilience.

Confronting the identified challenges necessitates a proactive adoption of green building strategies in the design of residential housing estates in Minna, Niger State—an area where documentation on such initiatives is notably limited. The primary objective of this study is to cultivate an understanding of how green building strategies can be seamlessly integrated into the design of residential housing estates. This integration is deemed crucial to mitigate the adverse effects of environmental conditions on building materials, energy consumption, and overall structural resilience.

Green Building Strategy

Green building strategies encompass a holistic approach to designing and constructing building projects, directly impacting the environment with the goal of creating a sustainable and carbon-neutral built environment (Zuo & Zhao, 2014). These strategies incorporate a blend of technology, smart systems, and traditional techniques (Meena et al., 2022). It is imperative to recognize that green construction strategies surpass simplistic actions like tree planting; instead, they harmoniously blend conventional and traditional methods to establish an effective built environment (Xing et al., 2017).

These strategies yield multiple benefits, supporting buildings with certifications and ratings, fostering the creation of healthy structures, and aligning with global sustainability standards.

The subsequent section outlines notable green building techniques crucial for steering Minna, Niger State, towards a more resilient and sustainable built environment.

Passive Design Strategy

Passive design strategies, as elucidated by Jung et al. (2021), center on optimizing design by leveraging the inherent power of nature and its surrounding features. These strategies are crafted to foster comfortable indoor spaces with minimal reliance on mechanical systems. In the realm of green building, passive design takes a principled stance on maximizing the use of natural resources—sunlight, air movement, and natural heat (Jung et al., 2021). The primary objectives are to elevate occupant comfort, curtail dependence on artificial heating and cooling, and enhance overall energy efficiency (Mehmood et al., 2019).

These tactics are pivotal as they substantially reduce the energy consumed in the built environment. Noteworthy examples of passive design techniques encompass considerations such as orientation and layout, insulation and thermal mass, natural ventilation, daylighting, shade and overhangs, thermal comfort, landscaping, and vegetation. Embracing these passive design principles becomes instrumental in Minna, Niger State, as it not only aligns with global sustainability standards but also ensures the creation of resilient and energy-efficient residential housing estates.

Integrating Renewable Energy

The momentum for renewable energy in building systems is rapidly increasing as sustainability takes centre stage. Integrating renewable energy into green buildings is not just a choice; it's a crucial step in reducing carbon emissions, enhancing energy efficiency, and fostering overall sustainability (Abubakar & Alshammari, 2023; Lu et al., 2020). This approach empowers buildings to generate their own electricity, heat, or cooling by tapping into renewable sources, with solar power emerging as a popular and versatile choice for lighting, heating, and cooling purposes.

The shift towards renewable energy lessens dependence on fossil fuels and traditional energy systems, aligning with the broader goal of creating

environmentally conscious and sustainable built environments. Key methods for seamlessly incorporating renewable energy into green buildings include Solar Photovoltaic (PV) Systems, Wind Turbines, Geothermal Systems, Biomass Energy, Hydropower, Piezoelectric and Kinetic Energy Harvesting, Building-Integrated Renewable Systems, and innovative Energy Storage Solutions. By adopting these methods, Minna, Niger State, can pave the way for a more sustainable and energy-efficient future, reducing its environmental footprint while embracing the potential of renewable energy.

Energy Efficiency

Enhancing the sustainability of buildings involves a fundamental reduction in their energy consumption (Zhuang et al., 2021). The remarkable truth is that energy-efficient buildings have the ability to operate at peak efficiency, providing comfort while using significantly less energy—a testament to their effectiveness (William et al., 2021). Energy efficiency, a pivotal facet of green construction, strives to curtail building energy usage while concurrently maintaining or even enhancing comfort and functionality (Li et al., 2021).

Implementing energy-efficient measures in buildings carries substantial benefits, significantly reducing their environmental impact, cutting electricity costs, and contributing to a more sustainable future. This strategy spans various applications, encompassing the construction stage to ongoing operations and involving stakeholders. Key facets of the energy efficiency strategy include Building Envelope Improvements, Energy-Efficient Lighting,

High-Efficiency HVAC Systems, Energy-Efficient Appliances and Equipment, Renewable Energy Integration, Smart Building Technologies, Energy-Efficient Windows and Doors, and fostering Education and Occupant Engagement. By embracing these aspects, Minna, Niger State, can pave the way for a built environment that not only conserves energy but also ensures the well-being of its occupants and the sustainability of the broader community.

Site and Nature

Irrespective of the chosen green building approach, a profound connection to the natural world is inherent. The site, its features, and their meticulous management for maximum efficiency and minimal energy use collectively contribute to critical aspects such as orientation, ventilation, and overall comfort. Recognizing the

significance of the site and environment is a cornerstone in the design of green buildings (He, 2019).

Architects and builders, armed with an understanding of and appreciation for the site's natural features, possess the ability to craft structures that are not only aesthetically pleasing but also ecologically sustainable, with minimal impact on the surrounding ecosystem (Ching & Shapiro, 2020). Key elements encompassed in this approach include Site Selection, Site Planning and Design, Resource Conservation, Sustainable Materials, Climate
Responsiveness, Site Connectivity and Accessibility, and the preservation of Cultural and Historical Significance. By prioritizing these elements, Minna, Niger State, can usher in a new era of green building that seamlessly integrates with its natural surroundings, fostering sustainability and resilience in the process.

Sustainable Materials

Sustainable materials emerge as foundational players in the realm of green building, placing a paramount emphasis on both user health and environmental well-being (Gurieff et al., 2020). These materials, sourced, produced, and utilized with meticulous care, are designed to minimize harm to the environment and public health, thereby reducing their impact on the methods previously outlined. The strategy revolves around a thoughtful consideration of the materials employed in construction, steering towards the adoption of renewable, organic, and degradable resources.
Key categories of sustainable materials integral to this strategy encompass Renewable Resources, Recycled Materials, Low-Impact Materials, Insulation and Thermal Materials,
High-Performance Materials, Durability and Longevity, and the meticulous application of Life Cycle Analysis. By prioritizing these categories, Minna, Niger State, can champion a sustainable and environmentally conscious approach to building, promoting not only the longevity and resilience of structures but also the well-being of its inhabitants and the broader ecosystem.

Method

Design

This study adopts a meticulous research design that combines the strengths of a case study and survey approach, emphasizing practice-based or practice-led

research in architectural design and design thinking (Aydemir & Jacoby, 2022). These chosen strategies are particularly well-suited for a comprehensive assessment of global green building practices, incorporating pertinent case studies and real-time observations of green building strategies within housing estates in Minna, Niger State.

Data Collection

The study employs a dual approach, incorporating both primary and secondary data. Primary data is meticulously gathered through observation checklists derived from the survey research design. This facet of the research identifies and captures current green building strategies implemented in housing estates, encompassing passive design, renewable energy utilization, site and nature integration, and the use of sustainable materials.

Secondary data, on the other hand, is qualitatively sourced from diverse online architectural repositories, including journals, publications, blogs, books, and news or podcasts. The focus of this secondary data is on green building strategies within residential housing estates. This two-pronged data collection approach ensures a comprehensive and nuanced understanding of the state of green building practices in Minna, Niger State, providing a robust foundation for the study's findings and recommendations.

Population and Sample Size

The population under scrutiny encompasses 260 housing units situated in the Bosso Estate,

Minna, Nigeria, according to data sourced from the Federal Authority of Housing (Souluap, 2023). To effectively assess green building strategies in the design of residential housing estates in Minna, Niger State, a judiciously determined sample size of 133 houses was selected using the Raosoft sample size calculator. Employing a 90% confidence level, a 5% margin of error, and a 50% response distribution rate, the study employed both cluster and purposive sampling techniques. Clusters, organized around distinct residential areas within the estate, facilitated the selection of smaller sample sizes. Concurrently, purposive sampling considerations took into account the research's specific objectives and the targeted sample's understanding of green building concepts.

This sampling methodology ensures both rigor and precision in gathering data, allowing the study to draw meaningful insights from a representative subset of

Bosso Estate's housing units. The selection process aligns with the study's overarching goal of comprehensively examining and understanding the adoption of green building strategies in residential housing estates in Minna, Niger State.

Procedure

The study employs observation checklists as the primary tool for data collection. Crafted as a result of the survey research design, these checklists play a pivotal role in identifying and documenting current green building strategies within housing estates. The primary data encompasses intricate details on passive design strategy, renewable energy implementation, site and nature integration, and the utilization of sustainable materials within carefully selected local case studies.

Conducting on-site observations and engaging in interviews with 13 residents, strategically chosen from the pool of 133, the researcher aims to gain first-hand insights into the practical application of green building elements within the Bosso Estate. This immersive approach ensures a nuanced understanding of how green building strategies manifest on the ground, offering a richer context for analysis. The study adopts a descriptive analysis approach, unravelling the intricacies of green building practices within Bosso Estate. Microsoft Excel serves as the analytical tool of choice, facilitating a systematic analysis of the gathered data. The results will be presented through tables and charts, offering a visual representation of the prevalence and distribution of various green building elements within the estate.

The primary analytical focus revolves around the integration of green buildings as a robust architectural response to climate change in the design of residential housing estates. This thematic lens ensures that the study not only identifies prevalent green building strategies but also contextualizes them within the broader framework of addressing environmental challenges through architectural innovation.

Findings

The study commenced with a thorough observation of 133 structures in Bosso Estate, Minna, revealing a diverse architectural composition. Notably, as shown in Figure 1, 37.5% comprised bungalows, 25% commercial structures (including churches and schools), 20.8% apartment or lodge buildings, and 16.7% duplex buildings, offering valuable insights into the Estate's architectural landscape.

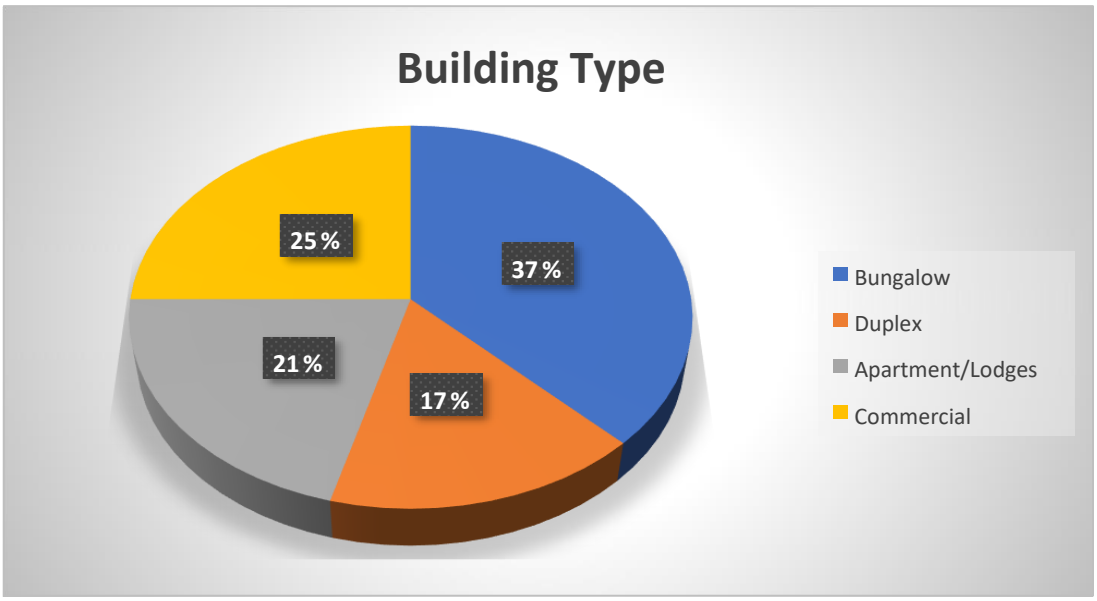

Figure 1: Predominant Building Type in Bosso Housing Estate

Green Building Strategies Employed in Bosso Housing Estate

The examination of green building strategies within Bosso Housing Estate brought to light the implementation of passive design solutions. The analysis (Table 1) depicts varying degrees of execution, with notable findings in solar orientation, building shape, insulation and thermal mass, cross ventilation, external shading devices, and trees/shrubs. For instance, 39.8% demonstrated fair or no solar orientation, while 71.43% exhibited fair crossventilation practices.

Table 1: Observed Passive Design Strategies employed in Bosso Housing Estate.

S/N	Passive Design Strategy	Frequency	Percentage
1	Solar Orientation	Not Present: 53	39.8%
		Present but Inadequate: 17	12.8%
		Fair: 53	39.8%
		Present and Adequate: 10	7.50%
		Excellent: -	0.0%

2	Building Shape	Not Present: 5 Present but Inadequate: 27 Fair: 90 Present and Adequate: 11 Excellent: -	3.76% 20.3% 67.67% 8.27%
3	Insulation and Thermal Mass	Not Present: 10 Present but Inadequate: 64 Fair: 59 Present and Adequate: - Excellent: -	7.50% 48.12% 44.36%
4	Cross Ventilation	Not Present: Present but Inadequate: Fair: 95 Present and Adequate: -27 Excellent: - 11	0.0% 0.0% 71.43% 20.3% 8.27%
6	External Shading Device	Not Present: 21 Present but Inadequate: 16 Fair: 75 Present and Adequate: 21 Excellent: -	15.79% 12.03% 56.39% 15.79%
9	Trees/Scrubs	Not Present: 16 Present but Inadequate: 15 Fair: 80 Present and Adequate: 11 Excellent: 11	12.03% 11.29% 60.15% 8.27% 8.27%

Source: Author's Fieldwork (2023)

It can be deduced that nearly 40% of the structures in Bosso Estate, Niger State, incorporate passive design green building strategies, often without conscious awareness. Additionally, among the observed buildings in Bosso Housing Estate, those with the highest adoption of renewable energy strategies included structures equipped with solar panels, solar water heating systems, and battery systems (inverters). Specifically, as shown in Figure 2, about 32.3% of the examined structures were equipped with solar panels, and 8.27% had sufficient energy generation capacity to meet daily household needs. In terms of inverters, 3.76% of houses had inverters with enough capacity to store power, while 44.4%

had inverters with a reasonably fair capacity. Moreover, solar water heating systems were reasonably sufficient in 12.03% of the households surveyed.

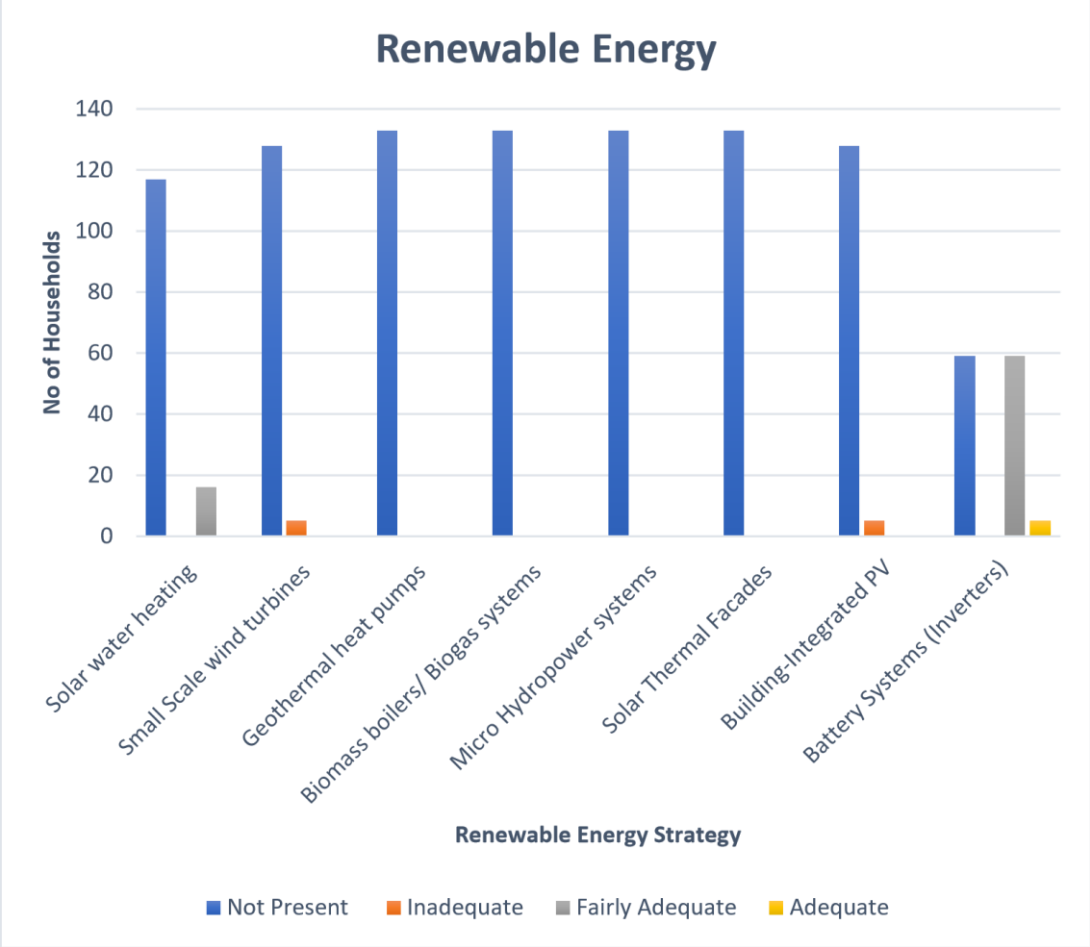

Figure 2: Predominant Renewable Energy Strategy Applied in Bosso Housing Estate.

Regarding energy efficiency measures, as shown in Figure 3, the analysis revealed that highperformance insulation was entirely absent in 56.4% of the building structures, present but insufficient in 24.1% of the buildings, and reasonably sufficient in 15.8% of the observed structures. LED lighting was employed in all but 12.03% of the buildings, with a fair level of adequacy in 79.7% of the structures and adequate use in 8.27% of other buildings. A similar trend was observed for the orientation towards efficient daylighting, which was present in 15.8% of the structures and fairly adequate in 84.21% of the buildings.

In terms of zoning and regulations for energy efficiency, they were deemed insufficient in 60.15% of the buildings. This inadequacy can be attributed to the prevalent practice of having a central control system for lighting and artificial ventilation in most buildings, without proper separation of controls. Some additional structures attempted to address this issue by dividing controls into two sections—one for specific rooms and another for security and external use. Overall, the adoption of energy efficiency as a green building strategy in the Bosso estate was found to be at a relatively low rate of 15%.

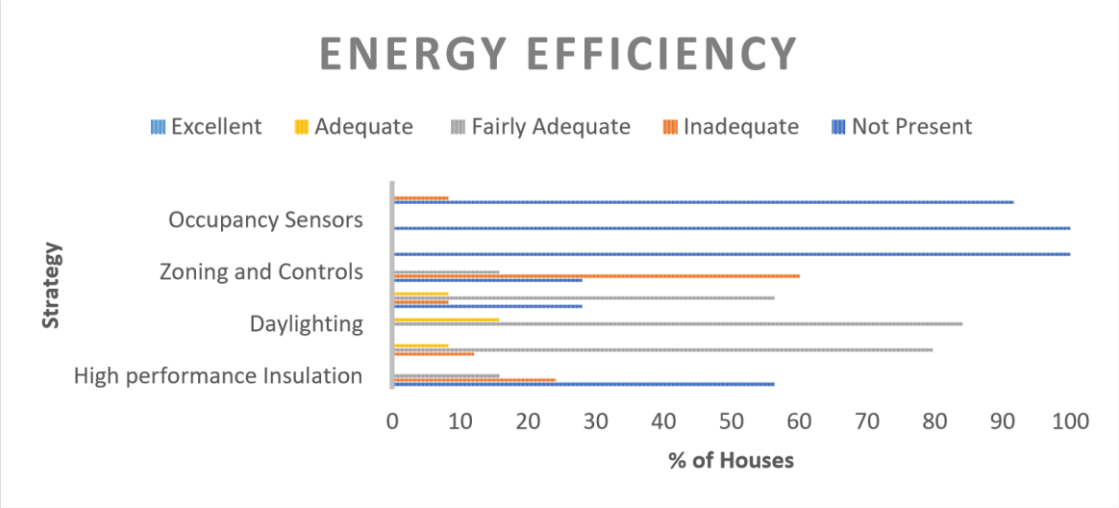

Figure 3: Energy Efficiency Strategy Applied in Bosso Housing Estate.

Among the various green building strategies employed at Bosso Estate, the site and nature strategy (Figure 4) emerged as the most widely adopted. Since construction and occupancy, 8.27% of the buildings have successfully preserved the natural habitat, demonstrating a commitment to maintaining the traditional ecosystem. Additionally, 3.76% of buildings have effectively managed storm water, contributing to sustainable water practices.

In terms of landscaping, 24.06% of buildings have been appropriately landscaped, enhancing the overall aesthetic and ecological aspects of the environment. Furthermore, 3.76% of buildings have demonstrated effective water conservation practices. The incorporation of natural ventilation was observed in 12.03% of the buildings, promoting energy efficiency and occupant comfort.

Accessibility to public transportation has been prioritized in 56.4% of the buildings, indicating a commitment to reducing individual carbon footprints. A significant portion, 72.2% of the buildings, features walkable paths and is conveniently located near major roads, fostering a pedestrian-friendly environment. Lastly, 12.03% of the buildings have successfully maintained some aspects of local culture and tradition, showcasing an effort to integrate green building strategies with the preservation of cultural heritage.

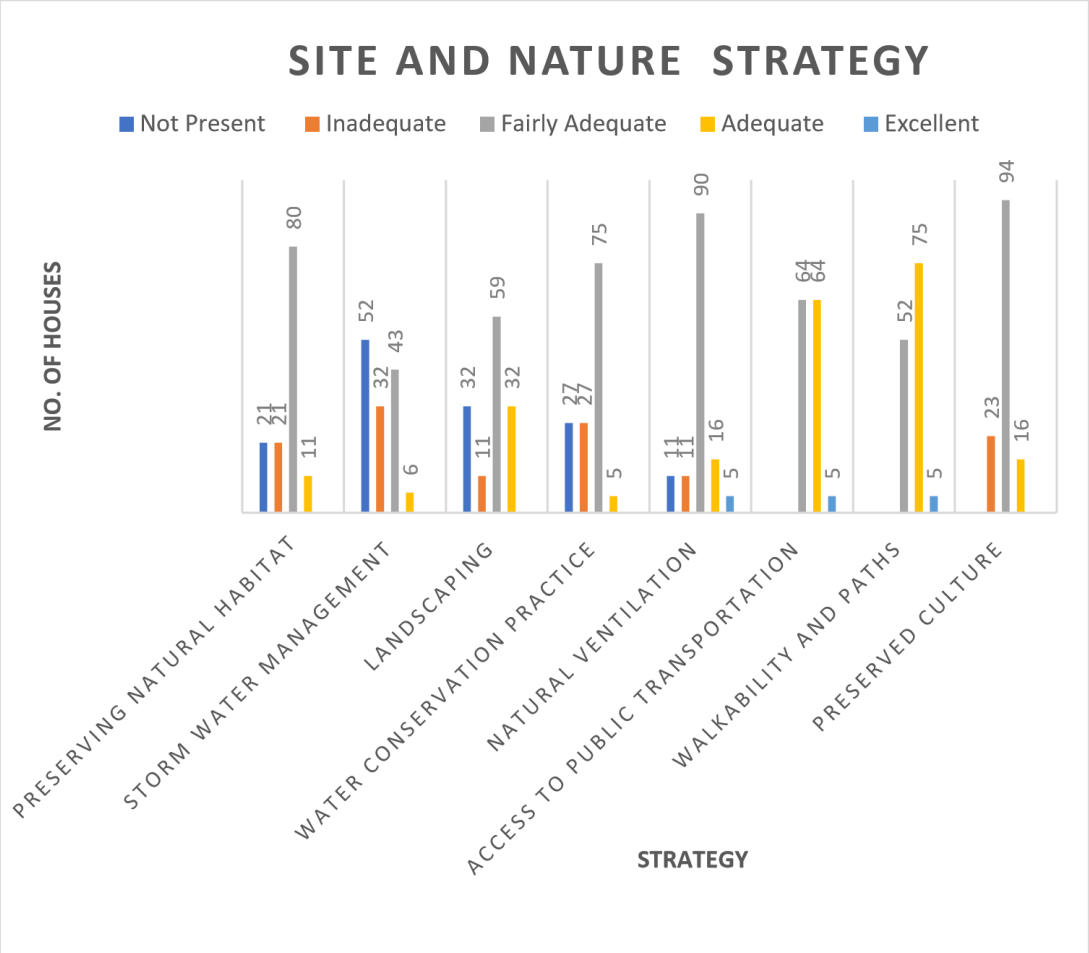

Figure 4: Site and Nature Strategy Applied in Bosso Housing Estate.

The findings reveal that among the environmentally friendly architectural materials, only five structures incorporated cool roofing materials such as stone rock, coatings, and shingles. Low-VOC (volatile organic compound) paints and coatings were utilized in 32.3% of the buildings, indicating a conscious effort to

reduce harmful emissions. In terms of traditional construction materials, wood was used in 28.6% of the buildings, recycled concrete in
24.06%, and glass and metal in 28.6% each.
Overall, it can be concluded that the Bosso Estate employed the least amount of sustainable material strategies, as shown in figure 5. This observation may be attributed to the Estate's construction during a period when the sustainability movement and sustainable design practices were only beginning to gain traction, possibly influenced by its age of more than thirty years. The limited use of modern sustainable materials suggests an opportunity for future retrofitting or enhancements to align with contemporary green building standards.

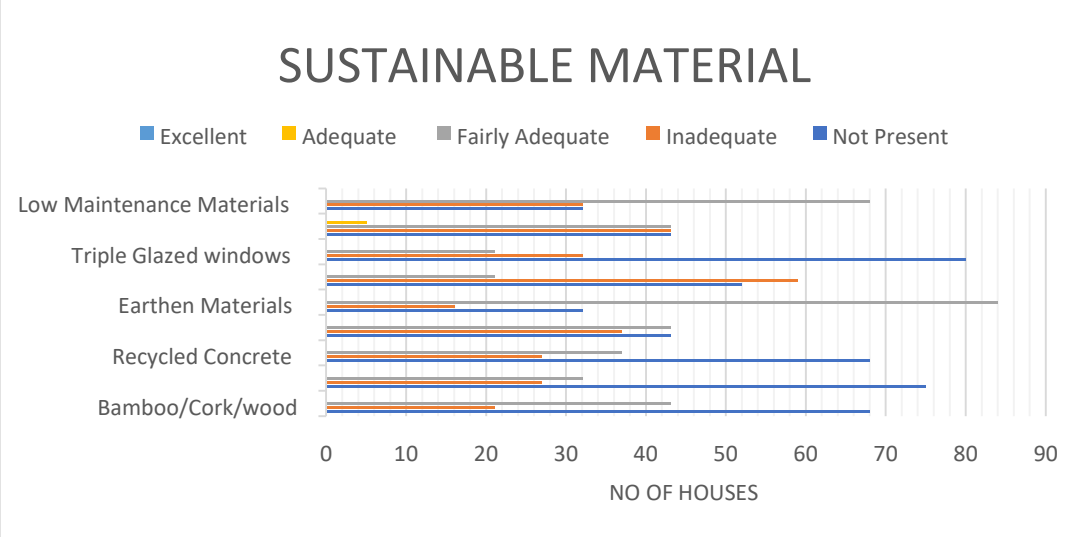

Figure 5: Sustainable Material Strategy Applied in Bosso Housing Estate.

Resident's Perception on Green Building Strategy

The interviews conducted with thirteen Bosso Estate inhabitants provided additional insights and perspectives to complement the observational findings. The demographic breakdown of the interviewees revealed that 30.8% were women, and 69.2% were men. In terms of age distribution, 30.8% fell between 36 and 45, 23.1% were between 26 and 35 and 18 and 25, 15.4% were between 46 and 55, and 7.69% were over the age of 55. Occupation-wise, 46.2% were students, 30.8% were employed, 7.69% were volunteers, and 15.4% were independent contractors.

An intriguing finding was that only six interviewees had prior knowledge of green building, while seven were unfamiliar with the concept. The common understanding of "green buildings" among respondents included structures with trees, grasses, playgrounds, those coexisting with nature, and those that do not harm or pollute the environment. However, this conceptual understanding did not significantly influence their housing choices, with only
15.4% considering it when selecting a structure, primarily influenced by affordability.

Thirty-eight percent of the respondents acknowledged finding and preserving trees on their property before occupancy. Remarkably, 61.5% of respondents had unknowingly incorporated green building techniques, such as solar panels, inverters, external shading devices, and cross ventilation measures, to improve building comfort and reduce costs. All respondents rated the use of green construction strategies in their structures as fairly sufficient, emphasizing cost-effectiveness and enhanced comfort.

When questioned about occupant engagement and education on green building strategy, respondents unanimously conveyed a lack of awareness among residents, emphasizing the responsibility of architects and builders to make informed decisions on behalf of homeowners. This response highlights a significant gap in communication and education between homeowners, architects, and builders, suggesting a need for increased awareness and collaboration to promote green building principles in residential estates in Minna.

Discussion

The comprehensive analysis of green building strategies in Bosso Housing Estate provides valuable insights into the current state of sustainability practices. Passive design strategies, notably solar orientation, revealed a positive trend, yet areas like insulation and thermal mass present opportunities for improvement. The adoption of renewable energy was modest, with solar heating, PV systems, and inverters making incremental contributions. Noteworthy was the prevalence of energy-efficient practices, particularly LED lighting and daylighting, showcasing a commitment to energy conservation. The nature and site strategy demonstrated strengths in ease of access to public transportation and walkable paths, although water conservation and landscaping opportunities exist. The

embrace of sustainable materials, including wood, recycled concrete, glass, and metal, indicates an emerging interest in ecofriendly construction.

Conclusion

This study successfully explored the integration of green building strategies, emphasizing the multifaceted nature of sustainability encompassing energy efficiency, renewable energy, site and nature considerations, and sustainable materials. The identified strategies align with green architectural principles, emphasizing Minna's potential for sustainable living practices. However, the study illuminated a gap in residents' understanding of green buildings, highlighting a reliance on builders and architects for sustainable choices. Despite a positive perception, actual implementation remains modest, primarily driven by comfort and financial considerations.

Recommendations

1. Enhanced Communication and Collaboration: Strengthen communication channels between stakeholders, fostering collaboration among architects, builders, and residents for effective green building implementation.
2. Diversification of Shading and Ventilation Strategies: Explore and implement diverse shading and ventilation strategies to optimize passive design and improve energy efficiency.
3. Government Standardization and Regulation: Introduce and enforce standardized regulations to ensure consistent integration of green building practices in residential projects.
4. Occupant Education and Engagement: Develop educational initiatives to enhance residents' understanding of green buildings, encouraging active participation in sustainable practices.
5. Financial Incentives for Sustainable Practices: Introduce financial incentives or rebates for builders and residents adopting sustainable practices, promoting widespread implementation.
6. Research and Development Initiatives: Invest in research and development initiatives to identify innovative green building solutions tailored to local needs and conditions.
7. Community Engagement and Advocacy: Foster community engagement through awareness campaigns and advocacy, creating a shared commitment to sustainable living.

8. Integration of Green Building in Educational Curricula: Incorporate green building principles into educational curricula to instil awareness and understanding from an early stage.

These recommendations collectively aim to bridge existing gaps in awareness, encourage collaborative efforts, and establish a supportive framework for the broader adoption of green building principles in Minna, Niger State. Through concerted efforts, the region can progress toward a more sustainable and environmentally conscious built environment.

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