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Assessing green building practices: A case study of Ozoro, Delta State, Nigeria

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ABSTRACT

Green building practices offer sustainable solutions to environmental and social challenges in construction. However, their adaptation to regions with unique climatic and socio-economic conditions, such as Ozoro in Delta State, Nigeria, remains underexplored. This study evaluates green building practices in Ozoro, focusing on energy efficiency, water management, and occupant health. A mixed-methods approach, involving surveys, interviews, and focus group discussions, was used to assess the awareness and adoption of sustainable construction methods. Results indicate limited awareness of green practices, with the most adopted being energy-efficient lighting (91%) and natural ventilation (37%). Barriers include unreliable energy infrastructure, low adoption of solar panels and rainwater harvesting, and inadequate waste management practices. Interviews highlight the need for increased public education, policy support, and the integration of local materials to enhance sustainability. The findings contribute to addressing the gap in sustainable development research by proposing tailored strategies to promote green building adoption in tropical environments like Ozoro.

Keywords: sustainability, green building practices, Ozoro, energy efficiency, water management, waste management

INTRODUCTION

Green building practices have gained global recognition as a vital approach to mitigating the environmental and social challenges posed by conventional construction methods. These practices, which emphasize sustainability, energy efficiency, and minimal environmental impact, offer numerous benefits, including improved indoor air quality, enhanced occupant well-being, and long-term cost savings (Balaban & de Oliveira, 2017; MacNaughton et al., 2018). However, there is a gap in the existing literature regarding the adaptation of these practices to unique environmental and socio-economic conditions, particularly in regions like Ozoro, Delta State, Nigeria. In these regions, the adoption of green building practices becomes even more pressing due to the specific environmental challenges posed by tropical climates, such as high temperatures, intense sunlight, and substantial rainfall (Hsueh et al., 2021; Pratama et al., 2023).

While green building practices are globally recognized, their implementation in diverse cultural and geographical contexts can be complex. While green building practices are globally recognized, their implementation is often complicated by regional differences. As highlighted by Ozsari (2023), there has been a global trend towards energy efficiency, but its application in developing tropical regions remains limited due to a lack of tailored approaches. Additionally, innovations in energy generation, such as those discussed by Karakurt et al. (2022), are critical to supporting sustainable building practices. These studies underline the need for localized frameworks that consider the unique energy demands of tropical regions.

The motivation behind this study stems from the pressing need to develop context-specific sustainable solutions in regions like Ozoro, where conventional building practices fail to address environmental and socio-economic needs. This research aims to bridge the gap by identifying the barriers to the implementation of green building practices and proposing regionally-adapted strategies.

As Kioumarsi et al. (2022) argue, sustainable development requires balancing economic growth, environmental stewardship, and social welfare. This is particularly important for regions such as Ozoro, where current building practices do not sufficiently consider the unique climatic demands of the area. Kioumarsi et al. (2022) emphasize that global sustainability policies often overlook regional and cultural variations, leading to ineffective implementation. This study, therefore, seeks to address this gap by focusing on the

application of green building practices in Ozoro, contributing to the broader discourse on sustainable development in tropical regions.

A key component of sustainable building design in tropical regions is the integration of energy-efficient, water-efficient, and resource-conserving solutions, yet these areas remain underexplored, particularly in developing countries. Ozsari (2023) stresses the critical importance of optimizing energy efficiency through exergy analysis, a concept that can be applied to various sectors, including sustainable building practices. This is particularly relevant in tropical regions where energy demand is high, and efficiency improvements are essential for sustainability. In addition, Karakurt et al. (2022) examine advancements in steam turbine technology, which play a crucial role in improving energy generation efficiency, a foundational element of sustainable practices in various sectors, including building design. Collectively, these studies reinforce the necessity for tailored energy solutions that address the distinct environmental conditions of tropical regions–an objective central to this research.

Studies by Asman et al. (2019) have identified five major components crucial to the design of sustainable buildings in tropical environments: energy efficiency and conservation, water efficiency and conservation, material conservation, waste reduction, reuse and recycling, and humane adaptation. These findings emphasize that designing for tropical regions like Ozoro should prioritize these aspects to enhance sustainability. The ability to adapt building designs to specific local contexts, where climate and socio-economic conditions differ significantly from more developed regions, remains a key challenge for green building implementation (Callejas et al., 2020; Pratama et al., 2023).

To further enhance sustainable building design in tropical regions, the tropically adapted energy performance certificate (TEPC), highlighted by Wagner (2014), plays a significant role in assessing and improving building performance in tropical climates. The TEPC model, developed specifically for tropical regions, integrates the United Nations' triple bottom line principle (planet, people, and profit) into a more holistic green building sustainability model. This tool evaluates CO_2 emissions, thermal comfort, and affordability, making it particularly suitable for assessing green building projects in regions like Ozoro, where high temperatures and substantial rainfall pose unique environmental challenges.

In tropical regions, where climatic conditions can create significant cooling demands, adapting green building practices becomes critical. Callejas et al. (2020) emphasized the importance of passive adaptation strategies like earth-sheltered walls to reduce thermal loads in tropical climate zones. Their research suggests that such measures, although facing limitations due to rising global temperatures, can offer substantial sustainability benefits by lowering cooling energy demands. Similarly, Jegede and Taki (2022) demonstrated how the optimization of building envelopes using indigenous materials in Abuja, Nigeria, could significantly improve thermal comfort and reduce energy consumption, making it a viable strategy for addressing the thermal challenges faced in Ozoro.

Beyond Nigeria, Kenya serves as another relevant case study for green building adoption in tropical regions. Khaemba and Mutsune (2014) explored the potential for adopting green building attributes in Kenya, revealing key factors that support sustainable practices in the region's construction industry. The study highlights the importance of developing green building standards tailored to the specific environmental, economic, and social geographies of tropical countries, which could provide meaningful insights for similar green building initiatives in Nigeria. The identification of locally adaptable "green" attributes ensures that countries like Kenya and Nigeria can avoid replicating unsustainable building practices common in more temperate climates.

The global shift toward sustainable development has led to the widespread promotion of green building standards, such as leadership in energy and environmental design and the building research establishment environmental assessment method, which encourage energy-efficient designs and resource conservation (Ali, 2021; Grzegorzewska & Kirschke, 2021). However, there is a significant gap in understanding how these practices can be adapted to specific local contexts, especially in developing countries where the socio-economic and climatic conditions may differ substantially from those in more developed regions (Durdyev et al., 2023; Khan et al., 2021).

Ozoro, a region in Nigeria, faces unique environmental and socio-economic challenges that make the adoption of green building practices particularly pertinent. The local climate, characterized by high temperatures and abundant sunlight, necessitates efficient cooling and energy management solutions (Pratama et al., 2023). Additionally, significant rainfall presents both opportunities and challenges for water management (Pyke et al., 2011). Traditional building practices in Ozoro often involve the use of conventional materials and techniques that result in poor insulation, inadequate ventilation, and high energy consumption (Eleftheriadis & Hamdy, 2018). These practices not only contribute to environmental degradation but also lead to uncomfortable living conditions and increased utility costs for residents. Additionally, the inefficient water management practices in the community fail to capitalize on significant rainfall to provide a sustainable water supply, and the inadequate waste management practices exacerbate environmental pollution, health issues, and reduce the quality of life for residents (Abubakar et al., 2022; An et al., 2015).

Given these challenges, it is critical to assess the feasibility and potential benefits of green building practices in Ozoro. This study seeks to evaluate the current state of building practices in the region, identify the barriers to adopting sustainable construction methods, and propose strategies that can enhance energy efficiency, improve water management, and promote better occupant health. This research is novel in its approach by tailoring green building strategies specifically to tropical, developing regions, contributing to a broader understanding of sustainable development in these environments. By addressing these challenges, the study aims to contribute to the growing body of research on sustainable development, particularly in regions facing similar climatic and socio-economic conditions.

METHODOLOGY

This study employs a mixed-methods approach, combining both qualitative and quantitative research techniques to comprehensively assess the adoption of green building practices in Ozoro. The decision to use a mixed-methods approach stems from the need to capture not only measurable data on green building practices through surveys but also in-depth insights into stakeholder attitudes, challenges, and perceptions through interviews and focus group discussions. This combination ensures a nuanced understanding of both the extent of green building adoption and the contextual factors influencing these practices.

The research focuses on Ozoro, the headquarters of Isoko North Local Government in Delta State, Nigeria. Ozoro was chosen due to its unique climatic conditions, economic factors, and the availability of local building materials, which present both opportunities and challenges for the adoption of green building practices. This selection was made to ensure that the findings from this case study would be applicable to other regions with similar characteristics, especially in tropical environments, thereby enhancing the relevance of the research.

The target population for this study includes homeowners, construction professionals, local government officials, and other stakeholders involved in building practices in Ozoro. To ensure proper representation of all relevant groups, a stratified sampling method was employed. This approach was selected to capture a diverse range of perspectives, which is crucial for understanding how different segments of the population perceive and engage with green building practices. By ensuring proportional representation of each group, the study aims to deliver a comprehensive and balanced analysis.

Data collection involved the use of surveys, interviews, and focus group discussions. Surveys were distributed to residents and professionals to gather quantitative data on current building practices, levels of awareness about green building concepts, and perceived benefits and challenges. These surveys provided a broad overview of trends and patterns across a large sample. In addition to the surveys, interviews with key stakeholders, including builders, architects, and government officials, were conducted. These interviews were crucial for obtaining expert insights into the specific challenges faced in adopting green building practices within the local context. Focus group discussions were also held with community members to explore their collective attitudes toward green building and to identify community-specific needs and potential solutions. The focus group format encouraged collaborative discussions that yielded insights into group dynamics and consensus views that might not have emerged from individual interviews or surveys.

Quantitative data are analyzed using statistical tools such as SPSS to identify trends, correlations, and significant differences among different groups. Qualitative data are analyzed using thematic analysis to identify common themes and insights from interviews and focus group discussions, with NVivo software utilized to organize and code the qualitative data.

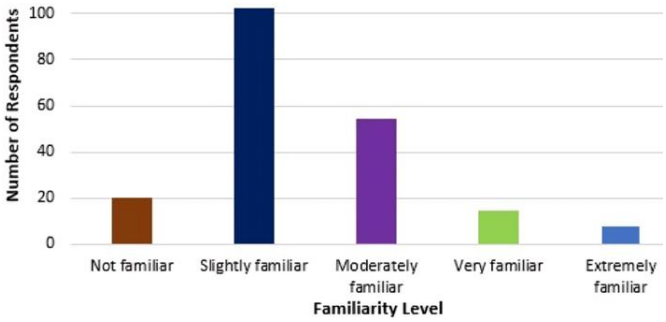

Figure 1. Familiarity with green building (Source: Authors' own elaboration)

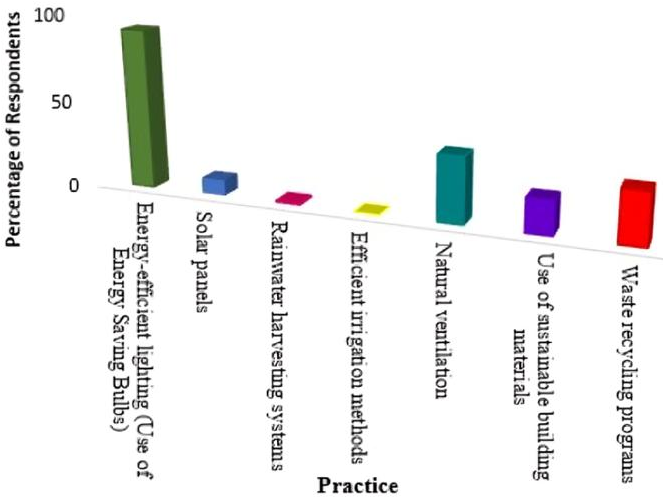

Figure 2. Implemented green building practices (Source: Authors' own elaboration)

RESULTS AND DISCUSSION

The survey received 198 completed responses, yielding a 79.2% response rate. Respondents were primarily tenants (72%), followed by homeowners (21%) and construction professionals (7%). This demographic distribution provided a broad perspective on the adoption of green building practices in Ozoro. The majority of respondents were only slightly familiar with green building practices (52%), with a small fraction being extremely familiar (4%), indicating a significant gap in awareness (**Figure 1**). This awareness gap likely influences the adoption rates of various green building practices.

The most commonly adopted practices among respondents included energy-efficient lighting (91%) and natural ventilation (37%), while the use of solar panels and rainwater harvesting systems remained notably low, at 9% and 1%, respectively (**Figure 2**). Qualitative data from stakeholder interviews revealed that increased awareness and policy support are critical for promoting wider adoption of green building practices. These findings align with existing literature, which underscores the importance of awareness in driving sustainable practices (Durdyev et al., 2018).

The adoption of energy-efficient practices is further reflected in the choice of roofing materials, with 64% of

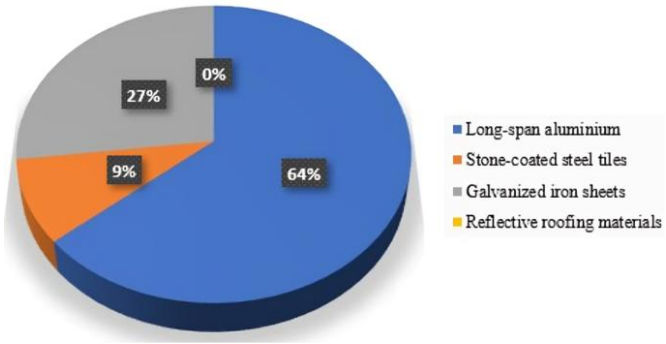

Figure 3. Distribution of roofing materials used by respondents (Source: Authors' own elaboration)

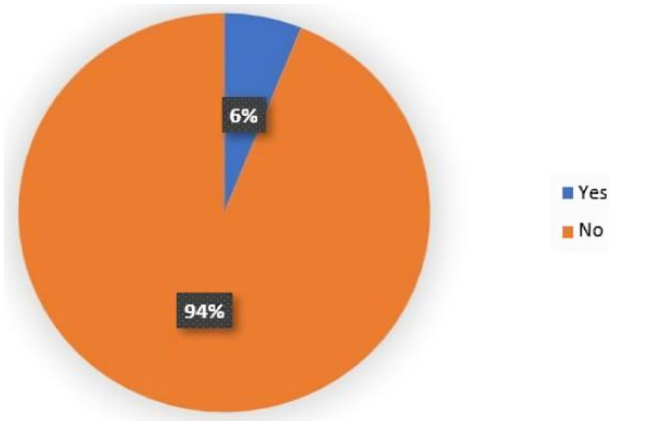

Figure 4. Usage of air conditioning systems among respondents (Source: Authors' own elaboration)

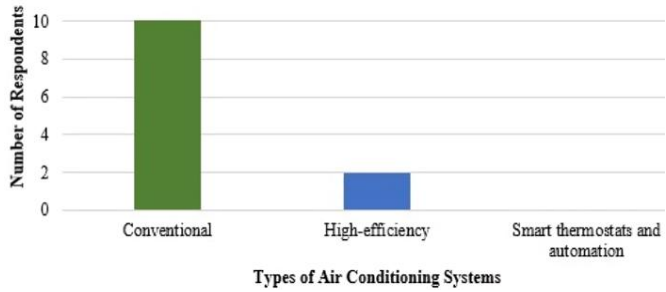

Figure 5. Types of air conditioning systems used by respondents (Source: Authors' own elaboration)

respondents using long-span aluminum roofing, known for its durability and energy efficiency.

However, none reported using reflective roofing materials, which could significantly reduce heat absorption and improve energy efficiency (**Figure 3**).

The use of air conditioning systems was also limited, with only 6% of respondents using them, primarily due to unreliable power supply and high operational costs associated with generator use (**Figure 4**). This low adoption rate of air conditioning systems highlights the need for reliable and affordable energy solutions, as noted in other regions with similar challenges (Abid & Jassim, 2015). Interviews revealed that high generator costs and unreliable power grids deter the use of energy-intensive cooling systems, emphasizing the need for improved energy infrastructure. Among those who use air conditioning, the majority rely on conventional

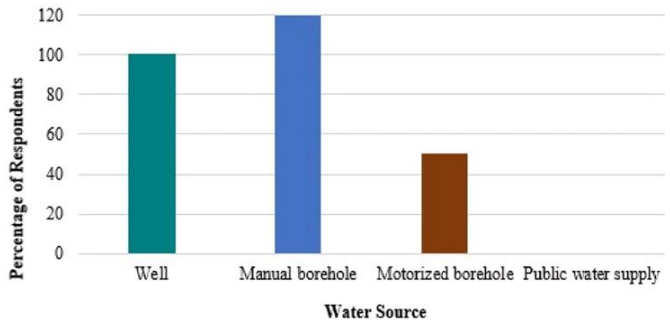

Figure 6. Primary source of water (Source: Authors' own elaboration)

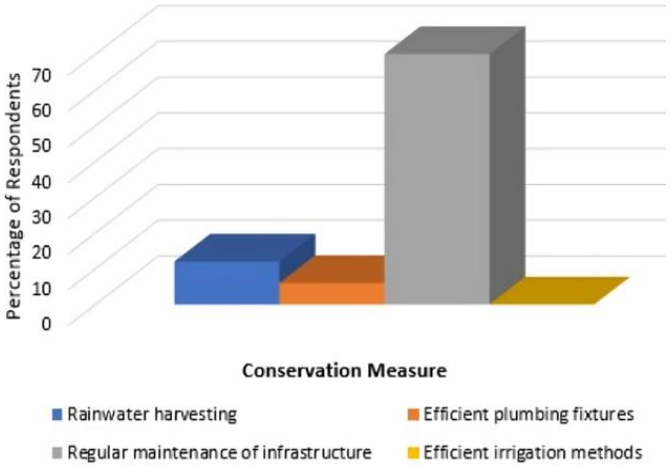

Figure 7. Implemented water conservation measures (Source: Authors' own elaboration)

systems (83%), with only a small percentage using high-efficiency systems (17%). No respondents reported using smart thermostats and automation systems (**Figure 5**). The preference for conventional air conditioning systems over high-efficiency options suggests a lack of awareness or availability of more energy-efficient alternatives.

Water management practices showed that 61% of respondents relied on manual boreholes, with no usage of public water supply (**Figure 6**).

Despite the availability of alternative water sources, only 12% practiced rainwater harvesting and 6% used efficient plumbing fixtures (**Figure 7**). Stakeholders emphasized the potential of rainwater harvesting to supplement water supply, suggesting that its low adoption rate is due to a lack of infrastructure and awareness. These findings suggest a need for promoting sustainable water management solutions, aligning with global challenges in water resource management (Marcos et al., 2021; Zhang et al., 2022).

Indoor air quality was rated as fair by 50% of respondents, with only 5% rating it as excellent (**Figure 8**). The qualitative data indicated that building materials and ventilation significantly impact indoor air quality. This aligns with studies emphasizing the importance of proper ventilation and the use of non-toxic materials to improve indoor environments (Hormigos-Jimenez et al., 2017; Suzuki et al., 2019). Enhancing building designs and materials to improve ventilation and reduce indoor pollutants is crucial for better indoor air quality.

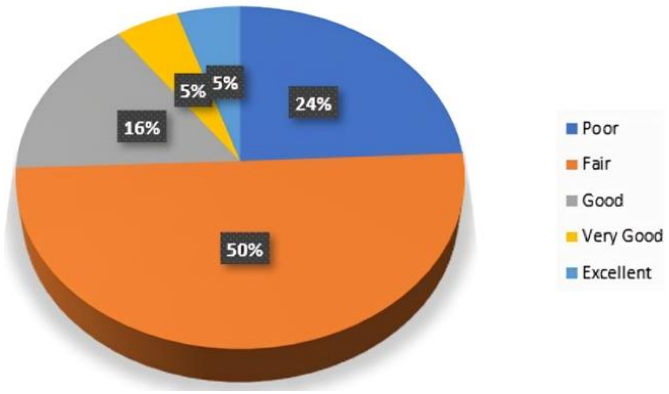

Figure 8. Indoor air quality and comfort (Source: Authors' own elaboration)

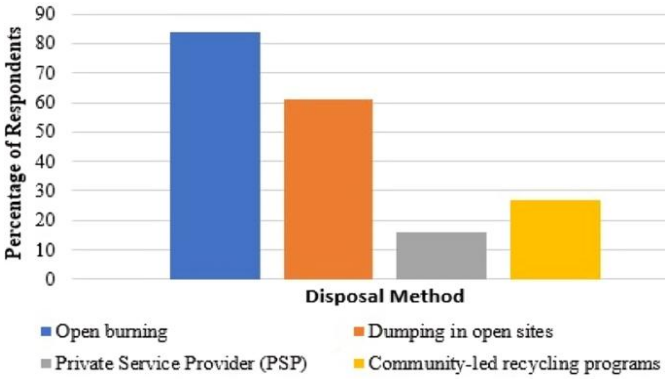

Figure 9. Waste disposal methods (Source: Authors' own elaboration)

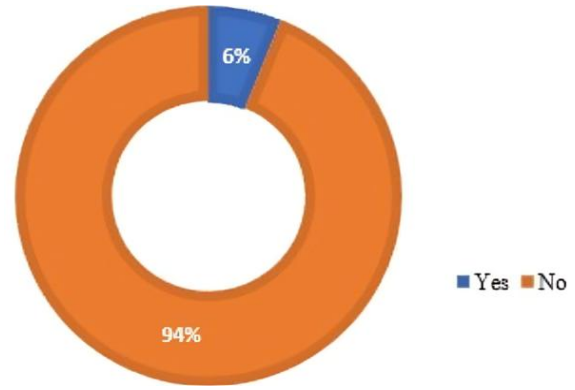

Figure 10. Practice of waste separation (Source: Authors' own elaboration)

Waste management practices were predominantly traditional, with 84% of respondents practicing open burning and 61% dumping waste in open sites (**Figure 9**).

Only 6% of respondents practiced waste separation (**Figure 10**). Interviews highlighted the need for better waste management infrastructure and public education on recycling and waste separation. These findings reflect similar challenges in waste management observed in other developing regions, underscoring the critical need for comprehensive waste management systems (Awino & Apitz, 2024).

Overall, this study highlights the current state of green building practices in Ozoro, emphasizing the need for increased awareness, reliable energy and water infrastructure, and improved waste management systems. By focusing on the adaptation of green building practices to the unique environmental and socio-economic conditions in Ozoro, this research contributes to addressing a significant gap in existing literature.

CONCLUSION

This study assessed the adoption of green building practices in Ozoro, Delta State, Nigeria, with a focus on energy efficiency, water management, and occupant health. Key findings from the research are summarized, as follows:

1. **Energy-efficient practices:** The most commonly adopted practice was energy-efficient lighting, with 91% of respondents using it. However, the adoption of renewable technologies like solar panels remains very low at 9%, highlighting a significant gap in the use of sustainable energy sources.
2. **Natural ventilation:** 37% of respondents employed natural ventilation in building design, but more advanced cooling technologies and passive design strategies were underutilized.
3. **Water management:** Rainwater harvesting systems were adopted by only 12% of respondents, and 61% relied on manual boreholes for their water needs, indicating a strong potential for promoting rainwater harvesting and efficient plumbing solutions in the region.
4. **Waste management:** 84% of respondents practiced open waste burning, with only 6% implementing waste separation practices, pointing to a critical need for improved waste management systems and public education.
5. **Indoor air quality:** The indoor air quality was rated as "fair" by 50% of respondents, primarily due to inadequate ventilation and poor material choices. This highlights the need for improved building designs to enhance air quality and occupant health.

In conclusion, addressing these gaps through enhanced public education, policy support, and incentives for adopting green technologies will be crucial for promoting sustainable building practices in the region. There is a strong need to integrate local materials and traditional building techniques that can improve energy efficiency and occupant well-being. Additionally, the introduction of training programs and certifications for green building practices can further drive adoption.

Author contributions: MOO: conception, data collection and/or processing, analysis and/or interpretation, writing, funding, & critical review; **CM & BEI:** design, literature review, data collection and/or processing, funding, & critical review; & **EA:** supervision, analysis and/or interpretation, funding, & critical review. All authors agree with the results and conclusions.

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context and challenges related to sustainable construction methods.

Ethical statement: The authors stated that the study posed no risk to the participants or their surroundings. The authors took steps to maintain highest ethical standards by ensuring participant anonymity and committing to honest and transparent reporting of all findings. Participants provided information voluntarily, and no sensitive or personally identifiable data were recorded. The findings have been reported with full transparency and integrity, adhering to ethical research standards.

Declaration of interest: No conflict of interest is declared by the authors.

Data sharing statement: Data supporting the findings and conclusions are available upon request from corresponding author.

REFERENCES

Abid, M. A., & Jassim, N. A. (2015). Experimental evaluation of thermal performance of solar assisted air conditioning system under Iraq climate. *Journal of Energy Technologies and Policy, 5*(12), 1-13. https://doi.org/10.31026/j.eng.2015.11.09

Abubakar, I., Maniruzzaman, K., Dano, U., Alshihri, F. S., Alshammari, M. S., Ahmed, S. M. S., Al-Gehlani, W. A. G., & Alrawaf, T. I. (2022). Environmental sustainability impacts of solid waste management practices in the Global South. *International Journal of Environmental Research and Public Health, 19*(19), Article 12717. https://doi.org/10.3390/ijerph191912717

Ali, M. A. E. K. (2021). The role of green buildings in rationalizing energy consumption. *International Journal of Advances Engineering and Civil Research, 1*(1), 21-37. https://doi.org/10.21608/ijaecr.2023.214442.1011

An, K. J., Lam, Y. F., Hao, S., Morakinyo, T. E., & Furumai, H. (2015). Multi-purpose rainwater harvesting for water resource recovery and the cooling effect. *Water Research, 86*, 116-121. https://doi.org/10.1016/j.watres.2015.07.040

Asman, G. E., Kissi, E., Agyekum, K., Baiden, B. K., & Badu, E. (2019). Critical components of environmentally sustainable buildings design practices of office buildings in Ghana. *Journal of Building Engineering, 26*, Article 100925. https://doi.org/10.1016/j.jobe.2019.100925

Awino, F. B., & Apitz, S. E. (2024). Solid waste management in the context of the waste hierarchy and circular economy frameworks: An international critical review. *Integrated Environmental Assessment and Management, 20*(1), 9-35. https://doi.org/10.1002/ieam.4774

Balaban, O., & de Oliveira, J. A. P. (2017). Sustainable buildings for healthier cities: Assessing the co-benefits of green buildings in Japan. *Journal of Cleaner Production, 163*(Supplement 1), S68-S78. https://doi.org/10.1016/j.jclepro.2016.01.086

Callejas, I. J. A., Durante, L. C., Guarda, E. L. A. D., & Apolonio, R. M. (2020). Thermal performance of partially bermed earth-sheltered house: Measure for adapting to climate change in a tropical climate region. *Proceedings, 58*(1), Article 32. https://doi.org/10.3390/WEF-06919

Durdyev, S., Koc, K., Karaca, F., & Gurgun, A. P. (2023). Strategies for implementation of green roofs in developing countries. *Engineering, Construction and Architectural Management, 30*(6), 2481-2502. https://doi.org/10.1108/ECAM-12-2021-1147

Durdyev, S., Zavadskas, E. K., Thurnell, D., Banaitis, A., & Ihtiyar, A. (2018). Sustainable construction industry in Cambodia: Awareness, drivers and barriers. *Sustainability, 10*(2), Article 392. https://doi.org/10.3390/su10020392

Eleftheriadis, G., & Hamdy, M. (2018). The impact of insulation and HVAC degradation on overall building energy performance: A case study. *Buildings, 8*(2), Article 23. https://doi.org/10.3390/BUILDINGS8020023

Grzegorzewska, M., & Kirschke, P. (2021). The impact of certification systems for architectural solutions in green office buildings in the perspective of occupant well-being. *Buildings, 11*(12), Article 659. https://doi.org/10.3390/buildings11120659

Hormigos-Jimenez, S., Padilla-Marcos, M. Á., Meiss, A., Gonzalez-Lezcano, R. A., & Feijó-Muñoz, J. (2017). Ventilation rate determination method for residential buildings according to TVOC emissions from building materials. *Building and Environment, 123*, 555-563. https://doi.org/10.1016/j.buildenv.2017.07.032

Hsueh, S.-L., Feng, Y., Sun, Y., Jia, R., & Yan, M.-R. (2021). Using AI-MCDM Model to boost sustainable energy system development: A case study on solar energy and rainwater collection in Guangdong Province. *Sustainability, 13*(22), Article 22. https://doi.org/10.3390/su132212505

Jegede, O. E., & Taki, A. (2022). Optimization of building envelopes using indigenous materials to achieve thermal comfort and affordable housing in Abuja, Nigeria. *International Journal of Building Pathology and Adaptation, 40*(2), 219-247. https://doi.org/10.1108/IJBPA-01-2021-0009

Karakurt, A. S., Özsari, İ., Başhan, V., & Güneş, Ü. (2022). Evolution of steam turbines: A bibliometric approach. *Journal of Thermal Engineering, 8*(5), 681-690. https://doi.org/10.18186/thermal.1187839

Khaemba, P., & Mutsune, T. (2014). Potential for green building adoption: Evidence from Kenya. *Global Journal of Business Research, 8*(3), 69-76.

Khan, M. A., Wang, C. C., & Lee, C. L. (2021). A Framework for developing green building rating tools based on Pakistan's local context. *Buildings, 11*(5), Article 202. https://doi.org/10.3390/buildings11050202

Kioumarsi, H., Ali Doust, M., & Allen, S. C. (2022). *Sustainable development*. Avaye Ostad.

MacNaughton, P., Cao, X., Buonocore, J., Cedeno-Laurent, J., Spengler, J., Bernstein, A., & Allen, J. (2018). Energy savings, emission reductions, and health co-benefits of the green building movement. *Journal of Exposure Science & Environmental Epidemiology, 28*(4), 307-318. https://doi.org/10.1038/s41370-017-0014-9

Marcos, K. J., Moersidik, S. S., & Soesilo, T. E. B. (2021). Extended theory of planned behavior on utilizing domestic rainwater harvesting in Bekasi, West Java, Indonesia. *IOP Conference Series: Earth and Environmental Science, 716*, Article 012054. https://doi.org/10.1088/1755-1315/716/1/012054

Ozsari, I. (2023). Historical research trends and overview about exergy: A comprehensive analysis. *International Journal of Exergy, 40*(1), 59-73. https://doi.org/10.1504/IJEX.2023.10053573

Pratama, H. C., Sinsiri, T., & Chapirom, A. (2023). Green roof development in ASEAN Countries: The challenges and perspectives. *Sustainability, 15*(9), Article 7714. https://doi.org/10.3390/su15097714

Pyke, C., Warren, M. P., Johnson, T., LaGro, J., Scharfenberg, J., Groth, P., Freed, R., Schroeer, W., & Main, E. (2011). Assessment of low impact development for managing stormwater with changing precipitation due to climate change. *Landscape and Urban Planning, 103*(2), 166-173. https://doi.org/10.1016/j.landurbplan.2011.07.006

Suzuki, N., Nakaoka, H., Hanazato, M., Nakayama, Y., Tsumura, K., Takaya, K., Todaka, E., & Mori, C. (2019). Indoor air quality analysis of newly built houses. *International Journal of Environmental Research and Public Health, 16*(21), Article 4142. https://doi.org/10.3390/ijerph16214142

Wagner, K. (2014). Generation of a tropically adapted energy performance certificate for residential buildings. *Sustainability, 6*(12), 8415-8431. https://doi.org/10.3390/su6128415

Zhang, D., Ding, X., Liu, J., & Mei, C. (2022). Review on mechanism and technical measures of urban rainwater harvesting. *IOP Conference Series: Earth and Environmental Science, 983*, Article 012106. https://doi.org/10.1088/1755-1315/983/1/012106