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Theoretical and Practical Implications of Sustainable Modern Approach to Hospital Design: Focus on Nigeria

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Abstract

The adoption of sustainable hospital design remains largely embryonic in the developing nations, including Nigeria. Public hospitals continue to reflect outdated design paradigms that ignore environmental and human-centred considerations, leading to inefficient energy use, poor ventilation, and compromised patient privacy. This issue is compounded by rapid urbanisation, increasing patient loads, and infrastructural decay, which collectively strain healthcare delivery. While global discourse advocates for climate-resilient and adaptable hospital environments, the Nigerian reality still contends with the dual pressures of limited funding and inadequate design regulation. The problem, therefore, lies in the insufficient integration of sustainability principles into hospital design practice, despite mounting evidence of their theoretical and practical benefits. Addressing this gap is critical not only for improving operational efficiency but also for enhancing patient outcomes and environmental responsibility. Investigating the theoretical and practical implications of sustainable modern approaches to hospital design thus becomes imperative. A structured literature review was adopted as the methodological approach for this study. It allows for a systematic, transparent, and replicable process for identifying, evaluating, and synthesising existing research evidence on sustainable hospital design and operations. Relevant studies were assessed based on their quality and insights drawn to reveal emerging patterns, research gaps, and directions for application in the design of a model sustainable hospital design. It detailed theoretical and practical considerations to inform real-world architectural practice, balancing ecological, economic, and human health objectives within the evolving healthcare landscape.

Keywords: Biophilic design, energy efficiency, healthcare infrastructure, hospitals, sustainable design.

Introduction

Sustainable design has emerged as a central theme in contemporary architectural discourse, particularly within healthcare infrastructure, where environmental stewardship intersects with patient well-being. According to Dolcini et al. (2025), hospital environments profoundly influence recovery rates, staff performance, and operational efficiency, showing the necessity of integrating sustainability principles into modern healthcare facilities. The global trend towards sustainable architecture has been reinforced by the pressing need to mitigate the environmental footprint of healthcare, as hospitals account for substantial energy consumption and waste generation (Singh, Verma and Kumar, 2025). Scholars such as Phuria (2024) argue that sustainable hospital design offers not only environmental but also long-term economic benefits through reduced operational costs and improved patient recovery times. This paradigm reflects a shift from traditional, resource-intensive models towards a holistic approach where sustainability, technology, and human-centred design converge.

Building on this global understanding, Wang and Wang (2017) have noted that the drive toward sustainability in hospital design transcends environmental concerns; it embodies a holistic framework that aligns architecture with human psychology, social well-being, and operational continuity. Within developed economies, particularly in Europe and North America, the adoption of sustainable hospital design principles has become mainstream. Studies reveal that healthcare institutions now integrate renewable energy systems, passive ventilation, and biophilic design features to foster healing environments (Turki et al., 2023; Bayır, 2024). However, the practical translation of these concepts in developing contexts remains inconsistent. The adaptation gap arises from financial limitations, insufficient regulatory frameworks, and limited awareness of sustainability benefits (Sholanke, Senkoro and Olukanni, 2024). These disparities show the theoretical debate on how modern sustainable design principles, often developed in Western contexts, can be effectively contextualised in low- and middle-income countries where infrastructural challenges differ significantly. In the context of developing nations, including Nigeria, the adoption of sustainable hospital design remains largely embryonic. Gurieff et al. (2020) argue that many public hospitals continue to reflect outdated design paradigms that ignore environmental and human-centred considerations, leading to inefficient energy use, poor ventilation, and compromised patient privacy. This issue is compounded by rapid urbanisation, increasing patient loads, and infrastructural decay, which collectively strain healthcare

delivery. While global discourse advocates for climate-resilient and adaptable hospital environments, the Nigerian reality still contends with the dual pressures of limited funding and inadequate design regulation (Umana et al., 2024).

The problem, therefore, lies in the insufficient integration of sustainability principles into hospital design practice, despite mounting evidence of their theoretical and practical benefits. Addressing this gap is critical not only for improving operational efficiency but also for enhancing patient outcomes and environmental responsibility. Investigating the theoretical and practical implications of sustainable modern approaches to hospital design thus becomes imperative. It enables a detailed understanding of how sustainability transcends theoretical rhetoric to inform real-world architectural practice, balancing ecological, economic, and human health objectives within the evolving healthcare landscape.

METHODOLOGY

Research Approach

A structured literature review was adopted as the methodological approach for this study. This approach provides a systematic, transparent, and replicable process for identifying, evaluating, and synthesising existing research evidence on a specific topic (Garcia and Corcoran, 2024). It allows the researcher to gather relevant studies, assess their quality, and draw insights that reveal emerging patterns, research gaps, and directions for future investigation (Elda, 2024).



Figure 1: Literature Search Strategy. Source: MakroCare, 2025.

According to Lawless and Foster (2020), a structured review also promotes a comprehensive understanding of the research topic by using an organised search strategy across reputable databases and scholarly sources. By synthesising the findings of previous studies, the review established a foundation for evidence-based recommendations to guide hospital designers, policymakers, and health system managers toward sustainable infrastructure development.

The quality and completeness of a literature review depend largely on the selection of reliable and diverse information sources (Ebidor and Ikhide, 2024). To achieve this, several academic databases and online libraries were systematically searched, including Scopus, PubMed, ScienceDirect, Architectural & Built-Environment Databases, and Web of Science. Each database was chosen for its specific contribution to the research scope. To ensure a broad and accurate search, Boolean operators (AND, OR, NOT) were employed to combine key search terms. The main search phrases included: "sustainable hospital design," "green building materials," "energy-efficient hospitals," "biophilic design," "hospital operational efficiency," and "environmental impact in healthcare architecture." These terms were refined iteratively to include relevant synonyms and ensure that the search captured both theoretical and practical studies (See figures 2 and 3 below showing the PRISMA Style flow diagram for systematic reviews which included searches of databases and registers adopted for this study).

Inclusion and Exclusion Criteria

Defining inclusion and exclusion criteria ensured that only studies directly relevant to the objectives of the review were analysed. This step maintained focus and improved the validity of the synthesis.



Figure 2: Selection criteria in the literature search. Source: McCartan, (2025).

Inclusion Criteria

Studies published between 2016 and 2025 were considered, ensuring that only recent and relevant evidence was considered. Peer-reviewed journal articles, conference papers, and official reports focusing on sustainable hospital design and its theoretical or practical implications. Studies examining sustainability interventions such as energy efficiency, biophilic design, green building materials, and environmental performance in healthcare settings. Research written in English to maintain consistency in interpretation and analysis. Studies employing quantitative, qualitative, or mixed methods that provide empirical or conceptual insights into sustainable hospital design.

Exclusion Criteria

Articles not focused on hospital design or those discussing sustainability in unrelated contexts. Non-peer-reviewed materials such as blogs, news articles, or opinion essays. Studies published

before 2016 or after 2025, to maintain contemporary relevance. Non-English publications that could introduce interpretation bias through translation. Studies with poor methodological quality or insufficient data to support analytical synthesis.

Data Collection and Screening Process

A comprehensive search yielded records from the selected databases. After removing duplicates, titles and abstracts were screened based on their relevance to the topic. From these, studies were excluded for not aligning with the research objectives. The remaining full-text articles were assessed for eligibility based on the inclusion and exclusion criteria. Following a detailed evaluation, studies met the final inclusion standards and were included in the review. The selected studies represented a wide range of research designs. Geographically, the studies covered both developed and developing nations, with significant contributions from different countries reflecting diverse architectural, climatic, and healthcare contexts. All retrieved references were managed using Mendeley Reference Manager, which facilitated organisation, deduplication, and referencing. Manual verification was performed to ensure that duplicates were accurately removed and that all included studies matched the review objectives.

Data Extraction and Synthesis

Data extraction was performed systematically using a predesigned Microsoft Excel template. The extracted variables included. Reported outcomes such as energy savings, patient satisfaction, staff wellbeing, and environmental benefits. The data were categorised into major themes, including theoretical frameworks of sustainability, practical implementation challenges, operational efficiency, environmental benefits, and psychological impacts on hospital users. The thematic analysis approach enabled the identification of recurring patterns and contrasting findings across studies. Comparative synthesis was used to highlight the extent of alignment between theoretical perspectives and practical outcomes in hospital design.

Quality Assessment

To ensure methodological integrity, the included studies were critically appraised using the Joanna Briggs Institute (JBI) Critical Appraisal Tools. These tools facilitated systematic evaluation of study quality, focusing on research design, data collection techniques, analytical rigour, and the clarity of findings (Barker et al., 2024). Each study was assessed for its relevance, credibility, and reliability, with priority given to those demonstrating strong methodological coherence. This critical appraisal process ensured that only robust, high-quality evidence informed the synthesis. By maintaining methodological rigour, the review provided credible insights into both the theoretical underpinnings and practical applications of sustainable modern hospital design. The findings are thus grounded in reliable evidence, forming a solid basis for recommendations that can inform policy, architectural practice, and future research in sustainable healthcare infrastructure.

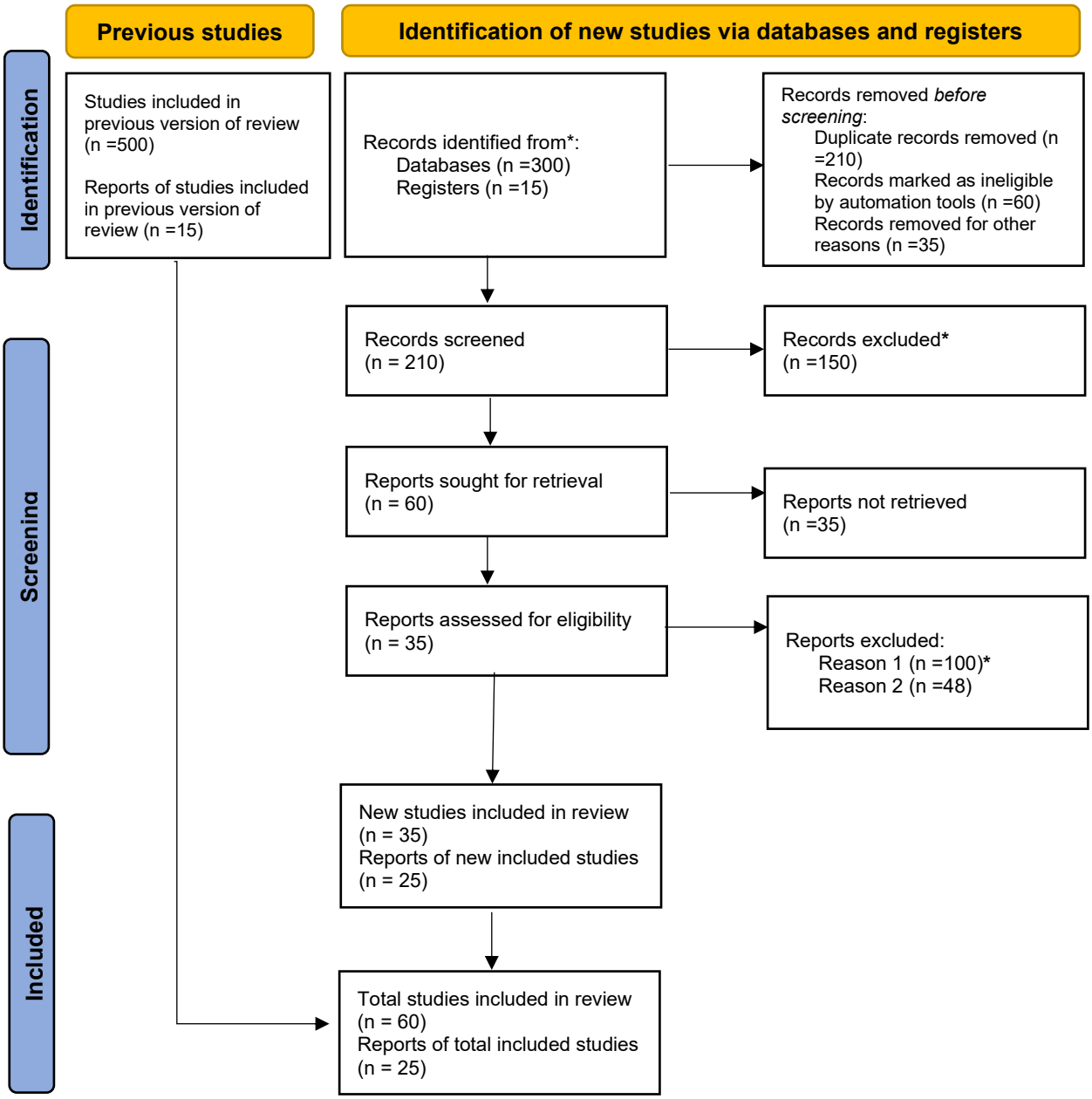


Figure 3: PRISMA Style flow diagram for updated systematic reviews which included searches of databases and registers. Source: Adapted from Page, et al. 2021.

Reasons for exclusion: Reason1: Focus on general sustainable construction without specific hospital application. Reason 2: Lack of empirical data or theoretical depth regarding the Nigerian context.

Theoretical Foundations of Sustainable Hospital Design

Liu and Yeo (2025) highlight that sustainable hospital design is framed increasingly as the integration of environmental, social and economic goals with established healthcare design theories such as evidence-based design (EBD), healing environments and environmental psychology. This review identifies a salient shift: hospitals are no longer simply seen as buildings that mitigate ecological impact, but as complex socio-clinical systems whose physical form influences patient recovery, staff wellbeing and operational resilience (Patil, 2025; Odeyale, 2015; 2023). A key critique here is that many studies still treat sustainability and human health outcomes as parallel domains rather than interwoven; therefore, this study calls for systems view in which design choices link ecological performance to clinical and organisational outcomes.

DISCUSSIUON OF FINDINGS

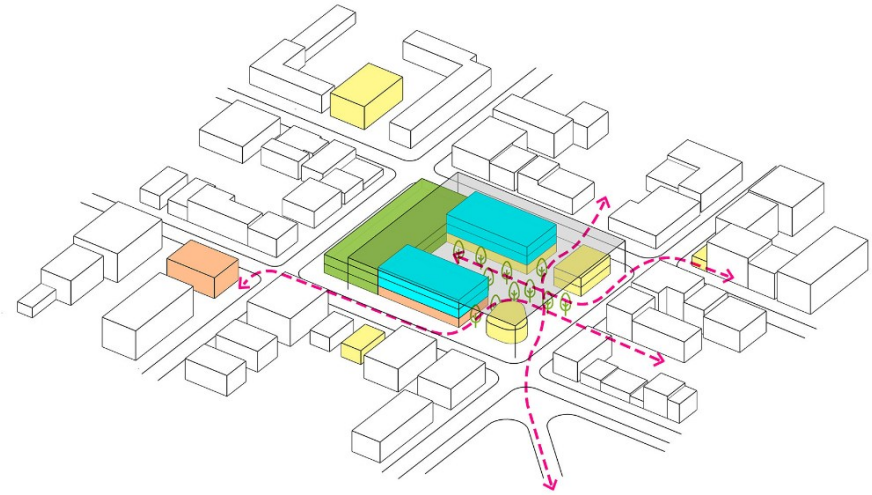


Figure 4: Environmental and human-centred considerations in a technology-driven and integrated hospital. Source: Slater, Guillot and Diamond, (2024).

Similarly, Bulakh *et al.* (2021) argue that hospital architecture must "care for both patients and the planet". The absence of a universally accepted framework for "sustainable hospital" is repeatedly noted, meaning that many individual studies remain context-bound or descriptive rather than generalisable (Ullah *et al*., 2020; Alsawaf and Albadry, 2022).

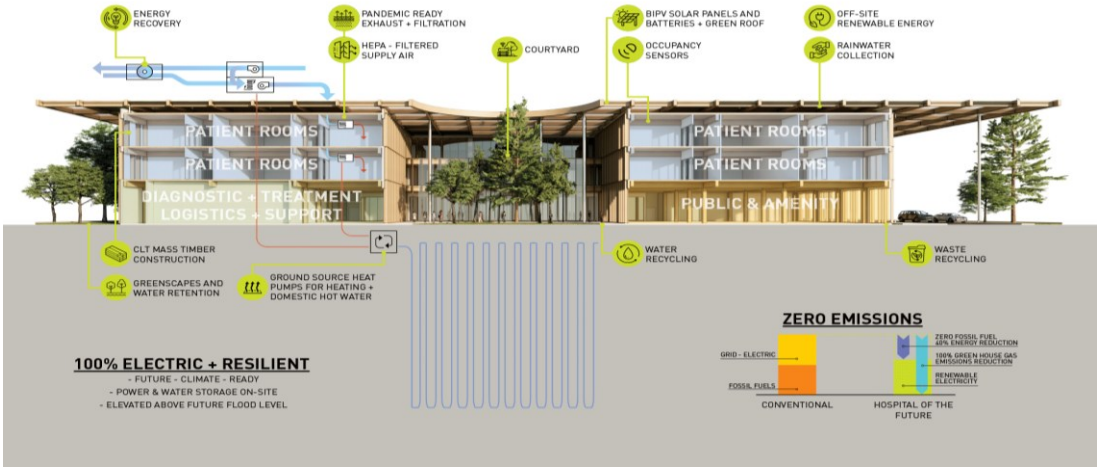


Figure 5: Energy-efficient and biophilic design for hospitals. Source: Horizon Hospital Design, Slater, Guillot and Diamond, (2024).

For example, while EBD often focuses on stress reduction or patient satisfaction, fewer studies integrate long-term sustainability metrics (Read & Meath, 2024). This theoretical gap presents a vulnerability in the literature without consistent conceptualisation, practical prescriptions risk being fragmented and hard to benchmark.

Sustainable Design Principles and Practical Measures

Awarding primacy to design strategies, some authors focus on naturally ventilated hospital wards in tropical climates, indicating that thermal comfort and energy performance are critical but often insufficiently studied in those settings (Al-Absi et al., 2022; Uzuegbunam et al., 2023; Chaloeytoy et al., 2024). Their studies draw attention to hybrid systems as promising but under-tested solutions. Such work emphasises the mismatch between ideal sustainable measures and contextual realities that include tropical climate, infrastructure limitations (see figure 4).

Furthermore, Kumari and Kumar (2020) argue that sustainable hospitals should reduce resource consumption and enhance occupant wellbeing while adapting to the built environment's constraints. They demonstrate this via case studies from Abuja showing how particulate matter and ventilation issues compromise both sustainability and patient health outcomes (Agmada and Ismaila, 2025).

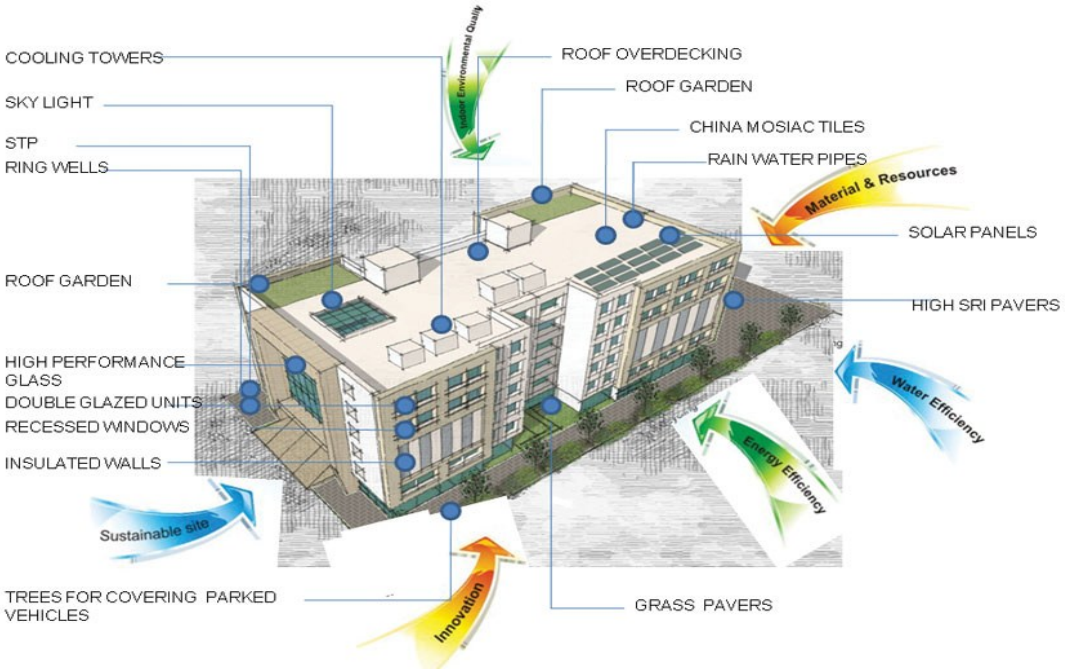


Figure 6: A technology. Source: Brambilla and Capolongo (2019).

Across the literature, a coherent set of design principles emerges: energy-efficient HVAC systems; high-performance building envelopes; renewable energy integration; optimised daylighting and ventilation; water conservation; and use of low-impact, durable materials. Yet the critique is that many such strategies are described descriptively, with limited empirical data detailing how they perform in hospital-specific contexts (e.g., infection control, 24/7 operations). In addition, context matters; the effectiveness of passive measures in a temperate zone differs significantly from humid tropical climates, which calls into question the transferability of some "best practice" guidelines (Chung-Camargo et al., 2023).

Patient-Centred and Healing Design Features

In recent years, the literature reveals a growing convergence of patient-centred design and sustainability objectives. For instance, Magyar (2020) identifies overlap between EBD and sustainability in the domains of indoor environmental quality and wellbeing, and energy/atmosphere. Another study indicates that biophilic elements (views to nature, gardens, indoor planting) and spatial layouts prioritising privacy, noise control and comfort are flagged as delivering therapeutic benefits, which in turn bolster the argument for sustainable design not only for environmental reasons but for human health outcomes (Maghlakelidze et al., 2024).

Nevertheless, there is critical commentary; many hospital design studies emphasise daylight and access to nature without sufficiently interrogating how these features interact with sustainability constraints e.g., increased glazing may raise thermal loads in hot climates (Besbas et al., 2022). In tropical wards, Uzuegbunam et al. (2023) report that naturally

ventilated spaces intended to save energy may compromise thermal comfort and infection control, thereby undermining patient well-being. This suggests a trade-off rather than a simple win-win; sustainability measures must be carefully balanced with clinical and user requirements (see figures 5, 6 and 7).



Figure 7: A technology-driven and integrated hospital design. Source: Hospital Design Hub, Hussein, (2022).

Technological Integration and "Smart" Hospital Solutions

The literature on digital and smart technologies in hospital design (e.g., Building Information Modelling (BIM) + Lean, smart sensors/controls) has grown rapidly. Koskela et al. (2023) provide a systematic overview of how the combination of Building Information Modelling (BIM) and Lean principles enhances hospital planning, design and resource efficiency. They argue that by integrating BIM's spatial visualisation and Lean's waste-reduction processes, hospitals can better deliver sustainability outcomes.

Likewise, Shahsavar (2025) proposes an integrated paradigm synthesising sustainable design principles, smart building systems and certification frameworks (e.g., LEED). The argument is compelling as smart systems that monitor occupancy, indoor air quality, energy use, and dynamically adjust ventilation, lighting and HVAC can deliver both sustainable performance and improve user experience (Bawa et al., 2024; Chauhan, 2025). Many studies remain theoretical, rely on case studies in high-income contexts, and overlook long-term maintenance, user training and system interoperability. As studies note that technology alone does not guarantee sustainability, successful deployment requires staff capacity, maintenance planning and alignment with clinical workflows (Jaana et al., 2024; Mahendrakar, 2025). Thus, smart solutions are promising but conditional; implementing them in resource-constrained settings remains a challenge.

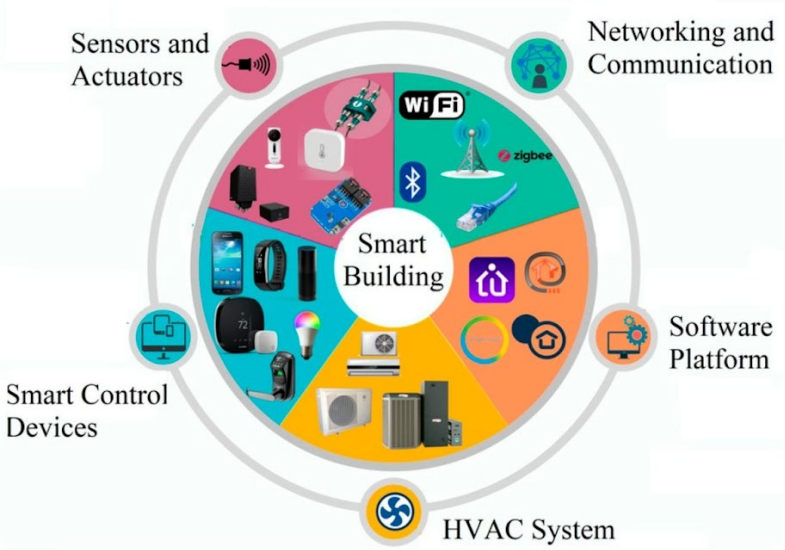


Figure 8: Components of smart and sustainable hospital design. Source: Anitabims, 2024.

THEORETICAL AND PRACTICAL IMPLICATIONS

This study asserts that theoretical frameworks such as Evidence-Based Design (EBD) and environmental psychology provide a sound basis for designing hospitals that are both sustainable and patient-centred. However, the critique is that many studies remain descriptive and fail to quantify outcomes (e.g., length of stay, staff retention, energy savings) in diverse settings. This undermines the evidence base and leaves practitioners with guidelines rather than strong, context-validated evidence.

Layered intervention approaches, i.e., combining passive design, efficient systems, renewable energy and smart controls, are consistently recommended. Studies show these produce better outcomes than single interventions (Rao and Periyasamy, 2025; Shi, 2025). Nonetheless, the challenge is implementation: how to finance, maintain and adapt these systems over their lifecycle, particularly in low-resource settings. Context adaptation emerges as non-negotiable. What works in temperate climates cannot simply be transferred to tropical contexts without modification, yet many design guidance documents gloss over this nuance. For example, glazing may optimise daylight in Scandinavia but exacerbate heat gain in Nigeria; natural ventilation may save energy but compromise infection control or thermal comfort in tropical regions (see figures 8 and 9). Hence, one implication is that hospital design must be locally grounded, climate-responsive and resource-aware.

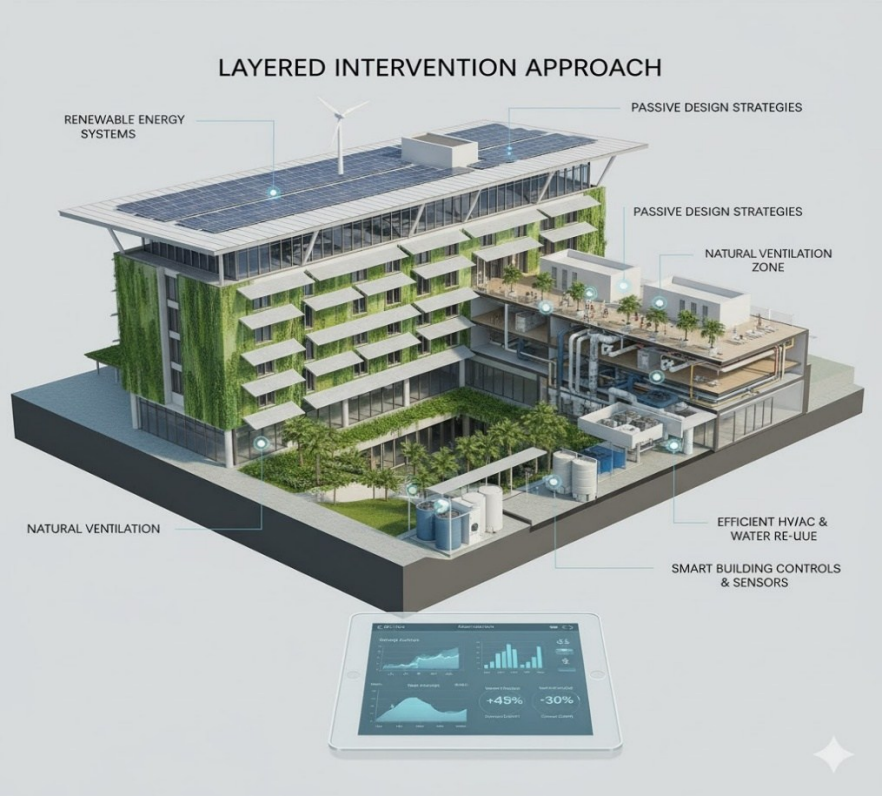


Figure 9: Proposed Sustainable Hospital design by the authors. Source: Author's Fieldwork, 2025

Institutional capacity, governance and policy frameworks matter at least as much as design. Without procurement aligned to sustainability, maintenance regimes and trained personnel, design innovations may fail to deliver their promised benefits. This is a common fault line in the literature: impressive designs on paper falter in operations due to governance or financial collapse. Finally, the research-practice gap remains significant. Studies repeatedly note the need for longitudinal studies, economic evaluations, and work on social sustainability indicators. For the practical goal of sustainable hospital design, this means that architects, facility managers and policy-makers must not only adopt design recommendations but also evaluate outcomes and feed back into standard-setting and guideline development.

Differences in Sustainability Practices between High-Income and Low-Income Countries—Adaptive Lessons

Sustainable hospital design in 2025 emphasizes that while high-income countries (HICs) focus on advanced technological integration, low-income countries (LICs) like Nigeria are increasingly leveraging vernacular wisdom and biophilic design to achieve similar health outcomes with lower resource intensity.

Comparative Global Perspectives (2025)

Feature	High-Income Countries (HICs)	Low-Income Countries (LICs)
Primary Driver	Net-zero targets and operational carbon reduction.	Resilience to infrastructure gaps (e.g., power/water).
Energy Strategy	Smart building management systems (BMS) and mechanical heat recovery (MVHR).	Passive cooling, natural ventilation, and solar-ready decentralized systems.
Material Use	High-performance synthetic composites and recycled industrial glass.	Low-carbon vernacular materials and "revived low-tech" local techniques.
Technology	Digital twins and AI-driven real-time energy optimization.	Mobile-first digital tools for operational efficiency and equipment tracking.

Source: UN Global Status Report for Buildings and Construction 2024/2025

Adaptive Lessons for Nigeria

- **Healing Architecture and Biophilia**: Global evidence confirms that integrating nature reduces patient recovery times and energy costs. In Nigeria, this can be achieved affordably by incorporating indoor-outdoor flow and community-centered green spaces.
- **Prioritize "Fabric-First" and Passive Energy Design**: Instead of relying on expensive mechanical cooling, Nigerian hospitals should adapt HIC building standards by focusing on high-thermal-mass materials and passive air movement. In Lagos, studies show natural ventilation and light are already highly rated by patients for their therapeutic effects.
- **Decoupling from Centralized Grids**: Global trends is the transition to on-site renewable energy. For Nigeria, this means designing hospitals to be "solar-native" from the start to avoid the high costs of retrofitting later.
- **Adopt "Inclusive Procurement":** LICs often face an "equipment graveyard" due to unsustainable procurement. Adaptive lessons from HICs suggest shifting from "buying equipment" to "buying a service/lifespan," ensuring international donor projects include 2025-standard maintenance and training.
- **Adopting Successsful Policy and Training**: International success shows that sustainability is only "assimilated" when backed by mandatory regulatory frameworks. Nigeria can adapt by implementing the mandatory GHG inventory plans currently becoming standard in other developing nations by 2025.

CONCLUSIONS

The review of literature on the theoretical and practical implications of sustainable modern approaches to hospital design reveals that sustainability in healthcare architecture is not merely an environmental concern but a multidimensional framework encompassing human health, operational efficiency, and patient-centred outcomes. Findings indicate that sustainable

hospital design enhances patient recovery rates, reduces operational costs, and improves staff performance through biophilic principles, daylight optimisation, and energy-efficient systems. The integration of green building materials and renewable energy technologies also contributes to long-term cost-effectiveness and environmental stewardship. However, critical gaps persist in balancing technological innovation with the emotional and psychological needs of patients, especially in contexts where cultural and social expectations influence design outcomes. Moreover, the evidence suggests that while high-income countries have effectively embedded sustainability into hospital infrastructure, developing nations often face barriers related to funding, policy implementation, and technical expertise. Therefore, it is recommended that future hospital projects adopt a holistic sustainability model that merges environmental performance with human-centred design principles. Collaboration between architects, healthcare professionals, and policymakers is essential to ensure that design frameworks are adaptable, culturally relevant, and responsive to emerging health crises. Additionally, local capacity building and policy incentives should be prioritised to promote sustainable hospital design practices in resource-limited settings. Ultimately, sustainability should be viewed as a continuous process that evolves with advancements in technology and medical care, ensuring that hospital environments remain safe, efficient, and supportive of patient well-being across diverse contexts.

REFERENCES

Agmada, J. and Ismaila, A. (2025). An Assessment of the Impact of Poor Indoor Air Quality on Public Health in Nigerian Urban Environments; Case Study of FCT, Abuja. *International Journal of Latest Technology in Engineering Management & Applied Science*, 13(12), pp.49–56. doi: https://doi.org/10.51583/ijltemas.2024.131205.

Al-Absi, Z.A., Hafizal, M.I.M. and Ismail, M. (2022). Field Assessment of The Indoor Thermal Environment and Thermal Comfort Levels for Naturally Conditioned Residential Buildings in The Tropical Climate. *Journal of Advanced Research in Fluid Mechanics and Thermal Sciences*, 100(3), pp.51–66. doi: https://doi.org/10.37934/arfmts.100.3.5166.

Alsawaf, E.S. and Albadry, A.M. (2022). Principles for the Sustainable Design of Hospital Buildings. *International Journal of Sustainable Development and Planning*, 17(6), pp.1797–1808. doi: https://doi.org/10.18280/ijsdp.170614.

Anitabims (2024). *BIM for Smart Buildings: Connecting IoT, Sensors, and Smart Controls*. [online] aniatabims.com. Available at: https://anitabims.com/blogs/blog-details/bim-for-smart-buildings-connecting-iot-sensors-and-smart-controls [Accessed 3 Nov. 2025].

Barker, T.H., Hasanoff, S., Aromataris, E., Stone, J., Leonardi-Bee, J., Sears, K., Habibi, N., Klugar, M., Tufanaru, C., Moola, S., Liu, X.-L. and Munn, Z. (2024). The revised JBI critical appraisal tool for the assessment of risk of bias for cohort studies. *JBI Evidence Synthesis*, 22(3). doi: https://doi.org/10.11124/jbies-24-00103.

Bawa, J.A., Abdullahi, M.L. and Abdulrahman, N.J. (2024). Sustainable Architecture and the Impact of Smart Ventilation, Air Conditioning, and Heating (Vach) Systems. *Open Journal of Engineering Science (ISSN 2734-2115)*, [online] 5(2), pp.19–31. doi: https://doi.org/10.52417/ojes.v5i2.776.

Bayır, E. (2024). The Role of Environmentally Responsible Interior Design in Healthcare for Enhanced Patient Well-being. *Journal of Environmental and Natural Studies:* doi: https://doi.org/10.53472/jenas.1384245.

Besbas, S., Nocera, F., Zemmouri, N., Khadraoui, M.A. and Besbas, A. (2022). Parametric-Based Multi-Objective Optimization Workflow: Daylight and Energy Performance Study of Hospital Building in Algeria. *Sustainability*, 14(19), p.12652. doi: https://doi.org/10.3390/su141912652.

Brambilla A. and Capolongo S. (2019), Healthy and Sustainable Hospital Evaluation—A Review of POE Tools for Hospital Assessment in an Evidence-Based Design Framework. Buildings 9(4), 76; https://doi.org/10.3390/buildings9040076.

Bulakh, I., Didichenko, M., Kozakova, O., Chala, O. and Kovalska, G. (2021). Is the hospital-park the future of sustainable hospital architecture? *E3S Web of Conferences*, 280, p.04014. doi: https://doi.org/10.1051/e3sconf/202128004014.

Chaloeytoy, K., Dubsok, A. and Kittipongvises, S. (2024). Evaluating Thermal Comfort in Ward Areas of the Public Hospital in the Tropical Climates. *E3S Web of Conferences*, 530, pp.05009–05009. doi: https://doi.org/10.1051/e3sconf/202453005009.

Chauhan, M. (2025). IoT Integration in HVAC Systems: Achieving Sustainable Energy Efficiency and Enhanced Occupant Comfort. *Journal of Civil Engineering Research & Technology*, pp.1–12. doi: https://doi.org/10.47363/jcert/2025(7)183.

Chung-Camargo, K., González, J., Solano, T., Yuil, O., Velarde, V. and Austin, M.C. (2023). Energy-efficiency measures to achieve zero-energy buildings in tropical and humid climates. *IntechOpen eBooks*. Doi: https://doi.org/10.5772/intechopen.1002801.

Dolcini, M., Ferrè, F., Brambilla, A. and Capolongo, S. (2025). Integrating environmental sustainability into hospitals' performance management systems: a scoping review. *BMC Health Services Research*, 25(1). doi: https://doi.org/10.1186/s12913-025-12928-x.

Ebidor, L.-L. and Ikhide, I.G. (2024). Literature Review in Scientific Research: An Overview. *East African journal of education studies*, 7(2), pp.179–186. doi: https://doi.org/10.37284/eajes.7.2.1909.

Elda, D.T. (2024). Thirty Years of Sustainability Reporting: Insights, Gaps and an Agenda for Future Research Through a Systematic Literature Review. *Sustainability*, [online] 16(23), p.10750. doi: https://doi.org/10.3390/su162310750.

Garcia, A.R. and Corcoran, J. (2024). The Role of Systematic Reviews in the EBP Process. *Evidence-Based Practice Process in Social Work*, pp.61–78. doi: https://doi.org/10.1093/oso/9780197579848.003.0005.

Gooroochurn, M. and Giridharan, R. (2021). Enhancing Energy Performance and Comfort of Built Environment in Tropical Climates. pp.137–161. doi: https://doi.org/10.1007/978-3-030-65421-4_7.

Gurieff, N., Green, D., Koskinen, I., Lipson, M., Baldry, M., Maddocks, A., Menictas, C., Noack, J., Moghtaderi, B. and Doroodchi, E. (2020). Healthy Power: Reimagining Hospitals as Sustainable Energy Hubs. *Sustainability*, 12(20), p.8554. doi: https://doi.org/10.3390/su12208554.

Hospital Design Hub (2025). *Patient-Centred Hospital Design: Comfort Meets Functionality – ACCO Construction - Hospital Design Hub*. [online] Hospital Design Hub - Hospital Design and Construction. Available at: https://hospitaldesignhub.com/patient-centered-hospital-design-comfort-meets-functionality-acco-construction/ [Accessed 5 Oct. 2025].

Hussein, A. (2022). Taking Advantage of Single Patient Rooms as a Major Support for the Healing Environment System in Egyptian Hospitals. Journal of Engineering Research. 6. 1-5. 10.21608/erjeng.2022.265202.

Jaana, M., MacPhee, E., Sherrard, H. and Walker, M. (2024). Sustaining e-health innovations in a complex hospital environment: learning through evidence. *Frontiers in digital health*, 6. doi: https://doi.org/10.3389/fdgth.2024.1346085.

Kalu, G., Ogunnaike, A.O. and Eze, N. (2025). Integrating Biophilic and Passive Design Strategies in Nigerian Architecture. *Deleted Journal*, 19(1), pp.324–335. doi: https://doi.org/10.62154/ajesre.2025.019.01030.

Koskela, L., Talebi, S., Tezel, A. and Tzortzopoulos, P. (2023). Building Information Modelling and Lean Construction. pp.121–146. doi: https://doi.org/10.1002/9781394264933.ch6.

Kumari, S. and Kumar, R. (2020). Green hospital - A necessity and not an option. *Journal of Management Research and Analysis*, 7(2), pp.46–51. doi: https://doi.org/10.18231/j.jmra.2020.010.

Lawless, J. and Foster, M.J. (2020). Searching Systematically and Comprehensively. *A Step-by-Step Guide to Conducting an Integrative Review*, pp.21–44. doi: https://doi.org/10.1007/978-3-030-37504-1_3.

Liu, J. and Yeo, Y. (2025). Bibliometric Analysis of Hospital Design: Knowledge Mapping Evolution and Research Trends. *Buildings*, 15(17), p.3196. doi: https://doi.org/10.3390/buildings15173196.

Maghlakelidze, M., Mesa, A., Sawyer, A.O., Morad, M.G. and Ben-Alon, L. (2024). Biophilic design elements and natural materials in healthcare environments. *Journal of Green Building*, 19(3), pp.1–39. doi: https://doi.org/10.3992/jgb.19.3.3.

Magyar, Z. (2020). Integrated Sustainable Building Design. *Proceedings of the 50th International HVAC&R Congress and Exhibition*, pp.15–21. doi: https://doi.org/10.24094/kghk.019.50.1.15.

Mahendrakar, N. (2025). Adopting Technologies in Medical and Healthcare Systems. *International Journal for Research in Applied Science and Engineering Technology*, 13(7), pp.1997–2009. doi: https://doi.org/10.22214/ijraset.2025.73297.

Makro Care, (2025) Literature Search: A Medical Writer perspective. https://www.makrocare.com/blog/literature-search-a-medical-writer-perspective/ (Accessed: September 2025).

McCartan, K. (2025) Re-integrating people who have committed a sexual offence. https://www.uwe.ac.uk/research/breaking-research-boundaries/health-and-wellbeing/re-integrating-people. (Accessed: September 2025).

Odeyale, T.O. (2015) “Actor-Network Theory, Construction of Meanings and Some Aspects of Non-Ordered Space: Exploring the Boundaries of Responsive Built Environment”. In: Bioye, F. Aluko; Henry, A. Odeyinka; Oludolapo, O. Amole; Babatunde, A. Ademuleya and Oluwole, P. Daramola (Eds.) Responsive Built Environment, Proceedings of Environmental Design and Management International Conference (EDMIC 2015), Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria, 9-12 March 2015, Pp. 378-387, (ISBN 978-2051-31-6).

Odeyale, T.O. (2020). Actor-Network, Conflict and the Commodification of Planning: Role of Traditional Food Markets in Shaping the Built Environment. Elsevier Habitat International, vol 104 (2020):102255, pp.: 1-16. ISSN 0197-3975.

Page MJ *et al* (2021) The PRISMA 2020 statement: an updated guideline for reporting systematic reviews BMJ 2021; 372 doi: https://doi.org/10.1136/bmj.n71.

Patil, A.V. (2025). Architectural Innovations in Cancer Hospitals: Addressing Challenges and Enhancing Care in India. *International Journal of Scientific Research in Engineering and Management*, 09(08), pp.1–9. doi: https://doi.org/10.55041/ijsrem51756.

Phuria, S. (2024). The role of hospital design in improving patient recovery. *International Journal of Advanced Research*, 12(09), pp.670–675. doi: https://doi.org/10.21474/ijar01/19499.

Rao, C.V. and Periyasamy, V.M. (2025). Renewable-Powered HVAC and Smart Ventilation Systems for Sustainable Hospital Environments. pp.284–313. doi: https://doi.org/10.71443/9789349552920-10.

Shi, C. (2025). Proposed Program On Energy Savings and Reduce Consumption In China Medical University Stomatology Hospital, Shenyang, China. *Pacific International Journal*, 8(2), pp.207–213. doi: https://doi.org/10.55014/pij.v8i2.812.

Sholanke, A.B., Senkoro, E.A. and Olukanni, D.O. (2024). Challenges of implementing biophilic design principles in hospital infrastructure development: A review. *Development and Infrastructure in Developing Countries: A 10–Year Reflection*, pp.22–30. doi: https://doi.org/10.1201/9781003483519-3.

Slater, B. Guillot, R and Diamond, G. (2024) Prototyping the Hospital of the Future. GenslerBloghttps://www.gensler.com/blog/prototyping-the-hospital-of-the-future#en

Singh, P., Verma, M. and Kumar, R. (2025). The Urgency of Sustainability in Clinical Medicine. pp.1–12. doi: https://doi.org/10.58532/nbennurtgch1.

Turki, W., Bouaziz, A., Taieb, A.H. and Gargouri, C. (2023). Guidelines for Greening Healthcare Spaces. *Journal of Salutogenic Architecture*, [online] 2(1), pp.113–124. doi: https://doi.org/10.38027/jsalutogenic_vol2no1_8.

Ullah, Z., Thaheem, M.J., Waheed, A. and Maqsoom, A. (2020). How Sustainability in the Healthcare Sector Challenges Guidelines and Code Development: A Framework for Design of Sustainable Hospital Buildings. pp.213–225. doi: https://doi.org/10.1007/978-981-15-1910-9_18.

Umana, A.U., Garba, B.M.P., Ologun, A., Olu, J.S. and Umar, M.O. (2024). Architectural design for climate resilience: Adapting buildings to Nigeria’s diverse climatic zones. *World Journal of Advanced Research and Reviews*, [online] 23(3), pp.397–408. doi: https://doi.org/10.30574/wjarr.2024.23.3.2701.

UN Global Status Report for Buildings and Construction 2024/2025. https://globalabc.org/sites/default/files/2025-03/Global-Status-Report-2024_2025.pdf

Uzuegbunam, F.O., Aja, F.N. and Ibem, E.O. (2023). Influence of building attributes on thermal comfort in naturally ventilated hospital wards in the hot-humid tropics of southeast Nigeria. *International Journal of Building Pathology and Adaptation*. Doi: https://doi.org/10.1108/ijbpa-12-2022-0189.

Wang, N. and Wang, J. (2017). Exploration of Humanistic Design of Hospital Architecture Humanistic Design of Hospital. *Proceedings of 4th International Conference on Education, Language, Art and Intercultural Communication (ICELAIC 2017)*. doi: https://doi.org/10.2991/icelaic-17.2017.134.